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Environmental Implications Of Residential Development In Albuquerque

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ENVIRONMENTAL IMPLICATIONS OF RESIDENTIAL DEVELOPMENT IN ALBUQUERQUE, NEW MEXICO

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THE ENVIRONMENTAL IMPLICATIONS OF RESIDENTIAL DEVELOPMENT IN ALBUQUERQUE, NEW MEXICO

BY
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B.S., University of New Mexico, 1966

THESIS

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THE ENVIRONMENTAL IMPLICATIONS OF
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ABSTRACT OF THESIS

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ABSTRACT

The development of a great urban environment is an incremental process. The main hypothesis of this thesis is that development can have adverse environmental impacts but these effects can be avoided or minimized through thoughtful design.

In particular, the thesis addresses the environmental aspects of residential development in the Albuquerque area. The emphasis is on natural resources rather than socio-economic factors.

The thesis serves as an environmental guidebook for such development in the following respects:

- Since the National Environmental Policy Act was passed, a few guildelines have been developed on how to prepare an enviornmental impact statement. The first chapter presents a history of environmental impact legislation and reviews relevant state and local statutes. It also attempts to familiarize the reader with some of the concepts and terminology of environmental related regulations.
- None of the guidelines presently available provide some of the necessary data to write an environmental impact statement for developments in Albuquerque, New Mexico. The second chapter provides some of

the necessary data. The natural resources of the Albuquerque area are discussed, including the geology, hydrology, biology and air quality factors. Hopefully, it will make a contribution by distilling a vast array of information. It does not purport, however, to furnish all the necessary or available data; the specific site for a proposed project will determine whether or not further information is required.

- The third chapter discusses potential environmental problems related to residential construction in the Albuquerque area, and presents alternatives for mitigation of such problems.
- The fourth chapter discusses other aspects of residential development such as noise, aesthetics and climatic considerations, and the interrelationships of energy, resource and economic factors in general.
- Concepts and information are summarized in tabular form throughout the test, in the last section of each chapter for easy reference, and in the Compendium.
- Since any discussion of environmental effects involves many fields with their own terminology, a glossary is provided as a reference to any reader who may not be familiar with a term. Pertinent abbreviations such as EIS or EPA are also defined.

- o The bibliography gives numerous references for obtaining detailed data.

The thesis is not only intended for the use of developers in the Albuquerque area; it is also written for planners, designers, architects, government officials, and interested citizens, i.e., a diversified audience. Its purpose is to provide the general information necessary to consider the environmental implications of a residential development in the Albuquerque area.

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INTRODUCTION

Since the National Environmental Policy Act was passed in 1969, the use of environmental impact statements has become widespread. They are required by the Federal Government, many states and some local authorities. Both private and public projects may be required to prepare a statement. The environmental impact statement concept has very important implications for land use planning and regulation.

The effect of all this legislative activity and the environmental impact statement procedure is to increase the understanding of environmental effects of development. In addition to governmental and industrial actions, residential construction can have environmental effects.

The main proposition of this thesis is that residential development can have adverse environmental impacts, but these effects can be avoided or minimized through thoughtful design. The effects of a development activity depend on the area where the project is and on the actual design of the project. Since the National Environmental Policy Act was passed, a few guidelines have been developed on how to prepare an environmental impact statement. None of the guidelines presently available provide some of the necessary data to write an environmental impact statement in Albuquerque, New Mexico.

This thesis is intended to provide sufficient basic information on local factors that a residential developer could prepare an environmental impact statement if required. It is not intended to be a prototype statement but simply a handbook. Hopefully, it will make a contribution by distilling a vast array of information. It does not purport, however, to furnish all the necessary or available data. The specific site for a proposed project will determine whether or not further information is required.

The first chapter attempts to give a history of environmental impact statement legislation, and to familiarize the resder with some of the concepts and terminology. The second chapter discusses the natural resources of the Albuquerque area, including the geology, hydrology, biology and air quality factors. The third chapter outlines problem areas for these resources and attempts to suggest some solutions. The next chapter describes other aspects of residential development such as noise and energy conservation. The emphasis is on natural resources rather than socioeconomic factors.

Since any discussion of environmental effects involves many fields with their own terminology, a glossary is provided as a reference to any reader who may not be familiar with a term. Pertinent abbreviations such as EIS or EPA are also defined. The bibliography attempts to list some useful resource references as well as material directly cited in the thesis.

The development of a great urban environment is an incremental process. This thesis was written in hopes of encouraging environmentally sound development. The intended users of this information are planners, designers, developers, contractors, and perhaps governmental officials.

CHAPTER I

HISTORY OF ENVIRONMENTAL IMPACT LAWS

A. Overview

Environmental problems did not develop suddenly. Since the beginning of civilization, mankind has created waste and made himself sick living in his own filth. Because Minoans on the island of Crete during the Bronze Age had waste disposal problems, they developed a rather sophisticated sewer system. Ancient Romans suffered from lead poisoning due to their utensils and plumbing systems. Oceanic cultures in the Pacific had a problem from over-development and overcrowding, forcing a continual pattern of exploration and migration to new, unsettled islands. The Industrial Revolution had smoke, smog, congestion, over-crowding, and all the other urban problems. Although the United States started with a rather clean slate, the pressures have been building. After World War II, virtually everyone in government and private development was attempting to meet the greatest pent-up demand for living quarters in the history of the nation. The increasing urbanization filled up much of the open space near urban areas. The environmental effects of these developments has now become an issue. Public pressure has resulted in legislation on the national, state and local levels.

The following section, Section B, briefly discusses the National Environmental Policy Act (NEPA). Section C discusses state environmental policy acts, with New Mexico's Environmental Quality Act outlined in Section C.3. The last section of this chapter discusses municipal environmental statutes, with particular attention given to Albuquerque in Section D.2.

B. The National Environmental Policy Act

Zoning codes were started in 1969, long before the past World War II boom. Occasionally there were certain other restrictions, such as control over building in areas subject to flooding. However, there were no formal controls on the planning of any type of structure or project in terms of its potential effects on the general environment. Only recently has our total environment been a matter for governmental concern. The National Environmental Policy Act (NEPA) was passed in 1969. There had been other laws passed concerning specific aspects of environmental problems such as clean air and water. However, NPEA is the most well-known and may potentially have the most effect on the environmental impacts of residential construction.

Actually, NEPA says nothing about housing. What it does say is that it is necessary to preserve the natural environment and important cultural artifacts for succeeding generations. It requires that every proposal for federal funding must report on any unavoidable adverse environmental impacts, the alternatives to the proposed plan must be considered, and the long term effects compared to the short term gains. NEPA states three purposes:[1.1]

1. to encourage harmony between man and his environment
2. to promote the prevention and elimination of environmental degradation
3. to enrich our understanding of ecological systems and natural resources

There is some discussion over whether NEPA will actually be successful in these goals. However, the law certainly has already had an impact. In addition to generating public discussion and awareness of environmental issues, there has been much activity in the courts. It has provided a stimulus to multi-disciplinary research and also has encouraged similar legislation on state levels.

Much of the activity in the courts resulting from the passage of NEPA has been concentrated on definitions. The courts have limited NEPA to a "full-disclosure" law, ruling that the purpose of an environmental impact statement is simply to provide information.[1.2] However, the act is very significant because now the burden of proof is shifted to the government and industries, rather than on the plaintiffs. Who can be a plaintiff has now been narrowly defined by the courts, severely restricting the ability of conservation organizations to bring environmental class action suits.

The courts have also carefully defined when an environmental impact statement (EIS) is required. When it is possible that an EIS may be necessary, an assessment report is made. The criteria commonly considered are:[1.3]

1. public controversy
2. uniqueness of resources
3. national versus regional and local importance
4. accumulative effects of several small actions
5. degree of disturbance of the ecosystem

Although it can be easily concluded that problems related to the environment will become more severe in the years to come, the recent flurry of activity in the courts has already begun to die down.

As mentioned earlier, NEPA has provided a stimulus to multi-disciplinary research. A perfect impact statement would require knowledge that simply does not exist presently. Contributions from many disciplines to the critical appraisal of proposed actions are necessary. These specialists include archaeologists, architects, biologists, seismologists, and engineers. Other specialists analyze aerial photographs, the aesthetics, landscaping and topography. Computer analysis may become possible for many projects. New professions are beginning to develop in the areas of environmental administration. Academic research at universities is focusing more on environmental aspects of such fields as engineering, architecture, economics, business administration, sociology, agriculture and even environmental education.

C. State Environmental Policy Acts

More relevant to housing is the effect NEPA has had on encouraging similar legislation on state levels. Environmental controls are being exercised by a variety of boards and commissions in most states. At least twenty-nine states have enacted land use laws or are planning more limited controls on development.

1. States with Environmental Impact Statement Requirements. The oldest attempt was Hawaii's comprehensive zoning legislation enacted over a decade ago, in 1961. Superimposed over local zoning are four zoning districts--conservation, agricultural, rural, and urban. Development can be timed through the concept of urban reserve areas.[1.4] This approach relies on the traditional concept of land use and thus environmental control through zoning. It is often pointed out that this approach is not effective, primarily because the commission that administers the comprehensive zoning is politically appointed, and has consistently failed to represent the public's interests.[1.5] Hawaii's idea obviously was not the offspring of NEPA, but the state now has its own mini-NEPA requiring an EIS for all major projects done by state agencies or on state-owned lands. This was enacted in 1974.

Vermont's 1970 legislation was definitely the result of NEPA. It established an Environmental Protection Board that must approve of any development beyond a certain size. This includes any residential subdivision with lots smaller than ten acres. The developer must satisfy all the environmental requirements before a project can be started. Also, there is further regulation of certain critical areas--the lake--shores and mountains above 2,500 feet. Pressures from ski resorts and second home developments generated the public support necessary.[1.6]

More than a half dozen states on the east coast now have regulation of coastal zones, tidewaters and wetland areas. These include: Massachusetts, Connecticut, Maryland, New Jersey, Rhode Island, Delaware, and Georgia. Massachusetts also has "anti-snob" zoning which is state review power over some aspects of local planning. In 1972, Massachusetts passed comprehensive statutory requirements for Environmental Impact Reports (EIR). The following year, 1973, Connecticut and Maryland passed Environmental Policy Acts.

New Jersey has not passed a law based on NEPA, but instead requires EISs on the basis of an Executive Order of October 15, 1973. Rhode Island, Delaware and Georgia do not have any comprehensive statutory requirements but rely on their coastal zone and highway regulation. Similarly, New York State has control over the land use of some 3.7 million acres in the Adirondacks. Wisconsin regulates lake shoreline areas in addition to having the Environmental Policy Act of 1971. Minnesota began regulating flood plains, but passed an Environmental Policy Act in 1973, which combined elements of NEPA with the American Law Institute's Model Land Development Code. Often these measures are piecemeal, and motivated not simply for environmental protection but also to control development of a key resource--land. Although ecological factors are being considered, four of these states do not actually require an EIS.

Pressured by the effects of heavy land development activity, Florida enacted in 1972 the Land and Water Management Act which allows state officials to regulate or prevent development anywhere in the state. Projects that would have multi-jurisdictional impacts or spillovers, as well as developments that would have regional impacts, are regulated by the state. The Governor and cabinet are empowered to designate specific geographical areas as "areas of critical state concern." The statute was based substantially on the American Law Institute Model Land Code (see page 15 for further discussion). Any developer who is planning more than five hundred residential units in the project is required to prepare an environmental impact report.

Colorado is another state that has seen heavy pressures from ski resorts and second home developments. The state has development control in the absence of local controls.

The recent victory of environmentalist Richard Lamm for the Governorship indicates that further legislation may be eminent.

Arizona contracted with Batelle Columbus Laboratory in 1971 to develop ATOM (Arizona Trade-Off Model). ATOM attempts to balance consideration of environmental issues with income and employment problems. The system would establish quantifiable measurements for environmental impacts, economic and demographic growth, ecological, aesthetic and human interest features.[1.7] Arizona's requirements for EISs are limited.

In addition to the states discussion above, other states have passed state environmental policy acts modeled after the Federal Law. These include the 1971 Acts of Montana, Washington, Indiana, New Mexico and North Carolina, followed by Virginia in 1973 and South Dakota and Utah in 1974. Although not a state, Puerto Rico has one of the older EPAs enacted in 1970. In addition to New Jersey, two other states did not pass EPAs but rather issued executive orders. These are Michigan, whose original executive order of 1971 was revised in 1973, and Texas, whose environmental policy was adopted in 1972. Nevada and Nebraska have limited environmental impact statement requirements similar to those mentioned earlier for Arizona, Delaware, New Jersey and Georgia.

Although additional states may be expected to pass a state environmental policy act in 1975, the present situation is that there are fourteen states with comprehensive statutory requirements, three states with comprehensive executive orders, five states with limited requirements for environmental impact statements, and at least six states with other land use laws controlling development. Table 1 summarizes the interaction as of August 1, 1974.

2. California Environmental Quality Act. By far the most famous of the "little NEPAs" is the California Environmental Quality Act (CEQA) of 1970. Initially, the act was interpreted to be consistent with NEPA in that it only applied to public projects. However, on September 21, 1972 the California Supreme Court made the now famous ruling in Friends of Mammoth, et. al. vs. Board of Supervisors, Mono County, et. al. (No SAC 7924, 8c31, 1972). This decision said that the CEQA requirements for environmental impact reports included private activities for which a public permit, lease, or other entitlement is necessary. This landmark case represented the first time that the idea of "environmental impact" was applied to private developments. Environmental groups and many concerned citizens viewed this as a significant victory. Private developers considered it a serious threat to the housing and construction industries. They contended that shutting down construction projects was not going to save the environment and that the demand for development was governed by population growth rather than by developers' whims. The decision certainly did shut down construction

projects for a while. The Wall Street Journal estimated that some $800 million in private construction was halted.[1.9] Developers were contending that the ruling affected 95 percent of all projects[1.10] and the California building industry, the largest in the nation was in a state of near panic. September 21, 1972, became known as the day every hammer in California stopped pounding. Also panic stricken were the municipal governments who were responsible for seeing that environmental impact records were prepared for any proposed development in their jurisdiction. The cities of San Francisco and Santa Barbara, as well as Mammoth County, stopped issuing building permits for fear of violating the law as it was now interpreted. Los Angeles issued permits with a disclaimer agreement that the developer was proceeding at his own risk. City and county governments complained that they (a) did not know how to make environmental impact studies, (b) didn't have the necessary staff or funds, and (c) did not know how to define "significant" private construction.[1.11]

This gloom was actually the climax of a series of events affecting California developers. The first was naturally the passage of NEPA and CEQA. Also in 1970, the Porter-Cologne Water Quality Control Act was passed (California Water Code 13020). It required developers to notify regional water quality boards of tentative subdivision maps and building permit applications. These boards could deny sewer connections

TABLE 1

STATES WITH ENVIRONMENTAL IMPACT STATEMENT REQUIREMENTS

States that Passed Environmental Policy Acts*	Year Passed	Revisions	Guidelines Issued
California	1970	1972, 1974	1970, amended 1974
Connecticut	1973	--	1972
Hawaii	1974	--	1974
Indiana	1971	1972	--
Maryland	1973	--	1974
Massachusetts	1972	1974	1973
Minnesota	1973	--	1974
Montana	1971	--	1973
New Mexico	1971	Repealed 1974	1972
North Carolina	1971	--	1972
Puerto Rico**	1970	--	1972
South Dakota	1974	--	1974
Utah	1974	--	--
Virginia	1973	--	1973
Washington	1971	1973	1971
States with Executive Orders			
Michigan	1971	1973	1974
New Jersey	1973	--	1973
Texas	1972	--	1973
States with Limited Environmental Impact Statement Requirements			
Arizona	1971	--	1971
Delaware	1971	1973	1973
Nevada	1971	--	--
Georgia	1972	--	1972
Nebraska	1973	--	1973

States with Other Land Use Laws Controlling Development

Colorado
Florida
Georgia
New York
Rhode Island
Vermont

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*California and New Mexico called their little NEPAs an "Environmental Quality Act." In Hawaii, Indiana and Massachusetts the laws are technically referred to only as statute numbers.

**Puerto Rico has been included even though it is not a state.

if they found that the proposed project would lower the quality of sewage outflow. This act was estimated to threaten "the indefinite suspension of $500 million worth of construction....(and) 50,000 construction industry jobs" in San Francisco alone.[1.12] This was followed by the California Government Code (65860(a), 65566, 65567) which required that all developments must be consistent with the plans, as well as requiring that zoning ordinances be consistent with a general plan, and open space ordinances be consistent with an open space plan. All the requirements caused this law to be nicknamed the "California Planners Relief, Welfare and Employment Acts."[1.13] About this time, many California cities began passing anti-growth ordinances. Public interest increased and finally the California Coastal Conservation Act of 1972 Initiative was put on the November 1972 ballot. It proposes to establish six regional commissions that could block any housing and industrial project in a coastal corridor 1,000 yards inland and three miles out to sea. The Commissions would need a 2/3 vote to approve any project likely to harm a beach or interfere with the line of sight from the Conservation Plan. This act was commonly referred to as Proposition 20 and engendered heated public debate. It was in the midst of this debate that the Mammoth Decision was handed down. A month and a half later, Proposition 20 was easily passed by the voters. The Mammoth case was appealed that month and the appelate court reaffirmed the lower court's ruling.

It is clear that the result of these events left California developers in a state of despair. The next month the California State Legislature met and lobbying activities were frenzied. The result was Assembly Bill 889, passed in December 1972. The bill provided specific amendments and definitions to clarify the CEQA, and established procedures for Environmental impact reports. It required that EIRs be prepared if the government agency reviewing a permit application has determined that the project might have a <u>significant</u> environmental impact. Developers heaved a sigh of relief. Things were bad, they thought, but not as bad as they could have been. A year later, December 17, 1973, the guidelines for implementing the CEQA were issued. They detailed policies, procedures, and exceptions. The guidelines also stated that even if an EIR is adverse, city and county governments don't have to reject a proposed project. This further reduced the impact of the Supreme Court Decision on the building industry. In March 1974, the California EQA was amended further.

Some effects of the Mammoth Decision would be to stop overdevelopment beyond a community's carrying capacity and the local resources. This in turn could encourage the development of new communities, so that the population would be more dispersed rather than concentrated in a few metropolitan areas. Thus, there is potential to avoid many of the chronic problems of contemporary urban areas.

Not all developers were chagrinned with the new environmental requirements. Some felt that the new ruling would not hurt responsible developers, but would end land speculation. Developers are learning that environmentally sound design makes life easier with the review boards and citizens' groups, and also makes for faster sales.

> It is no longer simply chic (for developers) to promote protection but financially expedient. Harold Burson, chairman of Burson-Marsteller, was an early advocate of developers joining, not fighting, doctrinaire environmental organizations, not as infiltrators, but openly, to learn what they can do to better meet the requirements of these groups.[1.14]

If you can't beat them, join them.

The Mammoth ruling is generating increased interest in statewide planning. Each major city in California is adopting its own guidelines. A development project can require permits for sewers, grading, zoning, subdivision, building, and occupancy, as well as business licenses and environmental impact reports. Local anti-growth ordinances can make the procedures even more complex. Projects have been delayed six to nine months for environmental studies and occasionally redesign of the project is required. The situation has become so chaotic that developers are pushing for reform of the development permission system. They are now wishing for "one-stop shopping" laws that would consolidate permitting programs into a single state agency. This would eliminate the need to deal with a whole host of boards, commissions, and local governmental authorities. Environmentalists are surprised to hear developers advocate consolidating the environmental programs into a statewide system that includes comprehensive land use planning. Not only would this make life simpler for the developers, but it would lower construction costs by reducing the total time necessary to complete a project. Environmentalists could benefit from one single forum on which to focus their attack, rather than the present dispersed situation. A major revision is eminent in California. The American Law Institute developed the first version of their Model Land Development Code in 1968. It has been rewritten every year since. It would revise the local zoning and planning statutory framework as well as provide state planning and development regulation. As mentioned earlier (page 8), Florida's Land and Water Management Act of 1972 was based on the Model Code. With the support of both environmentalists and developers, there is a strong likelihood for the adoption of a new set of statutes by many states in the foreseeable future. The public is expressing growing displeasure with the abuses of contemporary development regulations.[1.15] Thus, the time and costs for preparing the reports will continue to decrease. It is especially useful to have a prototype environmental impact report for a particular area, so that the preparation is simplified down to analyzing the unique features and problems of a particular site and a particular project design. Since it is important to have an environmental analysis of a particular area, the main emphasis of this thesis is to analyze the environmental implications of a residential development for Albuquerque, New Mexico.

One final effect of the landmark Mammoth decision is economic. A new industry, environmental consulting, has been created. After the passage of NEPA, a few firms across the country started getting contracts to prepare environmental impact statements. When the California Supreme Court ruled that developers must prepare an EIR, there was panic at first, then developers scrambled and found firms eager to prepare the necessary documents. A few of these firms already had some experience with EISs, but often the firms had shakey credentials and the resulting reports were inadequate. Nevertheless, the business is flourishing in California. It is estimated that the market for impact reports in California will soon be $12 million to $20 million a year.[1.16]

Generally, the EIR for a twenty unit housing development will cost $1,000 and can be done in less than a week. The final report will be about a dozen pages. For larger projects, an EIR takes ten to fifteen days and costs $4,000 to $8,000. However, the figures vary. Some estimates run as high as $1,500 to $5,000 per unit.[1.17] Generally, the larger the development, the lower the per unit cost. Large scale industrial projects, in comparison to residential developments, are much more complicated and expensive. A uranium mine might be about $100,000. A multi-million dollar power plant can run several hundred thousand dollars. Therefore, it is clear that NEPA and the little NEPAs can have a large economic impact; increasing initial capital costs for developers and industries, and creating a new industry of environmental consulting.

As consultants gain experience in preparing these reports, their procedures become standardized and they develop a body of background data. The Building Research Advisory Baord has proposed to develop criteria and procedures for builders and planners. First, we shall look at the situation in New Mexico and Albuquerque regarding environmental impact statements.

3. The New Mexico Environmental Quality Act. In April 1971, the New Mexico State Legislature passed the New Mexico Environmental Quality Act (NMEQA) modeled directly after the National Environmental Protection Act (NEPA) of 1969. The language also was very similar to the California Environmental Quality Act (CEQA) of 1970 requiring an EIS for any of their projects that would be classified as "major." The wording was such that an EIS could be required of developers, just as was the situation in California as a result of the "Friends of Mammoth" decision. The NMEQA (also referred to as "little NEPA") established a Council on Environmental Quality (CEQ)

to be appointed by the Governor. The State appropriated the necessary funding for the Council of Environmental Quality to develop the guidelines. However, the House of Representatives changed it so that the money would come from the budget of the Health and Social Services Department (HSSD). Governor King stalled on the appointment of the three member council until October. In the spring of 1972 a prohibition was placed in House Bill 300 (the traditional appropriations bill in the New Mexico State Legislature) to prevent any fiscal support for the Council of Environmental Quality from the Health and Social Services budget, even secretarial help. This was a deliberate attempt by opponents to neutralize the potentially powerful law. In spite of having no funding, the CEQ still came up with a draft of the guidelines for Environmental Impact Statements in June 1972. This ill-fated offspring of NEPA continued to have problems. The Governor did not like the guidelines, especially the definition of "major act" which defined what projects would require an EIS. The CEQ guidelines proposed to determine what was a "major act" on the basis of the amount of money and land involved. Because of the Governor's objections, the state agencies were not given the guidelines and the law never was implemented. As a result, the situation ended up in the courts in a landmark case involving the City of Roswell and Molycorp suing the state. The court upheld their case, declaring that if EISs were required, guidelines should be issued, and that the guidelines should be based on fact. So the battle was returned to the state legislature. In 1973 a compromise bill was presented. A second weaker bill was sent to the legislature by the Governor removing the requirements for an EIS. This resulted in a legislative deadlock and the legislature passed a one-year moratorium. The CEQ was expanded by four to a total of seven members. The Governor again stalled in appointing the new members of the CEQ until late June. Members of industry, construction and environmental groups, as well as representatives from the state agencies, were on this new CEQ. Once appointed, the CEQ worked feverishly through the summer and fall to prepare passable legislation. The resulting proposal represented much compromise and was a severe disappointment to the environmentalists. The battle waged on in the 1974 session of the legislation, with several alternative bills being proposed. The final result was not only that none of these suggested bills passed, but more shockingly, the NMEQA of 1971 was repealed.

Although several bills were presented during the 1975 legislative session, no environmental impact legislation was passed. The present situation is that all interested parties anticipate several new bills will be presented at the 1976 legislative session. Some of these are presumed to be very weak laws. Although such a law would be virtually ineffective, industry could then argue against environmentalists that we don't need any more environmental laws, but we just need to give the one we have a chance. Environmentalists would then be stalled until they could indeed prove the law to be ineffective. Some of the legislation being prepared may be very good and effective; however, its chances of being passed can only be speculated on. Until the legislature meets, though, the situation remains that New Mexico had a law requiring EIS which never really went into effect and has now been repealed.

D. Municipal Environmental Statutes

1. Brief Comments on Other Cities. In addition to the National Environmental Policy Act and the many state laws that have been passed, there has been activity in many cities.[1.18] At least two cities have passed equivalents of little NEPAs--Bowie, Maryland passed their first ordinance in 1971, and revised it in 1973, requiring environmental impact statements. New York City in October of 1973 issued an executive order requiring environmental analysis. Other cities have similar environmentally oriented laws and policies.[1.19]

2. Albuquerque. The situation in Albuquerque has progressed slowly. In a series of issues, the City's voters have consistently voted environmentally. The City has adopted official laws and policies in response. Albuquerque's environmental goals have been recorded in Article IX of the City Charter, the Albuquerque Goals Program, the Bernalillo County Goals Program, the current Comprehensive Plan, several area

master plans, various ordinances, and the innumerable outputs from many citizen committees.

After the voters passed Article IX as an amendment to the City Charter, the City Commission eventually appointed the Environmental Ad Hoc Committee. The Environmental Ad Hoc Committee produced many recommendations, including changes to the City Planning Commission. The Planning Commissions was expanded, renamed the Environmental Planning Commission (EPC), and divided into subcommittees, with specific concerns. One of these, the Environmental Guidelines Subcommittee, working the the City staff and some citizens, has produced a set of recommendations to insure adequate consideration of the environmental effects of public and private projects. Actually, these recommendations were the second set developed by the City. Previously, members of the City staff, two members of the Environmental Planning Commission, and a Chamber of Commerce member had "proposed a formal environmental impact statement ordinance to apply to both public and private projects. This approach drew heavy criticism at a public hearing dominated by the real estate interests."[1.20] For this reason, the present recommendations are directed more at using already existing mechanisms to encourage environmental consideration. The following statement was made in the report of the Environmental Guidelines Subcommittee report:[1.21]

> Our subcommittee, with the help of staff, studied approaches to environmental analysis in our own and other states. We concluded that a broadly-applied formal

> Environmental Impact Statement requirement would put a burden in time and money on both public and private sectors far out of proportion to its usefulness. Furthermore, proposal of such a requirement would produce strong negative reaction that might imperil adoption of environmental protection measures, as happened recently in our state legislature. We do feel, however, that the EPC needs more information about environmental impacts, and the public needs better access to the information which the EPC uses in arriving at decisions. Therefore, we are suggesting some modified procedures which we feel will be accepted generally as sensible and necessary steps for a program of environmental protection.

These procedures are divided into two categories, public and private projects. For private projects, the City will strengthen the Service Availability and Suitability Statement, in the process renaming it the Service Availability and Project Suitability Analysis. Applicants will be required to submit additional information in the Activity Description and Environmental Checklist. The City may also provide guildelines that would include the present criteria of agencies and utilities as well as those incorporated in the Environmental Checklist. The EPC intends to use this information on the environmental effects when approval or disapproval of a proposed project is given. Thus, presently existing mechanisms will be augmented to implement Albuquerque's environmental policies for private projects.

Thus, the present structure of the City's administration can be adapted for private projects. However, there does not exist a mechanism that could be adapted for requiring analysis of public projects in the City's administration. The City can review the Environmental Impact Statements required for local public projects which use federal funds. For other public projects, the subcommittee recommends using the City capital improvements program and the Comprehensive Plan as a tool to promote consideration of environmental effects. The department proposing a project would perform an environmental and economic analysis which would be reviewed by another part of the City administration such as the Planning or Environmental Health Departments. Finally, the Mayor, City Council, and Environmental Planning Commission would use the analysis when deciding on capital improvement projects. The subcommittee concluded that a "directive" was needed which required "explicit consideration of environmental effects of each proposed public project."[1.22]

Although it is impossible to accurately predict when these suggestions will be implemented, the estimates are November 1975. The City staff is presently formalizing the Environmental Guidelines Subcommittee's recommendations. After approval by the subcommittee, these recommendations will be presented to the Environmental Planning Commission for acceptance. Hopefully, they will be effective in generating increased consideration of the environmental impact of both public and private construction in Albuquerque.

E. <u>Summary for Albuquerque and New Mexico</u>

State of New Mexico

- o New Mexico does not currently have an Environmental Policy Act: it was repealed in 1974.
- o Other state statures that relate to residential development include:

--New Mexico Subdivision Act, New Mexico Laws 1973. Chapter 348 (House Bill 170).

--Land Subdivision Act NMSA 1953 70-3-1 through 70-3-9.

--Water Quality Control Commission Act NMSA 1953 75-39-4.

--Air Quality Control Act NMSA 12-14-5 through 12-14-8.

--Environmental Improvemental Improvement Act NMSA 1953 12-19-9..

--Forest Conservation Act NMSA 1953 62-3-6.

--Regional Planning Act NMSA 1953 14-57-1 through 14-57-9 and New Mexico Laws 1953 Chapter 298.

--New Mexico Water Laws NMSA 1953 citation 75-5-1, 75-11-1, 75-11-3, 75-11-22 and 75-39-4.

--Municipal Land Use Authority Laws NMSA 1953 Citation 14-18-1 through 14-18-12 planning and platting powers.

14-19-1 through 14-19-14.1 Subdivision planning and platting

14-20-1 through 14-20-24 Zoning Authority.

14-47-1 through 14-47-19 Urban Development.

14-49-1 through 14-49-7 Refuse Disposal

--State Natural Resources Conservation Act 45-5-47 through 45-5-64.

--Drainage and Land Reclamation Act 75-19-1 through 75-23-54.

--Conservancy District Act 75-28-1 through 75-32-43.

--Carey Land Act NMSA 1953 citation 7-4-17.

o State agencies involved in land use planning decisions that may affect subdivision activity in New Mexico include the Bureau of Mines, the Cultural Properties Review Committee, the Energy Resources Board, Environmental Improvement Agency, The Interstate Stream Commission, the Museum of New Mexico, State Engineer, State Fire Marshall, State Forestry Department, State Game Commission, State Land Office, State Park and Recreation Department, State Planning Office, and the Water Quality Control Commission.

Bernalillo County

o New Mexico State enabling statures that relate to residential development include:

--Zoning Authority Act NMSA 1953 14-20-1 through 14-20-24.

--Ordinance Power Act NMSA 15-36-26 through 15-36-41 NMSA 1953.

--County Planning Commission Act 15-58-1 through 15-58-3.

--Refuse Disposal Districts Act NMSA 1953 15-58-1 through 15-58-3.

o Applicable Bernalillo County Ordinances include:

--Bernalillo County Comprehensive Zoning Ordinance, February, 1972.

--Bernalillo County Subdivision Ordinance, 1968.

--Uniform Building Code with amendments and administrative regulations.

City of Albuquerque

o Applicable City Ordinances and Policy Statements include:

--City of Albuquerque Comprehensive Zoning Ordinance.

--701 Comprehensive Plan.

--Environmental Guidelines Subcommittee Report.

--Uniform Building Code.

Copies of the above statutes are available from the appropriate agencies (See Table 2, Major Information Sources).

Note: Developments that involve federal land, funding, or approval will be under the jurisdiction of NEPA and thus an Environmental Impact Statement may be required. Figure 1 shows the environmental review process that occurs after an Environmental Impact Statement has been prepared.

Table 2

MAJOR INFORMATION SOURCES

Local

Middle Rio Grande Council of Governments
Middle Rio Grande Conservancy District
Middle Rio Grande Flood Control Association
Albuquerque Metropolitan Arroyo Flood Control Authority
City of Albuquerque, Public Works Department
City of Albuquerque, Planning Department
City of Albuquerque, Environmental Health Department
Albuquerque Public Schools

Bernalillo County and the City of Albuquerque have combined the Planning Department and also the Environmental Health Department.

State

State Planning Office
State Engineer Office
Environmental Improvement Agency
State Park and Recreation Commission
Department of Game and Fish
Department of Health and Social Services
University of New Mexico, Bureau of Business Research

Federal

Environmental Improvement Agency
U.S. Geological Survey
Soil Conservation Service
Bureau of Reclamation
Bureau of Outdoor Recreation
Fish and Wildlife Service
Department of Housing and Urban Development
Army Corps of Engineers
U.S. Department of Agriculture Cooperative Extension Service

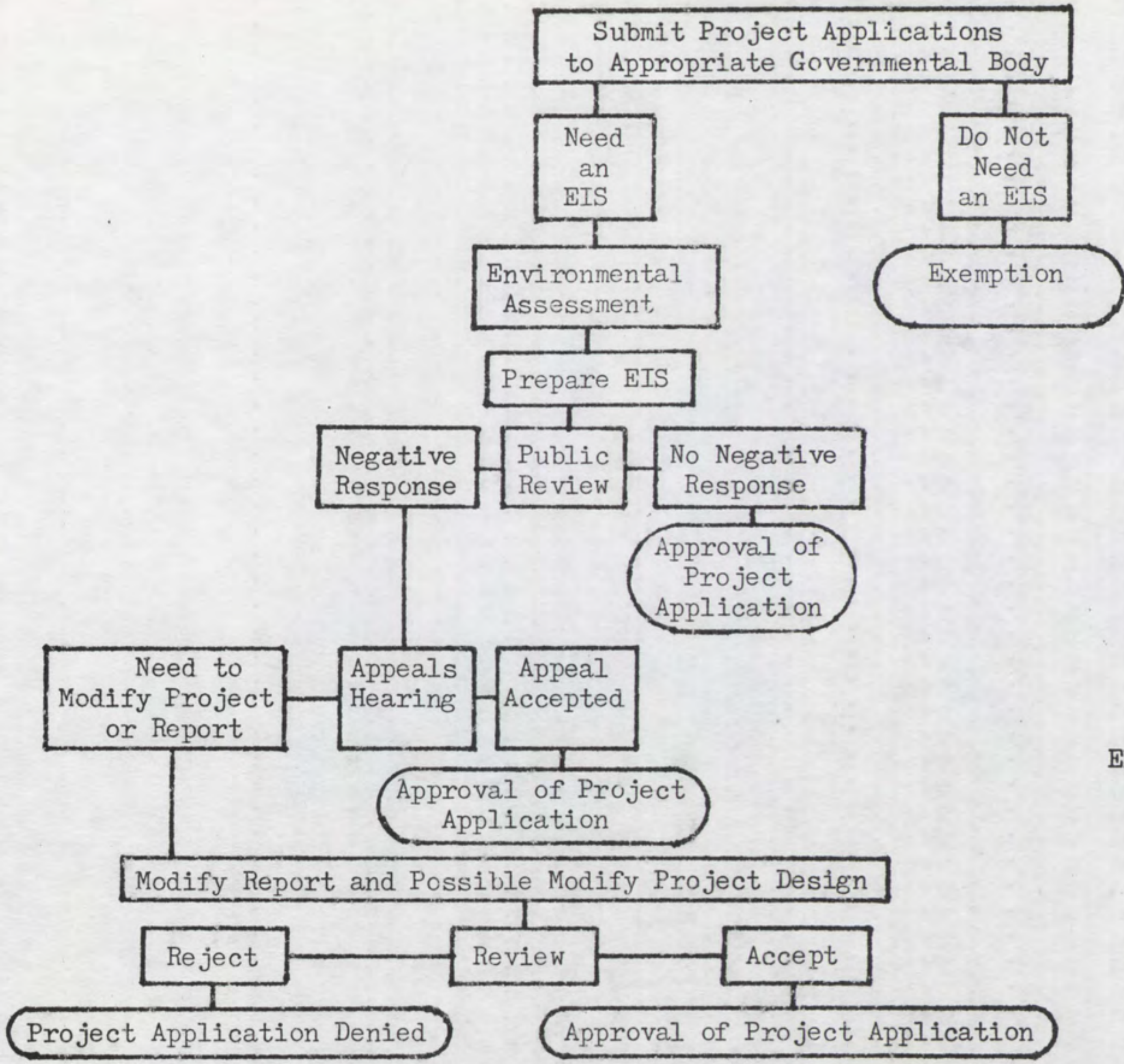


Figure 1

ENVIRONMENTAL REVIEW PROCESS

CHAPTER II

NATURAL RESOURCES

A. Overview

It is not sufficient to require analysis of environmental and economic effects. In order to promote more conscientious design and planning, there must be some sources of information on "how to do it right." If you tell someone they "have to," they also need to know "how to." The effect of a particular type of project, such as residential developments, will depend on its location. The location determines the climate, the geology, the hydrology, the biology, the sociology, and many of the economic aspects. The same design built on Albuquerque's east mesa and in the mountains of Vermont could have some very different impacts. Therefore, it is appropriate to analyze the unique features and problems of a particular area. The analysis should point out problems that could develop and, thus, should be avoided by careful design. Once this prototype analysis is done for an area, the task for designers is simpler.

