DRAFT ENVIRONMENTAL IMPACT STATEMENT
Flood Control Master Plan
Clark County Regional Flood Control District

Volume I
Environmental Setting and Impacts Analysis

CLARK COUNTY
REGIONAL FLOOD CONTROL DISTRICT

October 1990

prepared for

United States Bureau of Land Management
Clark County Regional Flood Control District
Las Vegas, Nevada

in cooperation with

Department of the Army
Sacramento District Corps of Engineers

prepared by

DAMES & MOORE

DRAFT ENVIRONMENTAL IMPACT STATEMENT

FLOOD CONTROL MASTER PLAN

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

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This Environmental Impact Statement (EIS) evaluates potential environmental impacts that may occur as a result of construction and operation of flood control facilities in the Las Vegas Valley, Clark County, Nevada. Potential impacts to sensitive resources were analyzed for the three major project alternatives. Two alternatives, the Detention/Conveyance and All Conveyance alternatives, were proposed in "Clark County Regional Flood Control District Flood Control Master Plan," prepared in 1986. Both alternatives were designed to provide a comprehensive, integrated, valley-wide plan to control 100-year flood flows, and both would meet project objectives. A third alternative, the No Project Alternative, assumes that facilities will not be installed according to a comprehensive regional plan, but may continue to be built on a piecemeal basis by local entities and development interests. This alternative may not meet project objectives. The EIS presents a programmatic analysis of regional flood control plan alternatives including: 1) a summary of baseline data resources, 2) a procedure to identify sensitive resources, 3) potential impacts, and 4) appropriate mitigation-of-impact procedures. In addition to the region-wide analysis, this EIS includes the development of an analytical procedure to be applied to specific flood control projects to determine potential impact, need for additional environmental study, and appropriate mitigation measures. This procedure is intended to provide policy direction that can help facilitate the implementation of a regional flood control program in a manner consistent with the National Environmental Policy Act (NEPA). The project-specific analysis procedure was applied to the District's 10-year construction program, and site specific impacts and mitigation measures associated with each proposed facility are identified in this EIS.

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BACKGROUND

In response to major floods in 1983 and 1984, the Clark County Regional Flood Control District (here after referred to as "District") was established in 1985 to develop a regional flood control program for the Las Vegas Valley and surrounding environs. As part of the District's mandate, a comprehensive, regional Master Plan was prepared entitled "Clark County Regional Flood Control District Flood Control Master Plan" (Montgomery Engineers, 1986). The Master Plan estimated 100-year peak flows in study areas throughout Clark County, developed two major alternative flood control plans, and projected capital and operations costs of both major alternatives. The two major alternatives, the Detention/Conveyance and All Conveyance systems were then evaluated by the District and local entities. The Detention/Conveyance alternative was then selected on the basis of its flexibility, reliability, and affordability as the District's preferred flood control program.

Many of the proposed facilities identified in the Master Plan are located on federal lands managed by the BLM. BLM review and approval of rights-of-ways applications are required before facilities can be installed. On June 20, 1988, the BLM and District entered into a Memorandum of Understanding (MOU) relating to rights-of-way applications for flood control projects. The MOU established the authority of the Federal Land Policy and Management Act of 1976 (90 Stat. 273) as implemented by 43 CFR 2800 and documents the responsibilities of the District and BLM. It also establishes the BLM as lead agency for environmental review in accordance with the National Environmental Policy Act. As lead federal agency, the Nevada State Office of the BLM has determined that an Environmental Impact Statement (EIS) should be prepared.

LOCATION

This EIS focuses on an area of about 984 square miles in southeastern Nevada, including portions of Las Vegas, North Las Vegas, Boulder City, Henderson, and unincorporated portions of Clark County. This area was divided into subareas in the Master Plan, including: Northern Las Vegas Valley, Central Las Vegas Valley, Southwest Las Vegas Valley, Boulder City, and Henderson areas. Other portions of Clark County were also included in the Master Plan, but are not addressed in this EIS.

PURPOSE AND NEED FOR THE PROPOSED PROJECT

In recent years Clark County has become one of the fastest growing urban centers in the United States. This growth, estimated at 4,000 new residents per month, has resulted in increased loss of life and property during flash flood events, as development has taken place in historical flood plains and alluvial fans. Increased loss of life and property is expected to continue unless efforts are made to control flood flows.

Historically, individual communities and development interests have prepared their own flood control plans and financed the cost of construction through local bond issues or costs passed on by developers as part of new construction costs. As a result, planning efforts to control flood flows were fragmented and without reference to a single comprehensive plan.

Because the historical process of piecemeal installation of flood control facilities to protect individual developments has not been effective in controlling flooding problems, the Nevada Legislature passed AB 169 in 1985 establishing the Clark County Regional Flood Control District to implement a regional flood control planning effort. Funds to support the District's planning and coordination efforts, and to provide funds for construction of facilities are generated by a one-quarter cent sales tax increase approved on September 2, 1985. The District revenues for fiscal year 1988/89 were $19,471,955. Anticipated revenues for the fiscal year 1990/91 are $24,359,000.

The principal objective of the Master Plan is to provide for the long-term improvement in public safety and property damage protection from flooding events by guiding the siting, design, and installation of flood control facilities to promote the effective function of the entire system. A secondary objective of the Master Plan is to identify the relative cost of different flood control options. Since cost-efficient systems are more readily implemented and hence more likely to accomplish the primary objective, relative cost of facilities is an important factor to be considered in the evaluation of the ability of a system or individual facility to accomplish the principal objective.

In a separate action, the United States Corp of Engineers (COE), Los Angeles Office, is currently preparing an EIS to construct flood control facilities on Flamingo and Tropicana Washes.

PROJECT DESCRIPTION OVERVIEW

The EIS addresses three principal project alternatives, including the Detention/Conveyance alternative and All Conveyance alternative (both described in detail in the Master Plan), as well as the No Project alternative. In addition to this review of each overall program alternative, a specific analysis of the District's 10-year construction plan is presented in the EIS.

Flood Control Program Alternatives

The Detention/Conveyance system uses a series of detention basins to reduce peak flows to levels that can be accepted by the existing downstream conveyance system with little or no major capacity improvements (Montgomery Engineers, 1986). The general configuration and spatial location of the system is similar to the All Conveyance system but is characterized by a greater number of large detention basins which slow the release of water to a series of interrelated facilities including lined and unlined channels, reinforced concrete pipelines, conduits, and floodways.

The All Conveyance system is composed of a series of structures and facilities that are designed to collect stormwater and convey it out of the area. The key difference between this system and the Detention/Conveyance system is that flood flows are conveyed directly into larger lined and unlined channels, pipelines, conduits, and floodways without first reducing the rates of the flow.

Under the No Project Alternative, no flood control facilities would be built under the auspices of the District. Flood control facilities would continue to be built by individual cities, Clark County, and land developers without reference to an overall integrated system. Flood control facilities would be built on a piecemeal basis as local entities are able to allocate funds and new land developments occur. Under this alternative, flood episodes are likely to become more severe as urban growth continues, resulting in greater property damage and loss of life.

In 1986, the District adopted the Detention/Conveyance alternative over the All Conveyance alternative. The former was selected primarily on the basis of three major criteria: flexibility, reliability, and affordability, as set forth in the Master Plan. The Plan offered the greatest degree of flexibility, although it was not considered the most reliable for certain types of storm events. Based on the cost estimating tool developed by Montgomery Engineers (1986), the Detention/Conveyance alternative costs substantially less to construct. In addition, there is less relocation of residents and disruption of traffic and businesses under this alternative, which also realizes the greatest potential for multi-use recreational facilities.

10-Year Plan Facilities

The 10-year plan facilities analyzed for this EIS consist of Detention/Conveyance facilities included in the District's Master Plan for fiscal years 1988-1989 through 1997-98. Most of these facilities are identified in the Master Plan as Phase 1 facilities. Phase 1 facilities include those that should be constructed as soon as funding is available for the purpose of mitigating substantial threats to life, public facilities, and private property. They will function effectively to control flooding immediately, without the presence of future related facilities. Some of the 10-year plan facilities are Phase 2 facilities, or were added to the Master Plan by amendment (and are not classified as Phase 1 or 2 facilities). Phase 2 includes facilities for the proper functioning of the overall flood control system and is linked with long-term future development.

Construction of 10-year plan facilities is estimated to result in 100.84 miles of construction disturbance from linear facilities, such as channels, pipelines, and dikes/levees, as well as 2.23 square miles of areal disturbance from construction of detention and debris basins. Most of the construction effort will be directed towards the construction of lined channels. Eighty channel segments will be constructed representing an estimated 294,500 linear feet of construction. Eighteen box conduits and 28 box culverts will be built totalling about 57,500 and 3,720 linear feet of disturbance, respectively. Fourteen dikes/levees will be constructed, primarily around the perimeter of the valley. They are estimated to represent about 78,050 linear feet of construction. Also included are 19 pipeline segments (12,840 linear feet), 13 bridges (1,900 linear feet), and five floodways (80,000 linear feet). Miscellaneous facilities include one inlet works, one outlet works, and two culverts. Twenty-one detention basins and one debris basin are planned, covering 1,426 acres.

ENVIRONMENTAL ANALYSIS

This EIS includes an overall analysis of the entire Master Plan as well as a more specific analysis of the District's proposed 10-year construction program. The flood control program analysis, or programmatic analysis, addresses environmental resources and issues associated with construction of flood control facilities in the Northern Las Vegas Valley, Central Las Vegas Valley, Southwest Las Vegas Valley, Boulder City, and Henderson areas. This information was used to develop procedures that may be applied in the review of specific projects to identify potentially significant environmental impacts and focus environmental studies. These procedures were then applied to the District's 10-year plan facilities in the analysis of project specific impacts. The general methodology employed in each study component was as follows:

Program Analysis: Potential environmental sensitivities associated with each area of public concern were evaluated over the entire study area, and analysis addresses each major flood control program alternative (Detention/Conveyance, All Conveyance, and No Project). Sensitive resources were identified through literature review, professional contacts, and field reconnaissance studies. Sensitive resources and their currently known distributions were then plotted on 1:100,000 scale maps incorporated as part of this document. A programmatic approach was used to identify potential impacts to sensitive resources, present mitigation options that could be used to reduce potential adverse effects, and develop a project-specific review procedure that could be applied to future facility proposals.

10-Year Plan Project-Specific Analysis: The programmatic approach developed as a result of the Program Analysis was applied to facilities currently proposed in the District's 10-Year

Construction Plan to identify potential impacts, additional study requirements, and applicable mitigation measures. Focused site-specific investigations were accomplished in accordance with EIS contract scope requirements and programmatic procedures recommendations. The results of these investigations were plotted on large-scale maps or presented in detailed tables and specific mitigation measures applicable to each facility were identified.

The review of potential impacts resulted in the identification of potentially significant environmental impacts associated with: air quality (carbon monoxide and particulate matter emissions), geology and soils (erosion and sedimentation, and mineral resources), ground water (reduction of discharge from shallow aquifer), surface water (changes in perennial flows and potential increased flood risk under some circumstances), terrestrial and aquatic biology (direct, indirect, and cumulative impacts on vegetation and wildlife), land use, visual resources, and cultural resources. Engineering and construction-related concerns associated with environmental conditions were also identified with respect to geology, soils, ground water, and surface water resources. A brief summary of the principal impacts and constraints are listed along with an overview of general mitigation measures in Table ES-1.

TABLE ES-1

SUMMARY OF ENVIRONMENTAL IMPACTS AND MITIGATIONS

AIR QUALITY	
Carbon Monoxide (CO): Construction of proposed flood control facilities may result in short-term construction related CO emission exceedances.	CO threshold emission levels were assessed based on location relative to exceedance zones. Emission exceedances will be mitigated to insignificant levels by: 1) routine inspection and maintenance of construction equipment and vehicles, and 2) planned management of construction activities in coordination with the Clark County Air Pollution Control District during known CO exceedance episodes.
Total Suspended Particulates (TSP): Windblown fugitive dust and combustion particular emissions associated with construction activities may result in short-term construction related TSP exceedances.	Project-specific TSP impacts due to facility particulate matter (PM) emissions were evaluated and PM emission thresholds established. Implementation of proposed mitigation measures: 1) fugitive dust reduction measures, and 2) planned management of construction activities during high wind periods when construction is within 1,000 feet of residential areas.

GEOLOGY AND SOILS	
Strong Ground Motion: Facilities may be damaged by seismic shaking. Unfavorable soil conditions could amplify the effects of strong ground motion.	Relocation of the facility to a more favorable location and modification of existing soil conditions and engineering design modifications will reduce impacts to insignificant levels.
Surface Fault Ruptures: Surface fault ruptures may result in damage to flood control facilities.	Mitigation of potential impacts may be reduced to insignificant levels by establishing appropriate setback requirements from potentially active faults and modifying designs based on site-specific investigation.
Slope Instability, Subsidence: Slope instability and subsidence may result in damage to flood control facilities.	Potential impacts can be reduced to insignificant levels by relocating facilities or using standard engineering practices based on site-specific investigations. Slope instability can be mitigated through buttressing.

TABLE ES-1 (continued)

GEOLOGY AND SOILS (continued)	
Collapsing Soils, Expansive Soils, and Liquefaction: Construction of flood control facilities in locations with soils exhibiting these characteristics may result in damage to facilities.	Potential impacts can be reduced to insignificant levels by relocating the facilities or implementation of standard engineering designs based on site specific investigations. Potential impacts resulting form construction in areas with these soil types can be mitigated by overexcavation and recompaction of existing soils or extension of piers and pilings beyond the soils; soils susceptible to liquefaction will be dewatered.
Erosion and Deposition: Wind, channel, and indirect erosion, and deposition may result in impacts to the correct functioning of flood control facilities. Wind erosion will be most prevalent during construction; channel erosion will tend to occur at locations where cross structures occur; indirect erosion will result in scouring of channel walls; accumulations of sediments may interfere with the proper functioning of flood control facilities.	Wind erosion can be mitigated to short-term construction related impacts by minimizing soil disturbance, use of small equipment and manual labor, water and chemical suppressants, and recompaction and revegetation following construction. Channel erosion can be mitigated using standard engineering practices such as limiting the area to be disturbed, avoiding highly susceptible soils, revegetating immediately following construction and constructing during low rainfall periods. Indirect erosion can be mitigated by selecting designs to reduce velocities and using erosion control structures on side-slopes. Soil deposition impacts can be reduced by relocating the facilities or through routine removal of accumulated sediments.
Caliche: The presence of caliche soils may interfere with routine construction and may require special construction practices.	Caliche soils can be avoided by relocating facilities or using special construction equipment to remove the soils prior to construction.
Corrosion: Corrosive soils may result in impacts to the long-term maintenance and integrity of flood control facilities.	Corrosive soils may be avoided by relocating the facility, removing soils prior to construction and use of corrosive resistant construction techniques and materials.

TABLE ES-1 (continued)

GEOLOGY AND SOILS (continued)	
Mineral Resources: Construction of detention basins and other flood control facilities may interfere with mining claims, or feasibility of flood control facilities may be adversely affected by existing mining claims.	Impacts to mining claims can be reduced to insignificant levels and project feasibility improved by relocating the facility or payment of fair compensation to the claimant.
Topographic Alteration: Construction of flood control facilities will result in topographic alterations.	No mitigation measures are proposed.
GROUND WATER	
Construction Difficulties Associated with Presence of Shallow Ground Water: Difficulties may arise in areas with shallow ground water affecting excavation or placement of materials.	This impact is not considered significant since it can be mitigated through standard engineering design methods and techniques.
Facility Impacts Associated with Reduction of Discharge from the Shallow Aquifer: Construction of lined channels and pipelines in channels currently allowing ground water discharge may result in shallow ground water increases.	Site-specific information will be gathered to evaluate whether the proposed channel or pipeline has the potential to cause water level rises in the project area. Significant impacts can be reduced to insignificant levels by relocating the facility or designing the facility to allow discharge.
SURFACE WATER	
Changes in Perennial Flows: Changes in perennial flows could result in impacts to biological resources.	Construction of individual facilities will be evaluated for potential changes in downstream perennial flows. If a change will occur impacts to biological resources will be evaluated. If significant impacts are identified, mitigation-of-impact measures will be identified as part of the COE Section 404 permit process. These measures may include establishment of wetlands.

TABLE ES-1 (continued)

SURFACE WATER (continued)	
Potential to Increase Flood Hazards: 100-year flood even discharge rates of proposed facilities could result in downstream flooding problems if discharge rates exceed the capacity of downstream facilities.	Projected 100-year flow discharges from proposed facilities should be compared to the capacity of downstream conveyances and redesign of facilities should be accomplished to prevent downstream flooding if potential problems are identified.
TERRESTRIAL AND AQUATIC BIOLOGY	
Botanical and Wildlife Resources: Construction of flood control facilities will result in direct and indirect impacts to a variety of botanical and wildlife resources. These resources will be affected by actual loss and crushing of species through clearing and grading, Establishment of weedy vegetation after construction will result in indirect impacts. Loss or displacement of individual animals will occur as well as disturbance or loss of wildlife habitat. Habitat fragmentation may occur from construction of linear facilities. Wetland vegetation may be degraded and/or lost by upstream diversion of flood waters and disturbance of existing wetlands.	Detailed mitigations measures have been prepared which will reduce impacts to less than significant levels. Many of these measures include detailed biological investigations, redesign and modification of facilities as appropriate, and consultation with resource agencies such as the BLM, U.S. Fish and Wildlife Services, U.S. Corps of Engineers, and the Nevada Division of Wildlife.
Herbicides: Use of herbicides may adversely impact sensitive biological resources.	Potential adverse effects will be evaluated including residual effects. Methods such as low-impact mechanical clearing will be considered.
LAND USE AND RECREATION	
Changes in Land Use: Construction of flood control facilities will result in changes in land use through creation of temporary construction-related and long-term effects such as: 1) eliminating existing land uses; 2) creating barrier effects; 3) dividing existing uses; 4) creating public inconvenience; 5) affecting health and safety; 6) attracting undesirable activities; and 7) creation of beneficial recreation areas.	Impacts will be reduced to insignificant levels by evaluating potential impacts by facility type in relationship to existing and proposed future land uses. Potential impacts are considered during both construction and operation of facilities. Potential mitigation measures are proposed based on type of land use and type of effect.

TABLE ES-1 (continued)

VISUAL RESOURCES	
Creation of Visual Obtrusions: Construction of flood control facilities have the potential to create significant visual obtrusions depending upon the type and location of the facility.	Facility characteristics were evaluated according to form, line, color, and texture. Levels of visual dominance were then assessed based on the facilities' compatibility with its setting and ability to be absorbed into the visual character. Potential impacts may be reduced to insignificant levels following the analytical procedure set forth in the EIS.
SOCIOECONOMICS	
Growth Inducement: Construction of the flood control facilities has the potential to induce growth if the District's construction prioritization procedures are not applied or followed consistently.	Analysis of the Districts construction prioritization procedures indicates that construction of the flood control facilities will be growth-accommodating rather than growth inducing as long as the prioritization procedures are applied consistently and continuously to all individual flood control facilities.
CULTURAL RESOURCES	
Archaeological Resources: Construction of flood control facilities will result in direct and indirect impacts to prehistoric archaeological resources.	Impacts to significant resources can be reduced to insignificant levels by completion of a site records search, intensive surface survey, and implementation of mitigation-of-impact procedures developed in consultation with BLM, SHPO, and ACHP following procedures set forth in 36 CFR 800.
Ethnographic Resources: Potentially sensitive Native American resources, including native plants, may be disturbed by construction of flood control facilities.	Knowledgeable members of the Las Vegas Paiute Tribe and Moapa Paiute Indian Tribe will be consulted regarding treatment of significant archaeological sites and resources of concern. Mitigation measures will be discussed with these individuals prior to implementation.