The fact that residential construction can have a negative environmental effect has had growing recognition by the construction industry.[2.1] The Fourteenth Annual Pacific Coast Builders' Conference in San Francisco during June 7-9, 1972 concentrated on these problems. Not only did they recognize the effects, but they discussed how builders can avoid many of the negative impacts. The possible alliance between the building industry and the ecology movement was further discussed in a telecast on June 27-28, 1972, entitled "Housing and the Environment."[2.2] Unfortunately, the attitude of builders is often cynically optimistic. The old opposition to environmental concerns is often replaced with advice like "Builders can get along with eco-nuts; buy them off with goodies."[2.3] Certainly,the issue generates intense interest. The Hawaiian Chapter of the Construction Specifications Institute met in February 1973 to discuss enviornmental protection and building construction. The attendance was greater than at any previous chapter meeting. The concensus apparently was:

> ....that the construction industry in all its parts should take seriously the need to analyze the environmental impacts of construction activities, and specifically that a section on ENVIRONMENTAL PROTECTION probably should become standard in all private and public construction specifications.[2.4]

Thus, there is a growing awareness of the environmental impact of residential construction, not only among conservationists, but also by the construction industry itself.

Residential buildings have environmental effects in several areas. In addition to the construction phase itself, the actual occupancy phase and the eventual demolition phase each have impacts. The following categories should be considered when determining the effects of each phase.

1. Geology and soils
2. Hydrology--water quality and quantity
3. Biology--floral and faunal
4. Air quality
5. Noise, health and safety factors
6. Land use and sociological factors
7. Economic
8. Energy and resource consumption

Any development has biological impact. Planting a tree for shade also provides a home for birds, insects, and possibly animals. The tree may also affect the plants nearby, providing valuable shade to some or depriving the plants of essential sunshine. The tree will also compete with the other plants for water and nutrients. Sometimes the effects are good and sometimes bad; nevertheless, every act has biological effects.

The living plants and animals of a region interact with each other and with non-living things. The non-living part of environment includes both organic and inorganic substances such as the water, soil and nutrients. The whole complex of physical factors facing the environment is termed the habitat. The term biomass is used to discuss all living things, plants and animals. For purposes of this discussion, the word flora means all plants, including trees, shrubs cacti, grasses, annual and perennial herbs. Fauna means all animals, including mammals, birds, insects, reptiles, fish and amphibians. Thus, the flora and fauna together constitute the biomass. The ecosystem is the interaction of the living things with each other and with their habitat.

Any ecological system involves interrelated processes. Ecology then is the study of the interrelationships between organisms and their environment. It involves the biological composition (species, numbers, and life history), distribution of non-living materials (nutrients, water and soil), conditions such as light and temperature, the flow of energy and the rate at which natural and physical elements recycle. In assessing the effects of residential development on the ecological system all variables need to be considered.

Vegetation types develop in stages or successions and reach a climax in growth or maturity. The process of plant succession occurs in all vegetative areas. Changes in plant life can be seen, for example, in the plant succession of an uncultivated field, denuded by man or nature. Annual weeds appear first, and after a few years are replaced by perennial herbs and grass. Brush may begin growing, then small or scrub trees, and eventually large forest trees may develop.

The final stage--climax vegetation--is determined by climate, especially temperature and moisture. There is also a correlation between begetation and elevation. The vertical changes correspond to latitudinal changes so that every thousand feet increase in elevation is equivalent to a two hundred mile northward shift in latitude. Other factors in determining the type of climax vegetation are soil type, drainage, erosion, water and wind. Forests occur where there is a moist growing season such that the soil is moist throughout the year. Grasslands are generally found where most of the rainfall is during the growing season and low moisture or a dry season prevents tree growth. Deserts occur when moisture is insufficient to support dense growths of trees or grass. Odum defines a desert as less than ten inches of rainfall annually.[2.5] Clearly then, in desert area water is a primary limiting factor. When deserts are irrigated and water is no longer a limiting factor, the type of soil becomes of prime consideration, thus the types of vegetation that can grow in an area is determined by many physical factors. Since all birds and animals must ultimately depend on plants for food or shelter, the succession of plants is also a succession of wildlife.

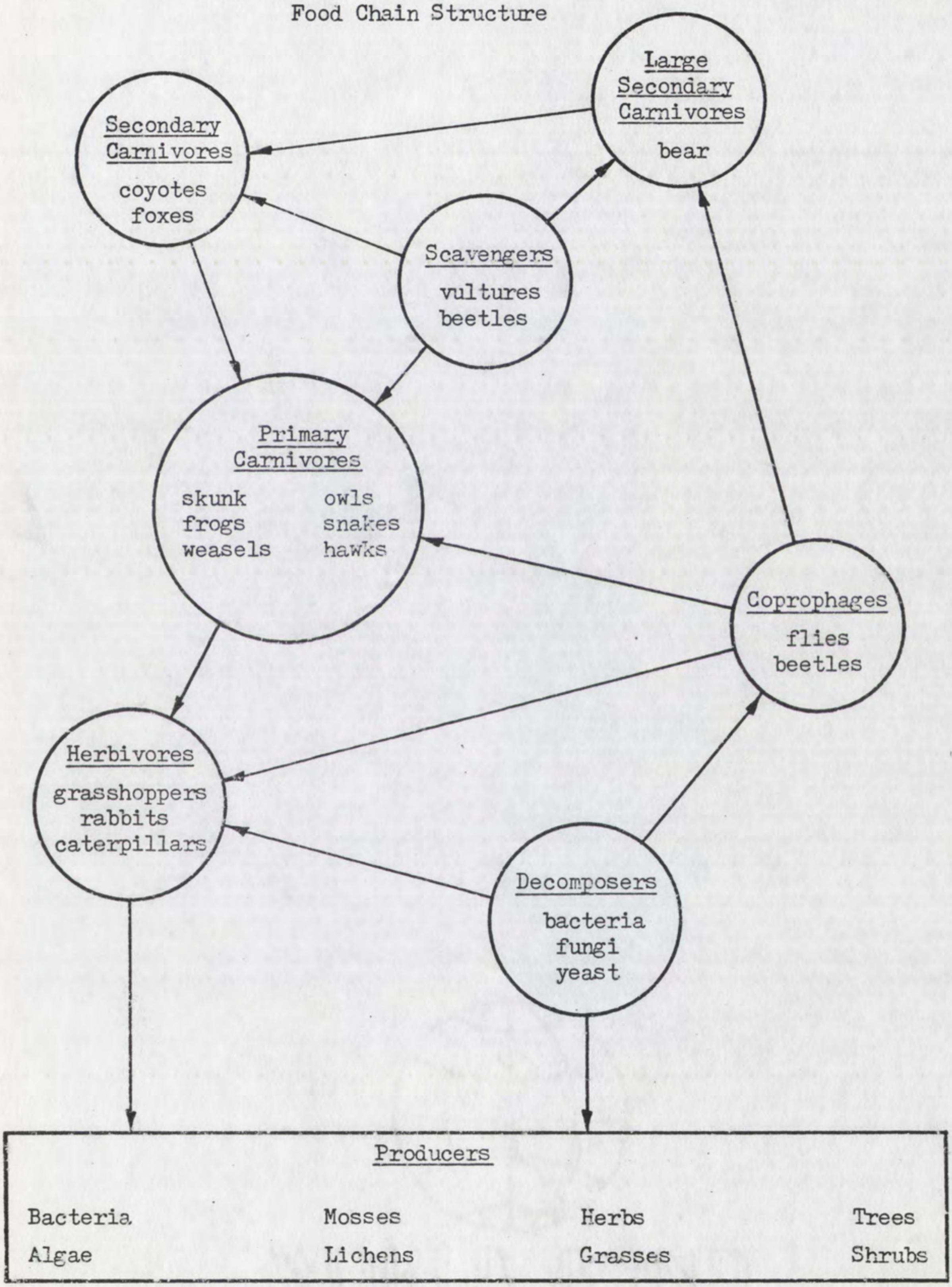
Distribution of animals is a result of unique combinations of climate variables such as temperature, rainfall and humidity. Another variable is man's use and development of the lands. As with natural variables, the animals either adjust to live with man, move to new habitats, or are eliminated. Pollution and pesticides, extensive land developments, livestock grazing and modification of the habitats for commercial or industrial purposes, have affected many wildlife habitats and related populations in one or more ways; reduction in numbers of breeding pairs; elimination of staging/production areas; introduction of domestic predators; disruption, especially during feeding or nesting times, due to foot and vehicular traffic; and destruction of food or shelter vegetation and watering areas.

Most animals stay within their habitat area and do not stray far from local conditions and food supply. For instance, deer do not often stray more than one-half to three-fourths mile from their home ranges; field mice and rabbits range from one-half to nine-tenths miles in their habitat; and quail live in an area comprising one-half square mile. Generally, the larger the animal, the greater his habitat range. Some birds have wide-range habitats due to their mobility. Each animal is related to every other animal in a region by a food chain structure (Figure 2). Each animal in the food chain depends on the animal beneath it for subsistance; therefore, habitats of the species in the food chain interrelate and overlap.

In the Albuquerque area, there are several distinctive areas with different types of climax vegetation. Although Albuquerque's latitude is 35 degrees, the total variation in elevation from the valley to the mountains is 6,000 feet. Therefore, vegetation at the top of the Sandias is more commonly occurring 1,200 miles north than at the latitude of

Figure 2

Food Chain Structure



Albuquerque. It is only reasonable then to expect considerable variation in plant and animal life within several different areas. Basically, there is the Bosque area in the Rio Grande Valley, the East and West Mesas, the Sandia foothills, and the Sandia Mountains themselves. Each area has its own unique vegetation and animal life although some species may be found in more than one area. The climax vegetation and the succession sequence for each area is different.

G. Geology

There are several distinctive areas in Albuquerque with considerable variation in plant and animal life. The biological features correspond to the variations in geological factors. The basic areas apply--the Valley, the East and West Mesas, the Sandia Foothilss and the Sandia Mountains themselves.

1. Geologic History. This portion of the Rio Grande Valley was formed when the Sandia Mountains were tiled up at the East and the Valley area subsided relative to the mountains. The West Mesa apparently was also uplifted slightly. The resulting trough was filled gradually by sediment deposited by the Rio Grande.

The block that subsided was twenty-five miles wide (east to west) and a hundred miles long (north to south). It subsided three or four miles relative to the surrounding area, though in some places it is as much as five or six miles or as little as one or two miles. It may still be subsiding. According to Kelly, it "is one of the greatest troughts on earth."[2.6] The Rio Grande trough is a series of basins along the Rio Grande Valley, the largest being the Belen-Albuquerque-Santa Domingo Basin. The City of Albuquerque is located almost in the center of the basin, at the widest part.[2.7] The massive faulting and tilting occurred in the Pliocene (or possibly late Miocene; see Table 3). There probably was a lot of volcanic activity during that period though the Albuquerque volcanoes were nor formed until later.

The present valley is obviously not as deep as the original basin. The Rio Grande filled the trough with gravel, sand, silt, clay and caliche deposits. This debris had been washed down from the neighboring mountains. The sedimentary deposits formed filled up 10,000 to 15,000 feet of the trough and are known as the Santa Fe Formation. Since valleys are technically carved out by a river, and in this case, a trough was filled in by a river, the Rio Grande Valley is technically not a valley.[2.8]

About mid-Pleistocene, the Rio Grande reversed the process and began eroding an inner valley ten miles wide. Later, less than 20,000 years ago, the river began filling again and has now deposited about seventy-five feet of new fill. Thus, the Rio Grande Valley in Albuquerque has a complex history, which accounts for the considerable variations in valley soils.

2. Topography (see Figures 3, 4, and 5). The Rio Grande Valley in the Albuquerque area is two to three miles wide. The valley can be divided into several sub-areas. There is the river itself, the flood plain areas, the lowland, and the sandy terraces. The flood plain is composed of alluvial washes generally where arroyos enter the valley. Sometimes the flood plain is of lower elevation than the river itself.

Due to the periods of cutting and filling, the land rises from the river in a series of terraces. Generally, the transitional slopes between the valley area and the mesas are broken into raw surfaces with many gullies and bluffs. On the west side, there are sand dunes near the arroyo mouths. The arroyos are generally shorter and smaller west of Albuquerque, getting larger towards the north, and are much larger on the east side. This is because of the terraces and the shorter distances between the West Mesa and the valley. The slopes rising up to thw West Mesa have major areas of erosion that have left many surfaces exposed with sparse vegetation. The soil is sandy and sometimes gravelly. The top of the mesa is also extensively eroded, but flat.[2.9]

The West Mesa, also called Ceja Mesa, is a block five miles wide and seventy miles long, and has experienced some uplifting. Consequently, it is about six hundred feet higher than the East Mesa. There are fault zones along the eastern and western edges of the West Mesa. The volcanoes are on a large north-south fault, four and a half miles long. There

TABLE 3

Geologic History of the Albuquerque Area

Era	System	Series	Age	Thickness (ft.)	Formations	Events
Quaternary	Holocene		recent	5-100	Gravel, sand, mud in lowlands, arroyos, low terraces and alluvial fans	Human settlements
	Pleistocene		2,000 years	75 ±	Llano de Sandia: gravel, sand and caliche	Rio Grande began filling trough again
			2,000 years	150 ±	Primero Alto: gravel, sand and caliche	Rio Grande cut Inner Valley
				varies	Lava flow: basalt	Albuquerque Volcanoes formed
			100,000 years	50 ±	Segundo Alto: gravel, sand and caliche	Rio Grande established, began filling trough
			200,000 years	200	Ortiz Surface: gravel, sand and caliche	
Cenozoic	Pliocene		12 million years	10,000 ±	Santa Fe Formation: san, clay and gravel	Tilting and faulting activity, Rio Grande trough formed
	Eocene			1,000 ±	Galisteo Formation: red and buff sandstone and mudstone	
Mesozoic	Cretaceous	Upper	90 million years	1,500	Mesaverde Formation: shale, sandstone and coal	
				1,500	Mancos shale: shale with thin limestone and sandstone beds	
		Lower	125 million years	5-100	Dakota Formation: sandstone, conglomerate, shale	
	Jurassic	Upper	165 million years	400-800	Morrison Formation: variegated mudstone and sandstone	
				200	Summerville Formation: red and buff mudstone and sandstone	
				100-200	Todilto Formation: gypsum and limestone	
				150-200	Entrada Sandstone: red and buff sandstone	
	Triassic	Upper	185 million years	1,500	Chinle Formation: red and tan mudstone and claystone	
				200-400	Santa Rosa Formation: sandstone and conglomerate	
Paleozoic	Permian	Upper	215 million years	100	Bernal Formation: sandstone, siltstone and limestone	
				30-100	San Andres Formation: limestone	
		Middle	225 million years	50-100	Glorieta Sandstone	
				600-800	Yeso Formation: red and tan sandstone, limestone and gypsum	
		Lower	235 million years	600-900	Abo Formation: red sandstone and mudstone	
	Pennsylvanian		270 million years	100 ±	Madera Formation: limestone, shale and sandstone	
				100-200	Sandia Formation: sandstone, shale and limestone	
	Mississippian		300 million years	0-100	Terrero Formation	
Precambrian			1,400-3,000 million years		Sandia Granite: gneiss, quartzite, greenstone and schist	

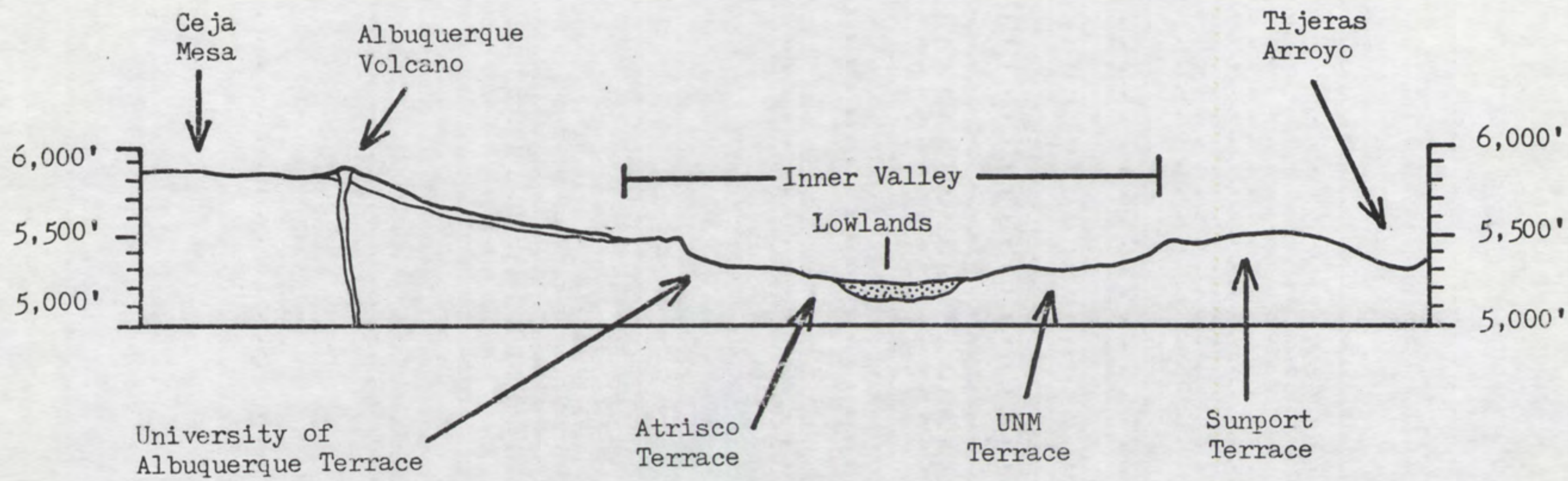


Figure 3

Profile of the Rio Grande Valley

Source: Kelley, Vincent C., Albuquerque, Its Mountains, Valley, Water, and Volcanoes, U.N.M. Printing Plant (Albuquerque, 1969).

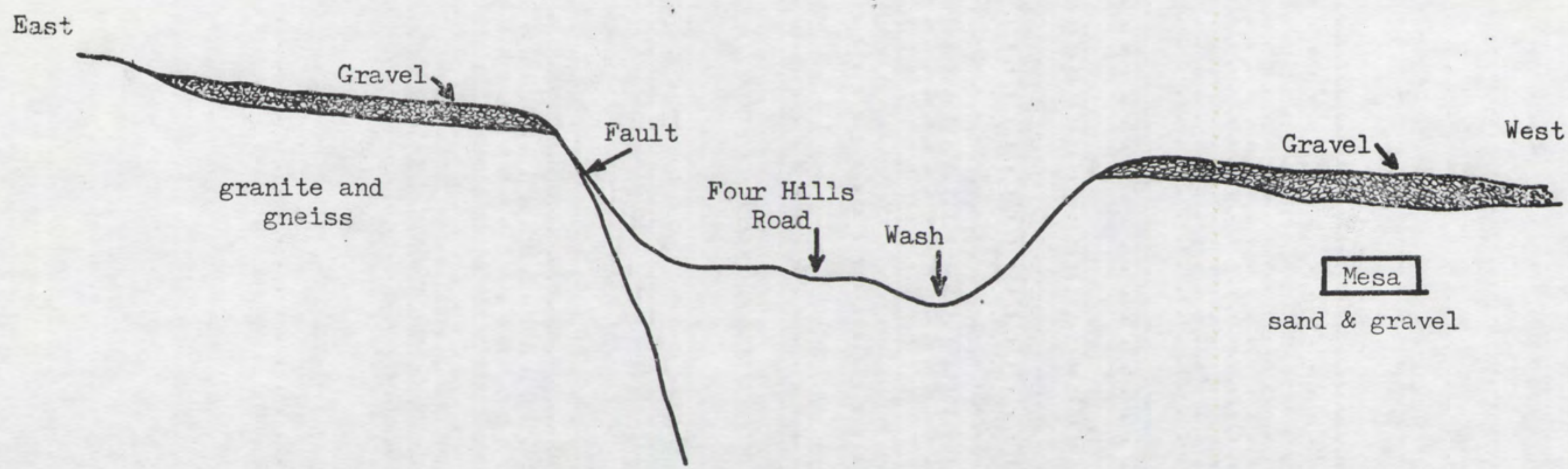


Figure 4

Cross Section of the Rio Grande Valley

Source: Kelley, Vincent C., <u>Albuquerque, Its Mountains, Valley, Water, and Volcanoes</u>, U.N.M. Printing Plant (Albuquerque, 1969).

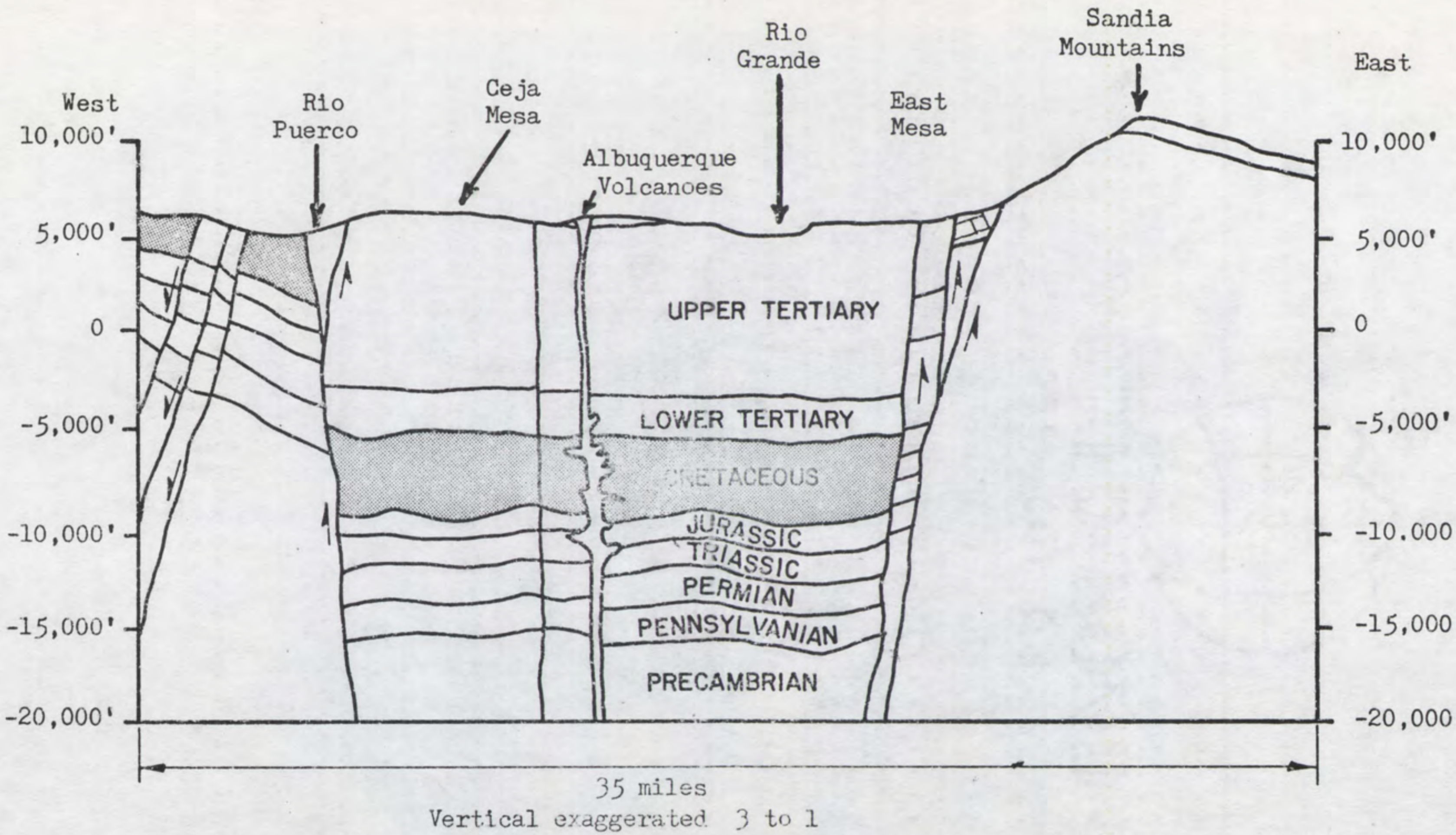


Figure 5

Cross Section of the Rio Grande Trough

Source: Kelley, Vincent C., Albuquerque, Its Mountains, Valley, Water, and Volcanoes, U.N.M. Printing Plant (Albuquerque, 1969).

are five small cones that are visible along the skyline, another five smaller cones and "eight nubbin points of eruption" on the West Mesa, making eighteen cones in all. Part of the basalt flow from the eruption has been eroded away. The eastern part may have extended to the Rio Grande. As Kelly points out, "Probably no major city in the United States has such an array of extinct volcanoes nearby as does Albuquerque."[2.10] There are also volcanoes at Canjilon, San Felipe Pueblo, Isleta Pueblo and Los Lunas. The Isleta or Wind Mesa volcanic field has seventeen cones. There is also the Caldera, known as Valle Grande, in the Jamez Mountains, and the Mount Taylor area consists of some two hundred volcanoes. This totals up to 270 volcanoes within sixty-five miles of Albuquerque.[2.11]

The land on the east side of the river rises in a series of terraces, somewhat more abruptly than on the west side. There are sandhills and areas of major erosion. The soil varies from clay to sand to gravel to eight-inch diameter boulders. The slopes are cut by bullies and major arroyos. To the north, the transition is more gradual from the valley to the Sandia foothills.

As mentioned earlier, the mesa area was formed when the Rio Grande deposited sediment over the subsided block of the Rio Grande trough (Belen-Albuquerque-Santa Domingo Basin). In addition, eroded material from the Sandia Mountains intermixed with the detritus deposited by the river. The East

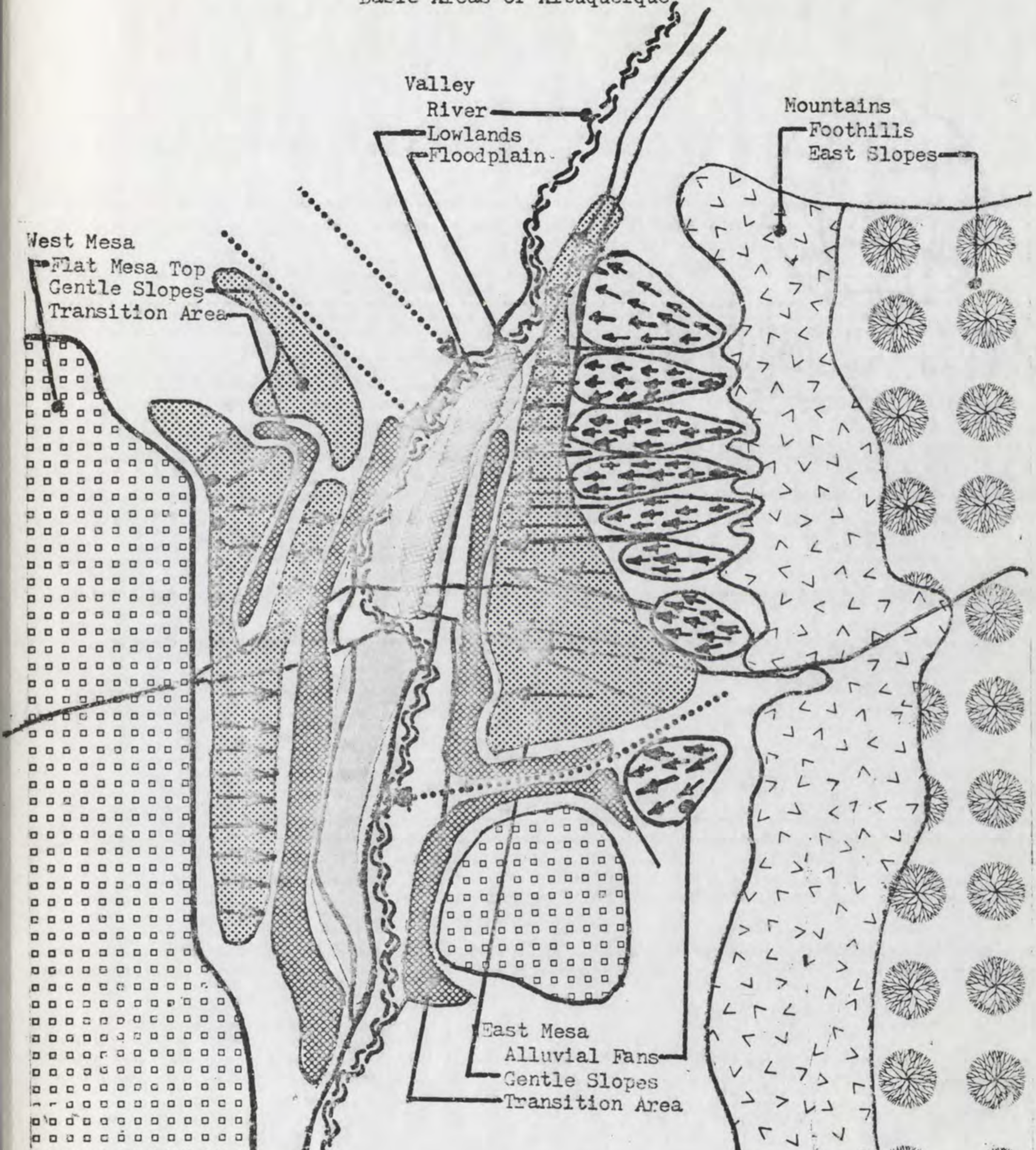
Mesa or Sandia Mesa is built of gravel, sand and clay. The elevation slopes upward from 5,200 feet to 6,000 feet at a rather uniform grade of one hundred feet per mile.

Arroyos and alluvial fans are characteristic of arid areas. There are many arroyos and gullies on the East Mesa. Although they are usually dry, they carry large volumes of runoff water when it rains. The danger from these flash floods is greatest during the summer. Arroyo cutting is a continuing problem on the mesa. (see Figure 6)

Alluvial fans form at the base of the mountains. The drainage channels of the mountains flow into canyons. When the canyons reach the mesa, they branch into many diverging channels again. The runoff water carries eroded material from the mountains which is deposited fanlike on the mesa. The center of these alluvial fans gets built up the most, resulting in a convex shape. There are numerous canyons draining the west face of the Sandias, and the numerous alluvial fans. The major canyons include Juan Tabo, Jaral, La Cuevo, Baca, Pino, Bear, Embudito, Embudo, Sunset, Montgomery, Piedra Lisa, and Tijeras. For each canyon there is the resulting alluvial fan and an arroyo. These alluvial fans form a fairly smooth alluvial piedmont along the mountain side. The interfan areas are susceptible to considerable concentrations of flood water.

As mentioned earlier, the Sandia Mountains were formed when a large fault block was tilted up at the west end. Most

Figure 6
Basic Areas of Albuquerque



Source: Crane, David A. and Associates, Quality in Environment, An Urban Design Study for the City of Albuquerque, New Mexico (Albuquerque, New Mexico (1970).

of this block was Precambrian granite and schists (metamorphic rocks). The Sandia granite is at least 1,350 million years old and is composed of feldspar, quartz and mica (biotite). This is overlain by a layer of Pennsylvania limestone. The limestone layer caps the crest and covers the eastern slopes. It is part of the Magdalena formation, with alternate layers of light grey limestone and dark grey shale. Its thickness varies from fifty to two hundred feet and the age is estimated at 250 million years old.[2.12.]

The escaprment of the Sandias is thirteen miles long and averages about four thousand feet higher than the mesa elevation. The Sandias were once much larger and three times as high, but eroson has left only 15 to 20 percent of the original mountain.[2.13] The eroded material filled the subsided basin and formed the alluvial fan that is the East Mesa.

The west face of the Sandias is quite steep, though not as steep as people generally think. The slope to Sandia Crest from the base is about twenty-one degrees and the slope to South Sandia Peak from the base is only twelve degrees. Few cliffs on the Sandias slope more than thirty degrees from the vertical.[2.14]

3. Faults and Earthquakes. There is a major fault line along the west base of the Sandias. There are numerous faults along the east side of the Sandias and the Tijeras Canyon. There are also fault zones along the eastern and western edges of the West Mesa. Albuquerque has experienced several

earthquakes recently. Apparently, the Rio Grande trough is still subsiding.

Earthquakes are caused by the release of accumulated strain. When the release is gradual, the result is termed fault creep. When the release is rapid, it is an earthquake. If a large amount of energy accumulates, the result is a large, potentially highly destructive earthquake. Frequent release of small increments of energy produce small, less destructive quakes. The amount of energy released is roughly proportional to the length of the fault break. Energy released is measured on the logarithmic Richter scale. Albuquerque's recent quakes have measured fairly low on the scale.

Another factor in the amount of damage that occurs during an earthquake is the distance from the source to the inhabited area. The amount of energy that arrives decreases with the distance away from the earthquake epicenter. The effect of distance itself tends to dampen the wave motion and produce longer waves. Apparently, many of the local earthquakes have been centered in the Socorro area, so that energy arriving at Albuquerque is diminished. A moderate earthquake very near an urban center can cause as much damage as a very large quake further away.

A third factor is the nature of the earth under the urban area. The seismic wave motion travelling through dense granite rock is of short wave lengths, and thus, rapid vibrations. If earthquake waves pass through less dense material such as the alluvium and sedimentary materials under most of Albuquerque, they are dampened and arrive as longer and slower waves. The wave motion is most greatly changed when it passes from dense rock into unconsolidated alluvium. This slower motion is often more damaging to structures than the rapid vibration. If an earthquake were to originate in the Sandias, the damage could be expected to be greater than if it originated near Belen, even when the distances to the epicenters were the same, because of underlying rock and soils.[2.15]

The fourth factor in the damage caused by an earthquake is the condition of the buildings themselves. In a major earthquake, unreinforced masonry buildings perform very poorly. Some homes and apartment buildings are of this type in Albuquerque. Older adobe homes with heavy vega roofs are particularly dangerous. The modern adobe house with lighter roofs, steel reinforcement in the walls, and binder in the adobe are comparable to cinder block buildings. The majority are one-story wood frame buildings, which are generally safe. They may suffer damage such as cracked plaster or chimneys that fail. Reinforced concrete buildings act as rigid structures and are generally undamaged by moderate quakes. Steel frame buildings are flexible, but may whip under repeated wave motion. However, reinforced concrete and steel frame buildings are rarely used for residential purposes in Albuquerque. In addition, these design considerations are basically an engineering function rather than an important environmental factor.[2.16]

4. Soils. Soil suitability is an important geologic factor in urban development. Soils vary in the physical and chemical characteristics. The texture is an important physical characteristic and is determined by the proportions of sand, clay, and silt in the soil. Some soils containing high amounts of clay have a high shrink-swell potential, shrinking when dry and swelling when wet. This will result in foundation problems. Many of the soils in the Albuquerque area are low in iron. The alkalinity of local soils is also a problem. Alkaline soils are especially found in portions of the West Mesa, the Southeast Heights, and along canyon bottoms. Generally, a slightly acid soil is the most fertile. The only soils in the Albuquerque area that have agricultural potential are in the Rio Grande Valley. Soils in the other areas of Albuquerque need to be supplemented and improved.[2.17]

Salt buildup in the soil is a common problem in arid areas. The water used for irrigation or sprinkling evaporates, leaving behind the salts that were dissolved in it. A particular problem results from the precipitation of calcium carbonate, called caliche, meaning lime-like. Moisture from rain, snow, or irrigation dissolves the calcium in the soil and carries it downward where it cements or replaces the soil. The result is a chalky white cement-like layer. Its depth may vary from an inch to six feet. Deposition of the caliche is generally caused by drying out of the soil and long weathering of an area under arid or semi-arid conditions. It can create a problem because it forms an almost impervious layer, so that water will percolate down to the caliche layer and no further. If a septic tank is above the caliche layer, it will not drain properly. Plant roots may not be able to penetrate through the caliche layer. A caliche layer can result in a poorly drained soil.

On site, sewage disposal can be affected by other soil factors as well. The permeability, porosity, the water table level, slope, hillside seepage, soil creep, erosion, surface runoff, and the depth of the soil to bedrock can all limit the effects of on-site sewage disposal.

Soils also affect municipal sewage systems. In areas where the soils are very shallow, the cost of utilities can be unbearably expensive if sewer and water lines must be blasted out of solid rock. Some soils are corrosive to metals, which affects water and sewer pipelines.

Another important soil quality is the bearing value of the soil. Obviously, building on concealed sink holes or soft compressible soils is a mistake. However, where there are loose natural deposits or insufficiently compacted fill, wetting the soil can lead to significant settlement.[2.18]

5. Mineral Deposits. Another aspect of land as a natural resource is mineral deposits. In both value and

tonnage, the extraction of sand and gravel materials may be the most productive type of mineral resource in Bernalillo County. In 1972, the production of cement, sand, gravel, stone and clay products amounted to $1,802,000. Cement, sand and gravel are the most important products. The deposits are vital to community development and urban expansion. To be of use, deposits must be close enough to the urban area to supply the needs economically. Sand and gravel are indispensable but not inexhaustible natural resources. Other mineral resources adjacent to the Albuquerque area include copper, coal, bypsum, and turquoise. For various reasons, these will not be discussed.

C. <u>Hydrology</u>

The main problem in urbanizing arid areas is water. Any urbanization creates a twofold problem by increasing runoff and by development of flood prone areas. Often water quality problems result as well. In arid areas, though, water quantity is a problem and may become a limiting factor.

1. <u>Water Supply (see Figures 7, 8, 9, 10, and 11).</u> The very term "arid" implies low rainfall. Actually there are three sources of water in the Albuquerque area: precipitation, surface water, and ground water. In each case, the water supply is controlled directly by geographic and physiographic features.

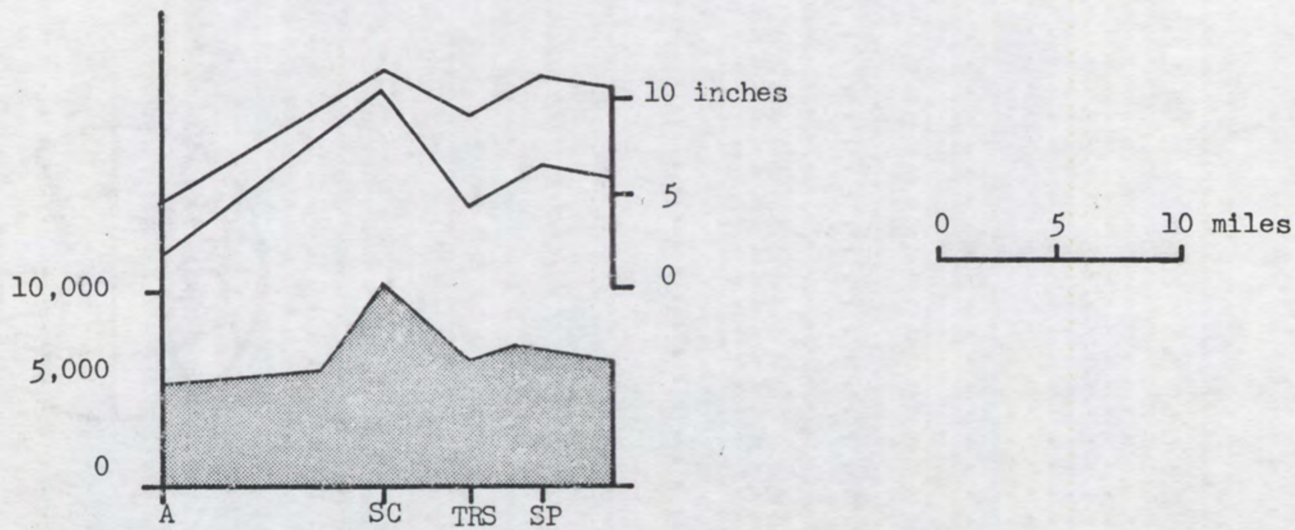
Precipitation includes rainfall, snow and hail. The average annual precipitation for Albuquerque is 8.4 inches.

However, there is a great variation between the precipitation levels in the valley, on the mesas, and in the mountains. As is the case throughout New Mexico, the areas of high elevation have the highest precipitation, around twenty inches. Sandia Crest, at an elevation of 10,675 feet, has varied from 13.69 inches to 30.18 inches.[2.19] The lowland sections of the city receive less than seven inches a year. About two-thirds of the annual precipitation occurs from May to October with almost one-third of the annual amount falling during July and August. Generally the rainfall originates in the Gulf of Mexico. Most rainfall during this period is the result of brief but intense thunder showers. During the winter months, most precipitation occurs as snowfall. The average monthly snowfall is two inches, and maximum snowfall recorded is 7.26 inches. November is the driest month of the year. Since the average annual precipitation in Albuquerque is so small, it is important to maximize the use of it. When an intense summer thunderstorm occurs, most of the storm runoff ends up in the river. This rainfall then becomes the Rio Grande River and is eventually used in Southern New Mexico, Texas or Mexico. It is not used in Albuquerque. Precipitation can be controlled to some extent by various management practices. Weather control techniques such as cloud seeding and hail suppression are attempts to manage precipitation before it has fallen. There are also techniques for after precipitation has fallen. It has been observed

Figure 7

Elevation and Precipitation

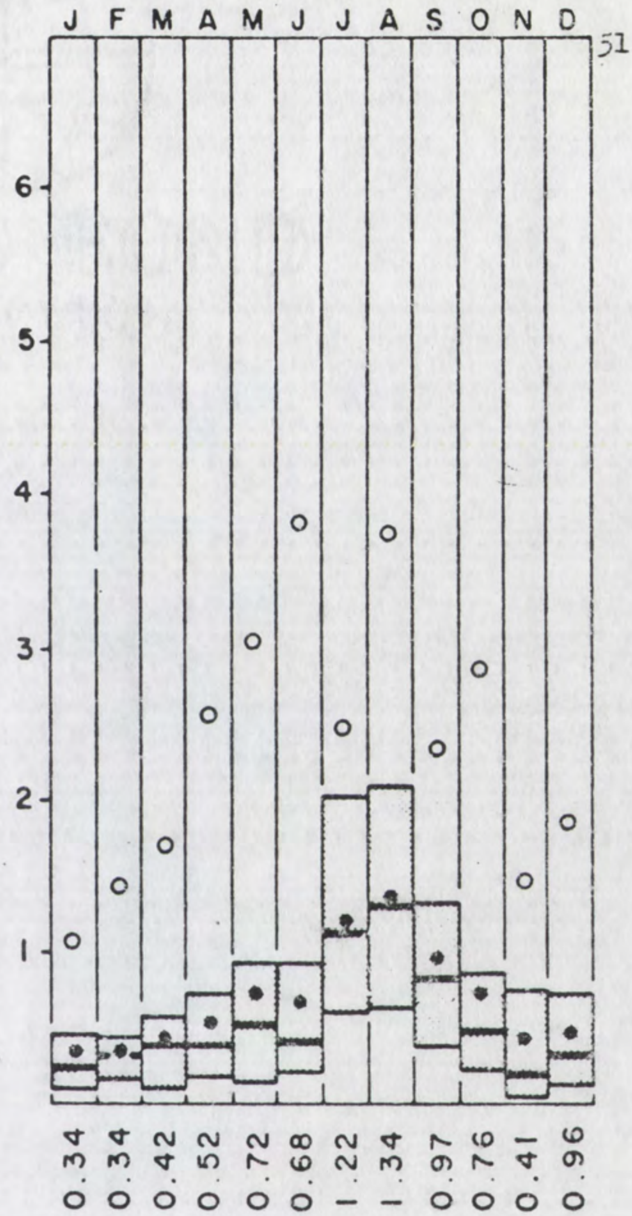
Sandia Section



A	Albuquerque	5,300 ft.
SC	Sandia Crest	10,675
TRS	Tijeras Ranger Stat.	6,300
SP	Sandia Park	7,011

Source: Tuan, Yi-Fu, Cyril E. Everard, Jerald G. Widdisin and Iven Bennett, The Climate of New Mexico, State Planning Office (Santa Fe, 1973).

Figure 8



○ Maximum Precipitation Recorded

● Average Precipitation

Upper Quartile

Median

Lower Quartile

Dry Years 1850 4.92 inches
1851 5.31 inches

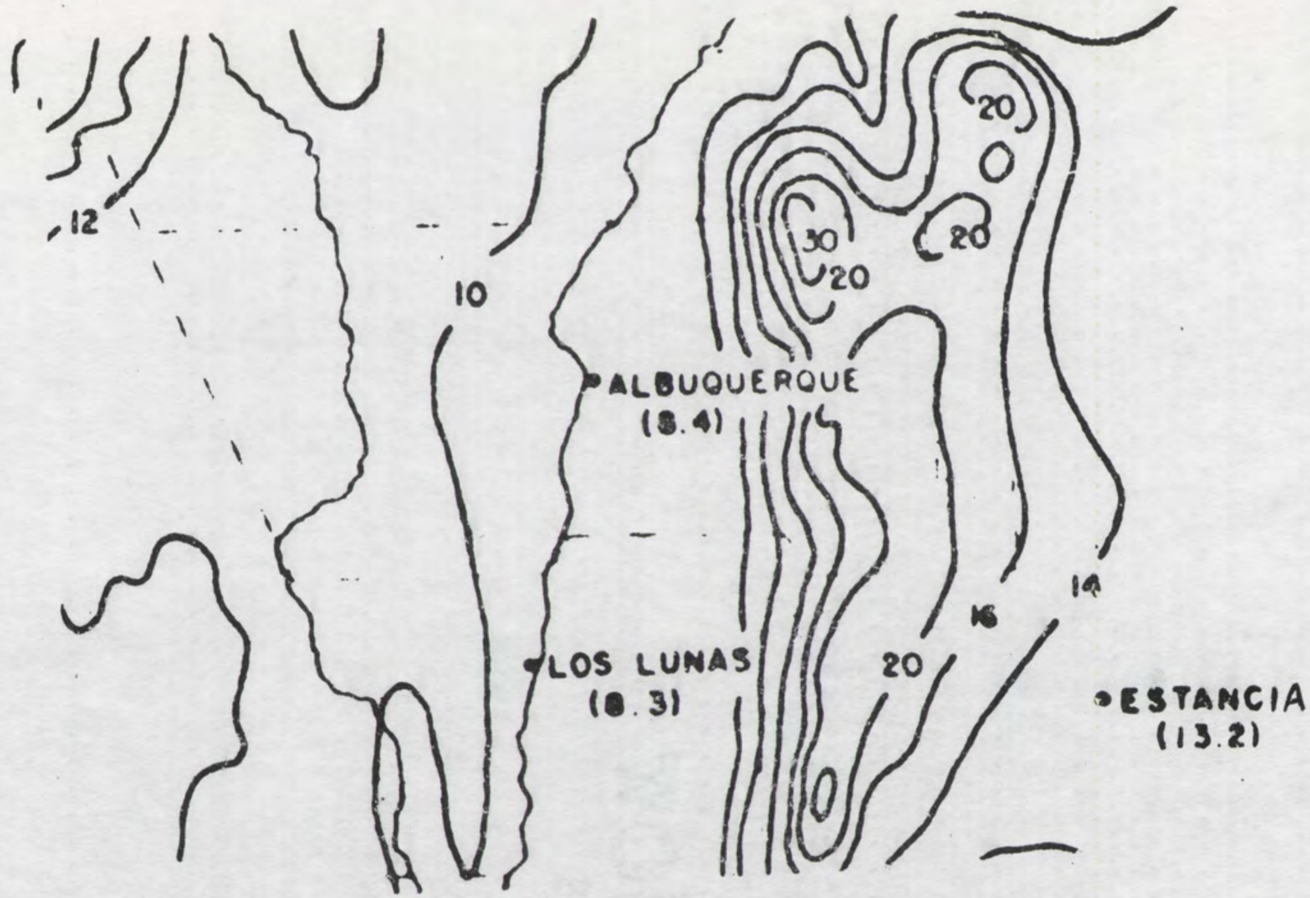
Average Rainfall 1931-1960

8.68 inches

ALBUQUERQUE

Source: Tuan, Yi-Fu, Cyril E. Everard, Jerald G. Widdisin and Iven Bennett, The Climate of New Mexico, State Planning Office (Santa Fe, 1973).

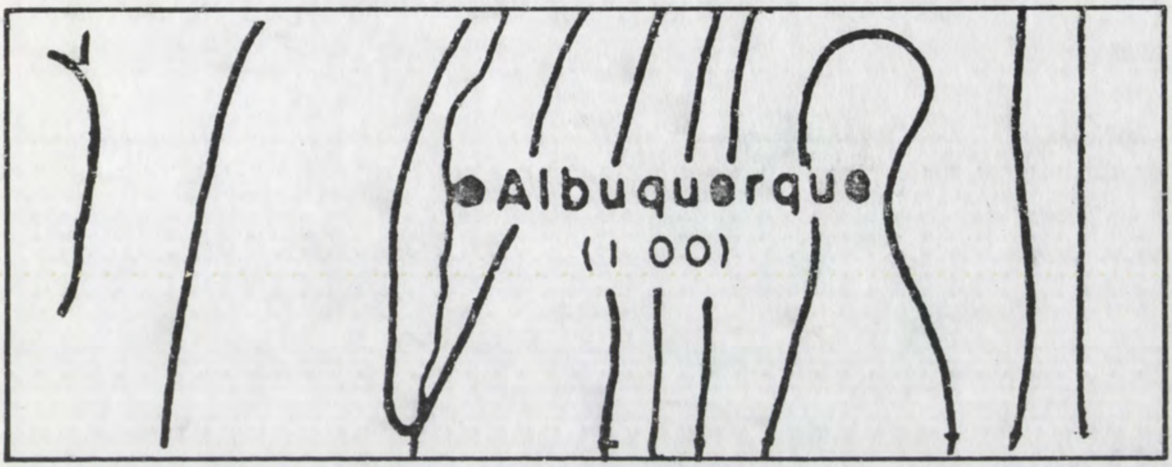
Figure 9



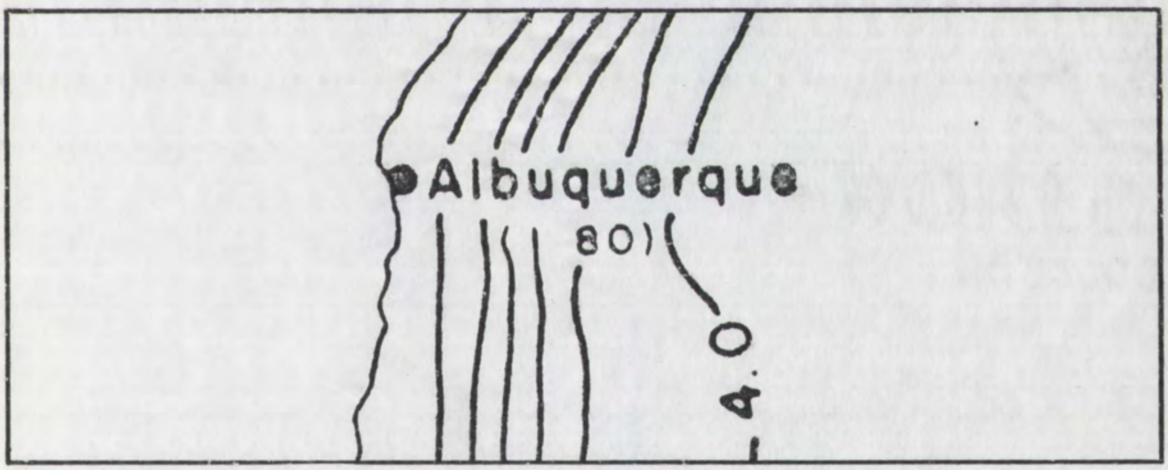
Average Annual Precipitation
Years: 1925-1954
Isohyet Interval: 2 inches

Source: Tuan, Yi-Fu, Cyril E. Evarard, Jerald G. Widdisin and Iven Bennett, <u>The Climate of New Mexico</u>, State Planning Office (Santa Fe, 1973).

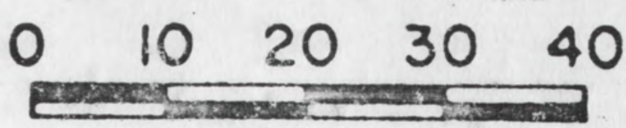
Figure 10
Years: 1925-1954
Isohyet Interval: ½ inch



Average Winter Precipitation: December, January, February

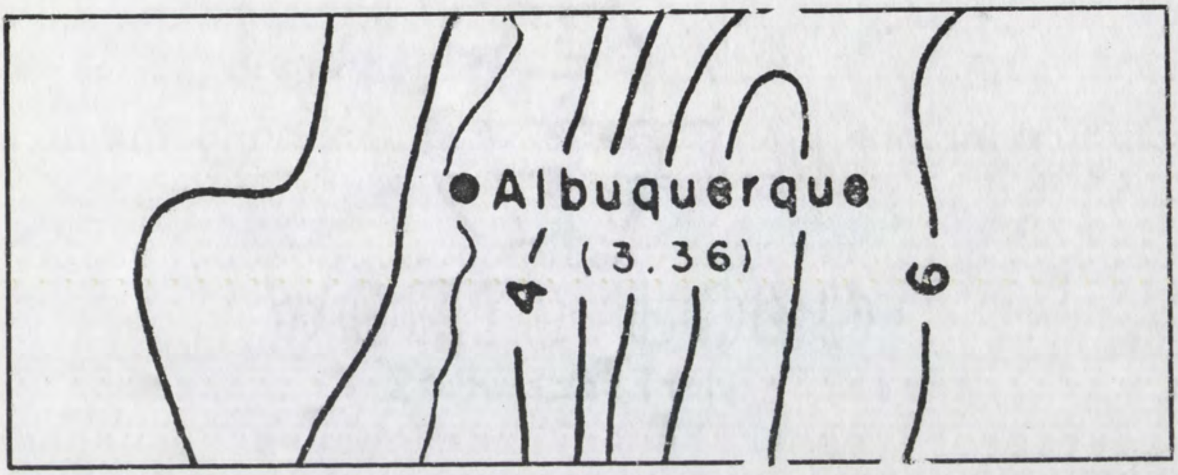


Average Spring Precipitation: March, April, May

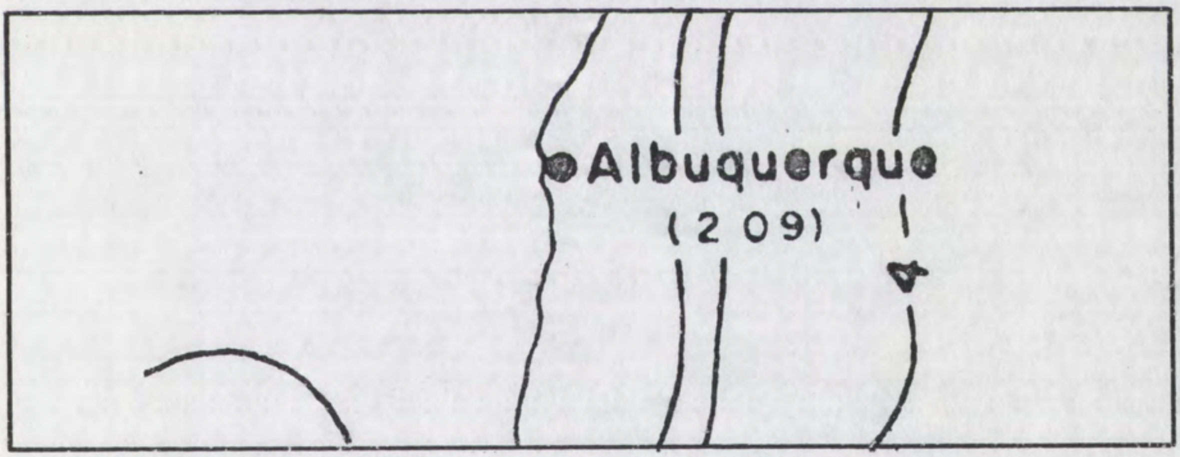
Scale:


Source: Tuan, Yi-Fu, Cyril E. Evarard, Jerald G. Widdisin and Iven Bennett, The Climate of New Mexico, State Planning Office (Santa Fe, 1973).

Figure 11
Years: 1925-1954
Isohyet Interval: 1 inch

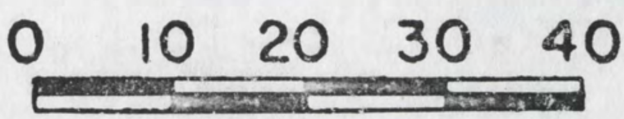


Average Summer Precipitation: June, July, August



Average Fall Precipitation: September, October, November

Scale:



miles

Source: Tuan, Yi-Fu, Cyril E. Evarard, Jerald G. Widdisin and Iven Bennett, The Climate of New Mexico, State Planning Office (Santa Fe, 1973).

that forests catch the falling snow in proportion to their openness, but retain it in proportion to their density. Therefore, the water content of soil can be significantly increased by snow fences or shelter belts of trees. This approach can only be feasible for portions of the East side of the Sandias. Grasslands have less evapotranspiration than forests but more runoff water. Thus, the main method for augmenting the water supply in grassland areas would be to retain runoff waters, although phaedophyte removal is another controversial approach. Paving sidewalks, driveways, buildings and lawns also increases the amount of runoff. If this runoff were reused locally instead of going down the river, the city would have less of a water problem.

River water is surface water. Surface water in the Albuquerque area is mainly limited to the Rio Grande, its two main tributaries--Galisteo Creek and the Jemez River, and the water in irrigation and drainage ditches. There is a small quantity of occasional surface flow in arroyos draining from the mountains, such as Tijeras. Also, there is sometimes water standing in low areas along the Rio Grande, Galisteo Creek and Jemez River, before it reaches the Albuquarque area. The structures are designed to not inhibit the base flow of the river, but simply to provide flood control and sedimentaion. Cochiti has a capacity of 692,000 acre feet, Galisteo has a capacity of 191,000 acre feet and

Jemez Canyon has a capacity of 120,000 acre feet for a total of over one million acre feet. However, the river and its ditches are basically the main surface water in Albuquerque. The average discharge rate through the Albuquerque area is about fifteen hundred cubic feet per second.[2.20]

The flood plain varies from one to three miles in width, with 400 to 600 feet occupied by a meandering, sandy channel with a low flow. This is the floodway itself and is about 1,000 feet wide with levees on each side. Most of the flood plain is quite flat, and the portions outside the city of Albuquerque are cultivated. This area is laced with irrigation channels and drainage ditches. The drainage ditches have been beneficial, lowering the water talbe in the valley bottom, eliminating most swamps and lakes, and helping to lower the alkalinity of the soil. Although the Rio Grande water is important to local agriculture, surface water, like rainfall, is not a major source of water supply for Albuquerque. This may change some in the future as a result of the San Juan-Chama Project. As a participating project of the Upper Colorado River Storage Project, it is an authorized annual average diversion of 110,000 acre feet of water from the upper tributaries of the San Juan River. After collection from three tributary streams in Colorado, the water is carried through a series of tunnels and canals across the Continental Divide in Heron Reservoir. The reservoir is on Willero Creek, a tributary of the Rio Chama. The

San Juan Project is the first major interbasin transfer of water in New Mexico and is, in some senses, an interstate transfer of water. The imported water will be used to serve the City of Albuquerque with municipal water and to provide supplementary water for irrigation in the Middle Rio Grande Conservancy District. It also will replace depletions in the Rio Grande Basin caused by new irrigation projects on Upper Rio Grande tributaries. In addition, this water will be used to maintain a permanent recreation pool in Cochiti Reservoir.[2.21]

Most of Albuquerque's water supply is from ground water. Ground water is found in an aquifer, an underground stratum of permeable rock, sand or gravel. In the Albuquerque area there are two types of aquifers: bedrock and valley fill. Bedrock aquifers are composed of sandstone, conglomerate or limestone. These beds yield moderate amounts of water when wells are located over saturated fractures. Bedrock aquifers are recharged by precipitation on the outcrop or a stream channel crossing the outcrop. The bedrock aquifers in the Albuquerque area occur in the mountain areas and account for very little of the area's water supply.

The second type of aquifer, valley fill, accounts for most of the water used in Albuquerque. As mentioned earlier in the discussion on geology, the Rio Grande Trough has been filled with a thick layer of sediments, the principal deposit being the Santa Fe Formation. The sediments within the Rio Grande are fully saturated below the water table. Nearly all of these subsurface beds are porous and permeable enough to allow slow movement of the water. The porosity is the proportion of the material not occupied by solids. Sand and gravel have a porosity of twenty-five percent, for example. The porosity indicates the storage capacity of an aquifer. The porosity in the Albuquerque area is about twenty percent.[2.22] The permeability is the ease with which water can pass through. Since the Rio Grande Trough consists of parallel layers of different types of sediments, these layers vary in the properties of porosity and permeability. Even within a given layer the permeability may vary significantly along the layer. Thus, the details of water movement within an aquifer are difficult to deduce. However, since all the rocks in the Rio Grande Trough are permeable, the ground water is unconfined. This means that the upper level of the ground water, the water table, can fluctuate up and down, depending on the recharge rate. Ground water is recharged when water percolates down through the soil to the water table. The aquifer is recharged mainly by local precipitation accumulated as storm runoff in the arroyos, by seepage from the Rio Grande, dams, canals, by infiltration of irrigation water. Therefore, the water tables can be expected to rise after years of heavy rainfall.

The water table slopes diagonally down to the valley from the base of the Sandia and Manzano Mountains to a ground water depression about eight miles west of the Rio Grande. There is another ground water depression near downtown Albuquerque formed by pumping from wells. In this downtown area, the depth of the water table is 29 feet compared to five to ten foot depth in the inner valley. The depth of water beneath Albuquerque increases eastward to 600 feet. On the West Mesa the water table slopes from the Rio Puerco down to the depression eight miles west of the Rio Grande. The depth of the water table beneath the West Mesa is as much as 1,000 feet. The water table beneath the inner valley itself slopes southward at approximately the same gradient as the river. There are twenty-two declared underground water basins in New Mexico. Each basin is regulated in its water usage by the State Engineer's Office. The Albuquerque area is part of the Rio Grande Basin, established November 29, 1956. The Rio Grande Basin totals 5,321 square miles in area. This basin stretches from the Colorado border in Taos County to Elephant Butte Reservoir in Sierra County, following the course of the Rio Grande. The river distance is about two hundred and seventy miles. Only generalized physical properties and water bearing characteristics are known about the ground water in this basin.[2.23]

2. Water Quality. Water pollution is undesirable substances in the water. There are eight major kinds of water pollution:[2.24]

1. oxygen demanding wastes
2. disease-carrying agents
3. plant nutrients
4. synthetic organic chemicals
5. inorganic chemicals and mineral substances
6. sediments
7. radioactive substances
8. thermal pollution

Oxygen demanding wastes are of organic origin, either plant or animal sources. They are contributed by domestic sewage and industrial operations such as food processing, meat packing, leather tanning and paper milling. They can be made harmless by the action of naturally occuring bacteria and oxygen. However, the oxygen present in the water is also necessary to support the plants, fish and other aquatic life. If the sewage load becomes excessive, the demand for dissolved oxygen exceeds the available supply, and the fish and plant life die. The amount of dissolved oxygen in water is measured by the biochemical oxygen demand (BOD). The higher the BOD, the more polluted the water. If water has a high organic pollutant content, it will require more oxygen to break down the sewage and consequently will leave the water with less oxygen.

A second aspect of sewage is disease-carrying agents. Infectious organisms can be carried in surface or ground water. There have been health problems in the valley area due to ground water contamination. Septic tanks and cesspools are the major source of ground water pollution. Although many waterborne diseases have been eliminated in the United States by chlorination and filtration, areas not supplied by municipal water systems are susceptible to such problems. New problems have arisen in municipal areas from agents suspected of having carcinogenic or other pathological properties. There has been recent concern over the discovery that well water in the valley area contains excessive amounts of manganese, a metal poison. Better known is the revelation that New Orleans residents have a higher risk of cancer due to some unspecified agents in their municipal water supply.

A third form of water pollution is plant nutrients, such as nitrogen and phosphorus. In addition to being naturally present in water in small amounts, sources include excretions from birds and animals, falling leaves, synthetic detergents, drainage from fertilized lands and runoff from animal feedlots. Since nitrogen and phosphorus encourage algae growth, the oxygen supply in the water is reduced. Conventional water purification only removes twenty to fifty percent of the nitrogen and phosphorus in waste water.

Detergents are also a source of the fourth form of water pollution, synthetic organic chemicals. Other sources are pesticides, synthetic industrial chemicals, and household cleaning products. These substances are often harmful to humans and aquatic life and some are highly poisonous in very low concentrations. They can cause taste and odor problems and conventional waste treatment is not often effective.

Inorganic chemicals and mineral substances come from mines, factories, farms, oil fields and natural sources. The most common source in the Albuquerque area is irrigation water, which dissolves minerals in the soil and underlying strata as it percolates down. The process often results in saline water, a particular problem of the underground water basins in New Mexico. Saline water occurs at several locations in the Rio Grande Basin. The water in the alluvium is more mineralized than the water in the upper part of the underlying Santa Fe Formation, although the chemical quality of the water in the Santa Fe Formation is not well known. Fresh water is present at depths of two thousand feet or more. Below that is saline water that is unsuitable for most uses. Irrigation water from lawns or farms will increase the mineralization of the upper level, fresher, water. Excessive mineralization may lower water quality, resulting in excessive hardness or an objectionable taste. Some mineralization is desirable, such as is associated with mineralized spring water. Therefore, not all substances in water are undesirable.

The sixth form of water pollution, sediments, occurs in surface water. Sediments are particles of soil, sand and minerals washed from the land and paved areas. Sediments produced by erosion is a serious problem and will be discussed in a later section. Sediments in the water greatly increase the cost of water treatment and reduce the holding capacity of reservoirs.

Another form of water pollution is radioactive substances. The sources include uranium mining, nuclear reactors and nuclear fallout. Radiation effects are often cumulative and may lead to skin cancer, leukemia, bone tumors and related diseases.

Thermal pollution is the last form. Industry and power plants are the main sources. The effects of additional heat can be positive or negative or insignificant. Thermally polluted waters are less effective at assimilating wastes and encourage nuisance plants and animals. Cooling towers, cooling ponds or artificially created waterfalls and water-sprays can reduce thermal pollution.

The chemical quality of both surface and ground water varies widely. The quality of both is influenced by the type of rocks the water comes into contact with. A steady buildup of dissolved minerals occurs as water flows downstream. Although this is a natural part of the hydrologic cycle, it is increased by human habitation. Passage through a municipal area will increase the salt concentration in water to about three hundred parts per million (ppm). Domestic and industrial sewage contribute some of the water pollution, but municipal storm water runoff can contain more suspended solids, coliform bacteria and chemically oxidizable organisms than domestic sewage. Storm runoff water is usually not treated. The amount of treatment that domestic sewage receives varies.

There are three levels of sewage treatment:[2.25]

1. primary
2. secondary
3. teriary

Primary treatment consists of a settling basin to remove suspended solid matter. Water is filtered to remove large objects, then passed through a grit chamber to remove sand, grit, cinders and small stones. Then it is passed through a sedimentation tank and the suspended solids are removed. Finally, the water is chlorinated to kill bacteria and remove odors and returned to the river.

Secondary treatment consists of trickling filters, activated sludge process, extended aeration, and stabiliation ponds. During secondary treatment the organic wastes are consumed by bacteria.

Tertiary treatment is further purification of the water. Tertiary treatment includes removal of the nutrients, such as phosphorus and nitrogen, as well as a high percentage of suspended solids. The resulting effluent will be of high quality, generally drinkable.

Recently, there have been some encouraging breakthroughs on sewage treatment, such as nuclear and reverse osmosis processes. However, many urban areas of the United States have only primary sewage treatment and sometimes none at all.

Any metropolitan area puts demands on the regional water resources. Continuing urbanization places great stress on the assimilative capacity of the river and makes it difficult to prevent water quality deterioration.

Sewage is not the only reason for an increase in the dissolved minerals in the water. Water used for industry, agriculture and landscaping will partially evaporate into the atmosphere. This will raise the dissolved mineral contend in the water that remains. The remaining water may be returned to the river or percolate down to the underground reservoir, resulting in buildup of dissolved minerals in the Rio Grande or the water table.

In addition, the process of water percolating into an underground basin changes the quality of the water. The water will dissolve some of the salts and other minerals in the rock. Generally, underground reservoirs have the most mineralization at the deepest depths. Thus, the Albuquerque underground reservoir water will probably be increasingly saline at deeper levels. Unfortunately, there is very little data on the quality of the water at the lower levels in the Albuquerque area.

In addition to dissolving minerals, the process of ground water percolation filters the water, removing suspended solids and bacterial contamination. Although ground water is thus generally protected from gross pollution, low level pollution may present a hazard. Septic tanks and cesspools are major sources of ground water pollution. It has been estimated that there are over thirty thousand septic tanks and cesspools in the Albuquerque area, sending almost six million gallons of sewage into the water table daily. In addition, ground water can be contaminated by leaching from sanitary land-fills and drainage containing chemical fertilizers and pesticides from agricultural areas and residential landscaping.[2.26]

It is not always possible to identify the actual sources of ground water pollution since the contamination process may take several years or decades, and the movement of ground water is seldom well known. Typically, the contamination increases gradually. Even when a source of pollution is found and stopped, it takes a long time before the contamination is reduced. Thus, ground water pollution is insidious and dangerous.