CULTURAL RESOURCES

Historic Resources: Significant historic sites will be subject to direct and indirect impacts as a result of construction of flood control facilities.	Potential impacts to historic resources will be identified through site records search, field reconnaissance and consultation with BLM, SHPO, and ACHP following procedures set forth in 36 CFR 800.

1.1 STUDY AUTHORITY AND OVERVIEW

This Environmental Impact Statement (EIS) was prepared for the United States Bureau of Land Management (BLM) to assess potential environmental effects of construction of flood control facilities in the Las Vegas Valley by the Clark County Regional Flood Control District ("District"). In 1985 the District contracted with a local engineering firm to evaluate existing flood related data, propose several alternative flood control systems, and recommend the most feasible approach to the District.

In 1986 the "Clark County Regional Flood Control District Flood Control Master Plan" was submitted to the District (Montgomery Engineers, 1986). Two major alternative flood control systems were proposed: 1) All Conveyance, and 2) Detention/Conveyance. Each of these alternatives consists of a series of interrelated facilities such as lined and unlined channels, detention and debris basins, dikes, box conduits, pipelines, and bridges. Although each system was of the same general configuration, the size and numbers of facilities varied between each alternative. Based on information presented in the Master Plan, the District adopted the Detention/Conveyance alternative as the preferred flood control system based on engineering and cost considerations.

Many of the facilities identified in the Master Plan are located on federal lands managed by the BLM. Before these facilities can be installed, BLM review and approval of right-of-way applications is required. On June 20, 1988 the BLM and the District entered into a Memorandum of Understanding (MOU) relating to applications for rights-of-way for flood control projects on federal lands administered by BLM. This MOU was accomplished under the authority of the Federal Land Policy and Management Act of 1976 (90 Stat. 273) as implemented by 43 CFR 2800. The MOU documents the responsibilities of the District and the BLM and establishes the BLM as lead agency for environmental review in accordance with the National Environmental Policy Act (NEPA). As lead federal agency, the Nevada State Office of the BLM determined that an Environmental Impact Statement should be prepared for the proposed District's rights-of-way. As a result, this EIS has been prepared to comply with provisions of NEPA and associated implementing regulations.

1.2 NEED FOR AND OBJECTIVE OF ACTION

1.2.1 Regional Growth

Clark County makes up the southern tip of the state of Nevada, encompassing 7,910 square miles that are largely undeveloped. The bulk of Clark County urban development is within the Las Vegas Metropolitan area, which currently represents four percent of the surface land (Las Vegas Perspective 1988, Cooper et al., 1988). This metropolitan area is one of the fastest growing urban areas in the country, with growth occurring in previously undeveloped and rural areas.

Since the turn of the century, flooding in Clark County has resulted in the loss of life and millions of dollars in property damage. In 1983 and 1984, damage to public property exceeded nine million dollars. Private property damage and business losses were estimated to be several times that amount. In 1984 alone, seven people drowned trying to cross flooded washes.

The population of the county increased from approximately 463,087 in 1980 to an estimated 648,900 in 1987. It is estimated that nearly 3,600 new residents are establishing themselves in Clark

County each month. Population is now estimated to be about one million people by the turn of the century.

As growth rates have increased, so have damages from flooding as development has taken place in historical flood plains and on alluvial fans where adequate flood protection does not exist. Historically, individual communities have developed their own flood control facilities, generally with little coordination between adjacent communities.

1.2.2 Flooding History

Clark County is located in an arid, desert climate. As is typical with this type of climate, flooding events occur and can be expected. Historically, Clark County has experienced several significant flooding events including significant events in 1974, 1975, 1981, 1983, and 1984 (Table 1-1, Figure 1-1). These floods have resulted in various levels of damage to the physical and urban environment, including loss of property and even life.

General winter and summer storms in the Las Vegas Valley are rare and typically have not resulted in major discharges. Those storm events that result in significant runoff rates are tropical depressions that approach the county from the south or southeast. These are summer thunderstorms which are of short duration and high intensity (Montgomery Engineers, 1986).

Historically, flash flood events in Clark County have been increasing, particularly in the last ten to fifteen years. A flood event database does not exist, therefore floods recorded are typically events that impacted property or life. Consequently, the increase in flooding is viewed as both an increase in recording of events, and a result of population increases. As population continues to grow and expand into previously undeveloped areas of Clark County the potential for increased flooding, extensive property damage, and loss of life continues to grow.

1.2.3 Objectives

Because the historical process of piecemeal installation of flood control facilities to protect individual developments has not been effective in controlling flood problems, the Master Plan was developed to provide a comprehensive regional approach to the configuration and design of an integrated flood control system for the Las Vegas Valley and nearby areas. The purpose of implementing the Master Plan is to provide protection from the estimated 100-year flows, thereby alleviating the damages to public and private properties in Clark County which result from flooding. The Master Plan identifies both those facilities needed to address the existing flooding problem (Phase 1) and those required to address the additional flooding that is anticipated upon ultimate development of the County (Phase 2).

The principal objective of the Master Plan is to provide for the long-term improvement in public safety and property damage protection from flooding events by guiding the siting, design, and installation of flood control facilities to promote the effective function of the entire system. A secondary objective of the Master Plan is to identify the relative cost of different flood control options. Since cost-efficient systems are more readily implemented and hence more likely to accomplish the primary objective, relative cost of facilities is an important factor to be considered in the evaluation of the ability of a system or individual facility to accomplish the principal objective.

1.3 DEVELOPMENT OF THE CLARK COUNTY REGIONAL FLOOD CONTROL MASTER PLAN

1.3.1 Establishment of the Regional Flood Control District

Public concerns regarding the need for flood control facilities surfaced in the early 1980's as rapid population growth and development in previously undeveloped areas lead to increasing property damage and loss of life with each major flood event. The first regional flood control funding occurred in 1981 when a $32 million bond issue was passed. These funds were used primarily for a small number of critical facilities and repairs. Several detention basins were built in North Las Vegas, the City of Las Vegas, and in unincorporated Clark County.

In response to major floods in 1983 and 1984, AB 169 was passed in 1985. This bill established the Clark County Regional Flood Control District with representation from local governments. Start-up funding for the district came from a one-year two cent property tax levy in Clark County. The $1.5 million in revenues was used to prepare the Master Plan and other activities.

The District was also asked to recommend to the Clark County Commissioners whether voters should be asked to approve a one-quarter cent sales tax increase or property tax increase to provide a continuing source of funds for the District. Some of the reasons why the District recommended a sales tax increase included:

- Tourists pay about 30 percent of the County's sales tax.

- Neither food nor medicine is taxed in Nevada and hence a sales tax would have a smaller impact on low and fixed income families.

- The tax was more closely tied to the ability to pay.

- All people pay sales tax and all people would enjoy the benefits of the flood control facilities.

On September 2, 1985 voters approved the one-quarter cent sales tax increase. As codified, the District derives its revenues as authorized by Nevada Revised Statute 543.600 and enacted by County ordinance.

To pursue the development of a regional flood control program, the District was given the authority and responsibility to:

- Establish a citizen's committee to assist in the selection of an executive director,

- Retain a qualified engineering firm to prepare a comprehensive, regional master plan, and

- Select a designated funding source to pay for ongoing flood control work in Clark County.

1.3.2 Clark County Regional Flood Control District Master Plan Goals

The District developed project goals to be addressed in the Master Plan in consultation with advisory committees of local citizens. These goals include:

- Estimation of 100-year peak flows in Master Plan study areas throughout Clark County,

- Development of alternative plans describing flood control facilities and selection of a recommended plan,

- Preparation of capital and operation cost estimates for alternative control plans,

- Development of the organizational requirements needed to successfully implement a cost-effective, County-wide flood control program, and

- Development of design standards to assure consistency in construction and operation of flood control facilities in Clark County (Montgomery Engineers, 1986).

These goals are addressed in the Master Plan (Montgomery Engineers, 1986) and the potential impacts associated with the implementation of this plan are the subjects of this EIS.

1.4 PUBLIC CONCERNS

In addition to public concerns regarding the adequacy of existing flood control facilities in populated areas of Clark County, local citizens have expressed concerns that flood control projects should be designed with a consideration of the potential environmental impacts associated with their construction and operation. In addition, concerns were expressed that the installation of flood control facilities recommended by the Master Plan could induce growth. An evaluation of this potential for growth inducement was considered appropriate, and an analysis of potential indirect and cumulative impacts was requested where induced growth would result from the proposed Master Plan. Topics raised as important areas of investigation in the EIS include: air quality, biological resources, geology and soils, ground water, surface water, socioeconomics, land use (including growth-inducement), visual resources, and cultural resources. Based on annual estimated revenues, it is anticipated that construction of all Master Plan facilities will take about 60 years.

1.5 PLANNING OBJECTIVES AND EIS METHODOLOGY

The Master Plan is a conceptual document to guide design and construction of flood control facilities without specific identification of construction schedules. For this reason, final engineering designs, precise facility locations, and specific construction and operation details of all individual flood control facilities are not presently known. Because the design characteristics of early flood control projects are determined by the overall flood control program alternative selected, it is appropriate to consider the regional-scale environmental consequences of each major alternative to provide guidance in the early stages of Master Plan implementation. By addressing potentially sensitive resources and impact categories using a programmatic, or "tiered" approach, this EIS provides this guidance and presents specific information that can be used to allow the consideration of sensitive environmental resources in the final siting and design of flood control facilities.

To accomplish the overall planning objective, this EIS includes two levels of a tiered analysis. The first level of this analysis addresses the overall flood control program alternatives (Program Analysis), and the second level addresses the specific impacts associated with facilities scheduled for construction over the next ten years (10-Year Plan Project-Specific Analysis). The general methodology employed in each study component was as follows:

- **Program Analysis**: Potential environmental sensitivities associated with each area of public concern identified in Section 1.4 were evaluated over the entire study area, and analysis addresses each major flood control program alternative (Detention/Conveyance, All

Conveyance, and No Project). Sensitive resources were identified through literature review, professional contacts, and field reconnaissance studies. Sensitive resources and their currently known distributions were then plotted on 1:100,000 scale maps incorporated as part of this document. A programmatic approach has been proposed to minimize potential impacts to sensitive resources.

- **10-Year Plan Project-Specific Analysis**: The programmatic approach developed as a result of the Program Analysis was applied to facilities proposed in the District's 10-Year Construction Plan to identify potential impacts, additional study requirements, and applicable mitigation measures. Focused site-specific investigations were accomplished in accordance with EIS contract scope requirements and programmatic procedures recommendations. The results of these investigations were plotted on large-scale maps or presented in detailed tables and specific mitigation measures applicable to each facility were identified.

1.6 EIS ORGANIZATION

Because this EIS includes both a Program Analysis and a Project-Specific Analysis in a single document, some modifications of a standard EIS format were necessary to improve this document's usefulness to individuals with a specific interest. The contents of this document include:

- **Abstract**: A brief, one page overview of the EIS and its major conclusions;

- **Executive Summary**: A detailed summary of major document conclusions, programmatic procedure recommendations, and project-specific mitigation recommendations;

- **Introduction**: A brief overview of the project need and objectives, public concerns, and EIS methodology;

- **Project Description**: Two chapters including one addressing the Master Plan alternatives and facilities associated with each alternative, and one chapter addressing the specific 10-Year Construction Plan facilities;

- **Environmental Analysis - Flood Control Program**: Several chapters addressing each topic of environmental concern, including a description of the affected environment, potential impacts, and applicable mitigation measures and project-review procedures;

- **Cumulative Impact Analysis**: This chapter analyzes potential cumulative project impacts.

- **Project-Specific Analysis Procedure**: Integrated presentation of the recommended approach to evaluation of specific projects including an environmental issues matrix;

- **Environmental Analysis - 10-Year Plan**: Application of the project-specific analysis procedure and presentation of environmental information applicable to each 10-year plan facility, including the identification of potential project-specific impacts and appropriate mitigation measures;

- **References**: Complete citations of all references cited in the text of the EIS are presented;

- **List of Preparers**: Individuals materially involved in the preparation of the EIS text are listed; and

- **Public Involvement Summary:** A description of the means used to involve the public in EIS scoping and preparation, agency coordination efforts, a list of EIS recipients, and a summary of public scoping comments is presented.

TABLE 1-1

FLASH FLOODING EVENTS IN CLARK COUNTY BETWEEN
1959-1988 FROM STORM DATA[1]

YEAR	DATE	COMMENTS ON EVENT
1959	12-24	Accidents in Las Vegas with 7 injured.
1960	08-09	Flash flood killed one person and caused significant damage in Henderson.
	09-12	Flash flooding in Pahrump Valley 50 SW of Las Vegas.
	11-5/6	Severe flooding on the Muddy River affected Glendale, Overton, and Moapa.
1961	08-29	Flash flooding in Las Vegas and wind damage.
	09-16	Severe thunderstorm produced wind and hail damage in a swath 1-1.5 miles wide with severe damage to the Las Vegas strip and West Charleston. One person was killed and 31 injured and approximately $2 million damage.
1962		No significant events reported.
1963	09-04	Flash flooding with about $1 million damage.
1964	06-07	Severe thunderstorm produced a tornado and wind damage in Las Vegas.
1965		No significant events reported.
1966	05-20	Severe thunderstorm produced wind gusts to 80 mph with 6 injuries and moderate damage.
	12-5/6	Severe thunderstorm produced flash flooding with 100 mph gusts and about $1 million damage.
1967		No significant events reported.

[1] Adapted from Table 8-6 (Montgomery Engineers, 1986)

TABLE 1-1 (continued)

YEAR	DATE	COMMENTS ON EVENT
1968		No significant events reported.
1969	02-23/26	Winter storm brought flooding to parts of Clark County and Las Vegas due to snowmelt and rains.
	10-09	Severe thunderstorm produced flash flooding in Las Vegas Valley.
1970	07-24/25	Thunderstorms produced over 1" rains in 2-3 hours with flash flooding from Lake Mead to Las Vegas.
	08-26	Thunderstorms produced 2"+ rains in Las Vegas with hail.
	08-29	Flash flooding in Henderson with 50-60 mph winds.
1971	07-21	Flash flood in Clark County near Mt. Charleston with mudslides on Highway 59.
	08-01	Severe thunderstorm produced $75,000 damage to boats at Lake Mead.
	08-08	Severe thunderstorm produced flash flooding and 53 mph gusts in the Las Vegas Valley with Charleston underpass flooded and 40 small fires started.
1972	07-16	A severe thunderstorm complex moved north from Lake Mead where it did marina damage into the Las Vegas Valley. The storm closed the airport with 54 mph winds and caused water damage in Las Vegas.
	8-13	Flash flood produced 1 death and heavy damage in the Valley. Hardest hit area was east of Sunrise Mtn. Roads were undercut in East Las Vegas and Route 41 was washed out.
	10-09	Flash flood produced moderate damage to homes, roads, and cars in Las Vegas.
1973	08-20	Severe thunderstorm produced $1.6 million damage to Las Vegas.
1974	07-20	Severe thunderstorm produced wind damage and flash flooding in Las Vegas with 53-67 mph winds reported.

TABLE 1-1 (continued)

YEAR	DATE	COMMENTS ON EVENT
1974 (cont.)	09-14	Flash flood killed 5 at Nelson Landing in Eldorado Canyon, Clark County.
1975	07-03	Thunderstorm rains of 3" or more damaged 700 cars at Ceasar's Palace, killed 2 persons and did $3.5 million damage in the valley and Las Vegas.
1976	07-25	Severe thunderstorm produced flash flooding and wind damage. $200,000 damage at Hughes terminal at airport with .55"/10 min and 1.10"/37 min rains.
	07-29	Flooding on the roads near Searchlight.
1977	07-24	Flash flooding produced road damage in Las Vegas.
1978	03-04	Severe thunderstorm rains in the nearby mountains produced flooding in Las Vegas.
	07-28	Heavy thunderstorm rains in the nearby mountains produced flooding in Las Vegas.
	08-12	Flash flooding near Lake Mead with moderate damage.
	09-04	Flash flooding in Las Vegas with little damage.
	10-24	Flash flooding in Las Vegas with moderate damage.
1979	08-12/13	Flash flooding of Las Vegas damaged streets, roads, and cars with 1800 homes with no power.
1980	06-30	Slight flooding noted near Mt. Charleston from a thunderstorm.
	07-01	Heavy damage in Henderson due to flooding.
	07-30	Flash flooding in Las Vegas with vehicle and road damage.
	09-09	Severe thunderstorm with heavy rains and hurricane force winds produced flash flooding near Mesquite in Clark County.

TABLE 1-1 (continued)

YEAR	DATE	COMMENTS ON EVENT
1981	08-10	Flash flooding in northern Clark County with $10 million damage and 700+ cattle killed in Moapa Valley, Glendale, and Overton.
	09-04	Flash flooding in Boulder City and Lake Mead with moderate damage.
1982	08-11	Flash flood near Boulder City and Searchlight flooded Highway 95 with 3 inches of water.
	08-13	Flash flood near Searchlight.
	08-23	Flash flooding killed one at Blue Diamond and flooded Cottonwood Wash and areas near Searchlight.
	08-25	Flash flood near Searchlight and Laughlin closed Highway 95.
1983	08-10	Thunderstorm formed in South Clark County and moved north across the Valley. Heaviest rain affected Flamingo and Las Vegas Washes. Two million in property damage and $1 million to roads.
	08-18	Similar to above but much less severe.
	11-20	Severe thunderstorm and winds to 70 mph in Las Vegas and to 96 mph in Henderson produced widespread damage.
1984	06-30	Severe thunderstorm and winds to over 75 mph affected the Valley from Lake Mead to Las Vegas.
	07-11	Widespread thunderstorm wind damage affected most of Clark County with gusts reaching 90 mph and $2 million damage to boats and facilities in Lake Mead.
	07-20	Severe thunderstorm damage in Las Vegas.
	07-21	Flooding in extreme southern Clark County.
	07-22	Severe thunderstorms raked Clark County and Las Vegas with a tornado at Willow Beach, 60+ mph winds at North Las Vegas, and a severe flash flood in Las Vegas that killed 2 persons and flooded streets.