3. Flooding. Possible flooding is a problem in many areas of the city. These include the valley areas and areas around the canyons and arroyos on the mesas and in the foothills. There are two types of floods: main stem flooding and arroyo flooding. Main stem flooding is the result of the Rio Grande overflowing. This problem has been substantially reduced in the Albuquerque area due to upstream flood control reservoirs in Colorado and New Mexico. These include Jemez Canyon Dam, Abiquiu Dam, Galisteo Dam, Cochiti Lake, and the Middle Rio Grande Floodway. In addition, to prevent flooding in the lowlands of the Rio Grande Valley from storms over the

Albuquerque area itself, two diversion channels have been constructed. These are the North and South Diversion Channels and are designed to intercept arroyo flows on the East Mesa and discharge the water into the Rio Grande. This will prevent floodwater from ponding in the valley areas. The two channels will outlet north and south of the city. Although these diversion channels should prevent ponding in the valley of the Albuquerque area itself, the floodway system upstream and downstream from Albuquerque does not provide an adequate degree of protection. The main contribution to main stream floods in these adjacent areas is urban runoff. Thus, developments within the city of Albuquerque can have an effect on nearby areas such as Corrales, Bernalillo, Los Lunas and Belen. Also the pastoral setting of small, irrigated farms of these areas is being transformed to populated urban and suburban areas, which require a greater degree of flood protection. The levees in these areas were designed to protect the agricultural flood plain, but are insufficient to protect residential areas. The result is that lives are threatened by levee failures during floods. There also is possible damage to buildings by inundation as occurred in Corrales during the summer of 1975. The mobility and normal activities of residents of a flooded area are disrupted. The taxpayers eventually pay the cost of evacuation, relief, and cleanup after each flood.[2.27]

The second type of flood, arroyo flooding, results from a severe thunderstorm in the Albuquerque area that briefly deluges the vicinity with high intensity rainfall. Most of these thunderstorms occur during July and August and are of short duration. Although complete records of flood drainage are not kept by the Corps of Engineers or the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA), the major floods frequently cited occurred in 1955, 1961 and 1963. AMAFCA feels that the flooding problem will intensify as development in Albuquerque continues.

> A study of storms and floods occurring in the Albuquerque vicinity indicates that future floods could be significantly greater than past floods. Hazardous flooding situations created during the city's early development can multiply in the expanding suburb areas.[2.28]

The Corps of Engineers has prepared for the Albuquerque Metropolitan Arroyo Flood Control Authority a four-part series on flood plain information. Each part deals with a different part of the city. It is highly recommended that these reports be used as a reference when planning any development.

D. Biology

The valley, the mesas, the foothills and the mountains each have their own distinctive fauna and flora. The biological aspects will be discussed according to their geographical divisions.

1. The Valley. Large portions of the valley are still irrigated cropland, but much has been converted to residential

and commercial development. The valley also has some natural areas left. The area is laced with irrigation ditches which create their own mini-environment.

The valley area has been changed significantly by the presence of man. The most obvious are residential and commercial buildings and the agricultural developments, both croplands and irrigation ditches. The areas that were left natural have been invaded by exotics. An exotic is any plant (or animal) that has been introduced into an area where it is not native. Examples in the valley area are Russial olive, salt cedar and sandburs. The Bosques have characteristic stands of dense vegetation predominantly cottonwoods, russian olive and salt cedars. These forests are dotted with willows, chapparal broom and senna. There are also meadow areas with rushes and yerb mansa (sometimes known as lizard tail). Changing the river bed has created artificial marshlands around the river. Since much of the vegetation in the valley is not really native, there is a disagreement over the aesthetic and ecological values of the area. Some arguments say that the vegetation is not natural and, therefore, of less importance. However, the river area has developed into a unique mini-environment that provides an excellent habitat for many animals. Table 4 gives the floral list for the valley.[2.29]

The sandy terraces are the transition area from the valley to the mesa. The area varies from rough slopes to major eroded sections. Many major arroyos empty into the valley areas.

The characteristic vegetation includes rabbitbush, yucca, smokethorn and wolfberry. The trees, cottonwoods and willows, reach fifteen to twenty feet in height along the arroyos. Generally, the vegetation in this transition area is sparse to non-existent where there has been heavy erosion. Like the valley area itself, the sandy terraces get only an average of eight inches of rainfall annually. Here aridity is an especially limiting factor, for the water table is not as accessible as in the lowland and flood plain areas. Since the soil is generally sand and gravel, the percolation rate is high, and the rain water quickly disappears. In actuality then there is much less water available for plant life. The vegetation in these areas is mostly quick chance plants often with a total life of three days. Thus, the typical determining factors of an arid area, water and soil, are especially limiting on these sandy terraces.[2.30]

2. The Mesas. The east and west mesas are different in many factors, but both are essentially desert grasslands. The Albuquerque area is considered part of the Upper Sonoral life zone.[2.31] The classification generally covers areas with elevations of four to six thousand feet and twelve to twenty inches of rainfall annually. Since the elevation of the valley area is less than 4,000 feet, it cannot be considered part of the Upper Sonoran. The mesa areas definitely fall into the classification, although the rainfall is marginal, since the mesa areas generally receive eight to ten inches of

rainfall annually. The west mesa gets more rainfall per year, up to twelve inches annually on the flat mesa top. Grassland areas generally require ten to thirty inches of rain per year, so the marginal nature of Albuquerque's grassland is obvious.[2.32]

The rainfall is so unpredictable in the growing season that it is often difficult for disturbed areas to recover. When a grassland area is disturbed, opportunity plants take over first. These are annuals, and are shallow rooted. This stage will last from two to five years. Gradually, short-lived grasses invade. They are generally low grasses with shallow wide spreading roots. This stage can take three to ten years. Early perennial grasses come next, taking from ten to twenty years. There is a definite progression from shallow root systems to deeper, narrower root systems, from low grasses to taller grasses, and from annuals to perennials. The climax grass can be reached in twenty to forty years. Since the area is so arid, each of the stages of secondary succession is slower than is generally expected.[2.23]

Shrubs are generally succession species and increase greatly whenever the native vegetation is disturbed. If a grassland area is continually misused, such as with constant overgrazing, the shurbs can gain complete and permanent control over an areas. The large sagebrush areas of Northwestern New Mexico resulted from overgrazing.[2.34] Originally, the Albuquerque area had tall grasses dotted with shrubs. The shrubs occurred in islands in areas where grasses couldn't grow such as sandy, gravely or rocky knolls, and also buffs and talus slopes. Talus is a sloping mass of rocky fragments. The present vegetation is disclimax, resulting from periods of drought and overgrazing.[2.35] Evidence indicates that the native grasses in the Albuquerque area were established during a period of heavier rainfall than present levels. Although the climatic change has been subtle, the slight decrease in rainfall has had an effect. When the topsoil and root structure is destroyed, these grasses have a difficult time being re-established.

Vegetation on the east and west mesas is not reaching climax, but rather is being invaded by shrubs. Table 5 gives the floral list and Table 6 gives the fauna list for the mesas.

3. Foothills. The Sandia foothills have the same delicate balance between the climate and the vegetation. Although the foothilss get more rain (10 to 20 inches per year) than the mesa and valley areas, the steep slopes and unstable soils contribute to the problem. Below 5,500 feet, the area is grassland with many shrubs. Junipers begin occurring at about 5,500 feet and pinons start at about 1,600 feet. Tree cholla, skunk brush and wavy-leaf oak are common in the lower slopes. The pinon-juniper area extends to the 7,600 feet elevation, which is certainly the limit of the foothills area. In general, the foothill area is sensitive to wind and water

erosion, fire, traffic and excessive animal use. The Juan Tabo area has an annual precipitation of fourteen to twenty inches as well as eight natural springs. This area is considered a key wilflife area. Portions of Juan Tabo and the Sandia Pueblo grant are key winter ranges for bighorn sheep. Scaled quail and such unusual animals as the redspotted toad, curved-bill thrushes and roadrunners are present. The Sandia Macfarlandi Butterfly, an uncommon species, is found in the area. Three rare species of native orchids occur in this area. The vegetative community is characterized as Mexican Plateau, a unique and uncommon plant community that includes live oak. The area has a low to moderate potential for revegetating when disturbed. The vegetative ground cover is sparse and has deteriorated due to overuse. Although the area was used for grazing in the past, the recent deterioration is because of recreational activities such as off-road vehicles, pedestrians, and horses. The overuse has also resulted in soil compaction and erosion.[2.36] A foothills floral list is shown in Table 7, and a faunal list is given in Table 8.

4. <u>The Mountains.</u> At higher elevations above 7,600 feet, on both the east and west faces of the Sandia Mountains, there are belts of ponderosa pine and douglas fir, and in some areas blue spruce, englemann spruce and timber pines. The floral list for the mountains is in Table 9.

TABLE 4

FLORAL LIST

Valley

Grass

Beardgrass	Lovegrass
Bermuda	Muhly
Bluegrass	Wild Oats
Bristlegrass	Orchardgrass
Brome	Panicgrass
False Buffalograss	Ricegrass
Cottontop	Wild Rye
Dropseed	Sprangletop
Fingergrass	Squirreltail
Gamma Grass	Threeawn
Johnson Grass	Timothy

Shrubs

Bugseed	Red Sage
Virginia Creeper	Fourwing Saltbrush
Summer Cypress	Russian Thistle
Wild Plum	Winterfat

Trees

Rio Grande Cottonwood	Russian Olive
Narrowleaf Hoptree	Tamarisk
New Mexico Olive	Treeofheaven

Willows

TABLE 4 (cont'd.)

Annual and Perrenial Families

Green Algae	Lizardtail
Aster	Mallow
Buttercup	Water Millfod
Cactus	Mint
Carrot	Mustard
Cattail	Nightshade
Duckweed	Pea
Figwort	Phlox
Gentian	Pink
Geranium	Primrose
Goosefoot	Rush
Honeysuckle	Saltgrass
Hornwort	Sedge
Lily	Sunflower
Caper	Watercress

Sources: Crane, David A. and Associates (1970) Quality In Environment, (Albuq. Community Renewal Program).
Rohovec, M.D., "Quantitative Studies on the Relation of Soil Texture, Moisture Content, Hydrogen-Iron Content and Soluble Salts on the Vegetation of the Albuquerque Division of the Rio Grande Conservancy District." Unpublished Master's Thesis, Univ. of New Mexico.
Castetter, Edward F. "The Vegetation of New Mexico." New Mexico Quarterly, Volume 26, No. 3 (Autumn, 1956).

TABLE 5

FLORAL LIST

Mesas

Grass

Barley	Fingergrass	Rabbitfootgrass
Beardgrass	Galleta Grass	Indian Ricegrass
Bentgrass	Gamma Grass	Wild Rye
Bermuda	Johnson Grass	Sloughgrass
Bluegrass	Lovegrass	Sprangletop
Bristlegrass	Mannagrass	Squirreltail
Plain Brittlegrass	Vine Mesquitegrass	Threeawn
Brome	Muhly	Timothy
False Buffalograss	Needlegrass	Tumblegrass
Burrograss	Wild Oats	Prairie Wedgegrass
Cottontop	Orchardgrass	Wheatgrass
Dropseed	Panicgrass	

Shrubs

Apacheplume	Broom Dalea	Fourwing Saltbrush
Red Barberry	Canyon Grape	Mormon Tea
Bugseed	Wild Plum	Russian Thistle
Virginia Creeper	Bigelow Rabbitbush	Winterfat
Summer Cypress	Red Sage	Pale Wolfberry

Trees

Rio Grande Cottonwood	Coyote Willow	Godding Willow
	Desert Willow	Peachleaf Willow

Cacti

Brittle Cactus	Turk's Head	Englemann's Prickly Pear
Cholla Cactus	Pincushion Cactus	Strawberry Cactus

Yucca

Banana Yucca	Soapweed Yucca

TABLE 5 (cont'd.)

Annual and Perrenial Families

Aster	Goosefoot	Pea
Bluebell	Honeysuckle	Phlox
Buckwheat	Lily	Pink
Buttercup	Mallow	Primrose
Caper	Mint	Rose
Carrot	Mistletoe (parasite)	Rush
Figwort	Mustard	Sedge
Gentian	Nightshade	Sumac
Geranium		

Sources: U.S. Forest Service Dept. of Agric., Draft Environment Statement, Sandia Mountains Land Use Plan.
Castetter, Edward F. "The Vegetation of New Mexico." New Mexico Quarterly, Volume 26, No. 3(Autumn, 1965).
Patrau, Pauline M. (1970) Flowers of the Southwest Mesas McGraw Printing and Lithographing Co., Phoenix, Southwest Parks and Monuments Assoc.
Dodge, Natt N. (1973) Flowers of Southwest Deserts, McGrew Printing and Lithographing Co., Phoenix, Southwest Parks and Monuments Assoc.

TABLE 6

FAUNAL LIST

Mesas

Mammals

Badger
Swift Fox
Ord Kangaroo Rat
Desert Cottontail
Silky Pocketmouse
White-footed Mouse
Hispid Pocketmouse
Black-tailed Jackrabbit
Bannertail Kangaroo Rat
Southern Plains Woodrat
Northern Grasshopper Mouse
White-tailed Prairie Dog
Bobcat
Coyote
Grey Fox
Bats
Mountain Lion
Spotted Skunk
Hog-Nosed Skunk
Mexican Pocketmouse
Spotted Ground Squirrel
Western Harvest Mouse
Southwestern Pocket Gopher

Birds

Meadowlark
Roadrunner
Horned Lark
Brown Towhee
Morning Dove
Scaled Quail
Robin
Raven
Red-tailed Hawk
Turkey Vulture
Golden Eagle
Virginia's Warbler
Western Flycatcher
Green-tailed Towhee
Red Shafted Flicker
Violet-green Swallow
Broad-tailed Hummingbird
Grey-headed Junco
Scrub Jay
Rufous-sided Towhee
House Wren
Stellar's Jay
Western Tanger
Chipping Sparrow
Mountain Chickadee
Black-headed Grosbeak
White-breasted Nuthatch
Pine Siskin

Reptiles

Broadtailed Horned Lizard
Collar Lizard
Wandering Garter Snake
Short Horned Lizard

Sources: Crane, David A. and Associates (1970), Quality in Environment, An Urban Design Study for the City of Albuquerque, N.M. Albuquerque Community Renewal Program.
U.S. Forest Service Dept. of Agric., Draft Environ Statement Sandia Mountains Land Us e Plan.

There are several areas of unique vegetation such as the riparian species around Las Huertas and La Madera, the wet meadow area at La Cienega, the aspen and open park areas.[2.37] Some animal species that once inhabited the Sandia Mountains no longer exist there, such as the grizzly bear, wolf, pronghorn antelope, prairie dog and black-footed ferret.[2.38] Some animals on the national rare and endangered species lists may occur in the Sandias, such as the Arizona grasshopper sparrow, mountain plover and the spotted bat.[2.39] Table 8 gives the faunal list for the Sandia Mountains.

The five distinctive areas of Albuquerque, the Rio Grande Valley, the East and West Mesas, the Sandia foothills and the Sandia Mountains each has its own unique type of vegetation and animal life. They all share certain characteristics in common. The rainfall varies over the Albuquerque area, but the climate remains basically arid. The vegetation is generally fragile and if disturbed, it is difficult to re-establish. Each area has a different potential.

E. Air Quality

The air that is necessary for life on this planet has become a sink for the wastes of industrial production, construction, energy generation, waste disposal and transportation. Changes of the composition of the atmosphere have in turn caused damages to natural vegetation, crops, livestock, wildlife, structural materials and human health. Residential developments can alter the quality of air.

TABLE 7

FLORAL LIST

Foothills

Grass	Shrubs	Trees
Barley	Apacheplume	Inland Boxelder
Beargrass	Barberry	Narrowleaf Cottonwood
Cane Beardgrass	Common Chokecherry	Siberian Elm
Bentgrass	Cliffrose	Netleaf Hackberry
Bluegrass	Summer Cypress	Narrowleaf Hoptree
Bristlegrass	Fendlerbush	Common Juniper
Brome	Canyon Grape	One-seeded Juniper
Dropseed	Hairy Mountain Mohogany	Rocky Mountain Juniper
Fescue		Gray Oak
Galleta Grass	Wild Plum	Live Oak
Gamma Grass	Rubber Rabbitbush	New Mexico Olive
Junegrass	Fourwing Saltbush	Texas Walnut
Lovegrass	Utah Serviceberry	Coyote Willow
Mannagrass	Skunkbush	Peachleaf Willow
Ring Muhly	Snakeweed	Sandbar Willow
Needlegrass	Winterfat	Tamarix
Orchardgrass		Russian Olive
Panicgrass		Treeofheaven
Rabbitfoot Grass		Arizona Cypress
Indian Ricegrass		
Sloughgrass		
Squirreltail		
Threeawn		
Timothy		
Tumblegrass		
Prairie Wedgegrass		
Wheatgrass		
Drooping Woodreed		

TABLE 7 (cont'd.)

Cacti	Yucca	Orchid
Tree Cholla	Banana Yucca	Striped Coralroot
Hedgehog Cactus	Datil Yucca	Spotted Coralroot
Prickly Pear	Soapweed Yucca	Fairy Slipper
Pincushion Cactus		Bogorchid
Strawberry Cactus		

Annual and Perrenial Families

Aster	Goosefoot	Pea
Bluebell	Heath	Phlox
Buckwheat	Honeysuckle	Pink
Buttercup	Iris	Primrose
Caper	Lily	Rose
Carrot	Mallow	Rush
Fern	Mint	Sedge
Figwort	Mistletoe	Sumac
Gentian	Mustard	Violet
Geranium	Nightshade	

Sources: Crane, David A. and Associates (1970), Quality in Environment An Urban Design Study for the City of Albuquerque, New Mexico, (Albuquerque Community Renewal Program).
Castetter, Edward F., "The Vegetation of New Mexico" New Mexico Quarterly, Volume 26, No. 3 (Autumn, 1956).
Martin, William C., and Hutchins, Charles R. (1975) A Manual of the Flora of the Sandia Mountains New Mexico, University of New Mexico Press, Albuquerque, New Mexico.
Little, Elbert L. Jr. (1950) Southwestern Trees Agriculture Handbook No. 9, U.S. Dept. of Agriculture.
Arnberger, Leslie P. (1968) Flowers of the Southwest Mountains Arizona Lithographers, Tuscon, Southwestern Monuments Assoc.

TABLE 8

FAUNAL LIST

Foothills and Mountains

Mammals

Ringtailed Cat
Abert Squirrel
Bear
Mule Deer
Porcupine
Striped Skunk
Colorado Chipmunk
Long-tailed Weasel
Bobcat
Coyote
Grey Fox

Bats
Mountain Lion
Western Harvest Mouse
Southwestern Pocket Gopher
Grey-tailed Antelope Ground Squirrel
White-Throated Woodrat
Merriam's Shrew
Ringtailed Cat
Rock Squirrel
Spotted Skunk

Pinon Mouse
Rock Mouse
Rocky Mountain Big Horn Sheep
Red Squirrel
Dwarf Shrew
Deer Mouse
Eastern Cottontail
Longtail Vole
Vagrant Shrew

Birds

Hermit Thrush
Red Grossbill
Poor-will
Goshawk
Brown Creeper
White-Throated Swift
Pygmy Owl
Robin
Raven
Red Tailed Hawk
Turkey Vulture
Golden Eagle
Virginia's Warbler
Western Flycatcher
Green-tailed Towhee
Red-shafted Flicker
Violet-green Swallow
Western Wood Pewee
Grey-headed Junco
Band-tailed Pigeon
Scrubjay

Pinonjay
House Wren
Steller's Jay
Western Tanger
Chipping Sparrow
Mountain Chickadee
Black-headed Grosbeck
White-breasted Nuthatch
Pine Siskin
Yellow-bellied Sapsucker
Red-breasted Flycatcher
Olive-sided Flycatcher
Orange-crowned Warbler
Williamson's Sapsucker
Hammond's Flycatcher
Ruby-crowned Kinglet
Sharp-shinned Hawk
Broad-tailed Humming Bird
Audubon's Warbler
Hairy Woodpecker
Pigmy Nut-hatch

Curved-bill Thrasher
Roadrunner
Blue Grouse
Crow
Hermit Thrush
Cooper's Hawk
Lesser Goldfinch
Rock Wren
Brown Towhee
Warbling Vineo
Solitary Vineo
Turkey
Ladder-backer Woodpecker
Black-throated Sparrow
Black-chinned Sparrow
Rufous-crowned Sparrow
Great Horned Owl

Reptiles

Wandering Garter Snake
Short Horned Lizard

Striped Whip Snake
Patch Nosed Snake

Checkered Whip Tail
Red Spotted Road

Source: U.S. Forest Service Dept. of Agriculture, Draft Environ Statement, Sandia Mountains Land Use Plan.

TABLE 9

FLORAL LIST

Mountains

Grass

Barley	Water Foxtail	Needlegrass
Beardgrass	Fescue	Oatgrass
Bentgrass	Blue Gamma	Panicgrass
Bluegrass	Tufted Hairgrass	Timothy
Bristlegrass	Junegrass	Wheatgrass
Brome	Mannagrass	Dropping Woodreed
Dropseed	Muhly	

Shrubs

Barberry	Fendlerbush	Littleleaf Mockorange
Buckbush	Gooseberry	Hairy Mountain Mohogany
Western Black Chokecherry	Honeylocust	Arizona Red Rasberry
Elderberry	Cerro Hawthorn	Utah Serviceberry
	New Mexico Locust	

Trees

Quaking Aspen	Alligator Juniper	Limber Pine
Inland Boxelder	Common Juniper	Mexican White Pine
Mountain Cottonwood	Dwarf Juniper	Pinyon Pine
Narrowleaf Cottonwood	One-seeded Juniper	Ponderosa Pine
Red-Osier Dogwood	Rocky Mountain Juniper	Blue Spruce
Alpine Fir	Rocky Mountain Maple	Englemann Spruce
Douglas Fir	Wavy Leaf Oak	Bebb Willow
White Fir	Gambel Oak	Scouler Willow
Narrowleaf Hoptree		

TABLE 9 (cont'd.)

Orchids

Bogorchid	Spotted Coralroot	Giant Rattlesnake Plantain
Striped Coralroot	Lady's Slipper	

Annual and Perrenial Families

Aster	Figwort	Mallow	Phlox
Bluebell	Gentian	Mint	Pink
Buckwheat	Geranium	Mistletoe (parasite)	Rose
Buttercup	Goosefoot	Mustard	Rush
Cactus	Heath	Nightshade	Sedge
Caper	Honeysuckle	Pea	Sumac
Carrot	Iris		Violet
Fern	Lily		

Sources: Crane, David A. and Associates (1970), Quality in Environment An Urban Design Study for the City of Albuquerque, New Mexico, (Albuquerque Community Renewal Program).
Castetter, Edward F., "The Vegetation of New Mexico" New Mexico Quarterly, Volume 26, No. 3 (Autumn, 1956).
Martin, William C., and Hutchins, Charles R. (1975) A Manual of the Flora of the Sandia Mountains New Mexico, University of New Mexico Press, Albuquerque, New Mexico.
Little, Elbert L. Jr. (1950) Southwestern Trees Agriculture Handbook No. 9. U.S. Dept. of Agriculture.
Arnberger, Leslie P. (1968) Flowers of the Southwest Mountains Arizona Lithographers, Tuscon, Southwestern Monuments Assoc.

Air pollution can have a biological, economic, medical and aesthetic effect. An economic effect can result from an adverse biological effect such as when crops or livestock are damaged. Likewise, damage to building materials increases the maintenance cost of buildings. The damage to priceless art treasures, such as in Rome, by air pollutants has been well documented. Any bronchitis, lung cancer or asthma victim in Albuquerque is well aware of the relation between air pollution and health. The human health effects of air pollution have been estimated by the Environmental Protection Agency to incur costs of at least two billion dollars per year, as seen in Table 10.[2.40] The National Wildlife Federation estimates of human health damage costs are much higher, six billion dollars per year. They set a total cost of air pollution damage to man, property, materials and vegetation at sixteen billion dollars annually.[2.41]

The unaesthetic aspects of air pollution causes the majority of complaints. Air pollutants may offend by sight or smell, or both. Air has maximum aesthetic appeal when it is free of pollutants, low in humidity, moderate in temperature, and relatively low in velocity. Although sound may be also considered an air-related aesthetic factor, it will be discussed separately.

1. Types of Pollutants. There are eight major types of pollutants: particulates, hydrocarbons (HC), carbon monoxide (CO), nitric oxides (NO and NO_2), sulfer oxides (SO_2,

TABLE 10

Health Costs of Air Pollution

Respiratory diseases	$1,220 million
Cancer	390 million
Cardiovascular disease	470 million
	$2,080 million

Source: Environmental Quality, Second Annual Report of the Council on Environmental Quality, August 1971, Washington, D.C., p. 106.

SO_3 and H_2S) and photochemical oxidants. Table 11 gives the sources of pollution in Bernalillo County and the emission levels. Unfortunately, the data available from the City of Albuquerque Environmental Department did not include photochemical oxidants. These are formed by interaction of the atmosphere with nitrogen oxides. The major causes are transportation and industrial sources. This type of pollution is associated more with the West Coast, especially Los Angeles. Photochemical smog only occurs for a few days each year in Albuquerque.[2.42]

Particulates are the second largest type of pollutant in Bernalillo County, accounting for almost fourteen percent of all pollutants. Particulates are liquid or solid material in the air, either organic or inorganic. They include dust, fly ash, dirt, smoke, soot and metallic fume. Particulates are generated from wind erosion, construction sites, fires and industrial sources.[2.43] In Bernalillo County, unpaved roads account for most, 83 percent, of the particulates. The problem is especially acute outside the city limits. However, it affects everyone in the city as well. Unpaved roads alone account for 11.46 percent of all pollutants in Bernalillo County. Another source of particulates is nonferrous mineral industries, such as concrete and cement plants. The city lists Ideal, Universal, Wylie, Valley, and American Gypsum as the sources. Other significant sources of particulates are domestic and commercial heating, and

TABLE 11. ESTIMATE OF EMISSIONS IN BERNALILLO COUNTY

1973 Inventory Revised
May 7, 1975

TONS/YEAR

	Particulates	HC	CO	NO_x	SO_x	Category Total	% of Total
I. TRANSPORTATION							
Gasoline Internal Combustion	837	19,854	258,187	5,655	321	284,854	76.59
Fuel Evaporation	0	9,415	0			9,415	2.54
Particulates from Tires	457	0	0			467	0.13
Automotive Repair	N	74	0	0	0	74	0.02
Total Auto	1,304	29,343	258,187	5,655	321	294,810	79.28
Other Transportation (diesel & aircraft)	62	650	3,203	1,381	121	5,417	1.45
TOTAL	1,366	29,993	261,390	7,036	442	300,227	80.73
II. STATIONARY FUEL COMBUSTION							
Domestic & Commercial Heating (natural gas)	202	85	212	980	6	1,485	0.40
Domestic & Commercial Heating (fuel oil)	202	6	212	85	980	1,485	0.40
Domestic & Commercial Heating (liquified gas)	4	1	4	21	1	31	N
Domestic & Commercial Heating (wood)	1,237	301	7,632	0	0	9,170	2.47
Total Domestic & Commercial Heating	1,645	393	8,060	1,086	987	12,171	3.27
Power Generation	179	37	163	3,974	742	5,095	1.37
TOTAL	1,824	430	8,223	5,060	1,729	17,266	4.64
III. INDUSTRIAL OPERATIONS							
Non Ferrous Minerals	2,879	0	0	0	0	2,879	0.77
Wood Products	464	8	N	0	0	472	0.13
Other	458	330	432	1,844	1,814	4,878	1.32
Government Operations	90	20	94	303	285	792	0.22
TOTAL	3,891	358	526	2,147	2,099	9,021	2.44
IV. REFUSE DISPOSAL (incineration & open burning)	184	331	915	65	13	1,508	0.39
V. UNPAVED ROADS (city and county)	42,628	0	0	0		42,628	11.46
VI. AEROSOLS & CIGAR/CIGARETTE SMOKING*	1,263	0	0	0		1,263	0.34
	51,156	31,112	271,054	14,308	4,283	371,913	100.00
% OF TOTALS	13.75	8.37	72.88	3.85	1.15	100.00	

HC = Hydrocarbons
CO = Carbon monoxide
NO_x = Nitric oxides
SO_x = Sulfur oxides
N = Negligible
* 1970 Estimate

Source: City of Albuquerque Environmental Health Department
Harry Davidson, Director of Air Quality Management Section

autos.[2.44] The relationship of home heating and autos (both are aspects of residential development) will be discussed later in this section. Pollen is another type of particulate that is an air pollution problem in Albuquerque. Mike Connelly of the City of Albuquerque's Environmental Health Department has kept a record of pollen levels since 1969 (see Table 12). Clearly the months of November, December and January give the most relief to allergy sufferers. Apparently some plants peak in pollen counts twice a year. Kochia is the term used for summer cypress and red sage, both members of the goosefoot family. It is found from 4,500 to 7,500 feet elevations, which includes the mesas and foothills. There is a peak in the pollen count in both March and September. Grass peaks in both June and October, due to the different seasons of the different species of grass. Likewise, pine includes several different plants and peaks in its pollen count in both February and June. Siberian elms, also known as Chinese elms, and junipers both peak in February, while poplar cottonwoods peak around April. Tumbleweeds peak in August and ragweed in September.[2.45]

In view of the high percentage of people who came to Albuquerque because of asthma, allergies, emphysema, tuburculosis and other respiratory problems, pollen, dust and other particulates are a significant health problem in Albuquerque. For this reason it is especially important to reduce dust generation and avoid landscaping with those

Table 12

MONTHLY POLLEN COUNT AVERAGE (5 Year Average)

Month	Kochia	Siberian Elm	Grass	Pine	Tumbleweed	Ragweed	Juniper	Poplar Cottonwood
January								
February		72.00		12.78			11.12	4.46
March	1.69	6.79		2.02			7.66	20.72
April	0.18	2.01		0.33			2.60	22.66
May	0.53		1.15	3.57	0.01	0.01	2.08	3.47
June	0.90		2.93	21.38	--	--	0.07	
July	2.74		0.53	1.42	1.74	0.41		
August	9.70		0.78	0.03	3.62	0.51		
September	12.46		1.94	--	1.66	4.31		
October	1.04		2.65	0.13	0.35	0.82		
November								
December								

Source: Mike Connelly, Air Quality Control Division, City of Albuquerque Environmental Health Department, personal correspondence.

plants that are offenders. This would include junipers, pines, Siberian elms and poplar cottonwoods. Control of weeds in naturally landscaped areas and undeveloped areas would also help.

Hydrocarbons are formed by the incomplete combustion of fuels. The category includes organic acids, aldehydes, unsaturated hydrocarbons and acomatus.[2.46] Hydrocarbon is the third highest amount of pollutant produced in Bernalillo County, accounting for over eight percent of the total tons per year of air pollution. A major portion of this air pollution is from the transportation sector, autos accounting for 95 percent, and other transportation sources (diesels and aircraft) another two percent. Other significant sources are domestic fireplaces and refuse burning. Again automobiles and home heating are significant sources of air pollution.[2.47]

Carbon monoxide is the greatest air pollutant in Bernalillo County accounting for 73 percent of the total emission in tons per year. Carbon monoxide is a colorless, odorless, tasteless gas. It, along with water and carbob dioxide, are the most common products of fuel combustion. Mainly, carbon monoxide is from auto exhausts. In Bernalillo County, 95 percent of all the carbon monoxide produced is from autos.[2.48] Other significant sources are fireplaces and non-auto transportation. Unfortunately, it is rather stable in the atmosphere with a half life varying from a few days to a few months. It will eventually convert to carbon dioxide, a harmless gas.[2.49]

The most common oxides of nitrogen are nitric oxide (NO) and nitrogen dioxide (NO_2), although there are six or seven all totaled. Nitric oxides primarily result from auto and power generation. Industry and other forms of transportation are also significant sources.[2.50]

Sulfur oxides include sulfur dioxide (SO_2), sulfur trioxide (SO_3) and hydrogen sulfide (H_2S). Although hydrogen sulfide is not actually an oxide of sulfur, its sources and effects are generally similar. Sulfur oxides result from the combustion of fossil fuels, particularly oil and coal, that have a high sulfur content. Principal sources are power generating and industrial plants.[2.51] In Bernalillo County, industrial sources account for 49 percent of all sulfur oxides, with domestic and commercial heating second with 23 percent followed by power generation at 17 percent of all sulfur diodes. Another source, of course, is autos. Table 13 gives ambient air quality standards according to the <u>Code of Federal Regulations</u>.[2.52] It also gives air quality goals for the interior of buildings.[2.53]

Other forms of air pollution not listed in Table 11 are insecticides, herbicides, ammonia, lead and plastic fumes, hydrogen fluorides, and some others. These all together constitute way less than one percent of all air pollution.

TABLE 13

AMBIENT AIR QUALITY STANDARDS

	EXTERIOR (micrograms per cubic meter)				INTERIOR (Part Per Million by Volume)	
	Annual Arithmetic Mean	Maximum 24 Hour Concentration	Maximum 8 Hour Concentration	Maximum 1 Hour Concentration	Design Parameter	Maximum Value
Sulphur Dioxide (SO_2)	80	364	--	--	0.01-0.02	0.04
Particulates	75[a]	260	--	--	25-50[c]	75[c]
Carbon Monoxide (CO)	--	--	10	40	1-2	5
Photochemical Oxidants	--	--	--	160	0.01	0.02
Hydrocarbons (HC)	--	--	--	160[b]	1-2	3
Nitrogen Dioxide (NO_2)	100	--	--	--	0.02-0.04	0.08

a = Annual geometric mean

b = Maximum three-hour concentration

c = Micrograms per cubic meter

Source: Code of Federal Regulations, Title 40, Protection of the Environment, Washington, U.S. Government Printing Office, 1973; and Wohlers, H.C. (1971) "The Control of Building Air Quality," American Institute of Architects Journal, August, p. 48.

2. Sources of Pollutants. As mentioned earlier, the majority of emission in tons per year is carbon monoxide, followed by particulates, then hydrocarbons, nitric oxides and sulfur oxides, in that order. The overwhelming source of pollutants is the automobile, accounting for seventy-nine percent of all emissions in Bernalillo County. The other forms of transportation, diesel engines and aircraft, become insignificant in comparison. Clearly reducing automobile usage will reduce air pollution and thus any residential development should be analyzed to determine if auto traffic is minimized.

The next most significant source of pollutants is auto related--unpaved roads. This pollution is entirely in the form of particulates--dust, but amounts to 11.46 percent of all emissions in Bernalillo County. When the dust from unpaved roads is combined with the other forms of automobile pollution, the auto is responsible for almost ninety-one percent of all pollution in Albuquerque. This shocking total is so dominating that all other categories seem insignificant in comparison. These unpaved roads are often related to residential construction. Although the streets must be paved for a house to be eligible for FHA insurance, there is no specific requirement in the City or County Zoning Code or Subdivision Regulations, nor in the "Uniform Standards Specifications for Public Works." Nevertheless, it is an unwritten policy of the Albuquerque Environmental Planning Commission to require the developer to pave roads.

The next largest source of air pollution is also directly related to residential development. Stationary fuel combustion generates 4.64 percent of all emissions in Bernalillo County and is, thus, the third largest source. This category includes domestic and commercial heating as well as power generation by the Public Service Company. Since some of the electricity generated is used for commercial heating, all of this pollution is not attributable to residential uses. Unfortunately, the majority of the emissions is caused by wood burned in fireplaces. This source contributes 2.5 percent of the total emissions in Albuquerque, and is responsible for over half of the emissions from stationary fuel combustion. Heating and electricity are the second most significant form of air pollution related to residential development.[2.54]

Although the amount of pollutants attributable to electric power generation in Bernalillo County is only a small fraction (1.37 percent) of the county's total, much of the electricity used by homes and businesses in Albuquerque is generated elsewhere. Total power generation emissions in New Mexico amounted to 164,742 tons or 10.32 percent of all New Mexico emissions in 1967,[2.55] nearly sixty-six percent of all emissions resulting from electric power generation in New Mexico are from the Arizona Public Service Company's operation in the Four Corners area. New Mexico receives about twenty percent of the power generated by this plant. Thus, a high percentage of the pollutants appearing outside of Bernalillo County can be attributed to electricity used in Albuquerque.

Certainly, electricity and heating is second to the automobile as an air pollution source.

Air pollution is a definite problem in Albuquerque and is increasing every year. However, the situation is better here than in other cities of the same size. There is still the opportunity to solve the problem, which would put Albuquerque in an enviable position. Air pollution in Albuquerque can be reduced by methods already available and feasible. The main necessity is to eliminate dependence on the automobile. Residential developers can help with this. The reduction of other forms of air pollution can also help. These possibilities will be discussed in more depth in the chapter on mitigation of air pollution problems.

F. Summary

Residential buildings have environmental effects in several areas; in addition to the construction phase, the occupancy phase and eventual demolition phase should be considered from the onset. Living plants and animals of a region interact with each other and with non-living things such as water, soil and nutrients, as an ecological system. Items to be considered in analyzing the system include:

- o Geology

  --geological history (see Figures 3,4,5 and Tables 3, 34)

  --topography (see Figure 6)

  --seismology (see Figures 5, 6)

  --soils (see Figure 12)

  --mineral deposits

- o Hydrology

  --water supply: precipitation, surface, underground (see Figures 7, 11)

  --water pollution: oxygen demanding wastes, disease caryiṅg agents, plant nutrients, synthetic organic chemicals, inorganic chemicals and mineral substances, sediments, radioactive substances, and thermal pollution (see Table 15)

  --water treatment: primary, secondary, and tertiary treatments

  --drainage and flood control (see Figures 6, 13)

- o Biology

  --flora (see Tables 4, 5, 7, 9, 17 and 22)

  --fauna (see Tables 6, 8, 16 and Figure 2)

- o Air Quality

  --pollutants (see Tables 10, 11, 13 and 19)

  --sources of pollution (see Tables 11, 12, 14 and 25)

- Climate

  --see hydrology and biology sections (see Tables 17, 24 and Figures 7 and 11)

  --prevailing winds

  --seasonal temperature data (consult the National Weather Service for records)

- Noise

  (see Tables 28 and 29)

CHAPTER III

MITIGATION OF ENVIRONMENTAL PROBLEMS AS RELATED TO RESIDENTIAL CONSTRUCTION IN ALBUQUERQUE

A. Overview

There are many possible impacts of residential development. Any development activities will affect the natural environment. The adverse effects of residential construction can be minimized. It is crucial to anticipate possible problem areas in advance and then to design accordingly. The previous chapter defined the natural resources for the Albuquerque area. This and the following chapter will discuss possible problem areas.

The first step is to perform a natural resource inventory of the selected site. A natural resource inventory describes the existing conditions of the area. This includes the topography, geology, soils, hydrology, meteorology, flora, fauna, etc. An aerial photo of the site of the project in large scale and a contour map are important. In addition, one should consider historical aspects and any pertinent socioeconomic factors, as well as zoning and other land use considerations. Much of this data has already been compiled by the Middle Rio Grande Council of Governments, and is available for public use. However, their inventory is not in sufficient detail to provide the specific data for a particular location. Table 2 lists agencies that are recommended as data sources.

The information gathered in the natural resource inventory is used in preparing an environmental impact statement. There are two recent publications that are excellent guides in the process of preparing an environmental impact statement itself. They are "The Environmental Impact Handbook" by Robert W. Burchell and David Listoken,[3.1] and "At the Edge of the Wilderness" by Peter Montague.[3.2]

B. Geologic Problems and Solutions

1. Soils. The soils in the Albuquerque area vary a great deal. Some soils within the Albuquerque area have limitations for particular uses. The most important problems involve shrink-swell soils, shallow soil over bedrock, high water tables, poor drainage, flood hazards, slopes, soil susceptibility to sliding, erosion and sedimentation. These limitations can be overcome by the use of soil survey information. Once a soil problem is identified, ways to overcome it may be devised or it may be best to select another site. The Rio Grande Council of Governments has soil maps of the area available.[3.3]

For large scale projects, aerial maps with soil types identified are the best tools for understanding the overall situation.

Generally the soils in the valley have erosion problems, and are frequently corrosive or saline. Although the soil is usually sandy, there are pockets of gravel or clay. Some of these soils, containing clay, shrink when dry and swell when wet. Where soils have a high shrink-swell potential, foundation problems can result; therefore, it is important to design buildilngs to resist any resultant soil movement. Stronger and larger footings are necessary. Otherwise, the foundations will crack and the building will be damaged. Because of this high shrink-swell potential, there are pockets of the valley area that have moderate to severe building foundation limitations. There are also building limitations because the valley soils tend to slump.[3.4]

The water table is also high in the valley area. Where there is a high water table, a septic tank will not function well and cause pollution of the ground water such that contamination of the water table is found throughout the valley. This has been a chronic problem in the valley since most homes in the area have septic systems and we-ls. This problem will be alleviated when the water and sewer systems for the area are completed. Unfortunately though, some residents have selected not to hook into the water and sewage system, so the problem will continue to exist on a smaller scale. Although most of the valley area of Albuquerque will be hooked up to the municipal water and sewer system by 1980, the rapidly urbanizing areas north and south of Albuquerque will be plagued by problems with on-site sewage disposal. The resulting health hazards are great.

The main reason the valley area is unsuitable for residential development is that it is a flood plain. Building in a flood plain is the most common example of bad land use by planners, geologists, or environmentalists and still continues to be ignored. According to the Rio Grande Council of Governments,[3.5] the valley area has soil limitations for foundations, roads and septic systems as well as high flood danger.

Finally, the only arable soils in Albuquerque are in the Rio Grande Valley. The Atrisco area in the South Valley especially has loam soils with agricultural potential. Again, innumerable geologists, planners and environmentalists have urged the preservation of agricultural lands and have been ignored. The change in land use in the valley from agricultural to residential and commercial uses will have a strong enviornmental impact.

The soils on top of the West Mesa are very fragile, with definite limitations for residential use or vegetation growth in some areas. These soils are sometimes corrosive which will affect water utilities. The rapid permeability of the West Mesa soils results in a low water holding capacity. Therefore, landscaping will be difficult since the water will rapidly percolate down. There are other landscaping problems on the West Mesa due to the occasional presence of caliche and alkaline soils. Generally this area has a very poor topsoil with low fertility. There is some tendency for the soil to slump, but this should be no real limitation.

The West Mesa soils are clay and fine sand, and thus are particularly subject to erosion by wind or water, especially if they are disturbed. However, as long as erosion problems are considered in the planning and construction, these areas are suitable for residential development. However, there are problem areas on the West Mesa where the soil is very shallow over the bedrock (less than two feet). This is particularly true on the top of the lava flow such as part of the Volcano Cliffs subdivision. Since utilities would literally have to be blasted out of solid rock, these shallow bedrock areas are unsuitable for residential development. Where soil is difficult to excavate because of underlying rock, costs go up drastically. In soil that is shallow over bedrock, septic tanks are impractical. There are also two large playas on the West Mesa that have flooding hazards. Playas are flat beds of clay which fill with storm runoff to form temporary lakes. The clay has a high concentration of dissolved salts and is highly alkaline. These areas should also be avoided for residential development (see Figures 12 and 13.) Nevertheless, most of the East Mesa area is suitable for residential development in the areas where flood danger can be avoided. Consideration should be given in foundation design of the occasional tendency of these soils to slump or shrink-swell. Landscaping limitations do exist due to gravelly nature of the soils, the rapid permeability, the generally poor poor topsoil qualities and low fertility values of the soils.

Some portions of the Southeast Heights do have greater soil limitations, especially for vegetation, since they are frequently alkaline or contain caliche. There also may be some problems with corrosiveness, but generally the low water holding capacity and low fertility values are the main limitations. These problems can be solved by careful landscaping and soil preparation.

The bearing value of the soil affects settlement of the soil. This has been the situation in Albuquerque when houses were constructed on top of filled-in arroyos. The soil settled when it got wet, resulting in cracked foundations and walls. In some cases, the damage was so severe that recently constructed houses were condemned. Settlement can also result from lowering the ground water levels. More subtle are the problems associated with the withdrawal of water from strata which underlie, perhaps at great depth, the urban area.[3.6]

Another factor affecting the landscaping potential of Albuquerque soils is the rapid permeability and low water holding capacity. The water that is intended for the lawn and plants travels so quickly through the soil that it is lost for landscaping uses. This is a problem on all the mesa areas and in some sections of the valley.

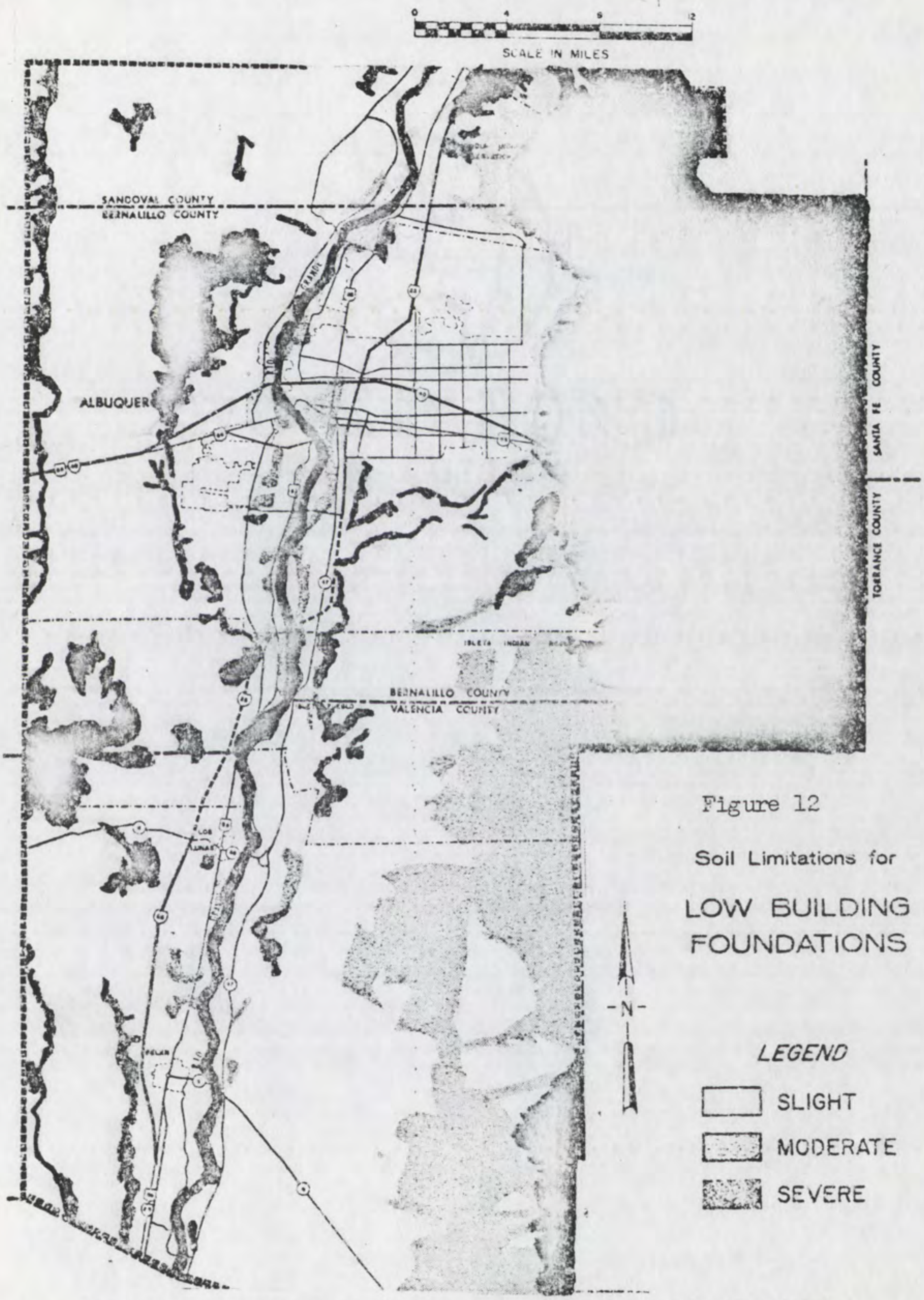
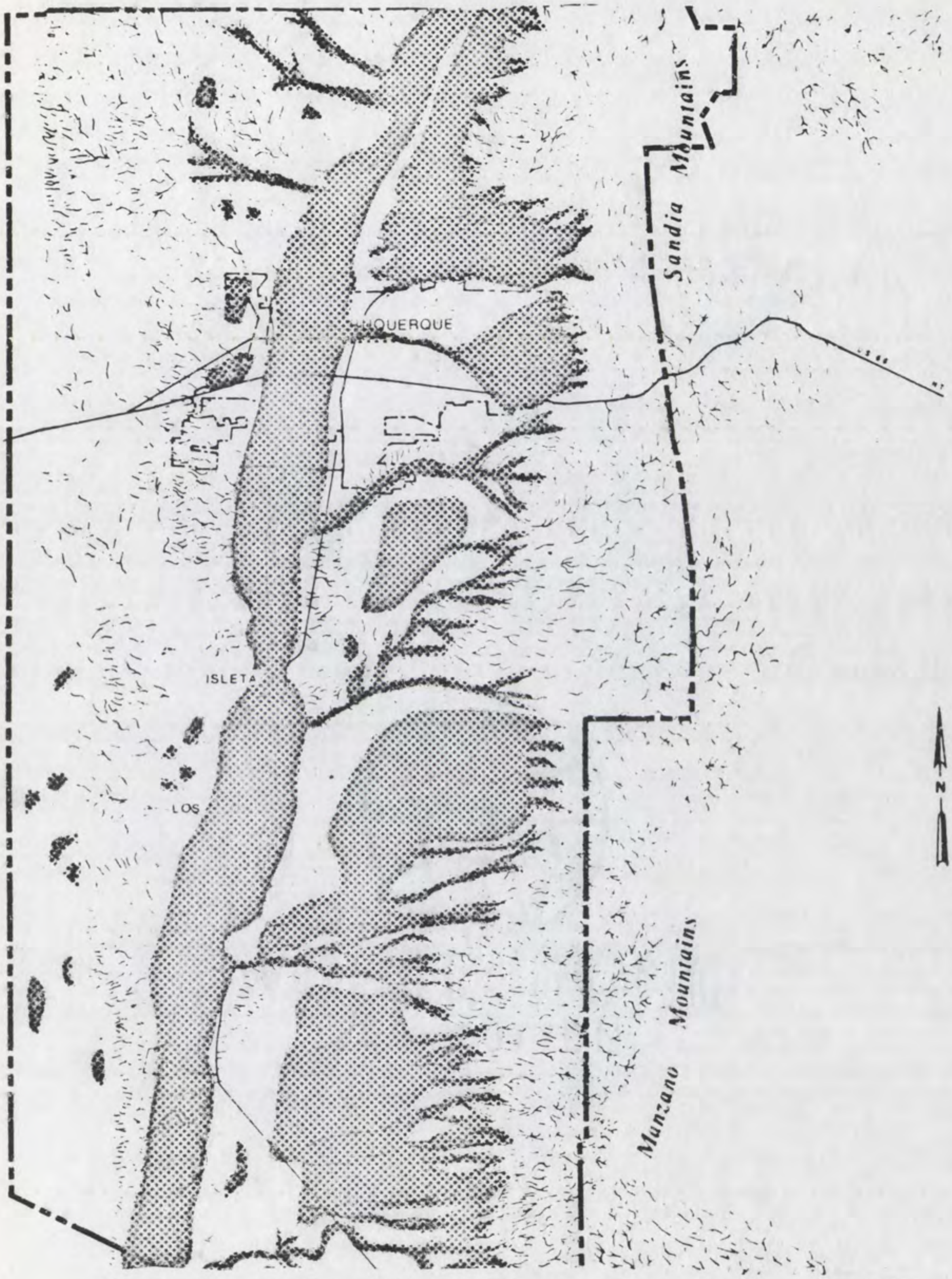


Figure 12

Soil Limitations for

LOW BUILDING FOUNDATIONS

Source: Decision Making Guide for Land Use Planning, #1, Soil Data Handbook, Special Report No. 56, Feb. 1974, Middle Rio Grande Council of Government of New Mexico, Albuquerque.



Areas of Possible Flood Hazards

Figure 13

Source: Decision Making Guide for Land Use Planning, #1, Soil Data Handbook, Special Report No. 56, Feb. 1974, Middle Rio Grande Council of Government of New Mexico, Albuquerque.

One important soil quality that could cause problems in some areas of Albuquerque is the slope. This is especially important in the foothills and mountain areas. As mentioned earlier, the steepness of the Sandias, especially the west face, makes it unlikely that they will be used for residential purposes. This unlikelihood is even greater since a large portion of the mountains is publicly owned.

As mentioned earlier, there are areas of the foothills, however, that are likely to be developed for residential use, especially the Juan Tabo area. There are definite geological problems involved in this area. The Council of Governments considers this area to have severe limitations for building foundations.[3.7] Not only are the slopes quite steep, but the soils are unstable and shallow. In most areas, the bedrock is less than two feet beneath the surface. The foothills soils are essentially decomposed granite. Although these soils don't need normal compaction when preparing for foundations, the soil will compact itself when wet and settle. Therefore, extensive watering around a house or a broken pipe will cause settlement of the soils and result in foundation problems. In order to avoid trouble, the foundation site should be excavated four to five feet and filled with ninety-five percent compacted fill. The area has already been overused, which has caused compaction and erosion of the soils. The revegetation potential is low; therefore, once an area is disturbed, it is very difficult to re-establish the native vegetation. Deterioration of the plant community will cause more runoff and accelerate erosion. Increased runoff will decrease replenishment of the aquifer as well. It is important to protect the soil and vegetation in the Juan Tabo area especially. Developments in other foothill areas such as the Elena Gallegos and Sandia Pueblo Grants will have the same problems. Because of the geological impacts, there should be no residential developments in the foothills or on the west face of the Sandias.[3.8]

2. Erosion. Erosion is an important geologic factor in the Albuquerque area. Removal of vegetation usually results in erosion of the top soil. Arroyo cutting can be traced to the destruction of the protective grassland cover because of overgrazing cattle. Loss of the top soil is a particularly pertinent problem in Albuquerque because the top soil is so very thin. Soil stability will decrease and erosion potential will increase as the result of earthwork on the site. The amount of erosion will vary according to the season, wind conditions, amount of precipitation, soil type, amount of disturbance and the quality of the site design.

Erosion by water will result in siltation, the deposit of sediment downstream of the site. In the Albuquerque area, the siltation is most likely to occur in neighboring arroyos or along the concrete drainage channels, or possibly in the river itself. Soil erosion has caused accelerated aggredation of the Rio Grande bed. Generally, all of these possibilities are undesirable. Erosion and siltation will always occur at a greater rate in disturbed earth than native earth. Newly created slope banks can be expected to erode fairly rapidly until plant materials become established, which may be a very slow process. Underground storm drains and surfaced swales will mitigate against the effects of erosion. Siltation can be one of the most significant environmental impacts of land development. Any area where the slopes are steep enough that erosion can be a problem should be carefully planned before any construction activity begins in order to prevent needless erosion.[3.9]

Soil can also be eroded by wind and traffic. The construction process will cause dust, which is a major air pollutant in Albuquerque. The dust can be minimized by minimizing grading and disturbance of existing vegetation, keeping the soil well wetted and compacted, and planting vegetative cover where appropriate as soon as possible. It should be noted that the most dust storms are during the spring months (see Table 14). April averages more dust storms than any other month, with five days when some blowing dust will occur. March storms normally last somewhat longer. Fall and early winter have the most dust. September has the least number of dust storms, recording some dust on an average of every other year. Dust storms in July and August are usually of short duration.[3.10] Since spring is often

TABLE 14

Dust Storms in Albuquerque
(16-year period 1945-1960)

Month	Total Number Of Days With Blowing Dust	Storms Classified Severe	Moderate	Light
January	14	4	3	7
February	26	7	11	8
March	44	15	12	17
April	75	18	21	36
May	55	2	8	45
June	56	5	6	45
July	38	1	2	35
August	10	0	1	9
September	8	0	2	6
October	15	0	5	10
November	13	1	2	10
December	10	3	3	4
TOTAL	364	56	76	232
Average Year	23	3	5	15

the season when construction projects are started, the most grading activity is also when there is the grestest chance of dust storms. Dust generation is a form of erosion. If this form of dust is eliminated, the amount of erosion is reduced.

During the construction phase, grading can have the most dramatic effect. It affects the native vegetation and animals, the soils, the water runoff and the air quality. Earthwork can result in changes where water percolates into the ground, or also in changes where the groundwater intersects the surface. Grading can even be an unnecessary waste of energy and a source of noise pollution. Any extensive regrading of the ground surface must be approached with great caution if the geomorphological balance is not to be upset.

This implies that grading be limited, if possible, to the actual streets, driveways, sidewalks and foundation areas. Grading may also be necessary to modify drainage patterns. In effect, grading would be done on a small, limited scale. Careful detailed site planning will be necessary. This additional design work will raise the planning cost womewhat. It is unclear whether the smaller amount of actual grading will inversely reduce the construction costs. Less grading will also affect the landscaping since the natural ground surface will not be as smooth as a graded yard.

3. Other Factors. Soils are the principal geologic factor to be taken into account in urban development. Another

important factor is natural geologic resources. It may become necessary to arrange for planned protection of the deposits in Bernalillo County. Urban pressure can put constraints on mining activity. Some sites are covered by houses. Pits and quarries tend to be dusty and noisy, and to generate heavy truck traffic. Modern pollution control techniques can materially reduce, but not completely eliminate these sources of irritation. The resulting scars in the landscape can cause objections from nearby residents. The objection of local residents is a major problem for extractive industries near urban areas. Often extracting operations are forced out or prevented from starting by the proximity of residences. Sand and gravel deposits are essential for urban growth, yet are often overrun by this same growth.

A final geologic aspect of urbanization occurs after the area is developed. The natural conditions are altered or obliterated by grading, paving, construction and landscaping. Grading and landscaping operations modify the original topography, natural vegetation, drainage and groundwater conditions of an area. The information and records are often missing. When redevelopment occurs, old structures and modified natural features that are encountered can sometimes cause problems. Examples include filled arroyo channels, quarries, tunnels, wells, cisterns, building excavation, earth and rubble fills, and buried utilities. If the designer of a replacement project was unaware of underlying conditions, then serious problems may occur during construction. Since most of Albuquerque is fairly recent, this aspect is most likely to be a problem only in older areas.[3.11]

In summary, most geologic problems can be avoided by aforeknowledge of the conditions and good engineering. If the problem is recognized and understood, ways to overcome it may be devised. Admittedly, in some cases, it may be wiser to avoid the problem by selecting another site.

C. Hydrologic Problems and Solutions

1. Flooding and Drainage Problems. Urbanization creates a double flooding problem by increasing runoff and by development of flood prone areas. Runoff is increased by the creation of large areas of impervious surfaces. Buildings, streets, driveways, sidewalks and patios are all impervious surfaces. As mentioned earlier, landscaping can also increase the runoff. Grassy lawns can generate more runoff than trees and shrubs or native vegetation. Therefore, a typical subdivision of single family detached homes can result in a tremendous increase in runoff. In addition, the natural drainage patterns are disturbed.

This increased runoff may flood adjacent streets, exceed storm sewer or arroyo capacity, or flood developed areas below the project site. Many historic areas of Albuquerque did not experience flood damage until the East Heights were developed. The heights runoff was channeled down major streets right into old residential areas. For several decades residential developers in Albuquerque have designed streets to function as storm sewers. The effects are obvious after a good summer storm because the main east-west thoroughfares (Central, Menaul, Candelaria) are almost impassable. The large arroyos that are left in development areas carry great amounts of water.

There is nothing wrong with the concept of using streets as storm sewers; the trouble comes with the definition of acceptable design criteria. The first basic assumption concerns what is an acceptable storm intensity to design for. If a design is based on the ten year flood level, this means that every ten years on the average there will occur a flood that exceeds the designed capacity. The result could be extensive damage. Therefore, in establishing as a design criteria a ten-year flood level or a fifty-year flood level, the basic assumption that the damage from a greater flood is acceptable.

Eventually it boils down to economics. It costs more money to design for a fifty-year flood than for a ten-year flood, whether the streets or storm sewers are used to handle the runoff. Storm sewers costs are proportional to the pipe size (up to three feet in diameter) since the trench cost is fairly constant.

Expensive public works projects had to be built to alleviate the situation. Clearly, failure to adequately design the drainage for a residential project can result in a large public expense. This results in a negative cost/benefit ratio. Unless the drainage plans for a project are carefully designed to handle this runoff, there will be adverse environmental effects. It is not sufficient to develop a good drainage plan for the project site itself, and then channel the runoff onto a major street. A proper design will provide that the runoff is either diverted to an arroyo, ditch or storm sewer that has the capacity to handle the load that is additional to what it has been previously carrying. The presently popular rollover curbs are too shallow to carry much storm runoff water and should not be used if the street is intended to serve as a storm sewer. The peak of a driveway break should be as high as the curb to avoid flooding driveways and possibly damaging homes.[3.12]

In addition, the maintenance costs can be a critical factor. These average about five percent of the initial capital cost per year. However, asphalt, paving and inverse crowned streets wear faster than concrete and regular crowns. The City of Albuquerque is having difficulty in financing the maintenance of presently existing streets. Unfortunately many, especially the east-west thoroughfares in the Northeast Heights, need to increase their capacity for handling storm runoff. For instance, Candelaria, Menaul, Indian School and Central were originally designed to handle only the runoff from the areas immediately adjacent to the north and south. The extensive development east of Wyoming was not anticipated. Therefore, these streets were not designed to handle all the runoff that is channeled onto them. Eventually, storm sewers will have to be installed on these east-west thoroughfares, necessitating a general obligation bond issue, or establishment of a sanitary district, all at the taxpayer's expense.

Albuquerque Metropolitan Arroyo Flood Control Authority is attempting to prevent future flooding and drainage problems. Their policy is that a development can create no more runoff than came off the undeveloped area.[3.13] These regulations are termed "defensive drainage planning."

As mentioned earlier, arroyo cutting is a continuing problem on the mesa. Flood waters are becoming concentrated into fewer arroyos due to both natural processes and manmade processes. Sometimes the feeder channels of one arroyo will cut into the headwaters of another arroyo, thus increasing the water flow of the second arroyo. Eventually, there are a few larger arroyos, which carry a tremendous amount of water, and thus have very destructive erosion capacity. Development also disturbs the natural drainage patterns. Smaller arroyos and gullies are erased by the bulldozer. The streets form new drainage channels.

The interfan areas of the alluvial fans at the base of the mountains are susceptible to considerable concentrations of flood water. Developments at the mouths of these canyons would be in danger. Kelly points out that Embudo, Embudito and Sunset-Montgomery canyons converge in a rather heavily inhabited area, posing a threat to those residents.[3.14] For this reason, residential developments in these areas should be avoided.

Building in arroyos is asking for trouble. In addition to increasing drainage problems and flood danger, arroyos are the primary areas of infiltration or ground water recharge. However, the most serious problem can be foundation settling. Some residential developments in Albuquerque were built over arroyos that had been filled. Water continued to flow in the underground channels and caused problems with the foundations settling. Damage was sometimes extensive and some homes were declared unusable.

In areas where development is being planned, drainage should be designed to use existing arroyos. It may be necessary to concentrate the runoff into one or two arroyos and provide flood control reservoirs in order to eliminate the possibility of flash floods in the areas below. Arroyos and catchment areas often provide opportunity to solve two problems simultaneously. They can become planned open space areas, providing recreation, flood control and ground water recharge areas. A series of these catchment areas would reduce the danger of flash floods by continually diverting the water. They could also serve as recharge traps.

The site would have to be excavated and refilled with gravel and covered with topsoil and sod. The amount of water each catchment area could handle is controlled by the State Engineer's Office. Ten acre feet of storage is allowable per retard structure without a permit. In addition, the State Engineer requires that any retard structure be empty within ninety-six hours. These design criteria are feasible. Therefore, it is possible to design a residential development that does not adversely affect the drainage patterns and flooding problems of an area.

In addition to designing storm runoff systems, there are other methods for minimizing flood damage. Selective zoning can reserve designated floodway zones. The local government determines the degree of flood risk allowable and the requirements of the city's zoning criteria for the area. The Corps of Engineers and the Albuquerque Metropolitan Arroyo Flood Control Authority recommend the hundred year frequency as the intermediate required flood criteria. In addition, the subdivision code already prescribes street widths, burb and gutter requirements, and elevation of land to avoid flooding. The Building Code should specify the structural integrity of buildings during flood periods, such as elevation control, strength considerations and susceptibility to deterioration involving materials, anchorage and other flood proofing. Unfortunately, there are many older homes in flood prone areas that would not meet such criteria. Governmental policies can limit the extension of public roads, utilities and other services into flood prone areas. Other governmental actions include preservation of floodways through urban renewal; providing favorable tax adjustments for open space lands; and retaining membership in the National Flood Insurance Program. Financial institutions can refuse funding for projects that would intensify flood problems.[3.15]

2. Water Quality Problems. A residential developer faces a variety of hydrological problems, including drainage, flood control, water supply, liquid waste disposal, and solid waste disposal. All such problems affect water quality. Residential developments affect each of these problems. Table 15 gives the ambient water quality standard for public waste supplies.

Presently the City of Albuquerque produces over twenty-five million gallons of sewage per day. Treatment consists of the reduction of solids and infectious organisms followed by the reduction of oxygen demand. Part of the time, the sewage is chlorinated. Albuquerque has two trickling filter plants; an activated sludge process is presently being added. The sewage is discharged into the Rio Grande.

Albuquerque's waste water disinfection was improved in 1974 but it still remains a problem. Presently the levels of fecal coliform bacteria frequently violate water quality standards. The levels are highest during the summer, from

May through September, when thunderstorms result in rural and urban runoff. Since Albuquerque has separate sewer systems for storm runoff and domestic sewage, the danger of storm water causing a spill-over of comestic sewage is not a problem. However, storm runoff does not receive complete waste treatment, resulting in the high levels of fecal coliform bacteria during hte thunderstorm seasons. This problem is aggravated by seepage and runoff from feedlots, dairies, farmlands, rangelands and leachate from sanitary landfills.[3.16] A residential development does not have control over these aspects. Urban storm water runoff in Albuquerque has not been qualitatively sampled so the problem cannot be attributed to any one or more specific sources. However, the negative aspects of storm water runoff from residential developments can be substantially reduced by the flood control methods discussed earlier. Catchment areas provide not only flood control, but act as a sediment trap and infiltration area.

A second water pollution problem is the level of phosphorus. The concentration of dissolved and total phosphorus increases by five to ten fold as the Rio Grande passes through Albuquerque. This level of nutrient loading is considerably higher than what is considered acceptable in other areas of the United States. Such an excessive level of phosphorus generally causes problems with algae growth. Fortunately, these problems have been minimized in the Rio Grande downstream

TABLE 15

AMBIENT WATER QUALITY STANDARDS FOR PUBLIC WATER SUPPLY

pH	5-9
Alkalinity	75% of natural
Fecal coliform bacteria	1,000 col/100 milliliters
Nitrates	45 milligrams per liter (mg/l)
Phosphorus	0.02 milligrans per liter (mg/l)
BOD	0.5 milligrams per liter (mg/l)
Mercury	0.002 milligrams per liter (mg/l)
Lead	0.05 milligrams per liter (mg/l)
Iron	5 milligrams per liter (mg/l)
Selenium	0.01 milligrams per liter (mg/l)

Source: "Comparison of TAC, AS, and Proposed EPA Numerical Criteria for Water Quality." Washington, D.C., U.S. Environmental Protection Agency, 1973.

of Albuquerque. The ratio of nitrogen to phosphorus is also an important water quality factor. Generally, the optimum ratio of nitrogen to phosphorus for supporting algae growth is between twn and fourteen to one (10:1 to 14:1). However, in the Rio Grande below Albuquerque, the ratio is only about 2:1 (1.6 mg/l total nitrogen and 0.8 total phosphorus).[3.17]

A third water pollution problem in the Rio Grande is heavy metals. Elevated concentrations have been noted of arsenic, boron, copper, iron, manganese, selenium, lead, chromium and cadmium. However, these levels may often be the result of natural weathering in areas geologically rich in a resource and also the concentrating effect of evaporative losses in the river. There may be problems with the elevated concentrations of boron, manganese, selenium and possibly arsenic, but further interpretation of the available data is tentative. Residential developments are not a major source of the heavy metal concentrations.[3.18]

Other regional water quality problems include high sediment load and salinity concentration.

There are several approaches to improving the regional water quality. It is expected that Cochiti Dam will improve the situation by providing a more constant level of stream flow. Since drought flows would then be augmented with the reservoir water, the concentration of pollutants will not be as high.

Land application, such as irrigation with waste water, can provide excellent water treatment and some aquifer recharge.

Sewage treatment is a traditional method of water quality control. Since the requirements for water treatment are increasing, reuse of effluents is being considered. Presently over sixty percent of Americans use water that has already been used at least once. This recycled water has been naturally or artificially purified. The first city in the world to actually recycle its waste water into drinking water was Windhoek, Southwest Africa in 1968. South Lake Tahoe, California was the first U.S. city to institute advanced waste water treatment resulting in water suitable for drinking.

3. Construction and Water Pollution. Construction has long been recognized as a significant source of water pollution. In 1972, the Federal Water Pollution Control Act was amended, requiring the states to draw up plans to deal with water runoff from construction sites by January 1, 1975. Construction was placed within the scope of Areawide Waste Treatment Plans. This act will certainly have a far-reaching effect on residential construction.[3.19] As discussed earlier, the major pollutant produced is soil that has been eroded and becomes sediment in the river. Although sediment deposition normally is a natural part of biological and geological cycles, the situation is now unbalanced. "About two-thirds of all sediment being deposited in our lakes and streams is of unnatural origin."[3.20] Dow Chemical reported that small urban areas can have erosion rates of up to 100,000 tons per

square mile-year compared with 100 tons per square mile-year that would be the natural erosion rate.[3.21] There are many techniques available to control erosion, either temporarily or permanently. The Environmental Protection Agency has published several guides on this. Techniques include:

1. Hydraulic devices such as ditches, pipelines and channels (sometimes paved).
2. Storage devices such as ponds.
3. Check dams of mixed gravel and earth or grouted riprap or concrete energy dissipator dams.
4. Dikes or beams to direct the flow from sensitive areas.
5. Gabions, erosion control mats, straw bales, sandbags and wire mesh.
6. Terracing and contour plowing.
7. Staging of construction schedule.
8. Grasses, either by seeding, sodding, plugging or sprigging.[3.22]

It should be noted that although Albuquerque has little rainfall, runoff from a summer rainstorm is often heavy and very destructive. Therefore, it is important to plan ahead for erosion control.

During construction existing sanitary sewers may have to be intercepted or moved. This can also be a source of water pollution. Another potential source is from soils contaminated with industrial wastes or pesticides. Due to the limited industrial and agricultural activities in the Albuquerque area, this problem would only occur in very specialized instances.

Another problem that can result from construction practices is water table changes.

> Settlement associated with the lowering of the ground water levels is well known, and in certain loose natural deposits wetting the soil has been found to lead to significant settlement....The recognition of this possibility is important in the urban scene, where ground water levels may be altered by construction procedures or changes in the water regime.[3.23]

Thus, it is important to know beforehand if the development is planned over a deposit that is likely to settle. Then ground water levels can be stabilized by construction procedures or avoidance of significant lowering of the ground water levels.