TABLE 1-1 (concluded)

YEAR	DATE	COMMENTS ON EVENT
1984 (cont.)	08-13	Thunderstorm at Lake Mead with severe winds to 64 mph and flooding.
	08-14	Numerous reports of flash floods throughout Clark County.
	08-19	Flash flooding occurred in most of Henderson.
	08-25	Localized thunderstorm rains produced flash flooding in parts of Henderson and Las Vegas.
	09-10	Severe flash flooding occurred near Boulder City. Ninety-five percent of the roads in the Las Vegas area were either closed or washed out. A total of 3.25 inches of rain reported at Boulder City.
1985	07-21	Flash flood with moderate damage in Clark County.
1986		No significant events reported.
1987		No significant events reported.
1988		No significant events reported.

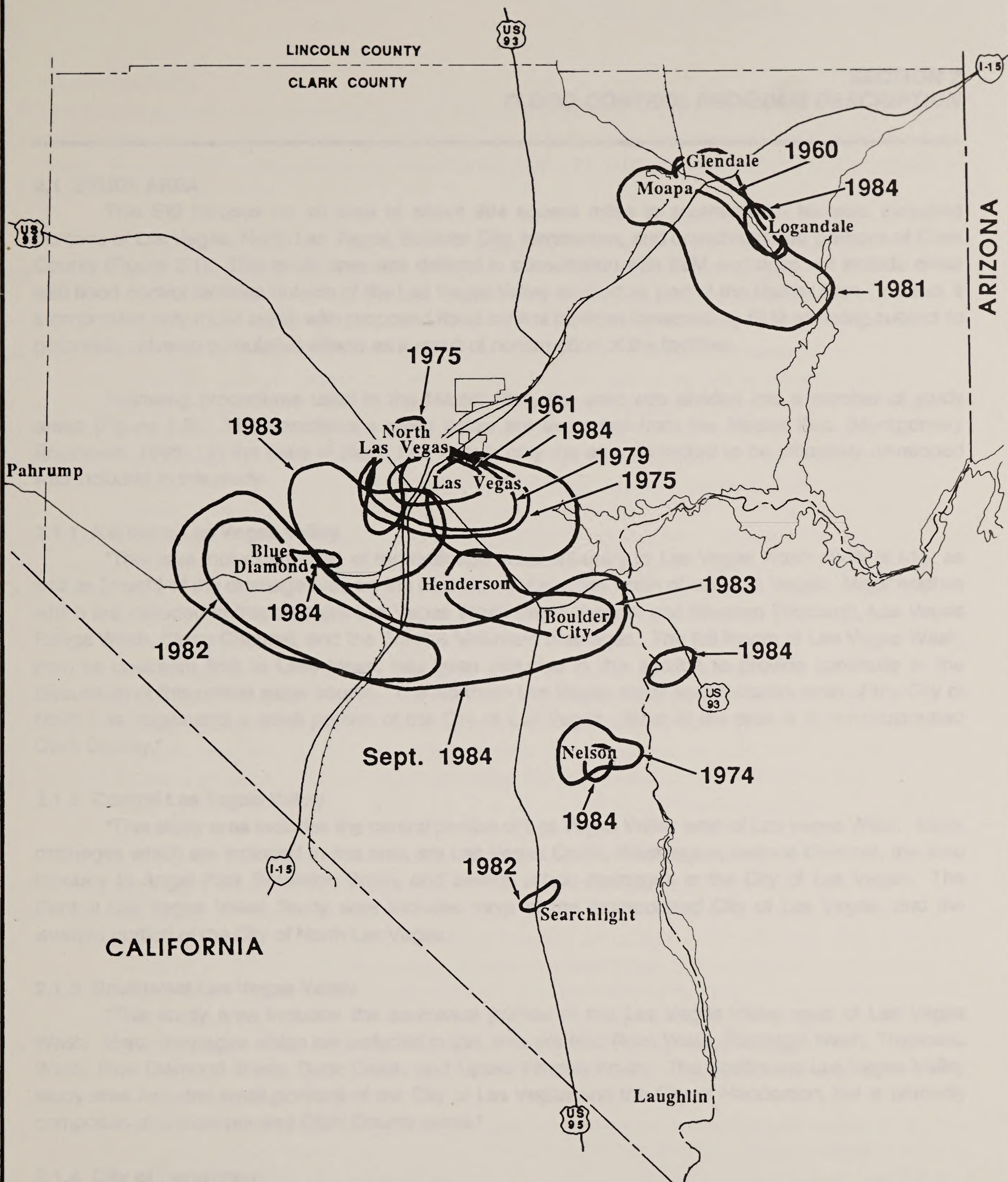

FIGURE 1-1

LOCATIONS OF SELECTED HISTORICAL FLOODING EVENTS

Source: Clark County Regional Flood Control District, 1989

2.1 STUDY AREA

This EIS focuses on an area of about 984 square miles in southeastern Nevada, including portions of Las Vegas, North Las Vegas, Boulder City, Henderson, and unincorporated portions of Clark County (Figure 2-1). This study area was defined in consultation with BLM and does not include areas with flood control facilities outside of the Las Vegas Valley studied as part of the Master Plan. Instead, it incorporates only those areas with proposed flood control facilities assessed by BLM as being subject to potentially adverse cumulative effects as a result of construction of the facilities.

Following procedures used in the Master Plan, the area was divided into a number of study areas (Figure 2-2). The descriptions given below are excerpted from the Master Plan (Montgomery Engineers, 1986). In the case of North Las Vegas, only the area projected to be ultimately developed was included in this study.

2.1.1 Northern Las Vegas Valley

"This area includes [most] of the drainage areas tributary to Las Vegas Wash north of I-15, as well as [much] of the drainage area on the east side of the valley north of east Las Vegas. Major washes which are included in this area are Las Vegas Wash (main channel and Western Tributary), Las Vegas Range Wash, Sloan Channel, and the Sunrise Mountain drainages. The full length of Las Vegas Wash, from its upstream limit to Lake Mead, has been included in this section to provide continuity to the discussion of this critical water course. The Northern Las Vegas study area includes most of the City of North Las Vegas and a small portion of the City of Las Vegas. Most of the area is in unincorporated Clark County."

2.1.2 Central Las Vegas Valley

"This study area includes the central portion of Las Vegas Valley west of Las Vegas Wash. Major drainages which are included in this area are Las Vegas Creek, Washington Avenue Channel, the area tributary to Angel Park Detention Basin, and several urban drainages in the City of Las Vegas. The Central Las Vegas Valley Study area includes most of the incorporated City of Las Vegas, and the western portion of the City of North Las Vegas."

2.1.3 Southwest Las Vegas Valley

"This study area includes the southwest portion of the Las Vegas Valley west of Las Vegas Wash. Major drainages which are included in this area are Red Rock Wash, Flamingo Wash, Tropicana Wash, Blue Diamond Wash, Duck Creek, and Upper Pittman Wash. The Southwest Las Vegas Valley study area includes small portions of the City of Las Vegas and the City of Henderson, but is primarily composed of unincorporated Clark County areas."

2.1.4 City of Henderson

"This study area includes the watershed area tributary to the City of Henderson, with the exception of upper Pittman Wash. Major drainages include Lower Pittman Wash, Whitney Wash, the "B" Drainage System and the "C" Drainage System. Essentially, all of the City of Henderson is included in this study area; no other incorporated areas are included."

2.1.5 City of Boulder City

"This study area includes all of the watershed area naturally tributary to the City of Boulder City, and all of the incorporated area of the city. Major flooding sources included in this area are Bootleg Canyon Wash, Buchanan Wash, Georgia Wash, Cemetery Wash, and Hemenway Wash."

2.2 MASTER PLAN OVERVIEW

2.2.1 Summary of Principal Program Alternatives

Three major project alternatives were considered as part of this study. They include the Detention/Conveyance, All Conveyance, and No Project alternatives.

The Detention/Conveyance system uses a series of detention basins to reduce peak flows to levels that can be accepted by the existing downstream conveyance system with little or no major capacity improvements (Montgomery Engineers, 1986). The general configuration and spatial location of the system is similar to the All Conveyance system but is characterized by a greater number of large detention basins which slow the release of water to a series of interrelated facilities including lined and unlined channels, reinforced concrete pipelines, conduits, and floodways.

The All Conveyance system is composed of a series of structures and facilities that are designed to collect stormwater and convey it out of the area. The key difference between this system and the Detention/Conveyance system is that flood flows are conveyed directly into larger lined and unlined channels, pipelines, conduits, and floodways without first reducing the rate of discharge.

Under the No Project alternative, no flood control facilities would be built under the auspices of the District. Flood control facilities would continue to be built by individual cities, Clark County, and land developers without reference to an overall integrated system. Flood control facilities would be built on a piecemeal basis as local entities are able to allocate funds and new land developments occur. Under this alternative, flood episodes are likely to become more severe as urban growth continues, resulting in greater property damage and loss of life.

2.2.2 Functional Requirements

Three major functional requirements were considered during the design and evaluation of the Detention/Conveyance and All Conveyance systems. These include: flexibility, reliability, and affordability. Master Plan evaluation factors used to evaluate each of these major functional requirements are summarized below (Montgomery Engineers, 1986).

2.2.2.1 Flexibility

The program must be flexible to allow for specific development conditions and to meet the administrative and financing needs of the District. The major factors include:

- Project Segmentation: The ability to segment the project into smaller parts that can function independently.

- Funding Compatibility: The ability to construct facilities as funds become available.

- Development Compatibility: The ability to be incorporated with site-specific development projects.

- Plan Flexibility: The ability to modify plans without sacrificing the proposed purpose.

2.2.2.2 Reliability

The selected alternative must provide the most effective flood protection under the most variable precipitation and runoff conditions. The system must also be able to remain intact and functional when design capacities are exceeded. It must pose the least risk to downstream people and property uses. The major factors include:

- Control of 100-Year Events: The ability to control 100-year rainfall events with the greatest degree of reliability.

- Control Probable Maximum Flood Events: The ability to function and withstand rainfall events in excess of design capacity.

- Function Under All Conditions: The ability to function if previously damaged or if maintenance has been inadequate.

2.2.2.3 Affordability

This is the alternative that will provide the greatest level of protection for the lowest capital cost and maintenance costs. The facility must also be able to be constructed in segments to match the funding availability of the District.

- Implementation with Available Funds: The ability to be built with funds available from the District and other sources.

- Small, Effective Project Implementation: The ability to construct small phased projects that effectively reduce downstream flooding and satisfy overall development criteria.

- Small Projects Constructed by Developers: The ability to have small segments of the system built by developers.

- Least Capital Costs and Operation and Maintenance Costs: The combinations of facilities that have the lowest capital development costs and the lowest yearly operation and maintenance costs.

Table 2-1 summarizes Montgomery's qualitative evaluation of the two systems based on criteria listed above. Based on their detailed evaluation of both alternatives they recommended adoption of the Detention/Conveyance system for the areas considered during this study (Montgomery Engineers, 1986).

2.2.3 Flood Control Implementation

The number of flood control facilities to be constructed on a yearly basis is limited by total revenues received by the District annually from the quarter-cent sales tax revenue. As mandated by implementing legislation, District expenditures for flood control facilities cannot exceed income on a yearly basis. The District's 1988 projected income was $18 million and is expected to increase at a rate of seven percent per year.

The Master Plan estimated the cost of construction of the All Conveyance alternative as $1,259,676,000 and the Detention/Conveyance alternative as $763,125,000 in 1986 dollars. Without adjusting for inflation and using the District's estimated 1986 income of $13,000,000 (Table 2-2), construction of the All Conveyance system and Detention/Conveyance system would require about 97 and 59 years, respectively. The estimated construction time would be slightly longer if funds needed for annual maintenance and operation of existing facilities were also included.

Because of the limited availability of funds, the District has established specific policies and procedures for the selection and prioritization of flood control facilities to be built (Bax-Valentine, 1988). In order to be considered for funding, a facility must be part of the Master Plan which is required to be updated every five years. Individual facilities may be added or deleted from the Master Plan on an annual basis through noticed public hearings. Once a facility is included in the Master Plan, construction of individual facilities is then prioritized on the 10-year and one-year lists by the Technical Advisory Committee (TAC).

Construction priorities are reviewed on a yearly basis by the TAC on the basis of ten criteria. Each criterion is assigned one to ten points, which are then multiplied by a weighted value (Table 2-3). The relative ranking in terms of importance is: 1) population affected, 2) assessed land value, 3) public perception of need, 4) emergency access and public inconvenience, 5) cost avoidance, 6) availability of other funding sources, 7) interrelationship to other projects, 8) timing and implementation, 9) environmental enhancement, and 10) annual maintenance cost.

Assessment of prioritization variables suggests that construction of flood control facilities favors construction of facilities that are most likely to result in increased flood protection to already developed or currently developing areas. The two most heavily weighed criteria for prioritization on the one-year and 10-year priority list are population affected and assessed land value impacts. The first criterion assigns the greatest number of points to proposed facilities that will provide additional protection to the greatest number of individuals. The second criterion assigns the greatest number of points to constructing facilities in areas where property damages are expected to be greatest in the event of a flood event. In addition, most one-year and 10-year list facilities are Phase 1 facilities, "which are critically needed to provide flood control protection against loss of life, and damage to public and private property. Phase 2 facilities would be typically constructed after Phase 1 facilities are in place. These facilities have the same criteria as Phase 1 facilities, but provide flood control facilities to accommodate future growth in Southern Nevada" (Montgomery Engineers, 1986).

2.3 FLOOD CONTROL FACILITIES DESCRIPTION

Master Plan facilities are general in terms of the type of structures to be built and very specific in terms of individual siting parameters. Structures consist of a series of related facilities that function in coordination with each other. In addition, improvements are to be made to existing facilities.

The All Conveyance and Detention/Conveyance alternatives are composed of eight types of interrelated facilities. The numbers and sizes of the facilities vary, but basic construction, operation, and maintenance concerns remain the same. Structural improvements consist of construction and installation of facilities such as: 1) reinforced concrete pipeline, 2) precast boxes (conduits), 3) lined channels, 4) unlined channels, 5) floodways, 6) dikes/levees, 7) detention basins, and 8) bridges. The following description of facilities types is partially derived from the Master Plan (Montgomery Engineers, 1986). However, it should be stressed that deviations from those described in the Master Plan are possible depending upon final engineering design.

Once a facility is approved for construction, the predesign, design, and construction activities can vary from 30 to 44 months for detention and debris basins and 21 to 37 months for channels, dikes, and pipelines (Table 2-4). Predesign efforts include completion of an interlocal agreement between the District and lead entity, preparation of a request for proposal, evaluation of proposals and negotiation of a contract, and completion of predesign engineering. The design phase is similar--the only difference being that final design engineering is completed during this time period. Construction efforts include negotiation of an interlocal agreement, advertising and award of the project, and completion of actual construction activities.

According to CCRFCD, facilities are expected to have a life-span of 100 years. All facilities will be maintained and repaired or replaced as necessary.

2.3.1 Reinforced Concrete Pipeline

2.3.1.1 Physical Description

Reinforced concrete pipeline (RCP) is grey and round or elliptical in shape. It varies between 36 inches diameter to 96 inches diameter for RCP class III storm drains. It is normally manufactured in eight-foot segments. The pipe is buried below surface and under normal construction conditions, three to five feet of cover is used.

RCP is typically placed under roadways in areas where space is limited. Associated structures include concrete inlet wing walls and an outlet. Channels convey water both into and out of RCP. Trash racks are constructed on the inlet side of pipe segments. Manholes are usually placed every 250 feet along the line.

2.3.1.2 Construction

The surface area disturbed for placement of RCP is typically 40 feet wide by the length of the pipeline. The area disturbed varies depending upon the location but is usually 20 feet on either side of the RCP centerline. It is estimated that in most cases, construction of a structure will require a construction yard less than one acre in size.

Construction activities include design survey; construction layout; traffic control within the construction area; pavement removal and disposal; grade excavation; importing of compacted bedding; site delivery and installation of the RCP; trench stabilization, which will include a cutback and/or trench box; compacted backfill to the subbase; road reconstruction, including subbase and asphalt surfacing; reconnection of existing storm drains and utilities; and site restoration. Excavated soils are recompacted in the pipeline trench or hauled to an approved disposal site. Typical labor and equipment needed for RCP installation are listed in Table 2-5.

The depth to which pipelines will be placed and specific difficulties arising during installation cannot usually be assessed prior to construction. Potential difficulties include deep excavation, presence of caliche, shallow ground water, and substantial utility interference from construction.

Construction costs are estimated to vary between $95 to $378 per linear foot depending upon the size of pipe and average, deep, or difficult construction costs (Montgomery Engineers, 1986). It is anticipated that all labor, equipment, and supplies will be obtained from local sources.

2.3.1.3 Operation and Maintenance

The area permanently occupied by the facility is limited to the length and width of the pipe. RCP is typically used under existing roadways and as a result no permanent right-of-way is maintained exclusively for the facility itself. The major advantage of RCP is that it saves space; however, it has limited flow and access. Operation of the system is entirely passive.

RCP will be inspected on an annual basis or after any major (25 year or greater) rainfall event. Maintenance is the responsibility of the local entity or the property owner if it has not been dedicated to the local entity. It will be completed on an as-needed basis and consists largely of manual clearing of debris from trash racks. The debris will be hauled to an authorized disposal site in a canvas-covered truck. Clearing of small debris not caught in the trash rack such as tumbleweeds, sticks, and stones, is done manually. Operation and maintenance costs are estimated to be 0.5 percent of construction costs on an annual basis.

2.3.2 Precast Boxes

2.3.2.1 Physical Description

Precast boxes are manufactured of gray concrete and are rectangular. They vary in size from six feet by eight feet to eight feet by twelve feet. Multiple connecting boxes are used under roads or bridges. Channels convey water in and out the boxes.

Associated structures used under roads include inlet wingwalls and outlets. Manholes are placed at regular intervals and trash racks are constructed at the inlet. When boxes are used under bridges, associated structures may include fencing, walkways, guard rails, utility lines, inlet wingwalls, and outlets.

2.3.2.2 Construction

The area disturbed for construction of boxes is typically three times the width of the finished area. The number of construction yards needed depends on the size of the project.

Construction activities include design survey and design; traffic control; pavement removal and disposal; grade excavation; site delivery and installation of the precast boxes; importing of compacted bedding; trench stabilization, which includes a cutback and/or trench box; compacted backfill to the subbase; road reconstruction, including subbase and asphalt surfacing; reconnection of existing storm drains and utilities; and site restoration. In cases where the precast boxes are not placed under roadways, the site may be revegetated if appropriate. Excavated soils are recompacted in the trench or hauled to an approved disposal site. Typical labor and equipment needs are similar to those required for RCP installation (Table 2-5).

Boxes are also used for trench stabilization related to RCP installation. The depth of placement will be decided upon during the time of construction since it is dependent upon the conditions present at the site of location. As with the RCP, difficult construction factors, such as caliche, shallow ground water, substantial utility interference, or deep installation requirements could arise during construction.

Precast boxes are estimated to cost between $120 and $750 per linear foot installed (Montgomery Engineers, 1986). It is anticipated that labor, equipment, and supplies will be obtained from local sources.

2.3.2.3 Operation and Maintenance

The area permanently occupied by the facility is limited to the length and width of the box. Since it is primarily used under existing roadways or bridges, no permanent right-of-way is maintained exclusively for the facility itself.

The typical function of boxes is to convey flows in areas where surface activities limit the space and depth of facilities. They have a large capacity and are used in areas where flows cannot be accommodated by RCP. The major disadvantage is that flows are limited and access is restricted. Operation of the system is entirely passive.

Precast boxes are easy to maintain and will be inspected on an annual basis or after any major (25 year or greater) rainfall event. Maintenance is the responsibility of the local entity or property owner if the facility has not been dedicated to the entity. It will be completed on an as-needed basis and consists largely of manual clearing of debris from trash racks. The debris will be hauled to an authorized disposal site in a canvas-covered truck. Clearing of small debris not caught in the trash rack, such as tumbleweeds, sticks, and stones, is done manually. Operation and maintenance costs are estimated to be 0.5 percent of construction costs on an annual basis.

2.3.3 Unlined Channels

2.3.3.1 Physical Description

Unlined channels are trapezoidal in shape and vary from three to 71 feet in width and are three to ten feet deep. The side slopes are generally 3:1. In most cases the proposed work represents modifications and improvements to existing channels.

Unlined channels are expected to have minimum bank protection and may require drop structures to decrease velocities and thereby minimize erosion. Drop structures across a channel will have a standard cross sectional shape and the width will vary depending upon the channel being crossed. The structures will typically be three feet high with a ten-foot approach slab and a ten-foot slab downstream of the drop. Typically, there will be five-foot-deep cutoff walls at both upstream and downstream ends of the structure. The cutoff walls will be constructed of six-inch thick, reinforced and formed concrete.

Adjacent structures include bridges, RCP, precast boxes, and debris/detention basins. Associated facilities include lined channels, dikes/levees, gates, floodways, fences, detention/debris basins, and bridges.

2.3.3.2 Construction

The area to be disturbed during construction is estimated to be twice the width of the channel over the length of the improvement. A minimum of 20 feet will be needed for channels less than ten feet in width. The size and location of construction yards will depend upon the size of the project.

Construction activities include design survey and design; traffic control; excavation and shaping, reconnection of existing storm drains and utilities; and site restoration. Excavated soils will be disposed of on-site or hauled to an authorized disposal site. Typical labor and equipment needs are listed in Table 2-6.

Estimated costs for construction of unlined channels are between $4 to $715 per linear foot depending upon the channel base width and difficulty of construction. The cost of construction of drop structures has been estimated at $168.00 per linear foot (Montgomery Engineers, 1986). Construction problems that might be encountered include excavation of caliche soils and substantial utility interference. Local labor, equipment, and supplies will typically be used for the project.

2.3.3.3 Operation and Maintenance

The area required for operation and maintenance of the facility includes the unlined channel and an unimproved maintenance road along one side. In some cases, the bottom of the channel may be used as the access road. Typically, unlined channels convey flows through relatively flat areas where velocities do not exceed five feet per second. The primary advantage of the system is the low cost and easy access to the system. The major disadvantage is that they require more maintenance than lined channels and may contribute to sediment loads.

Unlined channels are designed to operate passively. Each channel is inspected annually and after each major storm event. Routine maintenance will be completed by the property owner or lead entity responsible for its construction and may include periodic application of herbicides and clearing of vegetation, as well as grading to reduce erosion. Yearly operation and maintenance costs are estimated to be 1.5 percent of construction costs.

2.3.4 Lined Channels

2.3.4.1 Physical Description

Lined channels are trapezoidal in shape and range from four to 55 feet in width and three to nine feet in depth. Side slopes range from 1:1 to 3:1. Most channel linings are gray concrete but in some cases soil cement may be used. Color can be added to either the cement or soil cement.

Associated structures include floodways, RCP, precast boxes, gates, detention basins and drop structures.

2.3.4.2 Construction

The area disturbed during construction is estimated to be the length by twice the width of the channel. In the case of narrow channels, a minimum construction corridor of 20 feet is necessary. The number of construction yards depends upon the size of the project. Typical labor and equipment needs are listed in Table 2-7.

The King Charles Diversion Channel in the City of North Las Vegas is one of two District funded projects that has been completed. This project consisted of construction of a one-mile-long segment of lined channel. The project lasted for three months and had an average peak work force of 20 workers per day. Labor was from the local work force and included equipment operators, laborers, cement finishers, carpenters, iron workers, and surveyors. The work day was 7:00 am to 3:00 pm, five days per week.

Construction activities included design survey and design; traffic control; site preparation, excavation and shaping; concrete placement; reconnection of existing storm drains and utilities; and site restoration. During site preparation and development 1,000 cubic yards of material was leveled to permit construction staking. Weedy vegetation up to two feet in height was removed by scraping. Equipment used included three scrapers, one water truck, one grader, one compactor, one crane, one compressor, generators, and bulldozers. Water for dust abatement purposes was the major utility demand.

The cost of the project was $2,548,613, of which about 40 percent represented materials and 60 percent labor. The District contribution towards the project was $403,585. The balance was financed by a Clark County bond issue. Of the major materials used during construction, concrete was supplied locally, rebar was purchased from a California supplier, and other materials were purchased from firms in Ohio and Massachusetts.

General costs for construction of lined channels are estimated to range from $57 to $1,572 per linear foot depending upon the channel base width and difficulty of construction (Montgomery Engineers, 1986).

2.3.4.3 Operation and Maintenance

The area dedicated to the lined channel depends upon the length and width of the channel and would include an unimproved service road along one side. In some cases the bottom of the channel may function as the service road.

Lined channels are normally used to convey flows through areas where velocities would scour earthen channels. Their major advantage is that they are stable and are low maintenance. The major drawback is the high cost of construction.

Lined channels operate passively and are maintained by the lead entity responsible for their construction or property owner. They are inspected on an annual basis and after major storm events. In general most routine maintenance consists of removal of garbage such as mattresses, grocery carts, washing machines, and other trash that have been dumped into the channel. Annual maintenance costs are estimated to be 1.5 percent of construction cost.

2.3.5 Floodways

2.3.5.1 Physical Description

Floodways are conceptualized as wide bermed, unimproved channels that are maintained, not natural washes. They will typically vary from 300 to 500 feet in width and can range from three to 15 feet in depth. Floodways proposed as part of the Master Plan represent improvements to existing floodways, rather than construction of new areas. Adjacent structures are generally debris or detention basins, channels, RCP, and bridges. The two major types of associated structures are the low flow channel and flow spreading dikes.

In selected locations, a low flow channel may be constructed. Low flow channels are typically constructed in those instances where a limited permanent flow of water exists. The low flow channel transports the flow downstream, minimizing erosion.

The typical low flow channel described in the Master Plan consists of a two-foot wide by three-foot deep concrete-lined trapezoidal channel with a 2:1 slope. The channel is usually constructed in the middle of the floodway. Eight-foot wide by 12-inch thick gabion baskets may be placed on each side of the channel to protect the concrete structure from side cutting. The construction activities for low flow channels will include concrete installation, gabion installation, excavation of the site, and variable grading that is dependent on the site.

Flow spreading dikes are conceptualized as five-foot high by nine-inch wide reinforced concrete weirs buried across the floodway at assumed 500-foot intervals. The associated grading will provide a 100:1 upstream slope and a 10:1 downstream slope. A minimum width of 500 feet is anticipated to accommodate potential recreation uses.

The actual location, size, and number of low flow channels and flow spreading dikes will be proposed during preparation of detailed design studies.

2.3.5.2 Construction

The typical area disturbed during construction is the length by 110 percent of the width. One or more construction yards and access roads would be needed during construction.

Construction activities include design survey and design; construction layout; traffic control (if appropriate); site excavation and shaping; fabrication of low flow channels and flow spreading dikes; concrete pouring; reconnection of existing storm drains and utilities as appropriate; and site restoration. Excavated soils will be spread on site, or hauled to an approved disposal site. Typical labor and equipment needs are similar to unlined channels (Table 2-6) except that an estimated 750 feet of floodway can be constructed per day. No special construction problems are anticipated.

Cost of a low flow channel was estimated at $141 per linear foot and $40.50 per linear foot of dike. The total unit cost of the floodway was obtained from the following equation: $/ft(length) = $141 + $0.08 x floodway width (Montgomery Engineers, 1986). It is anticipated that labor, equipment, and supplies will be obtained locally.

2.3.5.3 Operation and Maintenance

The area permanently occupied is the length of the floodway by its width. An unimproved access road will be constructed on one side of the floodway. In remote areas one or more gates will be built to control access.

The typical function of a floodway is to convey flood flow through undeveloped areas. They are low cost but require maintenance and can contribute to downstream sediment loads. The entire operation of a floodway is passive.

Floodways will be inspected on an annual basis and after each major storm event. Routine maintenance will be performed by the lead entity responsible for its construction or property owner and may consist of removing vegetation to maintain desired flow velocities, surface recontouring to minimize erosion, and application of herbicides. The cost of annual operation and maintenance is estimated to be 1.0 percent of construction costs.

2.3.6 Dikes and Levees

2.3.6.1 Physical Description

Dikes and levees are conceptualized as trapezoidal in shape and vary from 30 to 72 feet in width and range from three to 10 feet in height. The dikes will have a 12-foot top and 3:1 side slope, for access and maintenance purposes. The dikes will either be unlined, concrete-lined or soil-cement lined. The former will be the color of the compacted soils. Concrete lining will be gray. Color can be added to soil cement. Adjacent structures include channels and floodways.

There are three separate types of dikes to be installed: unlined, lined on one side, and lined on both sides and the top. The dike lining will consist of six inches of concrete and will include a five-foot cut-off wall at the toe of the dike.

2.3.6.2 Construction

The area disturbed during construction for a dike or levee is typically twice the width times the length of the facility. In most cases soil for construction of the dike/levee is obtained by excavating from behind the facility to make the embankment. One or more construction yards will be built depending upon the size of the construction.

Construction activities include design survey and design; construction layout; excavation and shaping; concrete or soil cement pouring; and site restoration. Excavated soils will be used for construction of the dike/levee, or hauled to an approved disposal site. Typical personnel and equipment needs are listed in Table 2-8. The major construction constraint would be the presence of caliche soils.

The cost of dikes/levees varies from $4.67 to $281.61 per linear foot depending upon height and whether the dike/levees is unlined, lined on one side, or on both sides and the top (Montgomery Engineers, 1986). Costs could increase considerably depending on the type of terrain encountered.

2.3.6.3 Operation and Maintenance

The area permanently occupied by the facility includes the length and width of the facility, an access road along one side, and any associated channels. In remote areas gates will be built to restrict access.

Lined dikes and levees are customarily used where flood flow velocities would scour the earth. They are durable but expensive to construct. Unlined dikes and levees are used in areas where lined facilities are economically unfeasible. They are low-cost to build but require maintenance and can contribute to sediment load.

Dikes and levees will be inspected on a yearly basis after significant events. Maintenance is the responsibility of the lead entity or property owner, if the facility has not been dedicated. Annual operation and maintenance costs are estimated as 2.0 percent of initial construction costs.

2.3.7 Detention and Debris Basins

2.3.7.1 Physical Description

Both detention and debris basins are shaped to fit the natural topography of the site where they are constructed. They range in size from one-half to over 220 acres in size. Detention basins are larger than debris basins and include structures such as outlet structures to release flood waters and reduce downstream flow discharges. Lined channels typically convey water in and out of the basins. An outlet and spillway are integral parts of most detention basins. Outlets consist of an inlet screen, inlet slope protection, outlet pipe, outlet slope protection, and outlet energy dissipater. Conceptually, an outlet structure is viewed as occupying about 375 square feet and being as much as 15 feet high. This does not include RCP outlet piping (Montgomery Engineers, 1986). Spillways are concrete and may include a concrete slope channel, and an outlet apron and energy dissipater at the downstream end. The actual dimension and configuration of the spillway depends upon the size of the basin and final engineering design.

Debris basins are located in areas where sediment loads are anticipated to be higher. Adjacent structures ordinarily include a floodway or channel to convey water into the basin and a lined channel to convey water out of the structure. To the extent possible, basin sites are selected to maximize use of public lands.

2.3.7.2 Construction

The area disturbed during construction is typically 110 percent of the finished site depending upon the size of the facility. Spillways are physically incorporated into the detention basin embankment and constructed at the same time as the basin. Construction yards are usually located in the interior of the basin.

Excavation for basins includes design survey and design, construction layout, site excavation, on-site gravel sorting and preparation of soil cement as appropriate; construction of associated dikes; and site restoration. The basin will be cut and filled at approximately 50 percent of the excavation. Excavated soils are compacted and used for the construction of embankments. If deep excavation is deemed necessary, as determined by site conditions, excavation will consist of cut and fill that is 75 percent of the excavation. Difficult excavation resulting from the presence of caliche in the soils could be encountered during construction activities. Typical labor and equipment needs are listed in Table 2-9.

Detention basin construction costs are estimated at between $1,600 and $2,400 per acre-foot, while costs for associated outlet works are estimated to range from $72,458 to $387,674 depending upon the outlet flow (cubic feet per second). Spillway construction cost was estimated by multiplying the 100-year flow into the basin by 5.0; the total cost was then determined from predetermined cost curves (Montgomery Engineers, 1986).

One of two projects recently funded by the District included construction of the Meadows Detention Basin for a total estimated cost of $6,146,965, of which the District contributed $2,938,700. It is located in the City of Las Vegas and involved construction of a detention basin on the Las Vegas Water District's north main well field. The purpose of the basin is to detain stormwater collected from the storm drainage system along Charleston Boulevard, the Alta Drive system, and parts of Las Vegas Creek. The water will then be metered out after rainstorms at a rate that can be handled by downstream facilities.

The site is hilly and was originally used by the Las Vegas Water District for disposal of miscellaneous iron products. As currently designed the basins will reduce estimated 100-year storm flows from 3,640 cfs to 1,870 cfs for a peak discharge decrease of 1,770 cfs. The basin excavation required removal of 200,000 cubic yards of soils, of which approximately 30,000 were disposed of off site. The average depth when full will be eight feet with three feet of freeboard. The storage capacity is 270 acre-feet, which would empty over a period of about 36 hours. The site occupies 34 acres. The embankment slopes are 1.5:1 on the interior and 2.5:1 on the exterior. Soils were sorted on site to provide gravel for construction and soil cement was mixed on site and used for interior slopes and the top.

Adjacent structures include a trapezoidal inlet channel and outlet. The inlet channel is seven feet deep with a 20-foot wide bottom and 1:1 side slopes. The outlet is a single 42 inch diameter RCP.

Most major construction materials, including concrete, reinforcing bar, precast pipe, joint material, gravel, sand, and rock were obtained from suppliers in Las Vegas. Equipment was provided by local contractors. Utility demands included metered water service for dust abatement and electricity for construction trailers.

The peak average work force was 49 on the project for a duration of three to four weeks. The typical work force included:

Labor Skill	Number
L.V. Project Representative	1
Surveyors	4
Well Drillers	2
Laborers	12

Equipment Operators	12
Iron Workers	2
Concrete Workers	12
Pipe Relocation Supt.	1
Project Manager	1
Contract Inspector	1
Traffic Controller	1

The work day was 7:00 am to 3:30 pm five days per week. Construction of the basin required 240 days to complete.

2.3.7.3 Operation and Maintenance

Areas maintained for basins are typically ten percent larger than the finished basin. An access road is maintained to remote locations and may be controlled by a locked gate. The need for fencing around individual basins is assessed on a case-by-case basis. Basins and associated outlet structures and spillways operate passively.

The purpose of detention basins is to detain flood flows and release them at a rate that can be handled by downstream facilities. The major advantage of detention basins is that by reducing flows smaller facilities can be constructed downstream, reducing overall costs.

Debris basins are designed to remove the sediment load from flood discharges. These help prevent sediment loads from being deposited downstream, increasing maintenance costs and resulting in possible clogging of critical facilities.

Basins and associated outlet structures, and spillways are inspected yearly and after major episodes and maintained by the entity responsible for the construction of the facility. Trash racks will be cleared periodically and sediments removed as necessary. Each detention basin is expected to accumulate no more than a ten percent sediment load from each flood episode. Annual maintenance costs of basins a percentage of construction cost is estimated to be 1.0 percent for detention basins and 7.0 percent for debris basins.

2.3.8 Bridges

2.3.8.1 Physical Description

Bridges provide access across lined and unlined channels and will be designed to pass 100-year flows. Bridges consist of concrete free-span structures or structures with minimal supports. Bridge size is a function of channel width and design flow and may be as small 60 feet but generally varies between 80 to 120 feet. They range from six to 15 feet in height. Low flow crossings are considered adequate for secondary streets where emergency access would not be hindered. New road crossings are assumed to be required on major-mile streets in the undeveloped portions of the study area (Montgomery Engineers, 1986).

Adjacent structures are typically lined channels. Facilities associated with bridges include guardrails, drop structures, wing walls, walkways, fencing, and utilities.

2.3.8.2 Construction

The area typically disturbed during bridge construction is three times the width by the length of the structure. Labor and equipment associated with this effort are listed in Table 2-10.

Costs associated with the construction of bridges will vary depending upon the roadway and area. The important variable factors in the cost will be the flow rate and individual site parameters. A $60.00 per square foot estimate was used. This estimate varies considerably and can be as much as 4.56 times more expensive per square foot to construct in remote areas with difficult construction techniques than a standard paved bridge in the Las Vegas Valley. Section 6.3 of the Master Plan presents a detailed discussion of estimating procedures used for bridges (Montgomery Engineers, 1986).

2.3.8.3 Operation and Maintenance

The right-of-way maintained on either side of a bridge is the same as that maintained for the roadway. The major advantage of bridges is that they provide permanent access for public and emergency vehicles during flooding. The major disadvantage is the high cost of construction.

Annual maintenance and operation costs are estimated as 0.5 percent of original construction cost. They are inspected annually and after each major event. It is the responsibility of the agency to which they are dedicated to maintain and repair the facility.

2.4 FLOOD CONTROL SYSTEM ALTERNATIVES

One of the major objectives of the Master Plan was to formulate alternative methods to control flooding in the Las Vegas Valley (Montgomery Engineers, 1986). Two alternatives, the All Conveyance and Detention/Conveyance systems were modeled and evaluated for control of flood flows. The three major criteria used in the evaluation were flexibility, reliability, and cost effectiveness. The No Project alternative assumes that regional flood control facilities would continue to be built by local entities and developers without reference to an integrated regional plan.

Figures from the Master Plan illustrating the physical configuration of Detention/Conveyance and All Conveyance alternatives within the EIS study area are included as Appendix A and Appendix B, respectively. These figures illustrate that the two different alternatives are similar in general physical configuration and layout. The major variable is the size and types of facilities used to collect and convey flows from the various locations in the valley to Lower Las Vegas Wash. Detailed information on each facility and structure is included in Volume 2a of the Master Plan (Montgomery Engineers, 1986). In some cases, more than one variant of a particular alternative was proposed.

2.4.1 Detention/Conveyance Alternative

2.4.1.1 Functional Characteristics

The Detention/Conveyance alternative is characterized by a series of detention basins located around the perimeter of currently urbanized areas. These basins and associated dikes are designed to collect flood flows and release the flows at metered rates that can be handled by downstream conveyance facilities. Many of the proposed detention basins and dikes are located on undeveloped land owned by federal agencies, although some smaller detention basins are located in urbanized areas.