D. <u>Biologic Problems and Solutions</u>

1. <u>Wildlife.</u> The construction phase often has the greatest biological effect. Regardless of which area of Albuquerque it is in, construction implies the removal of vegetation. Not only are the plants removed from the actual building site, driveway and sidewalk areas, but the traffic from men and equipment normally destroys most of the plant life in the surrounding area. Grading entails drastic removal of vegetation. The removal or burying of vegetation destroys habitat for the animal population. The mere presence of man and equipment will cause many animals to desert an area,

especially the larger species. For instance, where leapfrog development in Albuquerque has left vacant lots, only small mammals and reptiles, as well as limited bird species, remain living there. The animal population which is displaced is forced to compete for the available food supply with the residents of the neighboring area which they are forced to enter. The capacity of the adjacent land to support these species will then be exceeded. Continual development of certain areas may completely destroy a limited habitat, such as Bosques in the Rio Grande Valley area. Certain areas of the West Face of the Sandias provide a unique home for some species, and there would be no suitable substitutes if these areas were completely developed. If similar undeveloped areas are near the site to be developed, it can be presumed that representatives of the fauna will be present.

Human presence disturbs large animals the most. In addition, domestic pets (dogs and cats) frighten away some carnivores. They certainly affect small animals such as squirrels, rabbits, mice and birds. These animals generally have high reproductive rates so the domestic pets may overcompensate for the loss of native carnivores.

Roadways have exacted a great toll of animals, including birds, mammals and reptiles. Regardless of whether they are diurnal or nocturnal, wildlife is susceptible to road-kill. This is especially true with multi-lane roadways and increased vehicle speeds. Road construction such as the proposed Sandia

Loop drive is a definite danger to wildlife in the area. Since wildlife habitats are generally decreasing, it is important that wildlife losses to highway mortality be reduced. Chances for survival can be increased by techniques such as providing passage over or under roadways, by bridges and large culverts. Roadside reflectors can be set at angles to shine in the eyes of approaching animals to frighten them. Sometimes it helps to remove fences or barriers along highway shoulders. If a roadway would force wildlife to cross a road in order to use watering areas, a drinking device can be installed to cancel the need for these animals to cross. Structures and devices to provide for wildlife can be placed to accommodate animal access routes after an analysis of the area reveals significant animal tracks. Wildlife will follow natural land forms as access routes from one place to another. Such animal trails can be found between hills, along water courses, in ravines or canyons and in the dense brush if the area is sparsely vegetated. Reducing the number of animals killed crossing roadways benefits not only the wildlife but adds to driver safety.

The extinction and endangering of wildlife can have irreversible effects on the ecosystem, making the environment more susceptible to unwanted change. For instance, the unrestricted taking of nonpoisonous reptiles may result in large rattlesnake and rodent populations, since some nonpoisonous snakes prey upon venomous snakes in addition to small mammals. Wildlife can exist, even benefit, from living in close proximity to man. Deer, quail, rodents, waterfowl, songbirds and fishes are among many species of wildlife whose numbers have increased as a result of man's direct or indirect influence. But the key to wildlife's coexistence with man is that nautral habitats must be maintained and, for some species, created to compensate for their natural habitat deficiencies. This abundance of wildlife is possible through the scientific principles of wildlife management. Simply this involves bringing water, shelter or cover and food into close proximity for the improvement of animal habitats.

2. <u>Landscaping.</u> Just as some wildlife can coexist with man, some plants can coexist. However, as mentioned earlier, the vegetation in the Albuquerque ares is very sensitive. Climax vegetation is in a dynamic equilibrium with the climate and the soil. Climax is a stable balance in the predominant vegetative types present. Any significant disturbance results in increased competition, and thus the species composition eventually changes. Often earlier succession species or invading species take over after native vegetation is disturbed. Thus, areas designed as open spaces may end up with the grasses being replaced by tumbleweeds, prickly pears, chollas, rabbitbush and creosote. The mesa vegetation is sensitive to wind and water erosion, fire, traffic, grazing and even excessive amounts of animal use.

There is such a delicate balance between climate and vegetation in the Albuquerque area that it is impossible to have any traffic on native vegetation. There is not a single natural grass that can stand the traffic of even a few people. Since the plant communities in the Albuquerque area are so extremely fragile, a totally naturally open space area cannot exist on either the east or west mesas. It is possible to have a managed "semi-natural" area, with careful site planning that preserves any large shrubs and trees that may exist on the site. These can be supplemented with other plants that would do well, both native and non-native species.

a. Natural areas. In many cases, revegetation is necessary. Revegetation is the replacement of plant cover on areas that have been denuded by grading, erosion, fire or drought. This is especially important on slopes that are subject to erosion. Possible replanting methods include seeding, sodding, plugging, sprigging, dulling, spot planting or hydroseeding, although grading may also be necessary. Sometimes seeding is done on a large scale by aircraft. Spot planting and sprigging are similar. A hole is made and the sprig planted. Hydroseeding is spraying a slurry of seeds and water on the site. It is effective on cuts and grades, but erosion problems cna result when irrigation or watering is attempted. Drilling is effective in level grades. A machine makes a hole and deposits the seed. Sometimes just watering an area is sufficient. However, in many cases, the natural vegetation should be supplemented by landscaping.

Some residential developments in the Albuquerque area have incorporated open space areas where the vegetation was left natural. La Luz, a residential development on the west mesa, is the most obvious example. The developers of La Luz took care to leave large open space areas with native vegetation. The high traffic areas were intensely landscaped with grass, shrubs and trees, but even there, the shrubs and trees were carefully chosen from native species or readily adaptable species such as will be discussed later.

When La Luz was being constructed on the west mesa, care was taken to minimize disruption of native vegetation in those areas intended to be left as undeveloped open space. However, it was necessary to dig a ditch for the water and sewer lines across the open space area. The disturbed areas were reseeded with native grasses and carefully watered. With this additional attention, it has taken about six years for these areas to return to normal. For the first couple of years, while the grasses are just getting started, the typical succession sequence occurs. The tumbleweeds and other opportunity plants dominate. Interestingly though, once the natural grasses have regained a hold on a disturbed area, the tumbleweeds and annuals disappear.[3.24]

Some development in the east slopes of the Sandias have tried to retain the wooded setting. Tramway Park (just west of the tram) has limitations in the contracts that specify what artificial landscaping is allowable. The intention is to retain as much of the feeling of the natural setting as possible. However, each of these projects has had an impact on the plants and animals. All larger species of wildlife that were present in the area have been forced out by the presence of humans and pets. The traffic on the natural areas will affect many plants, and eventually the types of plants present will change. Those projects on the Sandia's east slope will also drive off the larger animals. The smaller plants and younger trees will be affected, but not as dramatically as on a mesa area.

The tramway area development also affects larger animals. The small size of the lots guarantees that the effect on vegetation will be drastic. leaving only larger shrubs and forcing out many smaller animals also. There is a relationship between the size of the area left natural and how the vegetation and animal life are affected. Although any human presence affects the wildlife, the larger the natural area, the less dramatic the effect. With a typical single-family-detached home type of development, the biological effect will be great. Likewise, if the land area is used intensely, such as covered with apartment houses and paving, there is little chance for wildlife. However, cluster developments with open space areas have the least negative effects, especially if the project is planned with an awareness of the interaction of humans and the plant and animal life.

Landscaping the site should follow the environment parameters of aesthetic and wildlife values. Blending a developed site into existing plant communities can help to preserve the vegetative integrity of an area and make the project more compatible with the natural environment. Vegetation of course provides food and nesting cover for desirable wildlife. It is generally unfeasible to rely on only the natural vegetation in areas designated as open space unless it remains virtually undisturbed since few areas of Albuquerque can withstand much traffic. It is very expensive to leave open space areas in a single-family-detached-house type of development. Including natural areas in a residential development implies either higher costs, higher densities, or sacrificing the single-family house. Many cluster-type or planned-unit developments (PUDs) have the same densities per acre as traditional single family detached housing. There is a larger open space area and minimal private yards. Since the clustering reduces construction costs, this approach is often less expensive than typical subdivision developments. It does have a greater benefit by providing more wildlife areas.[3.25]

Proposed development sites should be assessed for rare and endangered species (see Table 16 for a list of endangered species in New Mexico). Specimen vegetation could then be maintained by hand clearing. Equipment operators should be made more aware of environmental values, and penalty clauses should be provided in construction contracts for their preservation. Earth moving should be monitored to prevent unnecessary adverse effects on natural environments, and effects should be made to improve or maintain wildlife habitats regardless of site design or area use. For example, escape cover could be planted at golf course edges. Condominiums and cluster developments could be landscaped with trees that provide foods preferred by wildlife. Small environments such as arroyo vegetation should be preserved as much as possible. Buffer zones for wildlife can lessen the impact of development. Parks and greenbelt designs should include the planting of native vegetation to a greater degree. Consideration should be given to the food and nesting values of trees and shrubs used in the landscaping. Foot traffic should be aesthetically guided away from specific areas of parks or greenbelts during certain times of the year for the benefit of nesting wildlife.

Open space and wildlife in the natural habitat are essential to man's survival and psychic well being. Attempts to justify a resource solely by its economic value are bound to fail; although some wildlife resource value can be quantified, most cannot. Proper judgment of values or choice among resource allocations must be based on more than market economics.

TABLE 16

ENDANGERED SPECIES AND SUBSPECIES OF NEW MEXICO

Group No. 1. Species and subspecies whose prospects of survival or recruitment in New Mexico are in jeopardy.

Mammals

white-sided jackrabbit, Lepus callotis gaillardi
black-footed ferret, Mustela nigripes
river otter, Lutra canadensis sonora
jaguar, Felis onca arizonensis

Birds

Mexican duck, Anas diazi novimexicana
(southern) bald eagle, Haliaeetus leucocephalus leucocephalus
caracara, Caracara cheriway audubonii
peregrine falcon, Falco peregrinus anatum
aplomado falcon, Falco femoralis septentrionalis
white-tailed ptarmigan, Lagopus leucurus altipetens
sharp-tailed grouse, Pedioecetes phasianellus columbianus
sage grouse, Centrocercus urophasianus
coppery-tailed trogon, Trogon elegans canescens
buff-breasted flycatcher, Empidonax fulvifrons pygmaeus
sulphur-bellied flycatcher, Myiodynastes luteiventris swarthi

Reptiles

Gila monster, Heloderma suspectum suspectum
(Chihuahuan) ridge-nosed rattlesnake, Crotalus willardi silus

Fish

shovelnose sturgeon, Scaphirhynchus platorynchus
American eel, Anguilla rostrata
Gila trout, Salmo gilae
Colorado River squawfish, Ptychocheilus lucius
bluntnose shiner, Notropis simus
beautiful shiner, Notropis formosus
proserpine shiner, Notropis proserpinus
Pecos gambusia, Gambusia nobilis
Gila topminnow, Poeciliopsis occidentalis occidentalis

TABLE 16 (cont'd.)

Group No. 2. Species and subspecies whose prospects of survival or recruitment within the state are likely to be in jeopardy within the foreseeable future.

Mammals

Mexican long-tongued bat, *Choeronycteris mexicana*
Sanborn's long-nosed bat, *Leptonycteris sanborni nivalis*
southern yellow bat, *Lasiurus ega xanthinus*
(Arizona) black-tailed prairie dog, *Cynomys ludovicianus arizonensis*
southern pocket gopher, *Thomomys umbrinus emotus*
prairie vole, *Microtus ochrogaster* ssp.
coatimundi, *Nasua narica molaris*
marten, *Martes americana origenes*
mink, *Mustela vison energumenos*

Birds

olivaceous cormorant, *Phalacrocorax olivaceus* sspp.
Mississippi kite, *Ictinia misisippiensis*
black hawk, *Buteogallus anthracinus anthracinus*
osprey, *Pandion haliaetus carolinensis*
(Mexican) turkey, *Meleagris gallopavo mexicana*
buff-collared nightjar, or Ridgway's whip-poor-will, *Caprimulgus ridgwayi*
violet-crowned hummingbird, *Amazilia violiceps elliotti*
broad-billed hummingbird, *Cynanthus latirostris*
blue-throated hummingbird, *Lampornis clemenciae* sspp.
red-headed woodpecker, *Melanerpes erythrocephalus caurinus*
Gila woodpecker, *Centurus uropygialis uropygialis*
thick-billed kingbird, *Tyrannus crassirostris pompalis*
beardless flycatcher, *Camptostoma imberbe ridgwayi*
Mexican chickadee, *Parus sclateri eidos*
Bell's vireo, *Vireo bellii* sspp.
varied bunting, *Passerina versicolor* sspp.
Baird's sparrow, *Ammodramus bairdii*
Mexican junco, *Junco phaeonotus palliatus*
McCown's longspur, *Calcarius mccowni*

TABLE 16 (cont'd.)

Reptiles

smooth softshell turtle, Trionyx muticus muticus
(western) spiny softshell turtle, Trionyx spiniferus hartwegi
(Texas) slider turtle, Pseudemys concinna texana
bunchgrass lizard, Sceloporus scalaris
(sanddune) sagebrush lizard, Sceloporus graciosus arenicolous
mountain skink, Eumeces callicephalus
giant spotted whiptail lizard, Cnemidophorus burti stictogrammus
rough green snake, Opheodrys aestivus
(Sonora) coachwhip, Masticophis flagellum cingulum
(blotched) plain-bellied water snake, Natrix erythrogaster transversa
narrow-headed garter snake, Thamnophis rufipunctatus
(Pecos) western ribbon snake, Thamnophis proximus diabolicus
Arizona coral snake, Micruroides euryxanthus euryxanthus
(mottled) rock rattlesnake, Crotalus lepidus lepidus
(Arizona black) western rattlesnake, Crotalus viridis cerberus
Mojave rattlesnake, Crotalus scutulatus scutulatus

Amphibians

Jemez Mountain salamander, Plethodon neomexicanus
Sacramento Mountain salamander, Aneides hardyi
(eastern) barking frog, Eleutherodactylus angusti latrans
Colorado River toad, Bufo alvarius
(Blanchard's) cricket frog, Acris crepitans blanchardi

Fish

Zuni mountain sucker, Pantosteus discobolus yarrowi
roundtail chub, Gila robusta
redbelly dace, Chrosomus erythrogaster
loach minnow, Tiaroga cobitis
suckermouth minnow, Phenacobius mirabilis
roundnose minnow, Dionda episcopa
spikedace, Meda fulgida
rainwater killifish, Lucania parva
Pecos pupfish, Cyprinodon sp.
"Chihuahua" pupfish, Cyprinodon sp.
White Sands pupfish, Cyprinodon tularosa
bigscale logperch, Percina macrolepida
Pecos darter, Etheostoma lepidum
mottled sculpin, Cottus bairdi
brook stickleback, Culaea incostans

Source: New Mexico State Game Commission's Regulation No. 563. As adopted January 24, 1975.

b. Urban Landscaping. Since many areas of Albuquerque are unsuitable for totally natural landscaping, some iscussion of landscaping considerations is appropriate. The personal and cultural values of residents strongly effect their landscaping decisions, although the local climate is a cominating factor. Easterners try to recreate their former homes with green lawns, shade trees, and flowering plants.[3.25] They are often accustomed to areas with rolling hills and space enclosed by large trees. Others, from urban areas, are also used to enclosed spaces, such as the canyons of New York City. Basically, Easterners find the openness of the southwest exciting but disturbing. Actually, creating enclosures is compatible with Albuquerque's environment. The use of walls, patios, courtyards, porches, verandas, and vegetation provide windbreaks and shade. Wind and dust are important factors of the climate here, and can made the out-of-doors less than pleasant. The shade provided by walls, roofs and plants is important in summer for reducing the solar heat. However, it is a common misconception to consider Albuquerque as a hot arid area, and then to design accordingly. Actually, it gets very cold here in winter, with a record lowest temperature of 17^{o} below zero in 1971, and an average of 107 days a year below 32^{o}. The average winter temperature from October to April is 45^{o}, the same as Portland, Oregon, Evansville, Indiana and Washington, D.C. Thus, windbreaks can also reduce the winter wind chill. The wind, dust and summer heat are especially important aspects for the mesa areas of Albuquerque. The valley areas run 10^{o} cooler, and the mountains can be considerably cooler. The terrain in the valley and the mountains can break up the wind. The dust factor is reduced in those two areas by the vegetation.

The dominant visual character of the mesas is openness. Enclosed spaces provide a pleasant contrast. Since the openness is often disturbing to people, the contrast can be comforting and accent the delightful vista. Thus, a patio or courtyard with intensive plantings is a much better landscaping approach than grassy lawns. The valley and mountain areas are not as open, windy, hot or dusty, so an enclosed space is not as important. The foothills have an open vista on one side and the steep mountain slopes on the other. Artificial enclosure does not have as intense a psychological effect, because the mountainside provides a natural enclosed effect. Since the area is subject to winds, dust and heat, the patio can make outdoor areas more useful.

The sharp contrast between summer heat and winter cold implies that deciduous plants are best for shade, leaving conifers more for year-round windbreaks. Green is commonly associated with coolness and, thus, plants help to create a cooler feeling in summer. Generally, trees can narrow the seasonal temperature range, reducing the summer maximum and increasing the winter maximum. They also can increase the humidity especially when planted intensely around a small area. The aridity of the area makes any increase in humidity desirable. The quasi-desert motif, with gravel, pinons, yucca and cactus, commonly used for landscaping the area, does not provide an effective wind or sun screen nor reduce dust nor generate much greenness and humidity. Carefully planned, intensely planted areas are more effective. Planting intensely in a small area can have a great psychological effect, causing a feeling of lushness with very little actual vegetation. Therefore, a court or small yard with a few deciduous trees for shade, a windbreak of conifers, a wall covered with vines, and several planters with flowers would convince one they had found a lush tropical garden in the middle of the desert.[3.26] It would be an appealing and effective use of plants with a minimum use of space and water.

There are several factors to consider when choosing plants for landscaping. The soil is generally alkaline and often low in iron. Since conifers frequently prefer moist acid soils, this is a problem, although the acidity can be raised and iron can be added. The low humidity and periods of drought eliminate some plants as possibilities. For instance, englemann spruce and douglas fir both need a moist soil. The pinon pine is very drought resistant. Most willows prefer a moist soil, but the coyote willow is drought resistant (see Tables 17 and 18). Sometimes the planting technique can help the chances of a tree that is not particularly drought resistant. The amount of natural water available

TABLE 17

SUITABLE NATIVE TREES

	Ornamental	Shade	Shelter Belt	Erosion Control	Height	Native Elevation (ft.)	Climatic Factors	Flowers, Fruits	Air Pollution
Pinon Pine	X				15'-35'	5,000-7,000	Drought resistant	Edible Nut, Cone	Sensitive to Hydrogen Fluoride
Ponderosa Pine	X		X		80'-150'	5,500-8,500		Cone	Very sensitive to air pollution
Englemann Spruce	X				80'	8,000-12,000	Needs cool moist climate	Cone	
Blue Spruce	X		X		80'	7,000-11,000	Needs moist soil	Cone	
Douglas Fir	X	X	X		100'-190'	5,200-10,000		Cone	Sensitive to HF & SO_2
White Fir	X	X			150'	5,500-10,000		Cone	
Alpine Fir	X				90'	8,000-12,000		Cone	
Soaptree Yucca	X				3'-6' (25')	1,500-6,000	Drought resistant	White flower	
Narrowleaf Cottonwood		X		X	50'	5,000-7,000		Catkins	
Rio Grande Cottonwood		X			40'-100'	3,800-6,000		Catkins Seed Capsules	
Gooding Willow				X	20'-50'	150-5,000			Very sensitive to SO_2 and ozone
Coyote Willow				X	6'-15'	0-7,000	Drought resistant	Seed capsules	Very sensitive to SO_2 and ozone
Scouler Willow	X	X			small	8,000-10,000		Seed capsules	Very sensitive to SO_2 and ozone
Desert Willow	X			X	25'	1,500-6,000	Needs moist soil	White, pink flowers	
Utah Serviceberry	X				5'-16'	2,000-8,500		White flowers, Blackberry	
Cerro Hawthorn	X				15'	5,400-8,000	Drought resistant	White, orange flowers	
Cliffrose	X			X	3'-6' (25')	3,500-8,000	Drought resistant	Whitish flower, feathery fruit	
New Mexican Locust	X			X	25'	4,000-8,500		Pink flowers, reddish pod	Sensitive to air pollution
Inland Boxelder		X			50'	4,000-8,000	Drought resistant	Green flowers, "keys"	Sensitive to HF
Red Osier Dogwood	X				8'	6,000-9,000		White flowers, white fruit	
Russian Olive	X			X	25'		Drought resistant		Sensitive to SO_2 and ozone
Rocky Mountain Juniper	X		X		20'-50'	5,000-9,000		Blue "berry"	Very tolerant

TABLE 18

OTHER NATIVE TREES (Not Particularly Suitable for Landscaping)

	Height	Native Elevation	Climatic Factors	Flowers, Fruits	Comments
One-seeded Juniper	10'-25'	3,000-7,000		Blue berry	Allergen
Common Juniper	3'	8,000-11,500			Low shrub, allergen
Quaking Aspen	40' (80')	6,500-10,000	Cool, moist	Catkins	
Peachleaf Willow	30'	3,000-7,000		Catkins	
Gray Oak	(65') shrub	5,000-7,000	Drought resistant	Acorn	Usually a scrub oak
Wavy Leaf Oak	1'-6' (15')	5,000-7,000	Drought resistant	Acorn	Carpet forming shrub
Gambel Oak	20'-70' (6')	4,000-10,000		Acorn	
Netleaf Hackberry	30'	2,500-6,000		Orange fruit	Forms galls
Hairy Mountain Mahogany	15'	5,000-8,000	Drought resistant	Yellowish flower	
Common Chockecherry	25'	4,500-8,000		White flowers, dark red fruit	Forms thickets
Catclaw Acacia	23'	0-5,000		Yellow flower	Vicious spines, allergen
Mesquite	(20'-50') shrub	0-5,500		Yellow flower and pod	Pest
Narrowleaf Hoptree	13'	3,500-8,500		Green flower	
Rocky Mountain Maple	25'	7,000-9,000	Moist soil		Requires moist soil, needs wind protection
Western Soapberry	25'	2,400-6,000		Yellow fruit	Poisonous fruits
French Tamarisk-Salt Cedar	10'-15'	0-5,000		Pink flowers	Good for erosion control, but a pest
Allthorn	3'-6'	1,500-5,000		Black berries	Thorns

can be increased by planting trees in a deep well filled with sand.[3.27]

When planting in an urban area it is wise to consider the effect of air pollution on a tree. Although the research reports are not complete on the effects of all types of air pollution and kinds of trees, different trees respond differently. It is known that sulfur dioxide, hydrogen fluoride, and ozone are the major tree despoilers. According to the U.S. Forest Service, ozone has affected trees and shrubs up to one hundred miles away from any metropolitan source.[3.28] (See Table 19 for the response of trees native in this area.) Of the native plants, ponderosa pine is the most sensitive to air pollution, and junipers in general are the most tolerant species. In the other two Tables (17 and 20), consideration is given to the trees' tolerance to air pollution when the information was known. Generally, the non-native trees that were recommended are chosen on the basis of their tolerance to air pollution.

Susceptability to wind damage can be an important consideration. Trees with brittle wood such as douglas fir, the tree-of-heaven, and apricots can be severely damaged by high winds. Generally, those native trees that occur on the mesas are tolerant of the wind. For non-native trees, Table 20 gives an indication of their tolerance of wind. The effectiveness of a windbreak is proportional to the height of the trees. Generally, a ten percent reduction in the wind speed

TABLE 19

RESPONSES OF TREES TO POLLUTANTS

	Pollutant								
	Sulfur Dioxide			Hydrogen Fluoride			Ozone		
Tree Species	Tolerant	Intermediate	Sensitive	Tolerant	Intermediate	Sensitive	Tolerant	Intermediate	Sensitive
Juniper (all species)	X			X			X		
Ponderosa Pine			X			X			X
Douglas Fir		X				X	X		
Singleleaf Pinon	X					X	X		
Arborvitae (all species)			X		X		X		
Russian Olive		X		X				X	
Willow (all species)			X	X					X
Alder (all species)			X		X				X
Gambel Oak	X				X				X
Live Oak	X				X				
Honey Locust		X			X				X
Apple (all species)			X		X				X
Maple (all species)	X				X		X		

can be expected for three times the tree height to the windward side and twenty times the tree height to the leeward side.[3.29]

When there is a potential erosion problem in an area intended as open space, planting native trees, such as one of the willow species, Russian olive or New Mexican locust, is recommended. The cliffrose would also be effective, although it is only found west of the Rio Grande.

Many fruit and nut producing trees are adaptable to Albuquerque's climate and should be considered. Frequently there is a warm spell during late March and early April bringing the fruit trees into bloom. Unfortunately, late spring freezes are common during the last part of April and sometimes the early part of May. Thus, many fruit crops are destroyed or reduced. The varieties recommended in Table 21 are chosen for their late blooming as well as adaptability to the Albuquerque climate. There is still the possibility that a late frost will affect the crop. Apricots and sweet cherries are the earliest bloomers and especially susceptible to frost damage. Although peaches also bloom early, the suggested varieties, especially redhaven and raritan rose, are tolerant of frost.[3.30]

Landscaping decisions should consider the soil and alkalinity, the wind, aridity and air pollution factors as well as the aesthetic decisions. The tables attempt to provide

TABLE 20

Recommended Non-native Trees

	Tolerates Wind	Tolerates Dry Soil	Tolerates City Conditions	Height	Flowers	Recommended by USDA
Norway Maple			yes	50'		yes
Sycamore Maple	yes		yes	80'		
Horse Chestnut		no	yes	40'-60'	pink, yellow	
Tree of Heaven	no	yes	yes	50'		
Silk Tree		yes	yes	35'-75'		
Catalpa			yes	50'		yes
Hackberry		yes	yes	50'		
Washington Hawthorn	yes		yes	25'	white	
White Ash			yes	75'		yes
European Ash			yes	75'		
Velvet Ash		no		40'	yellow, green	yes
Green Ash		yes	yes	50'		yes
Ginkgo		yes	yes	80'		
*Thornless Honeylocust	yes	yes	yes	70'-80'		
*Golden Raintree	yes	yes	yes	30'	yellow	
Crop Apple	yes		yes	15'-25'	pink, white	
London Plane Tree (sycamore)		yes	yes	80'-100'		yes
Bradford Callery Pear			yes	25'	white	
*Japanese Pagoda Tree		yes	yes	70'	white	
Village Green Zelkorsia			yes	75'		
Narrowleaf Poplar				75'		yes
Lanceleaf Poplar				75'		yes
Silver Linden			yes	100'		yes
Siberian Elm		yes	yes	50'		yes
Chinaberry		yes	yes	50'		

*Especially Recommended

TABLE 21

RECOMMENDED FRUIT TREE VARIETIES

Fruit	First Bloom	Recommended Varieties	Comments
Apple	April 23	Royal Red Delicious	Needs a Pollinator
		Yellow Delicious	Good Pollinator
		Turley (Stayman Variety)	Winesap Apple
Apricot	April 1	Tilton	Freestone
Peach	April 12	Redhaven	Yellow Freestone
		Raritan Rose	White Freestone
		Mayflower	White Cling
		Blazing Gold	Yellow Cling
Pear	April 17	Anjou	
		Bartlett	
Plum	April 19	Italian	Prune
		Stanley	Prune
Sour Cherry	April 21	English Morello	Large, Dark Red
		Montmorency	Medium, Red
Sweet Cherry	April 14	Bing	

Source: Trujillo, Phillip M., Hocks, Ronald F., and Sullivan, Darrell T. Tree Fruit Variety Trials, Espanola Valley Branch Station, 1953 to 1968, June 1972, Las Cruces New Mexico, Agriculture Experiment Station Bulletin 599.
Corgan, J. N. and J. V. Engle, D.S. Sullivan, and M.B. Jones, "Peach Variety Evaluation in Southern New Mexico," Agricultural Experiment Station, New Mexico State University, Research Report 104, December 1964.

information on a tree's adaptability. Native elevation can also be an important consideration. Those plants found at higher, cooler elevations especially need compensation for the change in climate conditions. Table 22 suggests a few native flowers and shrubs that would be attractive. For various reasons, these suggestions for native trees do not include any members of the oak, elm, or cedar families. Most native oaks tend to be low scrub oaks, less than six feet tall, although specimens of Gray Oak and Gambel Oak occasionally reach sixty-five feet in height. The only native member of the elm family is the net leaf hackberry which forms galls and is not very attractive. The cedars generally do not tolerate city conditions, especially air pollution, very well. The velvet ash is found in some parts of the southwest and is listed under recommended non-native trees. The plants listed in Table 18 are not recommended because of thorns, inedible fruits, a tendency to form thickets, or an inability to adapt to dry alkaline soils or city conditions.

c. Beneficial effects of landscaping. Vegetation provides many beneficial effects. These illustrate how closely interrelated are the various environmental factors, Vegetation has cross effects with the air quality, the water quality and quantity, the soils, the wind, the temperature, and many other environmental factors.

TABLE 22

Recommended Native Flowers

Rabbitbush
Wild Zennia

Squawapple
Wolfberry

Clematis
Fernbush

Bluebonnet
Mockorange

Apache Plume
Rasberry

Although plants can be adversely affected by air pollution, vegetation can often reduce air pollution. Air pollution consists of gases and aerosols. Generally, the gases are carbon monoxide, carbon dioxide, nitric oxides, sulfur oxides, hydrogen fluorides, and ozone. Many gases originage from the combustion of a fuel, especially gasoline, coal and oil. Hydrogen fluorides are commonly produced in the manufacture of brick and ceramics. Some gases, ozone and peroxyacetyl nitrate, are produced photochemically. Plants convert carbon dioxide into oxygen through the process of photosynthesis. If there is sufficient vegetation, the relative level of oxygen and carbon dioxide will be maintained. Plants can absorb some gases, such as sulfur dioxide, but will be injured if there is a lot present. Generally, areas with natural vegetation have a higher capacity to absorb carbon monoxide than do soils under cultivation. As mentioned earlier, the reaction of a plant to air pollutants varies with the type of plant. Sulfur dioxide, fluorides and ozone are the major tree despoilers. Whether or not a tree will die as a result of air pollution depends upon a number of environmental factors, such as proximity to pollution, duration of contact with the pollutants, the tree's age and genetic makeup. Generally, air pollutants injure trees through their foliage. Pine trees are generally more susceptible than broad leaf trees. Conversely, conifers are also best for reducing air pollution, both gases and aerosols.

Aerosols are particles, either solid or liquid, such as smoke, fumes, dust, pollen, fibers, or microbial spores. They often can remain suspended in the air for extended periods of time. Trees can effectively filter certain aerosols, especially those that are smaller than forty microns. Thus, dust, pollen, chlorides, fluorides and radiation can be reduced by vegetation. Vegetation can reduce air pollution, but can also be harmed by it.[3.31]

There are cross effects between vegetation and water quality and quantity as well. The best protection against soil erosion in canyons and arroyos is to use natural vegetation. Many native species have deep root systems, while most domestic landscaping plants are very shallow rooted and therefore are not as effective in controling water and soil movement in most areas (see Table 17 for suggested native trees for erosion control). Native plants usually require less water than related domestic vegetation. Shrublands are invaluable as a deterrent from erosion and as preventatives of flash floods. In areas of steep topography, trees are excellent for prevention of erosion. By reducing erosion, the silt and debris levels in the water decrease. Vegetation also reduces the particulate and undissolved materials as well as dissolved materials in the water. The damage from minor floods is lessened. Forested areas produce more permanent and uniform stream flow.

There are benefits to more urban areas as well. A more uniform stream flow reduces the need for artificial storage of water. However, surface water in arid areas suffer high evaporation losses. Since much of the urban water in Albuquerque and other cities in New Mexico is supplied from underground reservoirs, the infiltration rate of water is important. Large amounts of rainfall in Albuquerque runs off into the river. A large portion of land area in a typical residential development is covered with impervious surfaces, buildings, patios, driveways, sidewalks and streets. Given the same soil percolation rate, the type of vegetation affects the infiltration rate of water. Grass lawns get less infiltration that other vegetation, such as shrubbery. Table 23 gives infiltration rates for comparison.

Since some of the rain that falls on vegetation is absorbed by the plants, vegetation can reduce the water yield of an area. The humidity is increased by transpiration with higher humidities in forests than in open areas and the highest humidities near the ground. Forests can even cause minor variations in the precipitation patterns.[3.32] Generally, vegetation increases water quality and the humidity but reduces the water yield of an area.

Vegetation benefits the soil not only by preventing erosion but also by organic buildup of the soil, and enhancing the degradation of rocks into soil components. Frequently, solid waste materials from sewage treatment can be used as

Table 23 - Infiltration Rate of Vegetation

Type of Vegetation	Infiltration Rate
Woods	0.58 inch per minute
Fields	0.28 inch per minute
Lawns	0.10 inch per minute

fertilizer, thus alleviating another chronic urban problem.

The climatic benefit of vegetation has been discussed earlier. Almost all climate effects are beneficial to arid areas. Certainly the shade and the reduction in the solar heat reflected are desirable. Even plants on the roof would help prevent excessive temperatures. The narrowing of the seasonal temperature ranges, the increased humidity and the reduction in wind velocity are all beneficial effects.

Plants can reduce noise. Dense conifer forests are most effective. Unfortunately, to be effective in noise attenuation, vegetated areas would have to be excessively dense and very wide. A residential development would have low traffic noise if it were separated from a main artery by woods 660 feet wide. That is not a practical alternative for residential developments in the Albuquerque area.[3.33]

There is a financial value to vegetative cover as an animal habitat, a pollution guard, an erosion control and a climate modifier, since man would have to pay for whatever could be substituted for vegetation. Unfortunately, the common landscaping practices do not optimize the contributions from plants. It need not be more difficult nor more expensive to design with an awareness of the local environment requirements.

E. Air Pollution Problems and Solutions

Clearly every residential development affects regional air quality. The two primary sources of air pollution from residential development were discussed earlier. They are motor vehicles and fixed sources (power and heating).

A basic concept in discussing air pollution is the regional air shed. This is the air overlying a geographical region, such as a metropolitan area. Frequently several adjacent cities or areas which share intermixed air pollution problems are lumped together. Thus, the regional air shed for the Albuquerque area could be considered to include those areas in Bernalillo County that are outside the city limits as well as the city itself, such as the North and South Valleys, Corrales, Bernalillo, Belen, Los Lunas, and Tijeras Canyon.

Any urbanization can have an effect on air quality. Table 24 lists some of the climatic changes produced by cities. Not all of these effects can be avoided, but not all of the effects are necessarily undesirable. For instance, slightly more precipitation and somewhat less wind could certainly be considered desirable in Albuquerque.

In order to assess the impact a residential development will have on air quality, it must be determined whether the population addition will be from true regional growth or from intra-regional migration. It can sometimes be argued that the same population would still be residents of the Albuquerque

Table 24

CLIMATIC CHANGES PRODUCED BY CITIES

Element	Comparison With Rural Environs
Contaminants:	
Dust Particles	10 times more
Sulfur Dioxide	5 times more
Carbon Dioxide	10 times more
Carbon Monoxide	25 times more
Radiation:	
Total on Horizontal Surface	15 to 10% less
Ultraviolet, Winter	30% less
Ultraviolet, Summer	5% less
Cloudiness:	
Clouds	5 to 10% more
Fog, Winter	100% more
Fog, Summer	30% more

Element	Comparison With Rural Environs
Precipitation:	
Amounts	50 to 10% more
Days with 0.2 in.	10% more
Temperature:	
Annual Mean	1 to 1.5°F more
Winter Minima	2 to 3° more
Relative Humidity:	
Annual Mean	6% less
Winter	2% less
Summer	8% less
Wind Speed:	
Annual Mean	20 to 30% less
Extreme Gusts	10 to 20% less
Calms	5 to 20% more

Source: Wohlers, H. C. (1971) "The Control of Building Air Quality," American Institute of Architects Journal, August, p. 47.

area even if the particular project were not built and that the total pollution would not increase. If present residents were simply being relocated within the region, the development would not cause as great an air pollutant addition to the regional air shed. However, a large portion of Albuquerque's growth is from in-migration and an increase in population means an increase in air pollution. People are moving here both from other areas of New Mexico and from other areas of the United States. Even if the homes in a development were bought entirely by present residents of Albuquerque, their previous homes would become available to new residents and the city would experience additional air pollution. It is a moot point that they would move here anyway. Therefore, it is necessary to estimate the total emissions contribution of the project to the regional air shed.