Flows from the basins are conveyed to the Las Vegas Wash through a series of conveyance facilities including lined and unlined channels, pipelines, and conduits. Because the velocity of the flows is reduced and release rates are metered, flows can be managed using smaller conveyance facilities. In most cases these flows can be handled by existing facilities with little or no major capacity improvements (Montgomery Engineers, 1986). Because of the reduced flows there is greater flexibility in interchanging different types of facilities to handle predicted flows.

By reducing flow rates, the potential for downstream scouring and erosion is also reduced, resulting in enhanced protection of wetlands and areas with perennial flows. Detention basins can also be used for enhancement of recreational opportunities.

2.4.1.2 Facilities

Major characteristics of both alternatives were estimated from facilities information given in the Master Plan (Table 3-1). These represent best estimates since both size and location of facilities are considered to be conceptual.

The Detention/Conveyance alternative is composed of about 48 miles of dikes versus 44 for the All Conveyance alternative. Since width and height of dikes do not vary between alternatives, the major difference between the two alternatives is the total linear feet of construction. Four miles, or 9.2 percent more linear feet of dikes will be constructed under the Detention/Conveyance alternative.

Dikes are used to collect flood flows and convey them to detention basins for metered releases under the Detention/Conveyance alternative or to debris basins and the larger conveyance facilities proposed under the All Conveyance alternative. In general, dikes are proposed on federal lands and vary considerably in size. Many of the dikes proposed in the North Las Vegas Valley range from 1.0 to 1.5 miles in length. Most dikes are a minimum of 1,000 feet in length.

One of the major differences between the two alternatives is the number and size of detention and debris basins. The Detention/Conveyance system includes 53 detention basins and 16 debris basins covering a total of 3.37 square miles. The average size of a detention basin is 37.74 acres and a debris basin 9.69 acres. The total acreage used to construct basins is slightly over double the acreage (204 percent) as that utilized under the All Conveyance alternative. This alternative includes six detention basins and 28 debris basins covering a total of 1.65 square miles. The average size of a detention basin is 59.33 acres and a debris basin is 23.04 acres. In general, detention and debris basins are sited on public lands around the fringes of the valley.

The second major difference between the two alternatives is the size of lined and unlined channels. Although the total difference in miles of channel 197 miles for the Detention/Conveyance and 238 miles for the All Conveyance is not substantial, All Conveyance channels are often substantially wider in order to convey increased flood flows. In areas where the collection system is characterized by an upstream dike and debris basin, channels can be two to ten times greater in width under the All Conveyance alternative. If the system is characterized by an upstream detention basin, channel widths do not vary significantly between the two alternatives. They do not vary substantially in the middle and lower reaches of the Las Vegas Wash.

Both systems make use of existing floodways to control flows. The Detention/Conveyance system uses 42 miles while the All Conveyance system incorporates 34 miles. Many of these floodways contain wetland areas.

Both systems incorporate a similar number of linear miles of pipeline and box conduits: 105 for the Detention/Conveyance and 99 for the All Conveyance. In general, pipelines and box conduits are used in urban areas where excavation of channels is not feasible.

The Detention/Conveyance alternative utilizes 122 bridges and boxes as compared to 182 for the All Conveyance alternative. The larger number of crossings is due to the size of the channels and the need to replace existing facilities to span broader channels.

2.4.1.3 Construction Requirements

As presently estimated, it would require 59 years and $763,125,000 to construct the Detention/Conveyance alternative. Because of the configuration of the system, initial activities would focus on construction of the upstream dikes and detention basins necessary to convey and reduce flood flows to levels that can be accommodated by existing facilities and upgrading of downstream as appropriate.

2.4.1.4 Operation and Maintenance Requirements

Operation and maintenance costs for the Detention/Conveyance alternative are expected to be $5,765,000 per year at the end of Phase 2 construction activities. The responsibility for routine operation and maintenance of individual facilities varies depending upon the location of the facility and the entity having the greatest interest in the management of the facility. Although each facility will be inspected on at least an annual basis by an inspector from the District, operation and maintenance is the responsibility of the local entity. Routine maintenance activities may include the following:

- Clearing debris from detention and debris basins. Each detention basin is estimated to accumulate no more than a ten percent sediment load from each flood episode.

- Maintenance of associated facilities, such as fences, gates, and access roads, surrounding and leading to facilities.

- Application of herbicides and clearing of vegetation from channels. Typical herbicides are listed in Table 2-12.

Annual maintenance costs by facility type were estimated to be the following percentage of construction costs (Montgomery Engineers, 1986).

Facility Type	Percent of Construction Cost
Reinforced concrete pipe	0.5
Reinforced concrete box culvert	0.5
Channels (lined and unlined)	1.5
Dikes/Levees	2.0
Detention Basins/Debris Basins	1.0
Outlet Structures	1.0
Spillways	1.0
Bridges	0.5
Floodways	1.0

It is anticipated that routine operation and maintenance costs will be absorbed by local entities. These costs are estimated to be $5,315,000 for the five study areas at the end of Phase 2. These include $1,469,000 for North Las Vegas, $1,608,000 for Central Las Vegas, $1,568,000 for Southwest Las Vegas, $573,000 for Henderson, and $97,000 for Boulder City (Table 2-2).

2.4.2 All Conveyance

2.4.2.1 Functional Characteristics

The All Conveyance system is composed of a series of structures and facilities designed to collect stormwater and convey it out of the area. The system consists of a series of interrelated dikes, lined and unlined channels, floodways, pipeline conduits, bridges and boxes, detention basins, and debris basins located throughout the valley (Appendix B).

The major characteristic distinguishing this alternative from the Detention/Conveyance alternative is that channels have sufficient capacity to convey flows to the Lower Las Vegas Wash at any location in the system. As a result, the All Conveyance system is better suited to handle flood flows resulting from localized storms downstream of flow collecting dikes and detention basins. In most instances, larger channels, pipelines, and conduits are necessary to convey these flows.

The larger flows associated with the All Conveyance alternative may result in increased erosion of floodways and other unlined channels in the study area. Increased erosion may result in impacts to wetlands and areas of perennial flow.

2.4.2.2 Facilities

Facilities to be constructed under the All Conveyance alternative include 44 miles of dikes, 238 miles of lined and unlined channels, 34 miles of floodways, 99 miles of pipelines and conduits, 182 bridges, 6 detention basins, and 28 debris basins (Table 2-11). These are discussed in relationship to proposed Detention/Conveyance facilities in Section 2.4.1.2. Although existing channels and flow paths are used to the extent possible, massive replacement of existing channels and bridges is usually required (Montgomery Engineers, 1986).

2.4.2.3 Construction Requirements

The estimated cost of construction of the All Conveyance alternative is $1,259,676,000 versus $763,125,000 for the Detention/Conveyance alternative, a difference of $496,551,000. Construction of the All Conveyance alternative is projected to require 97 years based on estimated available funds. This is 38 years longer than the Detention/Conveyance alternative. The increased time is due to the higher construction costs associated with construction of more numerous and larger bridges.

Since operation of the system depends on the ability of downstream conveyances to handle increased flood flows, construction activities would tend to move from downstream to upstream locations. As a result many areas of the study area would not experience improved flood protection until the downstream facilities are in place.

2.4.2.4 Operation and Maintenance Requirements

The estimated cost of construction and annual operation and maintenance costs of the two systems varies considerably. Factors contributing to differences in costs include types and number of facilities.

Table 2-2 summarizes construction and operation and maintenance costs for each subarea as estimated in the Master Plan (Montgomery Engineers, 1986). The estimated annual operation and maintenance costs for each system is estimated to be about 0.7 percent of estimated construction costs. Overall, annual operating and maintenance costs are estimated to be $8,515,000 for the All Conveyance system and $5,315,000 for the Detention/Conveyance system. The latter system represents an estimated annual saving of $3,200,000 per year. Annual operation and maintenance costs at the end of

Phase 2 construction are estimated to be $2,225,000 for North Las Vegas, $2,315,000 for Central Las Vegas, $2,651,000 for Southwest Las Vegas, $1,212,000 for Henderson, and $112,000 for Boulder City (Table 2-2).

2.4.3 No Project

2.4.3.1 Functional Characteristics

The third alternative to be considered is the No Project alternative. Under this alternative no flood control facilities would be built under the auspices of the District. However, flood control facilities would continue to be built by local developers and by local municipalities without consideration of construction of a system of integrated and standardized facilities. Under this alternative, flood episodes would likely become more severe as urban growth continues, resulting in greater property damage and loss of life.

2.4.3.2 Facilities

An inventory of existing flood control facilities in the Las Vegas Valley was compiled as part of the Master Plan. These are mapped on Figures F-1 to F-13 and summarized on accompanying tables. Table 2-13 summaries the existing facilities by figure as identified in the Master Plan. Figures F-1 to F-12 correspond to Figures A1-1 to A1-12 and A2-1 to A2-12, respectively. Figure F-14 corresponds to Figures A1-14 and A2-14, since there are no existing flood control facilities on Figure A1-13.

There were 591 flood control facilities inventoried in the valley in 1986. Sixty-five percent of these, or 384 facilities, are culverts, box culverts, pipe culverts, and bridges. Most of these are located along elevated major highways and the Union Pacific Railroad and are designed to permit flood flows to pass under elevated fill banks. About half of the channel facilities are located along the Las Vegas Wash. For the most part pipelines are limited to short lengths in urban areas.

2.4.3.3 Construction Requirements

Under this alternative, flood control facilities would be built by local entities and development interests. It is anticipated that these facilities typically would be similar to those described in Section 2.3 and have similar construction and operation and maintenance requirements. It is not possible to predict the number, location, and rate of construction of these types of facilities at this time. It is anticipated that fewer facilities would be constructed and would likely be designed for less than 100-year flows.

2.4.3.4 Operation and Maintenance Requirements

Operation and maintenance activities would be the responsibility or the local entity of developer responsible for the individual facilities. It is also expected that many facilities constructed by developers would be dedicated to local entities for long-term operation and maintenance. Costs would be similar to those discussed in Section 2.4.1.4 above.

2.4.4 Alternatives Considered But Eliminated From Further Analysis

In several cases, a third alternative was considered for individual subareas in the Master Plan. The only alternative considered for the five subareas included as part of this study was the Detention/Conveyance Alternative No. 3 in the Central Las Vegas Valley.

This third alternative, the Detention/Conveyance Alternative No. 3 was developed for sections of the Central Las Vegas portion of the Master Plan but was eliminated from further consideration in the development of the Master Plan. This system was the same as the Alternative No. 2 in the areas upstream of the Angel Park and Gowan Detention basins. However, each of these basins would have its own discharge outfall system under Alternative No. 3. This alternative resulted in lower detention requirements at the Gowan Detention System, but required two additional small detention basins.

Alternative No. 3 was very similar to Alternative No. 2 in terms of flexibility to accommodate changing administrative and development related conditions and it provided the same degree of reliability as Alternative No. 2. This alternative had the same multi-use potential as Alternative No. 2. However, the planning and construction costs required for these facilities was estimated to be $16 million greater than the Alternative No. 2 facilities. The Alternative No. 3 facilities are less affordable than the Alternative No. 2 facilities and were eliminated based on that criterion.

2.4.5 Permits and Approvals Required

A variety of permits and approvals are necessary prior to construction of flood control facilities. These are listed in Table 2-14.

TABLE 2-1

QUALITATIVE EVALUATION OF FLOOD CONTROL ALTERNATIVES

KEY FUNCTIONAL REQUIREMENTS	ALL CONVEYANCE ALTERNATIVE	DETENTION/CONVEYANCE ALTERNATIVE	NO PROJECT ALTERNATIVE
FLEXIBILITY			
Project Segmentation		X[1]	N.A.
Funding Compatibility		X	N.A.
Development Compatibility		X	N.A.
Plan Flexibility		X	N.A.
RELIABILITY			
Control 100-Year Events	X		N.A.
Control PMF[2] Events	X		N.A.
Function Under All Conditions		X	N.A.
AFFORDABILITY			
Implementation with Available Funds		X	N.A.
Small Effective Project Implementation		X	N.A.
Small Projects Constructed By Developers		X	N.A.
Least Capital Costs and O & M Costs		X	N.A.

1 "X" indicates the most effective of the two alternatives, relative to the Key Functional Requirements
2 "PMF" means Probable Maximum Flood, which is the greatest potential flood that can occur in the watershed
Source: Adapted from Montgomery Engineers, 1986: Table 7-1

TABLE 2-2

SUMMARY OF ESTIMATED CONSTRUCTION AND OPERATION/MAINTENANCE COSTS[1]

STUDY AREA	ALL CONVEYANCE Construction	Operation/Maint/Year	DETENTION/CONVEYANCE Construction	Operation/Maint/Year
North Las Vegas	$356,801,000	$2,225,000	$211,016,000	$1,469,000
Central Las Vegas	$332,432,000	$2,315,000	$230,901,000	$1,608,000
SW Las Vegas	$380,406,000	$2,651,000	$225,056,000	$1,568,000
Henderson	$173,869,000	$1,212,000	$ 82,212,000	$ 573,000
Boulder City	$ 16,168,000	$ 112,000	$ 13,940,000	$ 97,000
	$1,259,676,000	$8,515,000	$763,125,000	$5,315,000

[1] Costs are calculated in 1986 dollars

TABLE 2-3

FLOOD CONTROL PROJECT PRIORITIZATION

WEIGHT	CRITERION
5.0	Population Affected Refers to the existing population affected by the construction of the project considered. Impact includes reducing flood hazards.
4.5	Assessed Land Value Impacts Assessed land values for developed and undeveloped land affected by the project, including all structures (public, commercial, or residential) will be reviewed. Impact on land values related to a reduction of the floodplain area will be considered under this item.
4.0	Public Perception of Need The project will be evaluated in terms of satisfying the public desire to their money spent on "worthwhile" projects and the public's perception of need.
3.5	Emergency Access and Public Inconvenience The project will be evaluated to determine its impact on the access of emergency vehicles including police, ambulance, and fire vehicles to their respective substation, hospital or station. The evaluation will include an assessment of the project's contribution to the development of an all-weather transportation system and accessibility to flood isolated residences, businesses, and public facilities.
3.0	Cost Avoidance Cost avoidance includes projects which will reduce future costs, including potential damage, construction of oversized facilities, and the ability to construct. This item should also address other costs associated the lost opportunity and the risk associated with inadequate or undersized facilities.
2.5	Availability of Other Funding Sources This includes an evaluation of the potential for funds from grants, developers, the Corps of Engineers, and other public and private interests. Additional funding sources shall include but are not limited to land donated by private developers and the Bureau of Land Management.
2.0	Interrelationship to Other Projects Projects which score high on this criterion can function independently or are needed to complete or increase the effectiveness of the existing regional and local drainage system.

TABLE 2-3 (concluded)

WEIGHT	CRITERION
1.5	Timing and Implementation All aspects of timing and implementation should be considered under this item including availability of right-of-way, permit review if necessary, and ability to administer and begin a project in a reasonable time-frame.
1.0	Environmental Enhancement Evaluation of this criterion includes benefits derived from improving or mitigating the threat to public health resulting from stagnant water, erosion, raw sewage spills, and contamination of the domestic water supply, It also includes, if applicable, information on the project's enhancement of habitat, recreational opportunities, and water quality.
0.5	Annual Maintenance Costs Projects which will rank high on this criterion have a lower maintenance cost than those facilities now in existence or will reduce maintenance costs downstream.

Source: Clark County Regional Flood Control District Policies and Procedures Manual (Bax-Valentine, 1988).

TABLE 2-4

TIMELINE FOR DISTRICT FUNDED PROJECTS

DETENTION BASINS/DEBRIS BASINS

Predesign

- Interlocal Agreement between District and lead entity - 1 to 2 months
- Request for Proposals/Evaluation of Proposals - 1 to 2 months
- Negotiations - 1 to 3 months
- Predesign Engineering - 4 to 6 months

Design

- Interlocal Agreement between District and lead entity - 1 to 2 months
- Request for Proposal/Evaluation of Proposals - 1 to 2 months
- Negotiations - 1 to 3 months
- Design Engineering - 6 to 8 months

Construction

- Interlocal Agreement - 1 to 2 months
- Bidding Process - 1 to 2 months
- Construction - 1 year

CHANNELS/DIKES/PIPELINES

Predesign

- Interlocal Agreement - 1 to 2 months
- Request for Proposal/Evaluation/Selection - 1 to 2 months
- Negotiations - 1 to 3 months
- Predesign Engineering - 3 to 6 months

Design

- Interlocal Agreement - 1 to 2 months
- Request for Proposals/Evluations/Selection - 1 to 3 months
- Negotiations - 1 to 3 months
- Design Engineering - 4 to 6 months

Construction

- Interlocal - 1 to 2 months
- Bidding Process - 1 to 2 months
- Construction - 6 months

Obviously, the size and difficulty of a given project have a large impact on its timeline. Steep slopes, erosive soils, shallow groundwater, limited right-of-way and a number of other factors all need to be properly and adequately accounted for in this process. Short, straight, uncomplicated channel reaches typically require less design and construction time than long channels with curves and transitiions through urbanized areas.

TABLE 2-5

TYPICAL LABOR AND EQUIPMENT NEEDED FOR RCP AND PRECAST BOX INSTALLATION

ACTIVITY	LABOR	EQUIPMENT	EFFORT/DAY
Design Survey	3 Surveyors	--	2500 Feet
Design	Variable	--	--
Construction Layout	2 Surveyors	--	5000 Feet
Traffic Control	1 Control Person	--	Duration of Project
Excavation:			
--Pavement Removal	1 Operator	1 Wheel Cutter	1000 Feet
	2 Laborers	--	
	1 Operator	1 Backhoe	
	1 Operator	1 Loader	
	2 Drivers	2 Hauling Trucks	
--Excavation	1 Operator	1 Excavator	150 Feet
	3-4 Drivers	3-4 Hauling Trucks	
Pipe Placement[1]	1 Operator	1 Excavator	150 Feet
	1 Operator	1 Loader	
	1 Driver	1 Hauling Truck	
	4 Person Crew		
Backfill	1 Driver	1 Hauling Truck	150 Feet
	1 Operator	1 Loader	
	2 Laborers	1 Compactor	
	1 Operator	1 Water Spray Rig	
Restoration	4 Person Crew		1 Mile
	3-4 Drivers	3-4 Hauling Trucks	
	1 Operator	1 Paver	
	1 Operator	1 Roller	

[1] Precast box placement is estimated as 100-125 feet/day

TABLE 2-6

TYPICAL LABOR AND EQUIPMENT NEEDED FOR UNLINED CHANNELS AND FLOODWAYS

ACTIVITY	LABOR	EQUIPMENT	EFFORT/DAY
Design Survey	3 Surveyors	--	2500 Feet
Design	Variable	--	--
Construction Layout	2 Surveyors	--	5000 Feet
Excavation and Shaping	1 Operator	1 Bulldozer	500 Feet
	1 Operator	1 Grader	
	1 Operator	1 Loader	
	4 Drivers	4 Hauling Trucks	
	1 Operator	1 Grade All	
	4 Laborers	--	
	1 Operator	1 Water Truck	
Site Restoration	1 Operator	1 Bulldozer	1000 Feet
	1 Operator	1 Grader	
	2 Laborers		

TABLE 2-7

TYPICAL LABOR AND EQUIPMENT NEEDED FOR LINED CHANNELS

ACTIVITY	LABOR	EQUIPMENT	EFFORT/DAY
Design Survey	3 Surveyors	--	2500 Feet
Design	Variable	--	--
Construction Layout	2 Surveyors	--	5000 Feet
Excavation and Shaping	1 Operator	1 Bulldozer	500 Feet
	1 Operator	1 Grader	
	1 Operator	1 Loader	
	4 Drivers	4 Hauling Trucks	
	1 Operator	1 Grade All	
	4 Laborers	--	
	1 Operator	1 Water Spray Rig	
Concrete Placement:			
--Bottom	5 Carpenters		1000 LF/Month
	5 Laborers		
	5 Steel Workers		
	7 Concrete Workers		
	1 Operator	1 Crane	
	5 Drivers	5 Concrete Trucks	
--Side	(Same as Bottom)		
--Side	(Same as Bottom)		
Site Restoration	1 Operator	1 Bulldozer	1000 LF/Day
	1 Operator	1 Grader	
	2 Laborers		

TABLE 2-8

TYPICAL LABOR AND EQUIPMENT NEEDED FOR DIKES/LEVEES

ACTIVITY	LABOR	EQUIPMENT	EFFORT/DAY
UNLINED			
Design Survey	3 Surveyors	--	2500 Feet
Design	Variable	--	--
Construction Layout	2 Surveyors	--	5000 Feet
Excavation and Shaping	3 Operators	3 Scrapers	500 Feet
	2 Operators	2 Bulldozers	
	1 Operator	1 Grader	
	1 Operator	1 Loader	
	4 Drivers	4 Hauling Trucks	
	1 Operator	1 Grade All	
	4 Laborers	--	
	1 Operator	1 Compactor	
	1 Operator	1 Water Spray Rig	
Site Restoration	1 Operator	1 Bulldozer	1000 Feet
	1 Operator	1 Grader	
	2 Laborers	1 Water Spray Rig	
	1 Operator		
LINED			
Design Survey	3 Surveyors	--	2500 Feet
Design	Variable	--	--
Construction Layout	2 Surveyors	--	5000 Feet
Excavation and Shaping	3 Operators	3 Scrapers	500 Feet
	3 Operators	2 Bulldozers	
	4 Drivers	4 Hauling Trucks	
	1 Operator	1 Grade All	
	4 Laborers	--	
	1 Operator	1 Compactor	
	1 Operator	1 Water Spray Rig	
Concrete Placement:			
--Bottom	5 Carpenters		1000 Feet
	5 Laborers		
	5 Steel Workers		
	7 Conrete Workers		
	1 Operator	1 Crane	
	5 Drivers	5 Concrete Trucks	

TABLE 2-8 (concluded)

ACTIVITY	LABOR	EQUIPMENT	EFFORT/DAY
--Side	(Same as Bottom)		100 Feet/2 Months
--Side	(Same as Bottom)		
Site Restoration	1 Operator 1 Operator 1 Operator 2 Laborers	1 Water Spray Rig 1 Bulldozer 1 Grader	1000 Feet

TABLE 2-9

TYPICAL LABOR AND EQUIPMENT NEEDED FOR DETENTION AND DEBRIS BASINS

ACTIVITY	LABOR	EQUIPMENT	EFFORT/DAY
DETENTION BASIN			Average/9 Months
Design Survey	3 Surveyors	--	3-5 Days
Design	Variable	--	--
Construction Staking	3 Surveyors	--	2 Days
Clearing and Grubbing	1 Operator	1 Bulldozer	
	1 Operator	1 Grader	
	2 Laborers		
Excavation	3 Operators	3 Scrapers	0.47 Acres/Day
	3 Operators	3 Bulldozers	
	1 Operator	1 Grader	
	1 Operator	1 Loader	
	4 Drivers	4 Hauling Trucks	
	1 Operator	1 Grade All	
	4 Laborers	--	
	1 Operator	1 Water Spray Rig	
Placement of Cutoff Walls	1 Operator	1 Backhoe	
--Cutoff Walls	1 Driver	1 Concrete Truck	
	2 Laborers	--	
Cut Keyway	1 Operator	1 Backhoe	
Placement and Compaction of Dike	1 Operator	1 Bulldozer	
	1 Operator	1 Grader	
	1 Operator	1 Loader	
	4 Drivers	4 Hauling Trucks	
	1 Operator	1 Grade All	
	4 Laborers	--	
	1 Operator	1 Compactor	
	1 Operator	1 Water Spray Rig	
Spillway Pour:			
--Bottom	5 Carpenters		
	5 Laborers		
	5 Steel Workers		
	7 Concrete Workers		
	1 Operator	1 Crane	
	5 Drivers	5 Concrete Trucks	
--Side	(Same as Bottom)		

TABLE 2-9 (concluded)

ACTIVITY	LABOR	EQUIPMENT	EFFORT/DAY
--Side	(Same as Bottom)		
Inlet Pour:			
--Bottom	5 Carpenters		
	5 Laborers		
	5 Steel Workers		
	7 Concrete Workers		
	1 Operator	1 Crane	
	5 Drivers	5 Concrete Trucks	
--Side	(Same as Bottom)		
--Side	(Same as Bottom)		
DEBRIS BASIN	(See Detention Basin Above)		Average/4 Months

TABLE 2-10

TYPICAL LABOR AND EQUIPMENT NEEDED FOR BRIDGE CONSTRUCTION

ACTIVITY	LABOR	EQUIPMENT	EFFORT/DAY
Design Survey	3 Surveyors	--	One Day
Design	Variable	--	--
Construction Layout	3 Surveyors	--	One Day
Site Preparation	1 Operator 1 Operator 2 Drivers 5 Laborers	1 Bulldozer 1 Loader 2 Hauling Trucks	1-5 Days
Excavation	1 Operator 1 Operator 2 Drivers 1 Operator	1 Backhoe 1 Loader 2 Hauling Trucks 1 Water Truck	1-3 Days
Fabrication	5 Carpenters 5 Laborers 5 Steelworkers 4 Concrete Workers 5 Drivers 1 Operator	5 Concrete Trucks 1 Crane	Average/2 Months
Fabrication of Wing Wall	5 Carpenters 5 Laborers 5 Steelworkers 4 Concrete Workers 5 Drivers 1 Operator	5 Concrete Trucks 1 Crane	1 Structure/Week
Backfill	1 Operator 4 Drivers 4 Laborers	1 Loader 1 Hauling Truck	2 Days
Surface Paving	1 Operator 1 Operator 3-4 Drivers 4 Paving Laborers	1 Paver 1 Roller 3-4 Hauling Trucks	1 Mile/Day
Site Restoration	1 Operator 1 Operator 2 Laborers	1 Bulldozer 1 Grader	1000 Feet

TABLE 2-11

SUMMARY OF ALL CONVEYANCE AND
DETENTION/CONVEYANCE FACILITIES

FACILITY TYPE	DENTENTION/CONVEYANCE	MILES	ALL CONVEYANCE	MILES
Dikes/Levees	255,000 LF	48	230,100 LF	44
Lined Channels	980,910 LF	185	1,179,700 LF	223
Unlined Channels	58,900 LF	11	77,650 LF	15
Floodway	222,300 LF	42	179,200 LF	34
Pipeline/Conduit	556,500 LF	105	520,400 LF	99
Crossings (Bridges/Boxes)	122		182	
Detention Basins	53 basins-2000 acres		6 basins-356 acres	
Debris Basins	16 basins-155 acres		28 basins-701 acres	

NOTE: Units for dikes, channels, floodways, pipeline and conduit are linear feet. Pipeline and conduits are grouped together as below ground conveyance facilities. Bridges and box culverts are grouped together as street crossings; the total number of basins is given in the table.

TABLE 2-12

EXAMPLES OF CLARK COUNTY ENVIRONMENTAL CONTROL[1]

LOCATION	HERBICIDE
1) Arlington Wash, Sunrise, NV	KARMEX 80W 3# 10 oz. AATREX 90 2# 3 oz.
2) Olive & Broadalbin, Sunrise, NV	KARMEX 80W 8# AATREX 90 4# 12 oz.
3) Cheyenne-Nellis, Sunrise, NV	KARMEX 80W 24# 4 oz. AATREX 90 14# 9 oz.
4) North Side of Vegas Valley at Winterwood Village, Sunrise, NV	KARMEX 80W 13# AATREX 90 7# 13 oz.
5) South Side Desert Inn and South Lamb, Paradise, NV	KARMEX 80W 8# AATREX 90 2# 2 oz.
6) Flamingo Wash-Paradise Rd. to Palos Verde, Paradise, NV	KARMEX 80W 16#
7) Sierra Vista Ranchos, Paradise, NV	KARMEX 80W 31#
8) Jimmy Durante & Tropicana West Side, East Las Vegas, NV	KARMEX 80W 11# OUST 5 oz.
9) Ditch in front of Silver Bowl, East Las Vegas, NV	AATREX 90 4# 11 oz.

TEST PLOTS

(CATTAIL CONTROL TEST PLOT):

Monson Hood Channel-Harmon to Stephanie	RODEO 333 fl. oz. X-77 SPREADER 160 fl. oz.

(TOTAL CONTROL):

Duck Creek at Rebel Rd. near the dip	KARMEX 80W 8# X-77 SPREADER 48 fl. oz.

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[1] Locations of flood channels with amount of herbicide that will be applied in Clark County to inside banks and/or bottoms of channels from 9-88 to 4-89.

TABLE 2-13

SUMMARY OF EXISTING FLOOD CONTROL FACILITIES[1]

FIGURE	BOX CULVERTS	PIPE CULVERTS	CULVERTS	BRIDGE	PIPELINE	CHANNEL	DETENTION BASIN	OTHER	TOTAL
F-1	3	27	0	0	0	0	0	0	30
F-2	0	4	0	1	0	0	1	0	6
F-3	2	8	0	0	0	0	0	0	10
F-4	4	0	0	9	12	1	1	1	28
F-5	3	54	0	9	23	68	0	7	164
F-6	6	0	0	1	0	4	0	0	11
F-7	0	0	0	4	8	5	1	1	19
F-8	5	11	24	40	16	30	0	0	126
F-9	15	2	6	2	0	7	0	2	34
F-10	0	3	2	11	0	0	0	0	16
F-11	7	6	8	9	0	0	0	0	40
F-12	73	7	0	0	0	10	0	1	91
F-13	7	0	0	1	3	5	0	0	16
	125	122	50	87	62	130	3	12	591

[1] Information tabulated from Tables F-1 to F-14, Volume 2B, Montgomery Engineers, 1986

TABLE 2-14

PRINCIPAL ENVIRONMENTAL PERMITS AND APPROVALS

AGENCY	PERMIT	REQUIRED FOR
1. Federal		
a. U.S. Bureau of Land Management	Environmental Review	National Environmental Policy Act, National Historic Preservation Act
b. U.S. Fish and Wildlife Service	Section 7	Endangered Species Review
c. U.S. Army Corp of Engineers	Section 404	Fill and Dredge Permit
2. State		
a. Nevada Department of Transportation	Encroachment Permit	Intersection of access roads with State Highways
b. State of Nevada Division of Water Res.	Construction Permit	Dam Approval
3. Local		
a. County Commission	Conditional Use Permit	Zoning Conformance
b. Clark County Department of Public Works	Plot & Grading Study	Regrading plans; must be found consistent with drainage study
c. Clark County Department of Public Works	Off-Site Permit	Paved access roadways to site
d. Clark County Health District Air Pollution Control Division	Permission to disturb topsoil permit	Required prior to commencing grading activities
e. Clark County Health District	Authority to Construct Certificate	New stationary source of air emissions
f. Clark County Health District Air Pollution Control Division	Operating Permit and Source Registration	For each air emissive structure
g. Additional Local Approvals		

FIGURE 2-1

PROJECT LOCATION

(SEE VOLUME II)

FIGURE 2-2

STUDY SUBAREAS

(SEE VOLUME II)

3.1 INTRODUCTION

In 1986, the District adopted the Detention/Conveyance alternative over the All Conveyance alternative. The former was selected primarily on the basis of three major criteria, flexibility, reliability, and affordability, set forth in the Master Plan (see Section 2.2.2). The plan offered the greatest degree of flexibility, although it was not considered the most reliable for certain types of storm events. Based on the cost estimating tool developed by Montgomery Engineers (1986), the Detention/Conveyance alternative costs substantially less to construct. In addition, there is less relocation of residents and disruption of traffic and businesses under this alternative, which also realizes the greatest potential for multi-use recreational facilities.

3.2 PRIORITIZATION OF FACILITIES

The 10-year plan facilities consist of Detention/Conveyance facilities the District plans to construct between fiscal years 1988-1989 and 1997-98. They consist of facilities identified in the Master Plan as either Phase 1 or Phase 2 facilities, or facilities that have been added to the Master Plan through amendment. Phase 1 facilities include those that should be constructed as soon as funding is available for the purpose of mitigating substantial threats to life, public facilities, and private property. They will function effectively to control flooding immediately, without the presence of future related facilities. Phase 2 includes facilities for the proper functioning of the overall flood control system and is linked with long-term future development.

Construction of 10-year plan facilities is financed by revenues received by the District from the quarter-cent sales tax. These revenues were projected as $18 million for fiscal year 1988-1989 and are expected to increase at a rate of seven percent per year. However, for planning purposes, a lower projected increase of three to four percent is used.

As currently estimated, $158,321,350 will be spent on 10-year plan facilities within the EIS study area (Table 3-1). This includes projected 10-year expenditures of $54,120,250 in Northern Las Vegas Valley; $49,106,600 in Central Las Vegas Valley; $28,767,000 in Southwest Las Vegas Valley; $4,119,000 in Boulder City; and $22,208,500 in Henderson. These expenditures are further broken down by fiscal year in Table 3-1. The balance of revenues is allocated for construction of facilities not included in the EIS study area.

Construction of proposed flood control facilities is financed entirely through District funds or on a negotiated cost share basis with local entities or development interests. However, due to limited availability of District funds, construction of flood control facilities is prioritized by the Technical Advisory Committee on a yearly basis as described in Section 2.2.3.

3.3 PROPOSED FACILITIES

The 10-year plan facilities considered in this EIS represent facilities included on, or likely to be included on, the 10-year construction priority list as of December, 1988. The 10-year plan list has been subsequently amended. Two alternatives to proposed facilities are included as part of the 10-year plan analysis (Section 15.0) but are not included as part of the summary information below.

The 10-year plan facilities considered as part of this study are summarized in Table 3-2 and illustrated in Figure 3-1. These 55 facility groups include 205 individual facilities. For construction and planning purposes, facility groups are also subdivided into structure groups. A structure number can refer to one or more individual facilities, such as one bridge, several consecutive segments of lined channel, or two detention basins.

Construction of 10-year plan facilities is estimated to result in 100.84 miles of construction disturbance from linear facilities, such as channels, pipelines, and dikes/levees, as well as 2.23 square miles of areal disturbance from construction of detention and debris basins. Most of the construction effort will be directed towards the construction of lined channels. Eighty channel segments will be constructed representing an estimated 294,500 linear feet of construction. Only two channels will be unlined, representing about 3,600 linear feet of construction. Eighteen box conduits and 28 box culverts will be built totalling about 57,500 and 3,720 linear feet of disturbance, respectively. Fourteen dikes/levees will be constructed, primarily around the perimeter of the valley. They are estimated to represent about 78,050 linear feet of construction. Also included are 19 pipeline segments (12,840 linear feet), 13 bridges (1,900 linear feet), and five floodways (80,000 linear feet). Miscellaneous facilities include one inlet works, one outlet works, and two culverts. Twenty-one detention basins and one debris basin are planned, covering 1,426 acres.

In the following sections the description, location, estimated cost, and construction schedule of facility groups and structures will be discussed. Since the nomenclature used to identify various facility groups in the Master Plan can be confusing, the following explanation is intended to assist the reader in identifying information relevant to individual facilities.

The primary organizing variable is the **facility group number**. In most cases the facility group number has been assigned a prefix of N, C, S, B, or H to represent facility groups in the Northern Las Vegas Valley, Central Las Vegas Valley, Southwest Las Vegas Valley, Boulder City, and Henderson, respectively. In the first table of each section the facility group number is listed, as well as a brief description, estimated dates of construction, and associated structure numbers.

The second table in each section lists pertinent information for individual facilities by facility group number. Each individual facility can be identified by a unique **figure number/identification number (FNIN)**. The FNIN is also used to identify the physical location of individual facilities on the 1":4,000' sensitivity maps (Figures A2-1 to A2-14) beginning in Section 15.0. **Structure group numbers** are not unique to individual facilities but represent groups of facilities that would be logically constructed at one time.

In addition to basic identifying information, the second table gives information on the nature of the proposed work effort, description of facility and size and any pertinent footnotes. The sizes listed in this table are approximate and have been derived from a variety of sources including the Master Plan (Volume 5) and various predesign and design reports. Sizes listed do not always correlate exactly with those illustrated on Figures A2-1 to A2-14 but represent the best available data from the District. Site-specific sensitivity data included in this EIS are based on facilities and locations as illustrated in the figures, regardless of the size listed.

Finally, the third table in each section lists the facility group number and estimated District expenditures by year.

3.3.1 Northern Las Vegas Valley

The key elements of the Detention/Conveyance Master Plan facilities in Northern Las Vegas Valley are six detention basins (including the existing North Las Vegas Detention Basin) that would "reduce the 100-year flood flows to levels either acceptable to existing drainage facilities or acceptable for construction of conveyance facilities in urban areas to transport these flows to the Lower Las Vegas Wash. The overall concept of [the alternative] is to provide facilities for flood control which reduce the peak flow rates and improve the Las Vegas Wash and Range Wash conveyance systems through the City of North Las Vegas, City of Las Vegas, and unincorporated Clark County" (Montgomery Engineers, 1986). Many of the facilities proposed for construction as part of the 10-year plan will result in substantial reductions in 100-year flood flows in much of the area.

Fifty-three individual 10-year plan facilities are proposed for construction in the Northern Las Vegas Valley representing total expenditures of $54,120,250 (Tables 3-1, 3-2). The 53 facilities are organized into nine facility groups representing 43 different structure groups (Table 3-3). Major efforts will be devoted to the construction of 33 segments of lined channels (143,600 linear feet) and five dikes/levees (50,200 linear feet). Improvements will be made to the Upper Las Vegas Wash and four of the six detention basins will be constructed. The total number and lengths of these and other proposed 10-year plan facilities are summarized in Table 3-2 and individual facilities are listed in Table 3-5. Proposed construction expenditures by facility groups by year are listed in Table 3-6.