1. Motor Vehicles. As mentioned earlier, the main source of air pollution created by any housing project will be from motor vehicles. Unless a proposed project is enormous in scale, the auto emissions from one residential development will seem insignificant due to the small number, proportionally, of vehicles involved. However, the cumulative effect of several residential developments becomes significant. Although one apartment complex on Montgomery Boulevard did not make a significant contribution to air pollution, the total effect of many apartment complex on Montgomery has caused a noticeable change in the local air quality and has also become a

significant factor in the air quality of the Albuquerque region.[3.34] An estimate of the emissions added to the regional air shed from motor vehicles belonging to residents of proposed projects can be calculated. Table 25 gives the basic rates for different pollutants. The factor in pounds per mile is based on data from the Environmental Protection Agency for 1972. However, the amounts of carbon monoxide, hydrocarbons and nitrogen oxides generated per vehicle mile is decreasing due to pollution control devices. The usage rate is also based on EPA data[3.35] which gives an average mileage of 12.5 miles per gallon, a total of 500 X 10^6 gallons of gasoline consumed per year, for an automobile population of 750,000. This results in an average rate of 22.8 miles per day per vehicle. Using an average of 1.6 vehicles per household results in an average usage rate in pounds per day per household. To calculate the total air pollutants contributed by a particular residential development, simply multiply the rate for each pollutant by the number of households, e.g.:

TOTAL POLLUTANT = Total Rate X Number of Households

If it is felt that the development will generate a higher or lower daily mileage, or that the average household will have more or less vehicles, simply recalculate the rates. The general formula is:

TOTAL RATE = Factor (lb/mi.) Daily Mileage/Vehicle

Table 25

FACTORS FOR ESTIMATING RESIDENTIAL EMISSIONS

	Factor lb/mi.	Usage Rate lb/day/vehicle	Total Rate lb/day/household	Factor $U/10^6 ft^3$	Total Rate lb/day/household	Rate With Fireplace
Carbon monoxide	0.109	2.49	3.98	20	.0047	.4229
Hydrocarbons	0.02	0.46	0.73	8	.0019	.0184
Nitrogen Oxides	0.0134	0.31	0.49	50	.0118	.0118
Sulfur Oxides	0.00039	0.0089	0.014	0.6	.00014	.00014
Particulates	0.00065	0.015	0.024	19	.0045	.0722
TOTAL POLLUTANTS					.023	0.525

<u>Assumptions</u>: 22.8 miles per day per vehicle
1.6 vehicles per household
16.83 cubic feet per household for usage rate of stationary sources

Source: Environmental Protection Agency "Compilation of Air Pollutant Emission Factors" AP-42 (revised February 1972).

Although air pollution from motor vehicles is related to residential development, the quality of emissions from automobiles cannot be controlled by the developer, but are regulated by state and federal standards. Nevertheless, the way a subdivision is designed can have an effect on air quality.

The unpaved roads problem is particularly acute in the county, outside the city limits. The county wishes to avoid a situation like Rio Rancho Estates (which is in Sandoval County), where there are miles of unpaved roads. Bernalillo County is trying to encourage continuous development from an access point. That means roads are developed and paved as they are needed, rather than grading the entire street pattern of a development project at the beginning. The unpaved roads will continue to be a problem, however, because some projects are still being approved without paved roads, and because of the large number of unpaved roads already existing. Even if the county had enough money to pave and maintain all county roads, there would still be a problem due to the number of private roads. Nevertheless, all future residential developments should have paved roads.

There are other aspects of subdivision design that effect air quality. For instance, meandering layouts for subdivision make it difficult to establish bus routes or other forms of mass transit, thus furthering the dependence on the automobile for transportation. The quantity of automotive emissions can be reduced by reducing the number and length of vehicle trips. For instance, early establishment of commercial facilities in the development will significantly reduce the number of shopping trips to outside areas. The mileage traveled per household can vary depending on where they live, work and other facets of their life style. Thus, developments far removed from the urbanized area will generate more total air pollutants than those adjacent to or within the urbanized area. Small neighborhood stores for groceries, gas, laundry, dry cleaning and drugs would reduce driving considerably. These could be combined with a string of optimally sized shopping centers along transit routes to further reduce our dependence on the automobile. Sprawl encourages strip development and the result is more driving and more air pollution. Therefore, air pollution considerations imply the same conclusions as the biological considerations. It is better to build densely with residential and commercial uses intermixed and adjoining open spaces, than it is to continue sprawl patterns. Once again, cluster-type developments are the most environmentally desirable.[3.36]

All this is pie-in-the-sky until developers adopt new approaches and local planning commissions put policies into effect. Deterioration of air quality will continue until the dependence on the automobile is eliminated and a substitute for the internal combustion engine is developed.

2. Fixed Sources. As already discussed earlier, regional air quality will also be affected by the type of energy used

in the residential units. Table 26 gives the types of fuels used for space heating and water heating in all occupied housing units in Albuquerque. The projections show that the use of all fuels except electricity for space heating will decrease. Nevertheless, utility gas will still remain the dominant fuel. The use of electricity for water heating is projected to decline with utility gas taking up the slack. Again, utility gas is projected to remain the dominant fuel for water heating.[3.37] As mentioned earlier, the pollution generated by natural gas equipment can be minimized by careful tuning. The pollution generated by all fuels except electricity will contribute directly to the Albuquerque regional air cell. The use of electrical energy transfers the air pollution emissions to the source of electric power generation. Local electrical generating plants use gas, but the majority of electricity consumed in New Mexico is generated at the Four Corners plant which uses coal. The pollutants resulting from that operation do not go directly into the Albuquerque region air shed, and thus are not accounted for in the Bernalillo County Emissions Inventory. Table 25 attempts to give the factors for estimating residential emissions from stationary sources. These include furnaces, other space heaters, water heaters, stoves, other gas-fired equipment and electrical equipment. The factor is in pounds per 10^6 dubic feet and is from Environmental Protection Agency data for 1972. This factor will actually vary according to the

Table 26

TYPES OF FUEL USED FOR SPACE HEATING AND WATER HEATING
IN ALL OCCUPIED HOUSING UNITS IN ALBUQUERQUE, NEW MEXICO

		Space Heating				Water Heating			
		1970	1980	1990	2000	1970	1980	1990	2000
Total Number of Housing Units		94,223	113,975	135,975	155,800	94,223	113,975	135,975	155,800
FUEL	Utility Gas	93.3%	88.0%	85.3%	83.1%	91.9%	94.3%	95.4%	96.3%
	Electricity	2.4%	10.0%	13.6%	16.8%	4.3%	3.7%	3.3%	2.7%
	Oil	0.8%	0.2%	0.1%	-	0.1%	-	-	-
	LP Gas	2.7%	-	-	-	2.1%	-	-	-
	Other	0.7%	1.8%	1.0%	0.1%	0.1%	1.6%	1.2%	1.0%
	None	0.1%	-	-	-	1.6%	0.4%	0.1%	-

Source: TRW Systems Group Solar Heating and Cooling of Buildings (Phase 0) Volume I, II, III, 31 May, 1974. Prepared for: National Science Foundation RANN/Research Applied to National Needs, Washington, D.C. 20550, Contract No. NSF C-853, TRW Report No. 25168.003, One Space Park, Redondo Beach, California.

fuel mix in a particular household or subdivision. The pollutants generated by an all electirc home differ from those generated by a home that relies on utility gas for space and water, heating and cooking. The total is calculated by multiplying the factor by an average usage rate of 235.6 cubic feet per day per household, e.g.:[3.38]

TOTAL POLLUTANT - Total Rate X Number of Households

Two rates are given; one for households without fireplaces and one for households with a fireplace. The emissions rate of households with a fireplace is almost twenty-three times the rate for households without a fireplace. The additional pollution from fireplaces is carbon monoxide, hydrocarbons and particulates. In spite of the sentimental appeal of fireplaces, this drastic difference in emission levels is a definite air pollution problem. This problem is more significant than it appears because this pollution is generated mostly during the winter, a season when inversions often cause air pollution crisis. Although fireplaces only amount to a small percentage on a year-round basis, the actual proportion contributed by fireplaces during winter months is clearly much higher. According to Harry Davidson, director of the Air Quality Management Division of the City's Environmentalist Health Department, people in Albuquerque use fireplaces more than in other parts of the country. He points out that almost all of the new houses and apartments in the city have fireplaces, and the sale of fireplace wood has almost quadrupled since 1970. Since a fireplace is not commonly used as a main source of heating, but rather for pleasure, it is questionable how long the air pollution situation in Albuquerque will allow people to use their fireplaces. The city may eventually reach the point where it will have to prohibit the use of fireplaces. London had to take such drastic measures to alleviate its classical air pollution situation. Therefore, residential developments in Albuquerque should no longer include fireplaces.[3.39]

If automobiles, dusty roads and fireplaces disappeared overnight, stationary fuel combustion would amount to one-third of all emissions in Bernalillo County. The fuels used for space heating, water heating and electrical generators include natural gas, fuel oil and liquified gas. Natural gas is used predominantly in home heating units. Unfortunately, the units are not kept properly tuned. Just as auto pollution can be minimized by adjusting the ratio of air to gas, likewise furnaces, stoves, water heaters and other gas burning equipment can be properly tuned to minimize the pollutants generated. Although it is possible to increase the efficiency of furnaces and water heaters, the average household does not have efficient, well tuned gas equipment. Generally, apartments and condominiums produce less pollution because their maintenance personnel tune them more carefully. Therefore, air pollution in Albuquerque would be reduced if homeowners kept their equipment well tuned and if there were more multi-unit housing. Certainly, heating and electricity are the second most significant form of air pollution related to residential development. Since people must have homes, the problem is a matter of minimizing the pollution generated by each household. A housing project should be designed to minimize the pollution from furnaces, space heating, water heating, other gas fueled equipment, and electric power.[3.40]

Naturally, the emissions generated by a residential development can be further reduced by alternate energy sources such as solar and wind energy. Simply using energy conservation techniques in the design can reduce the emissions level of a development because reducing the amount of fuel consumed reduces the amount of pollutants generated.

Energy conservation techniques and development of non-pollution alternate energy sources could make a great difference in air quality. However, achieving and maintaining desirable levels of air quality will depend partly upon direct modification of pollution producing processes. The quantity or the types of pollutants being produced can also be changed by using different fuels or raw materials. Pollution can also be reduced by adding mechanical devices to prevent pollutants from escaping into the atmosphere. These are all direct methods, and have technical and economic limitations.

Residential design should also include air pollution considerations. From the large scale, long term outlook, air quality is affected by such considerations as land use mix, zoning codes, building codes and land use policies, and other aspects of urban development. The design and operation of the transportation system is an integral part, and air quality is affected by arterial highways, road maintenance, location of public facilities, and the availability of alternatives to the automobile. The actual design of the building is a consideration. This would include factors such as the heating and ventilating systems, the choice of building materials, and the site selection and orientation.[3.41]

3. Air Pollution Resulting from Construction. Although most of the air pollution resulting from residential developments is generated after the homes are occupied, the construction phase also generates pollutants.

The construction process will cause dust which is a major source of air pollution in Albuquerque. The degree of erosion will depend on the season, wind conditions, amount of precipitation, soil type, amount of disturbance, and the quality of the site design. Contractors may have to pay much more attention to dust control and water runoff at construction sites due to the 1970 Clean Air Act. One section in this bill calls on states to institute measures requiring dust control during construction and at demolition. These measures would include the application at construction sites of chemicals or water on roads or other surfaces that could give off dust. Open trucks transporting dusty materials would have to be covered and dust would be contained during sandblasting. See page 115 in the section on geologic factors for further discussion of air pollution resulting from construction activities. Hopefully, these measures would control not only air pollution and water runoff problems, but also cut down on erosion.[3.42]

Another source of air pollution during construction is from vehicular emissions. These include the vehicles directly involved in construction, those transporting building materials to the site, and the vehicles used by the workmen in commuting to and from work. The normal pollutants resulting from fossil fuels can be expected, such as nitric oxides, carbon oxides, sulfur oxides, hydrocarbons and particulates. Hopefully, the pollutants from the vehicles and the contractors' equipment would be within existing emission standards. It should be noted that, although these pollutants are of a temporary nature, Albuquerque is under increasing pressure to conform to the Environmental Protection Agency's standards on vehicular pollution.

A third class of air pollution is the construction materials themselves. Although there is little regulation presently of such things as fumes from asphalt roofing, air quality standards issued in the spring of 1971 by the U.S. Environmental Protection Agency will affect construction techniques and materials. Already, asphalt fumes are considered a source of air pollution by the City of Albuquerque. In 1973, asphalt fumes accounted for 707 tons of emissions in Albuquerque. Unfortunately, the City's regulations on asphalt only apply to particulates, but not to carbon monoxide. There have been local incidents where workers were injured by carbon monoxide fumes from asphalt operations. Other materials and techniques will be affected by future regulations. For instance, local air pollution laws in Chicago, Philadelphia and New York have banned spray-applied asbestos. This will probably be of no consequence to residential construction in Albuquerque, since spray-applied asbestos is mainly used in fire-proofing material for steel framed towers. Nevertheless, other materials and processes may eventually be regulated.

Thus, there are three types of air pollution associated with construction: dust, vehicles and equipment emissions, and building materials. All are of short term duration and often can be avoided.

Many sources, such as the National Wildlife Federation's Environmental Quality Index, consider air pollution to be the worst environmental quality problem.[3.43] William Ruckelshaus, as head of the Environmental Protection Agency, said that air quality is getting worse in the United States, and the outlook is not promising for change by either technical or political means. Therefore, it will become increasingly important in the future to design developments that minimize the negative effects on air quality.[3.44]

F. Land Use

Land is a natural resource. Land in New Mexico is used for agricultural production, resource development, open space conservation, and residential and industrial development. Each of these issues has, in some circumstances, been mismanaged and has contributed to an environmental pollution problem.

Any discussion of land use involves the mix of different land uses within a given area. An improper mix or improper uses will result in negative environmental effects. Also, the lack of a balanced distribution of open space, agricultural land, forested areas, as well as commercial, industrial and residential areas, has created environmental problems. In order for Albuquerque to have a balanced land use system in the future, the areas where residential and commercial development will take place must be regulated. This means that further efforts will have to be made to preserve the agricultural lands in the Rio Grande Valley and to preserve important open space areas including the Bosque, the Sandia Mountains, the Volcanoes and the escarpment.

Since Albuquerque has a remarkable array of extinct volcanoes nearby, it seems a shame that the City has not taken better advantage of this asset. The City has acquired three of the five major cones. The remaining two cones and the escarpment need to be purchased. Plans to develop a volcano park are only in the discussion stage, unfortunately. The Volcano Cliffs subdivision on the top of the escarpment would certainly detract from the scenic and aesthetic impact of the volcano skyline.

The limited amount of arable land in the Albuquerque area is an important natural resource and should be preserved. Residential development of prime agricultural land is a classic example of land misuse. Large portions of the flood plains have been converted to irrigated cropland, a suitable type of development for the area. The area is unsuitable for residential and commercial development for several reasons: there is a great flood danger, the soil types are unsuitable, it is an area of high air pollution potential, and it is a misuse of prime agricultural land. Predictably, these developed areas have been plagued with flooding problems.

The lowland areas also have a mixture of buildings and agricultural development, as well as natural areas. Although the lowlands are much more suitable for development, especially because there is less danger from flooding, it is still questionable whether there should be any development in the valley.[3.45] In view of the soils problems and flooding hazards, further residential development in the valley is asking for trouble. Increased density in a flood plain area increases the degree of flood control protection necessary. This increased cost is borne by the taxpayers. Thus, development in a flood plain area is expensive to the general public. In view of the limitations of the valley for urbanization, it is advisable that residential and commercial development stop, and that the valley area be used for agriculture and open space. Since river banks can be developed into desirable recreational areas, the open space areas of the valley could include both natural areas and developed parks. Only limited areas of the valley, the foothills and the mountains are suitable for development. The east and west mesas are generally well suited to residential and commercial uses. There are some geological aspects of parts of the west mesa that would make those areas undesirable, but that has been discussed in the geological section. Vegetation on the east and west mesas is not reaching grassland climax, bur rather is being invaded by shrubs. Because the same type of grasslands can be found in other areas of the state, developing the mesa areas for residential and commercial uses is not endangering unique natural grasslands. For this reason, and in view of their excellent suitability, the mesa areas should be preferred for residential developments.

There has been a great deal of discussion concerning the possibility of developing the foothill area. A large portion of the area is owned by the Forest Service and, thus, is unavailable for residential development. Apparently, the Juan Tabo area is the main location of future development. There is danger in the Juan Tabo area of further soil loss and accelerated runoff. It is of critical importance to protect the unstable soil of the area. The extremely fragile nature of the plant community in the Juan Tabo area means that the increased traffic resulting from development will have strong biological effects. Since the soils also have foundation problems, development of the foothills is undesirable. A final point is that a fault runs alont the foothills area, and the City will not permit construction on a fault line.

The slope of the west face of the Sandia Mountains is generally greater than forty percent. Therefore, the higher elevations are completely unfeasible for development. On eht east side of the Sandias, the slopes are not as steep, but seldom less than fifteen percent, and development is more feasible. The area is beautifully forested and is aesthetically appealing for several types of development.

The Forest Service owns most of this land which limits development. Private holdings within national forest boundaries total 4,480 acres, but within the past decade, the area has become more urbanized. It is not within the city limits and jurisdictional problems occur. Bernalillo County, outside the Albuquerque city limits, includes both this area and much of the north and south valleys. The interests of the mountain residents and the valley residents are in frequent conflict. They do have one important issue in common. Both are areas which should not be intensely developed, and both are experiencing increasing urbanization pressures. This issue can be expected to become more prominent in local politics during the next decade.

In addition, other open space areas should be included amidst the developed areas. This can be readily done by developing arroyos to serve as both parks and drainage systems. Although it is often objected that providing for open space areas is an expensive luxury, it may actually be more costly not to guarantee the preservation of key sites. A resource like the Albuquerque volcanoes or the Bosque would be destroyed if residential developments covered them. Likewise, intensive development of the valley or the Sandia Mountains could not be undone. Central Park is a crucial open space area in New York City now. It would cost a fortune and might even be impossible to create such a park in an area that was already developed. Therefore, the city and county officials should make the maintenance of the key open space areas a high priority. In some cases, the areas may have to be purchased, such as the rest of the volcanoes and the escarpment. In other cases, a unified city-county policy on development could be effective, such as in the valley and the Sandias. Simply saying "no" to proposals for unsuitable developments may be sufficient. However, other methods of controlling undesirable development should be investigated. The decision-makers must start acting more in the public interest, since the over-development of land causes the people to suffer. If community plans are not implemented, the activities of planning groups become farcical.

G. Summary

As discussed above, there are several potential natural resource-related environmental problems associated with residential construction. Particular solutions depend on the construction site selected; general solutions are summarized in Table 27.

TABLE 27

CHECKLIST OF POTENTIAL PROBLEMS AND POSSIBLE SOLUTIONS RELATED TO RESIDENTIAL CONSTRUCTION

Problem Area	Generalized Problems	Possible Solutions
GEOLOGIC	Increased Fault Zone Loading	Select Another Site
	Rock Falls, Landslides	Embankments, Terracing, Talus Removal
	Soil slope wash, silling and gullying	Terracing, grasses, dykes or beams, gabions, erosion control, swales
	Swelling and loosening of soil and weathered rock	Excavation and backfilling; avoid landscaping
	Soil flow, slump or creep	Footings, retaining walls, concrete encased utilities, select another site
	Foreign soil layers	Avoidance, replacement, soil treatment
	Deep soil exposure	Minimize grading and erosion, replacement of topsoil
	Weighting slopes (Buildings, fill)	Backfilling with compacted fill, minimize watering, avoid site
	Surface compaction	Minimize traffic, soil treatment, landscaping
	Bedrock exposure	Alternating site, replacement of soil, avoid grading
	Rigid structures (utility lines, buildings, paving)	Planned and phased relocation
	Transitory stress (shaking by blasting or vehicle movement)	Avoid blasting and grading
GEOLOGIC AND HYDROLOGIC	Increased stream cutting	Grading and planning for drainage control, energy dissipation dams, directed flow, garbions, other erosion control devices
	Deposition of eroded material (sedimentation)	Erosion control, stream runoff treatment

Table 27 continued

Problem Area	Generalized Problems	Possible Solutions
GEOLOGIC AND HYDROLOGIC	Chemical alteration, surface and subsurface soil water	Sewage and storm water treatment
	Creation of unnatural seepage	Eliminate source, treat effluent
	Increase flooding	Diversion into arroyos, channels or catchment basins, selective zoning, code criteria, drainage design
	Runoff increase	Drainage control, catchment basins
	Impervious surfaces (Buildings, paving, compacted fill)	Runoff control
	Increase stream turbidity	Catchment basins, storm runoff treatment, erosion control, land application
	Change of water table	Aquifer recharge, water conservation
	Depletion of underground reservoirs	Water conservation, aquifer recharge, water harvesting
	Subsurface water reduction and interruption	Recharge basins, land application of wastewater, soil treatment
	Surface water concentration	Drainage control, pumping, backfilling soil treatment, eliminate septic systems
	Surface water sheet flow concentration	Dykes or beams, hydraulic devices, check dams, terracing
HYDROLOGIC AND BIOLOGIC	Unseasonal surface water addition and concentration	Reservoir, land application, flood control
	Reduced stream flow	Water conservation, reservoir, regulation of flow
	Accelerate stream and estuarine eutrophication	Sewage treatment, seepage control

Table 27 continued

Problem Area	Generalized Problems	Possible Solutions
BIOLOGIC	Change in native animal species composition	Preserve or replace predators, provide escape cover, landscape with food plants, minimize grading
	Increase pest species of plants and animals	Provide natural enemies, avoid development of imbalance
	Change of native plant community specific composition	Revegetation, minimize traffic and reintroduction
	Endanger of destroying regenerative capacity of native community	Revegetation, minimize traffic and reintroduction, eliminate threat
	Increase native plant community disease susceptibility	Maintain favorable environmental factors and minimize stress
	Partial tree canopy removal (valley and mountain areas)	Careful site planning
BIOLOGIC AND AIR POLLUTION	Under-tree vegetation, grass and debris removal	Minimize grading, landscape to provide food and cover
	Litter buildup	Improve construction maintenance controls, cleanup
	Introduction of exotic plants	Control or eliminate exotics, relandscape with native plants
AIR POLLUTION	Increase level of gases and particles in atmosphere	Minimize traffic and travel, efficient energy sources, no fireplaces
AIR POLLUTION AND GEOLOGIC	Shallow soil exposure	Minimize grading, drainage control, grasses
GEOLOGIC AND BIOLOGIC	Soil moisture zone increase or decrease (root zone)	Underground irrigation watering, grasses, mulching
	Loss of soil nutrients	Soil transplant, optimize irrigation
	Increase of salt levels in soil	Sewage treatment, underground irrigation

CHAPTER IV

OTHER ASPECTS OF RESIDENTIAL DEVELOPMENT

A. Noise and Aesthetics

Another form of pollution generated by construction activities is noise. It is difficult to attach a scale of importance upon the significance of the impact of noise generated by construction activities. Noise generated by grading and blasting occurs periodically and varies in intensity depending on the work being done. In a few areas of Albuquerque bedrock will be encountered, such as the Sandia Foothills or parts of the West Mesa. If blasting is necessary for grading, it will result in unavoidable dust and noise pollution. It can be argued that noise generated by construction equipment generally only occurs during normal weekday daylight working hours. This could be a problem if there is a school nearby, since the increased noise levels would coincide with school hours. The distance from the construction site to adjacent residential areas influences the degree of impact of construction noise. Construction noise can be minimized if all vehicles and equipment used in construction have mufflers and are maintained in good repair. Diesel engines are the most difficult engines to silence, because they have compression ratios of fifteen to one and more, and their combustion pressures are much higher than spark-ignition engines. Criteria for assessing noise impact and external noise exposure standards for new construction sites have been established by the U.S. Department of Housing and Urban Development. The normally Unacceptable Category are noise levels exceeding 65dbA for eight hours or more per 24 hours (Table 28 compares various noise sources).[4.1] Construction noise is a temporary annoyance. Permissable noise exposures are given in Table 29.

Although some pleasure may be gained from playing sidewalk superintendent, construction activities are seldom aesthetically pleasing to people who live or work in the vicinity. The grading and earthwork activities can create unsightly conditions. Waste materials are never aesthetic and often paper trash will blow onto neighboring properties. Some of this can be avoided by conscientious trash disposal. Once the construction is completed and the site is cleaned up, the situation improves. As soon as landscaping is planted, the adverse visual impact is reduced considerably. The final aesthetics of a project depend on the specific building and landscape plans. Conceivably a well designed project could be aesthetically better than the natural setting that existed before.

B. Climate Considerations

The present trends in population growth and the fact that 25 percent of the world's land is arid strongly implies that arid areas will be more densely occupied in the future.[4.2]

Clearly then, there is need for thought on the optimal development of these areas.

Generally, residential patterns are influenced by two major factors: climate determinants and cultural requirements.[4.3] Cultural demands are often so strong that climatic factors are ignored. The colonization of the New World by the English led to many incongruities of house form, whether in the tropics, the deserts or the arctic areas. However slow the process of adaptation is, Europeans have been gradually learning to change their building forms to accept the new conditions. The pressures of the future may be so intense that the attitudes will be forced to change at a faster pace.[4.4] Thus, it may be feasible to put aside cultural aspects in determining the optimal residential design.

There are many factors to be considered in planning for arid climates. Thermal control is one of the most obvious climate factors, and buildings are clearly a thermal controlled device. Although some arid areas have a cold climate, the majority have high daytime temperatures and low nighttime temperatures. Therefore, building forms are selected to delay the entry of the heat until night or to use different living areas for day and night. There is also the American brute force solution of over-air conditioning. More often, the building materials have a high heat capacity--such as adobe, mud or stone. These materials not only serve as an excellent

TABLE 28

A-WEIGHTED SOUND PRESSURE LEVELS OF SOME FAMILIAR SOUNDS

Source	dbA
Normal conversation	55
Vacuum cleaner	70
Normal street traffic	75
Heavy street traffic	92
Air compressor	92
Permanent hearing loss (exposed full time)	95
Punch press	100
Steel plate falling	105
Magnetic drill press	106
Positive displacement blower	107
Vacuum pump	108
Hard rock music	110
Ear discomfort	112
Jet plane passing over	115
Sand blaster	116
Pneumatic clipper	119
Jack hammer	120
Jolt squeeze hammer	122
Approximate threshhold of pain	149
Jet plane taking off	150

Source: Starr, Edward A. (1972), "Measuring Noise Pollution," IEEE Spectrum, June, p. 19.

Industrial Noise Manual, p. 2.

Federal Register, vol. 36, no. 105, Saturday, May 29, 1971.

TABLE 29

PERMISSIBLE NOISE EXPOSURES

Duration per day, hours	dbA
8	90
6	92
4	95
3	97
2	100
$1\frac{1}{2}$	102
1	105
$\frac{1}{2}$	110
$\frac{1}{4}$ or less	115

Source: Starr, Edward A., "Measuring Noise Pollution" IEEE Spectrum, 18 (June 1972).

heat sink, but also provide shelter from the wind, sand and sun. The obvious scarcity of plant materials make the choice of mud or stone somewhat obligatory in many areas. The need to minimize sunlight often results in a compact geometry; the surface area is minimized while the volume is maximized. Frequently, the buildings are crowded together, providing mutual shading and further reducing the area exposed to the sun. This would also increase the mass; that is, the heat sink function. Direct sunlight is not the only problem; ground radiation must also be avoided. Therefore, windows are generally few, small and placed high up the walls. Verandas and shaded arcades help to reduce sunlight, act as an extra form of insulation, and provide a transition area. These can be seasonal as well, wide enought to exclude the high summer sun, and narrow enough to allow the winter sun. Another seasonal control is deciduous plants. Not only do plant materials provide shade, but they can create a micro-climate, increasing the humidity, cutting the glare and wind, changing light patterns, and providing a refreshing change of scale.

Arid communities vary in the use they make of outdoor areas. Certainly the intensity of the wind, sand and sun is a factor. However, solutions have been developed that alleviate these problems. A common example is the courtyard. This provides an outdoor area protected from the wind and sand. If it is planted with trees, it very effectively acts as a cooling well, shading the buildings, lowering the ground temperatures and amount of surface radiation, and raising the humidity. A more public use of outdoor space in arid areas is the covered arcade, generally serving as an economic hub and community center. Insome areas, orchards are important outdoor areas as well. It seems disappointing that the sunny, rain-free outdoors so prized by Northern Europeans is not better utilized by such as New Mexicans, who seem to prefer air-conditioned cages.

As mentioned above, many aspects of the building design are responsive to climatic conditions. The use of porches, verandas, arcades, courtyards, and rooftops is a good adaptation. In some areas, buildings are built into cliffs or underground, also logical solutions. However, it must be emphasized again that cultural factors play a determining role in the floor plan selected. Culture also determines attitudes towards other comfort factors, such as privacy, light, heat, noise, smell and ventilation. Different societies vary in their tolerance and demands in these areas. These cultural variations affect not only the form of the individual building and the intensity of its use, but society also determines the urban form. Clustering of buildings is not acceptable to everyone, however optimal a solution it may be.

CHAPTER V

ENERGY, RESOURCES AND ECONOMICS

Although some people feel that the energy crisis is over, and others doubt that it ever really existed, the energy crisis is real and still present. Energy consumption doubles every fourteen years in the United States. Any school child can tell you our system is based on money, but the truth is simply that our economy runs on energy. If we run out of energy sources, or if the price of energy continues to sky rocket, American will have an economic disaster. Energy conservation is crucial. Buildings use about one-fourth of total U.S. energy consumption. This does not include construction itself. According to Griffin, the construction industry, coupled with other uses directly involved with architects' and engineers' work, would account for at least one-third and probably more like forty percent of the total United States energy consumption.[5.1] For instance, about 7.5 percent of all electricity is used just in building construction. The building materials industry accounts for ten percent of total energy. As an example, a typical one million dollar building requires 1,280,000 kilowatt hours of electricity expenditure in the construction process alone (1,250,000 KWHs for fabrication of building materials and 30,000 KWHs for construction, operation and maintenance on the same building would require 1,000 KWHs per year).[5.2] Energy can be saved in the actual construction process. For instance, low quality construction techniques account for a large part of energy eventually wasted in heating and cooling. As Table 30 shows, 40 percent of the heating and cooling losses are from leakage through poorly fitted windows and doors, and through cracks at joints between floors, walls, ceilings and roofs. These losses can be greatly reduced by using high quality materials and proper building techniques.[5.3] Since heating and cooling acocunt for two-thirds of the residential energy consumption in the United States, this would represent a substantial savings, possibly one-fourth. Therefore, careful construction is a way to save energy.

Construction techniques themselves are sometimes a waste of energy. High labor costs encourage the use of machinery whenever possible. Of the total electricity used by U.S. industries, 22 percent is used in the construction process itself. Since labor costs are now thirty percent of the total construction costs, this also creates economic pressure to waste building materials if labor time can be reduced.[5.4] However, materials costs have been rising at a terrifying rate in 1974. Petrochemicals have been rising at 1.5 percent per month. Benzine has gone from $0.24 per gallon in 1972 to $1.75 per gallon in 1974. Steel went up 40 percent, and nylon, 50 percent in the past year. The price of wood has fluctuated wildly over the past couple of years. In September 1974, hardwood was 80 percent higher than a year before.[5.5] Clearly, the construction industry is under pressure to minimize, if possible, both the cost of labor and materials.

Often labor costs are reduced by using machinery whenever possible. This raises energy costs. If labor costs could be reduced in other ways, energy could be saved. Energy consumption, materials usage, and economics are closely interrelated in building construction.

Building construction is related to energy and material consumption in several ways. The processing and manufacturing of building materials themselves consumes and wastes energy. Industry accounts for thirty percent of the total U.S. energy consumption and in that, the production of building materials represents ten percent. This energy consumption could be reduced in three ways. The amount of energy used in production could be decreased, less energy intensive materials could be substituted, and the amount of materials used could be decreased. According to Barry Commoner (Director of the Center for the Biology of Natural Systems, Washington University, St. Louis, Missouri), the industrial sector consumed forty-seven percent of the U.S. electrical production in 1970, about 720,000 million kilowatt hours. Of this, he estimates that 35.8 percent (257,900

TABLE 30

HEATING AND COOLING LOSSES
IN A TYPICAL SINGLE FAMILY FRAME HOUSE

40 percent infiltration	leakage through cracks or small openings at joints between floors, walls, ceilings, and roofs or around poorly fitted windows and doors.
60 percent conduction	15 percent wall cavities 15 percent glass 15 percent slab 9 percent ceilings 4 percent framing 2 percent doors

Source: Myhra, David (1974) "Let's Put an End to Energy Waste in Housing," Planning, August, p. 17.

million kilowatt hours) could be saved at no cost in goods or services being provided. This would represent 16.8 percent savings of the total U.S. electrical consumption. Commoner's figures are concerned only with electrical energy. Further savings might be possible in fossil fuels as well.[5.6]

Commoner contends that industry wastes 36 percent of the electricity it consumes (see Table 31, Potential Electrical Savings by Sector). Even more electricity is wasted in the production of <u>some</u> materials (see Table 32, The Productivity of Electric Power and Man-Hours in Manufacturing). The industries that use power least efficiently include primary metals, paper and allied products, chemicals and petroleum products. All of these are used in building construction. Among the most energy extensive building materials are concrete and cement products. One-third of their production costs are for energy. Other energy wasting industries include stone, glass and plastic products; again, all are used as building materials. Industries in the middle level of efficiency of energy use include electrical equipment, lumber and fabricated metal products. Of those industries that are most efficient in energy use, the only category that has much relation to building construction is furniture and fixtures. In summary, the construction industry accounts for a larger percentage of possible savings in electricity than other industries.

TABLE 31

POTENTIAL ELECTRICITY SAVINGS BY SECTOR

Sector	Million KWH Electricity 1970	Percent of U.S. Total	Savings in Million KWH	Percent of Sector	Percent of U.S. Total
Industrial	720,000	47	257,900	35.8	16.8
Commercial	309,900	20	68,100	22.0	4.4
Residential	442,000	29	212,000	47.9	13.8
Other	59,700	4	0	--	--
U.S. Total	1,531,600	100	537,800	--	35.0

Source: Commoner, Barry, "Alternative Approaches to the Environmental Cirsis," AIP Journal, 39 147 (1973).