Following construction of the proposed 10-year plan facilities, flooding should be reduced in the following areas:

- With implementation of the Kyle Canyon Detention Basin and diversion improvement, flooding will be reduced on the alluvial fan area northwest of the City of North Las Vegas. "The proposed improvements in this area collect and convey the Spring Mountain and Sheep Mountain runoff flows to the North Channel of the Las Vegas Wash, diverting them away from the areas south of the Las Vegas Wash which have been flood prone" (Montgomery Engineers, 1986). Flooding would also be reduced next to the Tonopah Highway.

- "The channel improvements on the outlet channel of the Las Vegas Wash Detention Basin reduce the flooding along the wash alignment, and the areas adjacent to the railroad and freeway at the head of 'A' Channel in North Las Vegas.

- "Through the implementation of the Kyle Canyon Detention Basin, the Tonopah Highway Detention Basin and the improvements to the North Las Vegas Basin, flows will be reduced to not exceed the capacity of the Lower Las Vegas Wash existing channel.

- "The detention basins on the North Tributary, West Tributary and East Tributary to Range Wash will reduce the flows to Sloan Channel reducing the flooding problems on Range Wash and its tributaries" (Montgomery Engineers, 1986).

The proposed plan also includes improvements to the Lower Las Vegas Wash to accommodate flows from conveyance systems in other parts of the valley.

3.3.2 Central Las Vegas Valley

The recommended Detention/Conveyance system in the Central Las Vegas Valley calls for 27 detention basins including the existing Angel Park Detention Basin. Like the facilities proposed in the

Northern Las Vegas Valley, the basins are designed to reduce 100-year flood flows to acceptable levels of existing or proposed downstream conveyance systems. According to the Master Plan, "the overall concept of [this alternative] is to provide a line of flood protection above the existing development boundary, and to re-establish major flood conveyance systems through the highly developed urban area of the City of Las Vegas, and portions of the City of North Las Vegas and Clark County" (Montgomery Engineers, 1986).

Forty-nine individual 10-year plan facilities are proposed for construction in the Central Las Vegas Valley representing total expenditures of $49,106,600 (Tables 3-1, 3-2). The 49 facilities are organized into nine facility groups representing 12 different structure groups (Table 3-6). Major construction efforts will be directed towards the construction of channels (28,100 linear feet), box conduits (34,400 linear feet), and six detention basins (311 acres). The total number and lengths of proposed facilities are summarized in Table 3-2 and described in greater detail in Table 3-7. Proposed construction expenditures by facility groups by year are listed in Table 3-8.

Following construction of the 10-year plan facilities the following areas will experience improved flood protection:

- Reduces major existing flooding problems, including those at Gowan Road, Cheyenne Avenue, Charleston Avenue underpass, Rancho Road, Interstate-15 (I-15), and areas adjacent to Tonopah Highway.

- Reestablishes several major conveyance systems and provides for several new systems including the Washington Avenue/Las Vegas Creek Channel, west side of I-15 conveyance facilities, and Lake Mead Boulevard to the existing freeway channel conveyance system.

- Provides for construction of a few major detention basins, which will result in a higher level of flood protection for existing populated areas (Montgomery Engineers, 1986).

3.3.3 Southwest Las Vegas Valley

The Detention/Conveyance alternative calls for the construction of 14 new detention basins including the existing Red Rock Detention Basin, in the Southwest Las Vegas Valley. These basins would be located on major washes and "sized to reduce 100-year flood flows to levels acceptable by the existing channel system with limited improvements" (Montgomery Engineers, 1986). Other key elements of the plan include: 1) it is made up of a number of small components that can be effectively phased; 2) it does not require replacement of existing major capital improvements; 3) it provides significant multi-use benefits associated with the use of detention basins and floodways; and 4) it allows substitution of most facilities with equivalent structures.

Sixty-five individual 10-year plan facilities are proposed for construction in the Southwest Las Vegas Valley representing total expenditures of $28,767,000 (Tables 3-1, 3-2). The 65 facilities are organized into 21 facility groups representing 50 different structure groups (Table 3-9). Major efforts include the construction of 21 segments of lined channel (37,300 linear feet), six dikes/levees (24,500 linear feet) and nine detention basins (560 acres). The number and lengths of proposed facility are summarized in Table 3-2 and individual facilities are listed in Table 3-10. Proposed construction expenditures by facility groups by year are listed in Table 3-11.

Construction of the 10-year plan facilities will result in significant reduction in existing flood flows. Some of the most important elements include:

- Mitigation of major existing flooding problems including those at Winnick Avenue, Green Valley and along the Rawhide and Van Buskirk Channels.

- Control of the present shifting flow division on the Blue Diamond alluvial fan between Blue Diamond and Tropicana Wash.

- Construction of a number of major facilities which will provide significant protection to existing urban areas.

- Reduces 100-year flows from Flamingo, Duck Creek, and Pittman Wash to acceptable levels for the Las Vegas Wash (Montgomery Engineers, 1986).

3.3.4 Boulder City

The Boulder City Detention/Conveyance alternative has "one detention basin which reduces the 100-year flood flows to levels acceptable to existing drainage facilities, or acceptable for construction of conveyance facilities to transport these flows for the Bootleg Canyon Drainage to outside of the development area. The remainder of the system as it exists to date is based on a conveyance system to transport the flows through the developed portions of the study area" (Montgomery Engineers, 1986).

Eighteen individual 10-year plan facilities are proposed for construction representing total expenditures of $4,119,000 (Tables 3-1, 3-2). The 18 facilities are organized into nine facility groups representing nine different structure groups (Table 3-12). The major efforts include construction of eight segments of lined channel (31,300 linear feet) and improvements to three floodways (24,500 linear feet). These and other proposed facilities are summarized in Table 3-2 and individual facilities are listed in Table 3-13. Proposed construction expenditures by facility groups by year are listed in Table 3-14.

Construction of proposed facilities will reduce major existing flooding problems along Bootleg Canyon Wash, Buchanan Boulevard, Cemetery Wash, Georgia Wash, and Hemenway Wash.

3.3.5 Henderson

Detention/Conveyance facilities in the City of Henderson include four detention basins which will reduce the 100-year flood flows to levels acceptable for the proposed new conveyance facilities needed to transport the flows to the Lower Las Vegas Wash. The alternative also permits the continued use of the existing C-1 Channel.

Twenty-one individual facilities are proposed for construction in Henderson representing total expenditures of $22,208,500 (Tables 3-1, 3-2). The 21 facilities are organized into seven facility groups representing 17 different structure groups (Table 3-15). The major effort consists of construction of 11 segments of lined channel representing an estimated 57,800 linear feet of disturbance. Other proposed facilities are summarized in Table 3-2 and individual facilities are listed in Table 3-16. Proposed construction expenditures by facility groups by year are listed in Table 3-17.

Following construction of the proposed 10-year plan facilities a reduction in 100-year flows will occur in the following areas:

- "The plan reduces the flooding problems experienced in the new developments along Sunset Road. Flows are collected in the channel parallel to the railroad tracks upstream of this development and diverted directly to Pittman Wash.

- "The plan reduces the flooding problem experienced in the south part of the urbanized Henderson Drainage by providing a positive collection/detention and conveyance from the upland watershed to the Pittman Wash/Duck Creek Channel on the west and the C-1 channel on the east" (Montgomery Engineers, 1986).

3.4 NO PROJECT ALTERNATIVE

Under the No Project alternative development would continue at approximately the same pace and flooding would continue to be a problem in the Las Vegas Valley. Individual entities would continue to construct local facilities as public funds become available but these facilities would probably not be designed in accordance with a regional plan. Individual flood control facilities would also continue to be constructed by developers to protect new subdivisions. Since it is unlikely that these developers would dedicate land and development for regional flood control facilities such as detention basins, it is probable that facilities that are constructed would favor a conveyance type system. Because of the cost new facilities constructed by developers will be associated with subdivisions and urban sprawl rather than urban infill. Whether constructed by local entities or development interests, adverse downstream effects are likely to occur if facilities are not built in accordance with a regional plan.

The proposed flood control program is subject to NEPA review by the BLM and conditions identified as part of this EIS would be applied to all facilities under the program. In contrast, environmental review of proposed flood control facilities would be limited to routine planning review by local entities under the No Project alternative. Many of these would probably be approved without the need for additional environmental review and mitigation measures to protect sensitive resources.

3.5 ALTERNATIVE FACILITIES ELIMINATED FROM FURTHER CONSIDERATION

The Master Plan considers both All Conveyance and Detention/Conveyance facilities throughout the Las Vegas Valley. However, due to the greater cost effectiveness and flexibility afforded by the Detention/Conveyance alternative the All Conveyance facilities were eliminated from further consideration. Alternative structure configurations and sitings are also considered during the predesign and design phases.

Since the preparation of the Master Plan and development of the 10-year construction and one-year priority lists only two structures have been eliminated from the District's 10-year plan. A detention basin (facility group number C6, FNIN A2-5/102, structure group 1371) on the conveyance and detention system intercepting the proposed Charleston Storm Drain and Edna Storm Drain system was eliminated after it was determined that another basin on the same system had adequate capacity. The only other structure eliminated from consideration was the pipeline (facility group number C5, FNIN A2-7/14-16 and A2-8/4-8, structure group 1345) connecting the Oakey Avenue detention basin to the I-15 conveyance system. This pipeline was eliminated after the preliminary design study indicated that the system was too costly to be considered at the present time. Construction of the pipeline may be reconsidered in the future.

TABLE 3-1

SUMMARY OF CONSTRUCTION COSTS BY STUDY AREA AND FISCAL YEAR

STUDY AREA	CUMULATIVE THROUGH CURRENT FY	FY 88-89 YEAR 1	FY 89-90 YEAR 2	FY 90-91 YEAR 3	FY 91-92 YEAR 4	FY 92-93 YEAR 5	FY 93-94 YEAR 6
Northern Las Vegas Valley	3,362,680	3,951,000	4,130,000	3,737,000	3,907,500	4,505,500	5,018,000
Central Las Vegas Valley	4,689,500	3,781,300	4,100,500	3,994,600	4,677,000	3,808,300	5,091,200
Southwest Las Vegas Valley	660,000	4,006,000	2,454,000	2,166,000	1,812,000	1,932,000	3,371,000
Boulder City	404,000	600,000	254,000	313,000	486,000	547,000	238,000
City of Henderson	1,592,000	3,128,500	1,705,000	1,500,000	1,998,500	2,000,000	2,042,500
TOTALS	10,708,180	15,466,800	12,643,500	11,710,600	12,881,000	12,792,800	15,760,700

STUDY AREA	FY 94-95 YEAR 7	FY 95-96 YEAR 8	FY 96-97 YEAR 9	FY 97-98 YEAR 10	10-YEAR TOTAL	CUMULATIVE TOTAL THROUGH 97-98
Northern Las Vegas Valley	5,317,000	6,063,000	6,300,000	11,191,250	54,120,250	57,482,930
Central Las Vegas Valley	5,299,200	5,692,600	6,295,900	6,366,000	49,106,600	53,796,100
Southwest Las Vegas Valley	3,230,000	3,045,000	3,195,000	3,556,000	28,767,000	29,427,000
Boulder City	467,000	488,000	259,000	467,000	4,119,000	4,523,000
City of Henderson	2,300,000	2,434,000	2,500,000	2,600,000	22,208,500	23,800,500
TOTALS	16,613,200	17,722,600	18,549,900	24,180,250	158,321,350	169,029,530

TABLE 3-2

SUMMARY OF FLOOD CONTROL FACILITIES BY SUBAREA

	FACILITY GROUPS	STRUCTURE GROUPS	CHANNEL, LINED[1] #	CHANNEL, LINED[1] LF	CHANNEL, UNLINED #	CHANNEL, UNLINED LF	BOX CONDUITS #	BOX CONDUITS LF	BOX CULVERTS #	BOX CULVERTS LF
Northern Las Vegas Valley	9	43	33	143,600	0	--	2	12,000	5	1,120
Central Las Vegas Valley	9	12	7	24,500	2	3,600	12	34,400	8	800
Southwestern Las Vegas Valley	21	50	21	37,300	0	--	4	11,100	10	900
Boulder City	9	9	8	31,300	0	--	0	--	1	200
Henderson	7	17	11	57,800	0	--	0	--	4	700
	55	131	80	294,500	2	3,600	18	57,500	28	3,720

	DIKES/LEVEES #	DIKES/LEVEES LF	PIPELINES #	PIPELINES LF	BRIDGES #	BRIDGES LF	FLOODWAY #	FLOODWAY LF	DETENTION BASIN #	DETENTION BASIN AC
Northern Las Vegas Valley	5	50,200	0	--	1	100	1	38,000	4[2]	415
Central Las Vegas Valley	0	--	10	3,200	3	300	0	--	6[3]	311
Southwestern Las Vegas Valley	6	24,500	9	9,640	5	500	1	17,500	9	560
Boulder City	2	1,350	0	--	1	100	3	24,500	0	--
Henderson	1	2,000	0	--	3	900	0	--	2	130
	14	78,050	19	12,840	13	1,900	5	80,000	21	1,416

	DEBRIS BASIN #	DEBRIS BASIN AC	OTHER #	OTHER LF	OTHER DESCRIPTION	TOTAL FACILITIES
Northern Las Vegas Valley	0	--	1	100	Inlet Works	52
Central Las Vegas Valley	0	--	1	100	Outlet Works	49
Southwestern Las Vegas Valley	0	--	0	--	--	65
Boulder City	1	10	2	200	Culverts	18
Henderson	0	--	0	--	--	21
	1	10	4	300		205

[1] Linear feet and acres summarized in this table are approximate and have been derived from a variety of sources including the Master Plan.

[2] Only four basins will be constructed. One alternative (N12-9 Alt) was considered as part of the analysis. Another alternative (N3-8 Alt) was not included in the total.

[3] Six basins are represented by five individual facility numbers.

TABLE 3-3

NORTHERN LAS VEGAS VALLEY

FACILITY GROUP DESCRIPTION, CONSTRUCTION SCHEDULE, AND STRUCTURE GROUP NUMBERS

FACILITY GROUP NUMBER	DESCRIPTION	CONSTRUCTION SCHEDULE FISCAL YEAR STARTING	STRUCTURE GROUP NUMBER
N1	Part of Gowan Road Detention Basin Outfall	1988-89, 91-93	2009-14
N3	Improv. to LV Wash Above LV Detention Basin 2105, 2106	1997	2105-06
N3-8 ALT	Alternative to LV Wash Improvements	See N3 Above	--
N4	Las Vegas Wash Below Las Vegas Wash Detention Basin	1992-93	2107-10, 13
N5	Kyle Canyon Detention Basin	1997	2100-04, 11, 12
N6	Lower Las Vegas Wash Improvements	1988, 90, 91, 94, 95	2201, 03, 04, 09, 11, 13, 15, 16
N7	Las Vegas Wash from Lamb Boulevard to Facility No. 8	1995-97	2208, 20, 24, 26, 28, 30, 32, 34
N10	West Range Wash Detention Basin	1989-90	2300-02, 04
N12	East Range Wash Detention Basin	1988, 93-94	2520
N12-9 ALT	Alternative East Range Wash Detention Basin	See N12 Above	--
"N" Channel	"N" Channel/I-15 to Cheyenne Avenue	1997	2205, 07

TABLE 3-4

NORTHERN LAS VEGAS VALLEY 10-YEAR PLAN FACILITIES

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
N1	A2-5	2	2009		Box Conduit	8'w x 6'd, rc	3,200 LF	
N1	A2-5	3	2010		Box Conduit	8'w x 8'd, rc	8,800 LF	
N1	A2-5	4	2011		Channel	5'w x 6'd, cl	7,200 LF	
N1	A2-5	6	2012/2013	Channel		10'w x 8'd, cl	10,400 LF	See footnote 1
N1	A2-5	7	2014	Channel		88'w x 9'd, cl	2,000 LF	Concrete Line Existing Channel
N3	A2-1	8	2105		Channel/Dike[2]	100'w x 10'd, cl/	7,000 LF	Kyle Diversion Structure
N3	A2-1	8ALT	----		Channel/Dike[2]	100'w x 10'd, cl/	7,000 LF	
					Det. Basin	2,870 acre-ft	200 AC	
N3	A2-2	1	2106		Floodway	Width 300-500'[3]	38,000 LF	
N4	A2-2	3	2107	Channel		30'w x 6'd, cl	20,000 LF	Concrete Line Existing Channel
N4	A2-2	8	----		Det. Basin	2000 acre-ft[4]	55 AC	See footnote 5
N4	A2-5	22	2107	Channel		30'w x 6'd, cl	See #3, A2-2	Concrete Line Existing Channel
N4	A2-5	23	2108		Box Culvert	8'w x 6'd, rc (double)	200 LF	
N4	A2-5	24	2109	Channel		30'w x 8'd, cl	6,000 LF	Concrete Line Existing Channel
N4	A2-5	26	2109	Channel		30'w x 8'd, cl	6,000 LF	Concrete Line Existing Channel
N4	A2-5	25	2110		Box Culvert	8'w x 6'd, rc (double)	100 LF	At Union Pacific Railroad
N4	A2-2	2	2113	Cont.Struct.		22,000 cfs inlet cap	100 LF	See footnote 6

1 Channel partially excavated on south half, concrete line complete section
2 42'w x 5'h, cl, 7,000 LF
3 Depth varies
4 Total 5,400 cfs outlet capacity
5 Addition to existing North Las Vegas Detention Basin; total volume = 3650 acre-ft
6 Inlet Control Facility, NLV Detention Basin

LEGEND

AC - acre
cfs - cubic ft. per second
cl - concrete lined
cs - clear span
d - deep
dia - diameter
h - high
l - lined
LF - linear feet
rc - reinforced concrete
ul - unlined
w - wide

TABLE 3-4 (continued)