TABLE 32

THE PRODUCTIVITY OF ELECTRIC POWER AND MAN HOURS IN MANUFACTURING

	Value Added 1958 Dollars x 10°		Electric Power Used Kwh x 10°		Electric Power Productivity 1958 Dollars/Kwh		Man Hour Productivity 1958 Dollars/MH		Resource Energy Productivity 1958 Dollars/10°BT		
	1947	1967	1947	1967	1947	1967	1947	1967	1947	1954	1967
Apparel	5.87	8.53	0.85	3.61	6.91	2.36	3.24	3.92		173	119
Tobacco manufacturing	0.85	1.73	0.16	0.85	5.76	2.03	4.28	13.72		79	71
Printing & publication	5.62	12.17	1.28	5.82	4.39	2.09	6.33	10.18		173	115
Leather & products	2.03	2.23	0.57	1.33	3.54	1.67	3.00	4.06		55	53
Instruments	1.51	5.44	0.55	3.08	2.77	1.77	3.87	10.27		74	78
Furniture & fixtures	1.78	3.54	0.83	2.52	2.16	1.40	3.05	4.94		55	56
GROUP A	17.66	33.64	4.24	17.21	4.17	1.95	3.88	6.35		105	89
Machinery	10.36	23.61	5.92	17.26	1.76	1.37	4.00	8.48		57	56
Fabricated metal products	6.51	15.30	3.90	14.76	1.67	1.04	3.84	7.08	38	39	38
Lumber wood products	3.33	4.22	2.34	7.97	1.43	0.53	2.66	4.32		29	18
Electrical equipment	5.11	20.77	3.62	19.20	1.41	1.08	4.00	7.95		46	57
Trans. equipment	7.73	23.89	6.06	23.56	1.28	1.01	3.94	8.70		48	45
Food & kd.	12.06	22.57	10.18	26.79	1.18	0.84	5.09	9.99	18	17	21
GROUP B	45.10	110.36	32.02	109.54	1.41	1.01	4.05	8.15		33	37
Textiles	7.04	6.91	10.04	20.80	0.70	0.33	3.05	4.09	21	16	15
Rubber & plastic products	1.72	5.77	3.45	10.77	0.50	0.54	4.05	7.07		15	23
Stone, clay, glass products	3.04	7.07	8.02	20.81	0.48	0.36	3.63	7.45	3	4	5
Petroleum, coal products	2.63	4.60	6.50	22.28	0.41	0.21	7.44	22.78		4	3
Chemicals	7.03	19.97	19.61	116.83	0.36	0.17	7.21	18.39	7	7	6
Paper, allied products	3.85	8.27	15.39	49.07	0.25	0.17	4.50	7.72	6	7	6
Primary metals	7.58	16.94	40.65	131.95	0.19	0.13	3.69	8.11	2	5	5
GROUP C	32.89	69.53	103.66	372.51	0.32	0.19	4.21	8.80		6	6
MANUFACTURING	95.65	213.53	139.92	499.26	0.68	0.43	4.07	7.99	11.2	14.4	14.6

Source: Commoner, Barry, "Alternative Approaches to the Environmental Crisis," AIP Journal, 39 147 (1973).

Increasing the efficiency of energy use in the processing and manufacturing of building materials will certainly save energy. Further savings could be made by substituting materials that are less energy intensive. For example, the power productivity of aluminum manufacture was only \$0.013/KWH compared to \$0.183/KWH for steel.[5.7] So steel manufacture could be considered to be fourteen times more efficient a use of energy than aluminum manufacture. The energy efficiency of aluminum processing will improve somewhat with the adoption of a new smelting process that is predicted to use thirty percent less energy than present methods. However, this would only increase the power productivity of aluminum to \$0.19/KWH which would then be one-tenth that of steel. In general, non-ferrous metals are high energy consumers. If possible, less energy intensive materials should be substituted for aluminum and other non-ferrous metals.

Since World War II there has been a displacement of power-thrifty materials by power-consumptive ones. Aluminum and plastics are the most important substitutes for traditional materials. Plastics are substituted for zink die castings, aluminum window frames, copper piping and exterior sidings. The energy crisis has now caused a reversal of this trend to begin. Previously there had been a succession sequence from wood to steel to aluminum to plastics. This sequence has occurred for window frames, for structural members, and for panels. Home builders recently had experimented with plastics for both structural members and window frames.[5.8] Now the trend appears to be descending this staircase, substituting aluminum for plastics; then using steel instead of aluminum, and perhaps eventually returning to wood. The succession goes generally from energy efficient materials like wood to less energy efficient materials like steel to even less efficient materials like aluminum. Therefore, advocates of energy conservation should certainly be delighted to see the trends beginning to reverse.

As a result of the material shortage that developed in 1974, an architecture of mass produce parts is beginning to develop, long after the years of the Bauhaus. Also, architects have begun designing ways to simplify both the materials and methods, thus possibly reducing both the amount of labor and the materials used. Another way to reduce both the amount of labor and materials used would be to use fixed modules instead of the present practice of custom cutting.[5.9]

Materials that are incorporated into a structure for other than structural purposes frequently make a structural contribution. Generally, this contribution is ignored or underestimated. For instance, the concrete fireproofing around steel members can make significant structural contributions. If this were taken into account, smaller steel members would be possible, reducing the amount of material used, the cost, and the weight of the structure. Reduced weight of the structural members would mean reduced sizes needed for footings and foundations, making possible further savings in materials, cost and weight of the structure. Buildings with masonry walls could be designed that consider the floor and roofs as diaphrams in the calculations. Other components that should be considered in engineering calculations are floor fills, continuously hung lintels, steel stairs, wood finish floors, and lath and plaster membranes. Tube designs for high rises are becoming more frequently used. Steel beam cross sections are designed to satisfy the worst loading conditions. When calculations are based on the maximum bending moments, the cross section will be much larger than necessary at the other points in the span. If steel components varied in their cross sections to actual structural demands, there would again be savings in materials and weight of the building. Liveloads are another aspect of structural design that should be more sophisticated. When liveloads are assumed to be simultaneously applied, the results are three times what is actually needed. Likewise, safety factors are grossly inflationary. The values given for concrete have a 300 percent safety factor, while those for steel have a 50 percent safety factor. When the designer selects the next size up, it adds another five percent. With concrete further savings could be made by considering that concrete gains with age, also giving structural credit to cement finishes. Concrete suppliers add to the structural inflation; in order to insure on-site acceptance of a batch, they frequently provide concrete 10 to 20 percent above the requested strength. It has been calculated that with the reduction in safety factors, structurally safe concrete buildings could be built using half the materials presently used.[5.10] According to the American Institute of Architects Task Force on Energy Conservation, 20,000 million KWHs per year could be saved on cement production alone.[5.11]

As with steel and concrete, many of the structural contributions of wood are not taken into account. Structures are designed as if each wood member were disconnected from the rest. For instance, the affect of the subfloor and floor above and the ceiling membranc below a floor joist are not included in the calculations. Present structural engineering calculations are generally very simple mathematically, and there is certainly room for further sophistication of engineering concepts. In addition, pressure from some industries for such changes is growing.[5.12] Plywood manufacturers are asking that the total assembled unit be given structural credit. This would be not only to their advantage, but also to the advantage of the builder (lower material costs), owner (lower final cost possibly), and designer (more design work required). Certainly these changes would entail revision of both structural theory and building codes. For some materials, such as steel beams, manufacturers would have to revise their product lines. For many materials, such as both steel and concrete, more careful construction techniques would be critical. It would become imperative that formwork be carefully constructed or that steel be correctly placed. This would raise labor costs. However, these changes, all concerned with more rigorous structural analysis, would eventually result in substantial energy savings.

Durable buildings save energy and materials. One building that lasts a century uses less resources than four buildings that last twenty-five years each. Operation, maintenance, remodeling and renovating consumes less materials and energy than demolition and construction. The increasing emphasis on life cycle costing will result in an increasing demand for higher quality materials. If buildings are to be built to last, then their materials must be selected on the basis of durability.[5.13]

The quality of workmanship and construction materials also affects the durability of the building. Improper installation can shorten the life span of a component. Often improper specification results in the use of the wrong material or a material being put to a use it is actually unsuited for. Job scheduling can also play a role. If sensitive materials are installed under unsuitable weather conditions, they may not last.

High quality materials and workmanship save energy and resources. Cost cutting and throw-away buildings are a waste of resources and bad economics. Buildings built to last are economically and enviornmentally sound.

The above discussion of energy and materials used in buildings demonstrates how tightly interrelated are the three factors: energy consumption, materials usage, and economics. Most attempts to save labor, energy, money or materials result in an increase in one of the other aspects. However, savings in materials result in savings in the energy used in manufacture and savings in money. The selection of building materials is being influenced by many factors, the energy crisis and the shortages due to insufficient production capacity being only two aspects of a complicated situation.

Other factors affecting building materials are the changes in ownership of natural resources and the depletion of important mineral resources. Political changes around the world may make some mineral resources unavailable. Independent governments in less developed countries are gaining control of high reserves of key resources. The oil situation in the Middle East is the best known example. Other critical materials such as bauxite and copper are being affected. The result is sudden price jumps and even stoppage in the supply. The same results can be expected with the depletion of other natural resources. The resource status of raw materials has been discussed in depth lately.[5.14] The main point is that shortages are making some materials effectively unavailable, and high prices will make other materials unfeasible. An economy never completely runs out of anything. When shortages occur and prices rise, demand begins to decrease and supplies increase. Gradually, the economy forces a change in consumption patterns and technology. Clearly, permanent changes in building technology will inevitably occur.

The effect of the situation is already visible. As mentioned earlier, substitutes are being made. Materials that consume limited resources, do great damage to the environment, or are energy intensive, are no longer preferred. They are often unavailable or expensive. Architects are inventing new uses for available materials.[5.15]

The subject of substitutes for building materials is very complex. Certain materials have properties that make them more suitable for a particular use than other materials. For instance, copper is especially suitable for electrical uses. However, the situation has been made more complicated by not only the energy crisis, but the present economic situation and the shortage of some resources.[5.16] Generally, the current demand is much greater than the current production capacity. Some industries have not had the capital for necessary expansion. Other industries simply have not reinvested their capital into expanding production capacity, instead declaring greater profits and dividends. Industry has complained that government regulations have great economic impact. Industry has been forced to invest capital into pollution controls and occupational safety equipment. In 1975 American business expects to invest $7.4 billion in air and water pollution controls, and another $3 billion in occupational safety. In 1969 pollution and safety expenditures accounted for four percent of all capital spending by manufacturing industries.[5.17] That percentage has now risen to 10.8 percent. Table 33 shows the percentage of total capital spending invested in pollution and safety expenditures by different industries. These expenditures add little to the productive capacity of an industry, raise consumer prices, and deplete expansion capital, causing shortages. On the other hand, the social costs are greater than the costs of these measures. Although these environmental and safety measures have an inflationary impact, it is only one-half of one percent per year,[5.18] a small fraction of the total rise in the national inflation rate. With an annual inflation rate of twelve percent, the government regulations have only added four cents to every dollar rise in prices. Nevertheless, money is becoming a scarce resource and capital for expansion of productive capacity is needed. Government regulations have not caused inflation nor material shortages, but have diferted only a fraction of the money desperately needed for expansion of production capacity.

TABLE 33

POLLUTION AND SAFETY EXPENDITURES

Industry	Percent of All Capital Spending
Manufacturing	10.8
Paper	23.7
Steel	22.8
Non-ferrous metals	20.9
Petroleum	15.0
Chemicals	12.5

Source: Business Week, September 14, 1974, "Government Interventions-Regulation," pp. 103-106.

The present situation may have further effects on building materials. Recycling and reclaiming of materials will become more attractive. Additional economies throughout the extraction, processing, transportation, and construction phases will certainly be encouraged. New manufacturing processes and new products can be expected. Technological progress will be accompanied by improvements in both management and labor productivity. New sources of raw materials hopefully will be discovered. Gradually, full-cost pricing of materials will result. The prices will reflect the environmental damage engendered in the manufacturing process and check the exploitation of scarce, depletable resources.

The trend will be towards using materials from plentiful resources, using products that are energy efficient, using quality construction, avoiding waste, returning to more natural materials, any recycling as much as possible. These measures have been advocated by conservationists for some time; but economics is finally forcing the changes. The contributing factors are many: inflation, environmental and safety regulations, insufficient production capacity, lack of capital for expansion, other aspects of economic intervention, the energy crisis, the world political situation, and depletion of resources. Altogether, the commitment of resources and the economic interrelationship is a very complex issue. The production and delivery of energy and goods is intricately wound into the American economic system. It may be ridiculous to say that one residential development will have an impact on the system. However, the cumulative effect of construction certainly does have an impact. These changes that are beginning in the American economy and technology will have a very impressive impact on residential construction in the future.

CHAPTER VI

COMPENDIUM

Since the National Environmental Policy Act was passed in 1969, the use of environmental impact statements has become widespread. They are required by the Federal Government, many states, and some local authorities. Both private and public projects may be required to prepare a statement. The environmental impact statement concept has very important implications for land use planning and regulation. The effect of all this legislative activity (see Section I.E) and the environmental impact statement procedure is to increase the understanding of environmental effects of development.

Residential development can have adverse environmental impacts. The major areas are geology, soils, land use, hydrology (including flooding, water quality, and water quantity), biology, ari quality, noise, socioeconomic, and energy and resources consumption. There are three crucial steps in order to minimize the negative effects: site location, site analysis, and project design.

The selection of a feasible site can avoid many problems. Generally there are more environmental problems such as soils, erosion, drainage, flooding, animals, and plants in the Sandia Mountains and foothills and the Rio Grande Valley than there are on the East and West Mesas. Admittantly there are exceptions to this rule, but the mesas are the most suitable areas for residential development. Simply avoiding residential projects in the valley and mountain areas avoids many potential problems. Unfortunately, land is becoming a scarcer resource in the Albuquerque area and the presures to develop the less suitable areas will increase. Consequently, the possible adverse effects of residential developments will be greater.

Thorough site analysis makes it possible to avoid many potential problems. Even though the mesa areas are most suitable for housing developments, there are still potential problems. Generally it is possible to design a project that minimizes the problems, but it is necessary to anticipate the problems. Therefore a site analysis should basically be a natural resource inventory (see Section II.F). The scale of the project determines how thorough and detailed the information must be. The amount of research necessary to design a doghouse is minimal. The research for a ten thousand acre home subdivision should be very complete. Table 34 gives a checklist of site suitability factors.

The main source of geological information is the U.S. Geological Survey. Other sources are the Middle Rio Grande Council of Governments (COG), State Bureau of Mines, and private consulting geologists.

The main sources of soils information are the Soil Conservation Service (SCS) and COG.

There are many sources for hydrology data. Flooding and drainage information is available from the Albuquerque Metropolitan Flood Control Authority (AMFCA), Corps of Engineers, COG, and the City Engineer's Office.

Water quality information is available from the City Environmental Improvement Agency, State Engineer, the Environmental Protection Agency (EPA), and the Extension Service.

Air quality data is available from the City Health Department, the State Environmental Improvement Agency (EIA) and the EPA.

The best sources for climatic data are the U.S. Weather Bureau and The Climate of New Mexico by Tuan, et al. Private consultants can also provide the necessary information for a site analysis.

Once the necessary data is available, the project designer can use the information to avoid negative environmental effects (see Section III.G). Many design solutions can solve more than one problem. It is crucial, however, to have the basic site analysis in order to design a project that minimizes any adverse environmental effects.

Soil survey information is crucial in overcoming possible soil problems. Difficulties with soils that have great slopes, poor drainage, or a tendency to shrink/swell, erode, or slump can be alleviated by site planning and engineering design. Water table contamination can be avoided with community water supply and sewage systems. Problems with alkaline soils, caliche, corrosivity, low water holding capacity, insuffucient iron, shallow topsoils, and low fertility can be handled by soil preparation and careful landscaping.

In some situations residential development is an inappropriate land use. This is often true in the valley, foothills and mountain areas. The land might be more appropriate for uses such as agriculture, recreational development, or extraction of mineral deposits.

Likewise many problems with flood control are best avoided by not building in specific areas such as arroyos, the interfan areas at the mouths of canyons, playa lakes, and the river floodway. There are good design solutions to other flooding problems. The development of catchment basins to simultaneously control runoff, reduce water pollution, and provide recreational areas is an especially good approach for the mesas.

Water treatment facilities are generally provided by the city, thus relieving the developer of most water pollution problems. Water pollution as a result of storm runoff is the main water quality problem a developer can directly affect. This is why well designed drainage plans are such a crucial aspect of minimizing the impact of a residential development.

Biological impact is impossible to avoid. Natural areas can help, but unless the open space area is rather large, it is certain that the larger animals will leave. Design techniques can reduce wildlife losses to roadways.

Since the plant communities in the Albuquerque area are so extremely fragile, a totally natural open space area cannot exist in either the east or west mesas. Revegetation and some landscaping is generally necessary when areas intended as open space are disturbed by development activities. It is possible to have a natural area in the Sandias and some parts of the foothilss or the valley.

Cluster developments with open space areas have the lease negative effects on plant and animal life, especially if the project is planned with an awareness of the interaction of humans and wildlife.

When designing urban landscaping, there are several factors to consider. The typical design of residential developments in Albuquerque does not optimize the climate and visual assets of the area. Landscaping decisions should consider the soil and alkalinity, the wind, aridity, late frosts, and air pollution factors as well as the aesthetic decisions. Landscaping designs can influence other environmental aspects such as air and water quality, runoff and infiltration rates, erosion, noise, and the micro-climate.

Design is the method of controlling the biological impact of a residential development.

Likewise, the design of a housing project can affect air quality. Although a developer seldom can include a mass transit system, there are many design decisions that can influence the amount the resident will be dependent on the automobile. It is far better to build densely with residential and commercial uses intermixed and adjoining open spaces than to continue sprawl patterns. Once again, cluster type developments are the most environmentally desirable.

Although way overshadowed by the automobile, home heating is the second most significant source of air pollution related to residential development in Albuquerque. This problem can be more readily influenced by the developer. Techniques include installation of efficient and well tuned equipment, elimination of fireplaces, use of alternate energy sources (such as solar and wind power), site selection and orientation, and the choice of building materials and techniques. Apartment condominiums and cluster type developments in general produce less air pollution. A developer can minimize the amount of air pollution generated by his project.

The energy consumption related to residential construction can be reduced in many ways. Heating and cooling losses can be reduced by using high quality materials and proper building materials. The amount of energy used in producing building materials could be reduced. Less energy intensive materials could be substituted for many present building materials, and the amount of materials actually used could be decreased. Designing for climatic factors using alternate energy sources will also reduce the amount of energy consumed in residential projects.

Present residential design does not consider conservation of energy. In view of the recent publicity on the energy shortage, the optimization of energy consumption is important in future housing design. There have been a plethora of publications issued within the past few years documenting ways to conserve energy in heating and cooling the home, as well as limiting the use of electricity for other domestic purposes. In addition there is also a large body of data available on the conductivity of various building materials, the efficient use of natural light, etc. This data verifies the assumption that present design is inefficient and that improved approaches are feasible.

Resource consumption related to residential construction can be reduced not only by decreasing the amount of materials used but also by selecting materials on the basis of durability. The trend will be toward using materials from plentiful resources, using products that are energy efficient, using quality construction, avoiding waste, returning to more natural materials, and recycling and reclaiming materials.

Some of these suggested solutions to the environmental problems resulting from housing projects are minor variations from present practices, while other approaches would involve major changes in present residential design. Predictably the minor variations will be adopted before the major changes occur. However, there is a strong impetus toward development of alternative energy sources. Technological innovations are generally readily accepted. Cultural change usually follows more slowly. Homeowners seem more likely to accept solar heated homes than to give up their green lawns. However, it is often inaccurate to predict the future.

This analysis of the environmental effects of residential development does lead to one conclusion. The single family home, as presently designed, is inappropriate in regards to climatic, economic, and environmental factors. The typical single family detached home is inefficient in regards to transportation, and the conservation of energy, materials, land, and water.

The final conclusion is that the environmental aspects of residential development can be optimized by building cluster type homes on the mesa areas only, landscaped with natural vegetation, and using catchment basins to control drainage. The project design should include climatic considerations, energy conservation techniques, and careful selection of materials. Alternate energy sources should be included. This approach would minimize the negative aspects of residential developments. The next step is to design a prototype, and finally to demonstrate that this approach is financially viable. Hopefully, that will soon be possible.

TABLE 34

SITE SUITABILITY FACTORS

Geology

Regional setting	Unconsolidated materials
Physiography & topology	Mineral resources
Bedrock--type, characteristics, depth	Faults and folds
	Earthquake risk

Soils

Physical Characteristics:

Texture		Percolation rate
Organic material	Profiles	Permeability
Erosion potential		Road & foundation suitability
Slope stability		Shrink/swell potential

Chemical Characteristics:

Alkalinity (pH)	Fertility
Major & trace elements	Corrosiveness

Hydrology

Drainage maps	Groundwater levels & movements
Runoff levels	Water quality data if city system is not used
Aquifer permeability	

Meteorology

Precipitation	Solar angle diagrams
maximum	Wind uses
minimum	Air quality
average annual	
seasonal variations	

Biology

Floral List:

Trees	Pestilent & parasitic species
Shrubs	Rare & endangered species
Grasses	

Faunal List:

Mammals	Reptiles
Birds	Insects
Amphibians	Rare & endangered species

Other

Ambient noise levels	Utilities & public services
History & archaelogy	Economics

GLOSSARY

ABATEMENT: The method of reducing the degree or intensity of pollution, also the use of such a method.

ACTIVATED SLUDGE PROCESS: The process of using biologically active sludge to hasten breakdown of organic matter in raw sewage during secondary treatment.

ACTIVITY: Project.

AERATION: The process of being supplied or impregnated with air. Aeration is used in waste water treatment to foster biological and chemical purification.

AEROSOLS: Either solid or liquid particles in the air such as smoke, fumes, dust, pollen, fibers, or microbial spores.

AESTHETIC: That which people find beautiful or attractive. The quality of being aesthetic is not the opposite of the qualities of "practicality" or "reality," but rather another aspect of the same real world phenomena.

AIR MASS: A widespread body of air with properties that were established while the air was situated over a particular region of the earth's surface and that undergoes specific modifications while in transit away from that region.

AIR POLLUTION: The presence of contaminants in the air in concentrations that prevent the normal dispersive ability of the air and that interfere directly or indirectly with man's health, safety, or comfort or with the full use and enjoyment of his property.

AIR POLLUTION EPISODE: The occurrence of abnormally high concentrations of air pollutants usually due to low winds and temperature inversion and accompanied by an increase in illness and death.

AIR QUALITY STANDARDS: The prescribed level of pollutants in the outside air that cannot be exceeded legally during a specified time in a specified geographical area.

AIRSHED: The air overlying any arbitrary geographical region, such as a metropolitan area. Frequently several adjacent cities or areas which share intermixed air pollution problems are lumped together.

ALKALINE: Having marked basic properties with a pH of more than 7.

AMAFCA: Albuquerque Metropolitan Flood Control Authority.

AMBIENT AIR: Any unconfined portion of the atmosphere; the outside air.

ANNUALS: Plants that last for only one year or season.

ANTI-DEGRADATION CLAUSE: A provision in air quality and water quality laws that prohibits deterioration of air or water quality in areas where pollution levels are presently below those allowed.

APPLICANT: Any person or agency which proposes to carry out a project which needs a lease, permit, license, certificate, or public funds.

APS: Albuquerque Public Schools.

AQUIFER: An underground bed or stratum of earth, gravel, or porous rock that contains water.

AREA SOURCE: In air pollution, any small individual fuel combustion source, including any transportation sources. Area source is defined legally and precisely in federal regulations.

A-SCALE SOUND LEVEL: The measurement of sound approximating the auditory sensitivity of the human ear. The A-scale sound level is used to measure the relative noisiness of common sounds.

AUDIOMETER: An instrument used for measuring hearing sensitivity.

BACKGROUND LEVEL: With respect to air pollution, amounts of pollutants present in the ambient air due to natural sources.

BBR: Bureau of Business Research, University of New Mexico.

BERYLLIUM: A metal that when airbourne has adverse effects on human health; it has been declared a hazardous air pollutant. It is primarily discharged by operations such as machine shops, ceramic and propellant plants and foundries.

BIOCHEMICAL OXYGEN DEMAN (BOD): A measure of the amount of oxygen consumed in five days by the biological processes breaking down organic matter in water. Large amounts of organic waste use up large amounts of dissolved oxygen, thus the greater the degree of pollution, the greater the BOD.

BEODEGRADABLE: Capable of decomposing quickly as a result of the action of microorganisms.

BIOTA: All the species of plants and animals occurring within a certain area.

BOD: Biochemical oxygen demand.

BOR: Bureau of Outdoor Recreation, a federal agency.

BRITISH THERMAL UNIT (BTU): The amount of heat required to raise the temperature of one pound of water one degree fahrenheit at its point of maximum density.

BTU: British thermal unit.

BUREAU OF RECLAMATION: Bureau of Reclamation, a federal agency (irreverently referred to as Bureau of Wrecklamation).

CARBON DIOXIDE (CO_2): A colorless, odorless, non-poisonous gas that is a normal part of the ambient air. CO_2 is a product of fossil fuel combustion.

CARBON MONOXIDE (CO): A colorless, odorless, highly toxic gas that is a normal by-product of incomplete fossil fuel combustion. CO, one of the major air pollutants, can be harmful in small amounts if breathed over a certain period of time.

CALICHE: A type of soil condition found in arid areas. Caliche means "lime-like."

CARCINOGENIC: Cancer producing.

CEQ: (a) National Council on Environmental Quality (established by NEPA).
(b) New Mexico Council on Environmental Quality.

CEQA: California Environmental Quality Act (1970).

CHANNELIZATION: The straightening and deepening of streams to permit water to move faster, to reduce flooding, or to drain marshy areas. Channelization reduces the organic waste assimilation capacity of the stream and may destroy fish breeding, the stream's natural beauty, flood retention capability, and aquifers recharge capacity.

CHEMICAL OXYGEN DEMAND (COD): A measure of the amounts of oxygen required to oxidize organic and oxidable inorganic compounds in water. The greater the degree of pollution, the greater the COD.

CHLORINATED HYDROCARBONS: A class of generally long-lasting insecticides of which the best known is DDT.

CHLORINATION: The application of chlorine to drinking water, sewage, or industrial waste for disinfection or oxidation of undesirable compounds.

CLIMAX VEGETATION: A stable, balanced vegatation community in an ecosystem which will remain in an area if undisturbed. The vegetative types present is determined by the climate.

CO: Carbon monoxide.

CO_2: Carbon dioxide.

COD: Chemical oxygen demand.

COG: Middle Rio Grande Council of Governments.

COLIFORM INDEX: An index of the purity of water based on a count of its coliform bacteria.

CORPS: U.S. Army Corps of Engineers, a federal agency.

DECIBEL: The unit of measurement of the intensity of sound.

DECOMPOSERS: Living plants and animals, chiefly fungi and bacteria, that live by extracting nutrients from the tissues of dead plants and animals. Decomposers are vital to the life cycle.

DESERT: A geographical area that receives less than ten inches of rainfall annually.

DISSOLVED OXYGEN: Oxygen suspended in water in the form of microscopic bubbles.

DISSOLVED SOLIDS: The total amount of dissolved material, organic and inorganic, contained in water or wastes.

DIURNAL: Animals that are active during the daytime.

DRILLING: Revegetation using a machine that makes a hole and deposits the seed.

ECOLOGICAL IMPACT: The total of an environmental change, either natural or man-made, on the ecology of the area.

ECOLOGY: The interrelationships of living things to one another and to their environment or the study of such interrelationships.

ECOSYSTEM: The interaction of living things with each other and their habitat, forming an integrated unit or system in nature, sufficient unto itself with a balanced assortment of life forms.

EFFLUENT: A discharge from a pollution source that is relatively self-contained, generally referred to in regard to discharges into waters but can also mean discharges into air.

EHD: Environmental Health Department (Albuquerque's equivalent of the State Environmental Improvement Agency (EIA) or the Federal Environmental Protection Agency (EPA)).

EIA: (a) Environmental Improvement Agency (New Mexico's equivalent of the Federal Environmental Protection Agency (EPA)).
(b) Environmental Impact Analysis (a study submitted by an applicant for approval of a project in order that an agency may determine as an environmental impact statement--or report--will be necessary.

EIR: Environmental Impact Report, a term used in some State Environmental Quality Acts, especially California's, for an Enrironmental Impact Statement.

EIS: Environmental Impact Statement (a detailed report setting forth the environmental effects and considerations pertaining to a project).

ELECTRIC POWER PRODUCTIVITY: Value added divided by electricity consumed expressed in dollars per kilowatt hours.

EMISSION: See Effluent. Emissions is generally used in regard to discharges into air.

EMISSION FACTOR: The average amount of a pollutant emitted from each type of polluting source in relation to a specific amount of material processed. An emission factor for a residential furnace would be a number of pounds of particulates per cubic foot of fuel.

EMISSION INVENTORY: A list of air pollutants emitted into a community's atmosphere, in amounts such as tons per day, by type of source. The emission inventory is basic to the establishment of emission standards.

EMISSION STANDARD: The maximum amount of a pollutant legally permitted to be discharged from a single source, either mobile or stationary.

ENVIRONMENT: The external conditions which exist within the area which will be affected by a proposed project including land, air, water, minerals, flora, farena, ambient noise, and objects of historic or aesthetic significance.

ENVIRONMENTAL QUALITY: The properties and characteristics of the environment, either generalized or local, as they impinge on human beings and other organisms. Environmental quality can refer to varied characteristics or the potential effects such characteristics may have on physical and mental health.

EPA: Environmental Protection Agency, which administers the National Environmental Protection Act as well as other environmental legislation such as the Clean Air Act.

EQD: Environmental Quality Department (California's equivalent of EPA, EIA, EHD).

ERODIBILITY FACTOR: The "k" factor in soil loss equations. The amount of soil which erodes from a standard experimental plot of bare soil under standard conditions of slope, rainfall, etc. It varies with the physical characteristics of the soil.

EXOTIC: Any plant or animal that has been introduced into an area where it is not native.

FECAL COLIFORM BACTERIA: A group of organisms common to the intestinal tracts of man and other mammals. The presence of fecal coliform bacteria in water is an indicator of pollution and of potentially dangerous bacterial contamination.

FILTRATION: In waste water treatment, the mechanical process that removes particulate matter by separating water from solid material usually by passing it through sand.

GROUND COVER: Grasses or other plants grown to keep soil from being blown or washed away.

GROUNDWATER: The supply of fresh water under the earth's surface in an aquifer.

HABITAT: The sum total of environmental conditions of a specific location. Habitat includes the whole complex of physical factors forming the environment.

HAZARDOUS AIR POLLUTANT: According to law, a pollutant to which no ambient air quality standard is applicable and that may cause or contibute to an increase in mortality or in serious illness, such as asbestos, berylium, and mercury.

HC: Hydrocarbons.

HEW: Department of Health, Education and Welfare, a federal agency.

H_2S: Hydrogen sulfide, a type of air pollution.

HSS: New Mexico Department of Health and Social Services.

HUD: Department of Housing and Urban Development, a federal agency.

HYDROCARBONS: A type of air pollution including organic acids, aldehydes, unsaturated hydrocarbons, and acromatics.

HYDROSEEDING: Revegetation by spraying a slurry of seeds and water on the site.

KWH: Kilowatt hours.

LEACHING: The process by which soluble materials in the soil are washed into a lower layer of soil or redissolved and carried away by water.

LITTLE NEPA: Any state environmental quality act modeled after the National Environmental Protection Act.

MAN HOUR PRODUCTIVITY: Value added divided by man hour of labor expressed in dollars per man hour.

MGD: Millions of gallons per day, a measurement of the rate of flow of water.

MICROCLIMATE: Localized climatic conditions which are different from the regional climate.

NEGATIVE DECLARATION: A statement that the project would not have a significant effect on the environment--a very desirable thing to have if you are the developer.

NEPA: National Environmental Policy Act (1969).

NMCEQ: New Mexico Council on Environmental Quality.

NMEPA: New Mexico Environmental Quality (1971-1974).

NO: Nitrogen oxide.

NO_2: Nitrogen dioxide.

NO_x: Nitrogen oxide, either nitrogen dioxide or nitrogen oxide, also referred to as nitric oxides.

NOCTURNAL: Animals that are active during the nighttime.

OPPORTUNITY PLANTS: Plants that are shallow-rotted rooted annuals.

PARTICULATE: Liquid or solid material in the air, either organic or inorganic, including dust, flyash, dirt, smoke, soot, and metallic fume.

PERENNIALS: Plants that persist for several years, as opposed to annuals.

PERMEABILITY: A measure of the ease with which water can pass through the sediment of an aquifer.

pH: A measure of the acidity or alkalinity of a material, liquid, or solid. pH is represented on a scale of 0 to 14 with 7 representing a neutral state, 0 representing the most acid, and 14 the most alkaline.

PHOTOCHEMICAL OXIDANTS: A type of air pollution formed by interaction of the atmosphere with nitrogen oxides.

PLAYA: Temporary lakes formed by storm runoff which may last for days or longer before evaporation leaves a flatbed of clay (playa). The soil is highly alkaline, containing sodium carbonate or sodium bicarbonate and a high concentration of dissolved salts.

POINT SOURCE: In air pollution, a stationary source of a large individual emission, generally of an industrial nature.

POLLUTANT: Any introduced gas, liquid, or solid that makes a resource unit for a specific purpose.

POLLUTION: The presence of matter or energy whose nature, location, or quantity produces undesired environmental effects.

POROSITY: The proportion of the materials in an aquifer not occupied by solids, thus the empty spaces. The porosity indicates the storage capacity of an aquifer.

PPM: Parts per million.

PRIMARY TREATMENT: The first stage in waste water treatment in which substantially all floating or settleable solids are mechanically removed by screening and sedimentation.

PROJECT: The whole of an action resulting in a direct or ultimate physical impact on the environment.

PUD: Planned unit development.

RESOURCE ENERGY PRODUCTIVITY: Value added divided by energy consumed per man hour expressed in dollars per 10^9 BTU.

REVEGETATION: Replacement of plant cover on areas that have been denuded by grading, erosion, fire, or drought.

RIPARIAN: Living on the bank of a stream or river.

RUNOFF: The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually is returned to streams. Runoff can pick up pollutants from the air or the land and carry them to the receiving waters.

SALINE: Containing salt.

SANITARY SEWERS: Sewers that carry only domestic or commercial sewage. Storm water runoff is carried in a separate system.

SCS: Soil Conservation Service, a federal agency.

SECONDARY TREATMENT: Waste water treatment, beyond the primary stage, in which bacteria consume the organic parts of the wastes. This biochemical action is accomplished by use of trickling filters or the activated sludge process.

SILTATION: The deposit of sediment downstream of the site as a result of erosion.

SIGNIFICANT EFFECT: In relation to environmental analysis, the term includes considerations of importance and magnitude.

SO_2: Sulfur dioxide, a form of air pollution.

SO_3: Sulfur trioxide, a form of air pollution.

SO_x: Sulfur oxides, either sulfur dioxide or sulfur trioxide.

SPO: State Planning Office, New Mexico.

SUBSTANTIAL EFFECT: In relation to environmental analysis, the term implies an impact which is great enough to alter the basic nature or substance of an environmental system or element.

TALUS: Sloping areas of rocky fragments.

TERTIARY TREATMENT: Waste water treatment beyond the secondary, or biological, stage that includes removal of nutrients such as phosphorus and nitrogen, and a high percentate of suspended solids. Tertiary treatment, also known as advanced waste treatment, produces a high quality effluent.

USGS: United States Geological Survey.

VALUE ADDED: Value of goods sold, less the cost of the necessary materials and power, expressed in 1958 dollars to account for inflation.

WATER POLLUTION: The addition of sewage, industrial wastes, or other harmful or objectionable material to water in concentrations or in sufficient quantities to result in measurable degradation of water quality.

YERBA MANSA: Perennial herb or moist places, commonly known also as Lizardtail, technically called Anemopsis Californica.

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