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
N5	A2-1	2	2100		Dike	42'w x 5'h, ul	15,600 LF	
N5	A2-1	3	2101		Det. Basin	1,500 acre-ft	100 AC	Kyle Canyon Det. Basin
N5	A2-1	5	2102		Channel	20'w x 8'd, cl	5,000 LF	
N5	A2-1	6	2103		Box Culvert	10'w x 8'd, rc, (double)	240 LF	
N5	A2-1	7	2104		Channel	20'w x 8'd, cl	11,000 LF	
N5	A2-1	1	2111		Dike	42'w x 5'h, ul	3,000 LF	
N5	A2-1	4	2112		Channel	15'w x 6'd, cl	9,600 LF	Det. Basin Overflow Structure
N6	A2-5	8	2201	Channel		20'w x 10'd, cl	5,000 LF	Concrete Line Existing Channel
N6	A2-5	10	2201	Channel		20'w x 10'd, cl	See # 8	Concrete Line Existing Channel
N6	A2-5	11	2203	Channel		80'w x 10'd, cl	2,400 LF	Concrete Line Existing Channel
N6	A2-5	27	2204	Channel		80'w x 8'd, cl	4,000 LF	King Charles Diversion Channel
N6	A2-5	12	2209	Channel		80'w x 10'd, cl	2,500 LF	Concrete Line Existing Channel
N6	A2-5	13	2211	Channel		80'w x 10'd, cl	3,200 LF	Concrete Line Existing Channel
N6	A2-5	14	2213	Channel		30'w x 10'd, cl	3,200 LF	Concrete Line Existing Channel
N6	A2-5	15	2215	Channel		30'w x 10'd, cl	4,800 LF	Concrete Line Existing Channel
N6	A2-5	16	2216		Box Culvert	10'w x 10'd, rc (four)	480 LF	
N7	A2-5	17	2208	Channel		80'w x 10'd, cl	2,400 LF	Concrete Line Existing Channel
N7	A2-5	18	2220	Channel		85'w x 10'd, cl	8,800 LF	Concrete Line Existing Channel
N7	A2-5	19	2220	Channel		85'w x 10'd, cl	See # 18 (2220)	Concrete Line Existing Channel
N7	A2-5	20	2220	Channel		85'w x 10'd, cl	See # 18 (2220)	Concrete Line Existing Channel
N7	A2-5	21	2224	Channel		85'w x 10'd, cl	1,200 LF	Concrete Line Existing Channel
N7	A2-8	1	2226	Channel		80'w x 8'd, cl	5,000 LF	Concrete Line Existing Channel
N7	A2-8	2	2228	Channel		80'w x 8'd, cl	2,000 LF	Concrete Line Existing Channel
N7	A2-8	3	2230	Channel		80'w x 8'd, cl	2,000 LF	Concrete Line Existing Channel
N7	A2-9	2	2230	Channel		80'w x 8'd, cl	See #2, A2-8	Concrete Line Existing Channel
N7	A2-9	3	2232	Channel		50'w x 8'd, cl	4,800 LF	Concrete Line Existing Channel
N7	A2-9	4	2234		Box Bridge	10'w x 6'd, rc (seven)	100 LF	

TABLE 3-4 (concluded)

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
N10	A2-2	9	2300		Dike	42'w x 5'h, ul	15,000 LF	
N10	A2-2	10	2301		Dike	42'w x 5'h, ul	14,000 LF	
N10	A2-2	11	2302		Det. Basin	1,550 acre-ft	105 AC	See footnote 7
N10	A2-2	13	2304		Box Culvert	8'w x 6'd, rc	100 LF	
N12	A2-6	9	2520		Det. Basin	1,400 acre-ft	155 AC	East Range Wash
N12	A2-6	9ALT	----		Det. Basin	----	80 AC	
N12	A2-6	10	2520		Dike	42 'w x 5'h, ul	2,600 LF	
N12	A2-6	11	2520		Channel	20'w x 8'd, cl	800 LF	
"N"	A2-5	28	2205	Channel		10'w x 8'd, cl	3,600 LF	Concrete Line Existing Channel
"N"	A2-5	30	2207	Channel		30'w x 8'd, cl	2,200 LF	Concrete Line Existing Channel
"N"	A2-5	31	2207	Channel		30'w x 8'd, cl	1,500 LF	Concrete Line Existing Channel

[7] Range Wash Western Tributary Detention Basin

TABLE 3-5

NORTHERN LAS VEGAS VALLEY 10-YEAR CONSTRUCTION PROGRAM

FACILITY GROUP NO.	STRUCTURE GROUP NO.	CUMULATIVE THROUGH CURRENT FY	FY 88-89 YEAR 1	FY 89-90 YEAR 2	FY 90-91 YEAR 3	FY 91-92 YEAR 4	FY 92-93 YEAR 5	FY 93-94 YEAR 6	FY 94-95 YEAR 7	FY 95-96 YEAR 8	FY 96-97 YEAR 9	FY 97-98 YEAR 10	10-YEAR TOTALS	CUMULATIVE TOTAL THROUGH FY 97-98
N1	2009-14	$1,595,300	$510,000	$480,000		$1,807,500	$4,405,500	$2,900,000					$10,103,000	$11,698,300
N3	2105-06											$1,908,250	$1,908,250	$1,908,250
N4	2107-10,13						$100,000	$1,368,000					$1,468,000	$1,468,000
N5	2100-04,11,12											$2,902,000	$2,902,000	$2,902,000
N6	2201,03,04,09 11,13,15,16	$1,377,380	$3,241,000		$2,537,000	$2,100,000			$2,303,000	$2,000,000			$12,181,000	$13,558,380
N7	2208,20,24,26 28,30,32,34									$4,063,000	$6,300,000	$4,632,000	$14,995,000	$14,995,000
N10	2300-02,04	$360,000		$3,650,000	$1,200,000								$4,850,000	$5,210,000
N12[1]	2520	$30,000	$200,000					$750,000	$3,014,000				$3,964,000	$3,994,000
"N"	2205,07											$1,749,000	$1,749,000	$1,749,000
	TOTALS	$3,362,680	$3,951,000	$4,130,000	$3,737,000	$3,907,500	$4,505,500	$5,018,000	$5,317,000	$6,063,000	$6,300,000	$11,191,250	$54,120,250	$57,482,930

[1] Facility N12-9ALT is an alternate site for facility N12 that is currently under consideration.

TABLE 3-6

CENTRAL LAS VEGAS VALLEY

FACILITY GROUP DESCRIPTION, CONSTRUCTION SCHEDULE, AND STRUCTURE GROUP NUMBERS

FACILITY GROUP NUMBER	DESCRIPTION	CONSTRUCTION SCHEDULE FISCAL YEAR STARTING	STRUCTURE GROUP NUMBER
C1	Angel Park Outflow Structure	1988	1030
C2	Angel Park/Gowan Detention Basin Conveyance System	1988, 91-93	1100, 42, 44
C3	Gowan Detention Basin and Outfall	1991-92, 94-96	1160
C4	Conveyance on Carey Avenue and Lake Mead Boulevard	1988-89	1230, 40
C5	Oakey Avenue System	1990	1342
C6	Meadows Dam and Collection System	1988	Meadows Dam (1347)
C7	Conveyance West Side I-15	1989-91, 93-95	1390
C9	Washington Avenue System	1989-92, 95-97	1430, 49

TABLE 3-7

CENTRAL LAS VEGAS VALLEY 10-YEAR PLAN FACILITIES

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
C1	A2-4	45	1030	Det. Basin	Outlet Works	Outflow structure[1]	----	Angel Park Det. Basin
C2	A2-4	47	1100		Channel	20'w x 4'd, cl	7,300 LF	
C2	A2-4	49	1100		Channel	20'w x 5'd, cl	2,000 LF	
C2	A2-4	51	1100		Channel	10'w x 6'd, cl	3,900 LF	
C2	A2-4	52	1100		Bridge	44'w x 6'd, cl	100 LF	
C2	A2-4	53	1100		Channel	20'w x 6'd, cl	5,000 LF	
C2	A2-4	48	1142		Bridge	40'w x 4'd, supported	100 LF	
C2	A2-4	46	1144		Bridge	28'w x 4'd, supported	100 LF	
C3	A2-4	55	1160		Two Det. Basins	1,660 acre-ft	220 AC	Gowan Det. Basin
C3	A2-4	56	1160		Pipeline	84" dia, rc	10,000 LF	
C3	A2-4	57	1160		Pipeline	90" dia, rc	3,200 LF	
C4	A2-4	68	1230		Pipeline	54" dia, rc	3,000 LF	
C4	A2-5	54	1230		Pipeline	54" dia, rc	See #68 A2-4	
C4	A2-5	55	1230		Pipeline	66" dia, rc	3,800 LF	
C4	A2-5	56	1230		Pipeline	66" dia, rc	2,100 LF	
C4	A2-5	57	1230		Pipeline	78" dia, rc	1,900 LF	

[1] 490 cfs outlet capacity at a 1400 acre-ft detention basin

LEGEND

AC - acre
cfs - cubic ft. per second
cl - concrete lined
cs - clear span
d - deep
dia - diameter
h - high
l - lined
LF - linear feet
rc - reinforced concrete
ul - unlined
w - wide

TABLE 3-7 (continued)

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
C4	A2-5	59	1240		Pipeline	60" dia, rc	2,600 LF	
C4	A2-5	60	1240		Pipeline	66" dia, rc	2,700 LF	
C4	A2-5	61	1240		Det. Basin	50 acre-ft	15 AC	Detention Basin LV-2B
C4	A2-5	62	1240		Pipeline	54" dia, rc	2,700 LF	
C5	A2-7	13	1342		Det. Basin	40 acre-ft	25 AC	Det. Basin CE-1B
C6	A2-5	103	1374		Det. Basin	40 acre-ft	28 AC	Detention Basin W-2B
C7	A2-5	115	1390		Box Conduit	2-10'w x 7'd, rc	500 LF	
C7	A2-5	117	1390		Box Conduit	2-10'w x 8'd, rc	850 LF	
C7	A2-5	118	1390		Channel	50'w x 6'd, cl	2,000 LF	
C7	A2-5	119	1390		Box Culvert	2-14'w x 8'd, rc	100 LF	
C7	A2-5	120	1390		Channel	50'w x 6'd, cl	1,900 LF	
C7	A2-5	121	1390		Channel	50'w x 7'd, cl	2,400 LF	
C7	A2-8	20	1390		Channel	10'w x 6'd, ul	1,200 LF	
C7	A2-8	21	1390		Channel	10'w x 7'd, ul	2,400 LF	
C7	A2-8	22	1390		Box Conduit	8'w x 7'd, rc	3,400 LF	
C7	A2-8	23	1390		Box Conduit	9'w x 8'd, rc	3,000 LF	
C7	A2-8	24	1390		Box Conduit	2-10'w x 7'd, rc	3,000 LF	
C9	A2-5	123	1430		Box Conduit	15'w x 10'd, rc	600 LF	
C9	A2-5	124	1430		Box Conduit	12'w x 10'd, rc	1,250 LF	
C9	A2-5	125	1430		Box Conduit	12'w x 10'd, rc	600 LF	
C9	A2-5	126	1430		Box Conduit	12'w x 8'd, rc	1,200 LF	
C9	A2-5	127	1430		Box Conduit	8'w x 6'd, rc	4,900 LF	
C9	A2-5	129	1430		Det. Basin	30 acre-ft	23 AC	Fantasy Park Det. Basin
C9	A2-5	131	1449		Box Culvert	14'w x 10'd, rc	100 LF	
C9	A2-5	132	1449		Box Culvert	14'w x 10'd, rc	100 LF	
C9	A2-5	133	1449		Box Culvert	14'w x 10'd, rc	100 LF	
C9	A2-5	134	1449		Box Culvert	14'w x 10'd, rc	100 LF	
C9	A2-5	135	1430		Box Conduit	14'w x 10'd, rc	8,000 LF	

TABLE 3-7 (concluded)

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
C9	A2-5	136	1449		Box Culvert	15'w x 10'd, rc	100 LF	
C9	A2-5	138	1449		Box Culvert	15'w x 10'd, rc	100 LF	
C9	A2-5	139	1430		Box Conduit	15'w x 10'd, rc	7,100 LF	
C9	A2-5	140	1449		Box Culvert	15'w x 10'd, rc	100 LF	

TABLE 3-8

CENTRAL LAS VEGAS VALLEY 10-YEAR CONSTRUCTION PROGRAM

FACILITY GROUP NO	GROUP STRUCTURE NO	CUMULATIVE THROUGH CURRENT FY	FY 88-89 YEAR 1	FY 89-90 YEAR 2	FY 90-91 YEAR 3	FY 91-92 YEAR 4	FY 92-93 YEAR 5	FY 93-94 YEAR 6	FY 94-95 YEAR 7	FY 95-96 YEAR 8	FY 96-97 YEAR 9	FY 97-98 YEAR 10	10-YEAR TOTALS	CUMULATIVE TOTAL THROUGH FY 97-98
C1	1030	$2,700	$147,300										$147,300	$150,000
C2	1100,42,44	$94,200	$1,672,700			$1,000,000	$1,091,800	$1,302,300					$5,066,800	$5,161,000
C3	1160	$216,000				$900,000	$2,033,500		$2,300,000	$3,467,600	$2,911,900		$11,613,000	$11,829,000
C4	1210[1],30,40		$750,000	$3,233,000									$3,983,000	$3,983,000
C5	1342,45	$126,000			$1,600,200								$1,600,200	$1,726,200
C6	MEADOWS DAM	$3,938,700	$1,211,300										$1,211,300	$5,150,000
C7	1390	$311,900		$154,500	$1,515,900	$2,000,000		$3,788,900	$2,999,200	$1,025,000			$11,483,500	$11,795,400
C9	1430,49			$713,000	$878,500	$777,000	$683,000			$1,200,000	$3,384,000	$6,366,000	$14,001,500	$14,001,500
	TOTALS	$4,689,500	$3,781,300	$4,100,500	$3,994,600	$4,677,000	$3,808,300	$5,091,200	$5,299,200	$5,692,600	$6,295,900	$6,366,000	$49,106,600	$53,796,100

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1 Structure 1210 has been dropped from the 10-year plan.

TABLE 3-9

SOUTHWEST LAS VEGAS VALLEY

FACILITY GROUP DESCRIPTION, CONSTRUCTION SCHEDULE, AND STRUCTURE GROUP NUMBERS

FACILITY GROUP NUMBER	DESCRIPTION	CONSTRUCTION SCHEDULE FISCAL YEAR STARTING	STRUCTURE GROUP NUMBER
S1	Upper Flamingo Detention Basin	1988-90	3009
S2	Flamingo Wash Improvements Upstream of Spanish Trails	1988, 90	3010
S3	Winnick Avenue Improvements	1994	3018
S4	Duck Detention Basin No. 1 on West Branch of Duck Creek	1997	3500-02
S6	Durango Road from Red Rock Wash to Upper Flamingo Detention Basin	1993-94	3004
S9	Flamingo Wash from Decatur Boulevard to Union Pacific Railroad	1995-97	3017
S10	Buffalo Road Channel	1994-95	3012
S11	Upper Blue Diamond Detention Basin	1996	3560
S12	Valley View Bridge on Flamingo Wash	1995	3052
S15	Industrial Road Bridge on Tropicana Wash	1995	3062
S17	Lower Blue Diamond Detention Basin	1996	3512
S18	NDOT Detention Basin in Lower Duck Creek	1997	3515
S19	Duck Detention Basin No. 3 in Lower Duck Creek Watershed	1997	3523
S20	Duck Detention Basin No. 4 in Lower Duck Creek Watershed	1997	3518-19
S21	Duck Detention Basin No. 5 in Lower Duck Creek Watershed	1997	3505
S22	Floodway on West Branch of Duck Creek	1997	3503
S23	Pachuca and Tomiyasu Bridges on Duck Creek	1991	3534-35
S24	Rawhide Channel	1988, 92, 94	3600-16
S25	Van Buskirk Channel	1988, 91-93, 95	3617-26
S26	Tropicana Detention Basin	1995-97	3031
S27	Boulder Highway Bridge on Flamingo Wash	1996	3057

TABLE 3-10

SOUTHWEST LAS VEGAS VALLEY 10-YEAR PLAN FACILITIES

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
S1	A2-7	59	3009		Det. Basin	610 acre-ft	70 AC	Upper Flamingo Det. Basin (FW-2B)
S2	A2-7	61	3010		Channel	30'w x 7'd, l	3,400 LF	See footnote [1]
S3	A2-8	36	3018		Box Conduit	15'w x 5'd, rc	1,500 LF	
S4	A2-10	23	3500		Dike	72'w x 10'h[2]	9,000 LF	
S4	A2-10	24	3501/3502		Det. Basin	1,500 acre-ft	125 AC	Duck Det. Basin #1
S6	A2-7	48	3004		Box Conduit	10'w x 6'd, rc	5,000 LF	
S9	A2-8	33	3017		Channel	20'w x 7'd, l	8,500 LF	
S10	A2-7	60	3012		Channel	13'w x 10'd, l	4,200 LF	
S11	A2-10	2	3560		Dike	72'w x 10'h, l	2,000 LF	
S11	A2-10	3	3560		Det. Basin	1,760 acre-ft	130 AC	Upper Blue Diamond Det. Basin
S12	A2-8	168	3052		Bridge	48'w x 7'd, cs	100 LF	Replace existing structure
S15	A2-8	188	3062		Bridge	34'w x 6'd, supported	100 LF	

[1] Channel oversized to handle spillway overflows
[2] Lined one side

LEGEND

AC - acre	h - high
cl - concrete lined	LF - linear feet
cs - clear span	rc - reinforced concrete
d - deep	ul - unlined
dia - diameter	w - wide

TABLE 3-10 (continued)

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
S17	A2-11	4	3512		Det. Basin	1,040 acre-ft	65 AC	Lower Blue Diamond Det. Basin
S18	A2-11	14	3515		Det. Basin	90 acre-ft	30 AC	NDOT Det. Basin
S19	A2-11	24	3523		Det. Basin	645 acre-ft	35 AC	Duck Det. Basin #3
S20	A2-11	17	3518		Dike	60'w x 8'h, ul	6,000 LF	
S20	A2-11	18	3519		Det. Basin	170 acre-ft	20 AC	Duck Det. Basin #4
S21	A2-10	28	3505		Dike	72'w x 10'h[3]	3,500 LF	
S21	A2-10	29	3505		Det. Basin	520 acre-ft	75 AC	Duck Det. Basin #5
S22	A2-10	25	3503		Floodway	500'w x 3'd	17,500 LF	
S23	A2-8	125	3534		Bridge	52'w x 8'd, cs	100 LF	
S23	A2-8	127	3535		Bridge	52'w x 8'd, cs	100 LF	
S24	A2-8	93	3600		Box Culvert	12'w x 5'd, rc	60 LF	
S24	A2-8	94	3601		Channel	6'w x 5'd, cl	1,000 LF	
S24	A2-8	95	3602		Box Culvert	12'w x 5'd, rc	60 LF	
S24	A2-8	96	3603		Channel	6'w x 5'd, cl	1,000 LF	
S24	A2-8	97	3604		Box Culvert	12'w x 5'd, rc	100 LF	
S24	A2-8	98	3605		Channel	6'w x 5'd, cl	1,000 LF	
S24	A2-8	99	3606		Box Conduit	8'w x 5'd, rc	1,000 LF	
S24	A2-8	100	----	Channel		10'w x 5'd, cl	1,500 LF	
S24	A2-8	101	3607	Pipeline	Pipeline	42" dia, rc	80 LF	See footnote 4
S24	A2-8	102	----	Channel		10'w x 5'd, cl	1,100 LF	

[3] Lined one side
[4] Add 42" reinforced concrete pipe to existing 3-54" dia, rc pipeline

TABLE 3-10 (continued)

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
S24	A2-8	103	3608	Pipeline	Pipeline	54" dia, rc	60 LF	See footnote 5
S24	A2-8	104	3609		Channel	10'w x 5'd, cl	1,100 LF	
S24	A2-8	106	3609		Channel	10'w x 5'd, cl	See 104, A2-8	
S24	A2-8	105	3610	Pipeline	Pipeline	54" dia, rc	300 LF	See footnote 6
S24	A2-8	107	3611	Pipeline	Pipeline	42" dia, rc	100 LF	See footnote 7
S24	A2-8	108	----	Channel		6'w x 5'd, cl	2,000 LF	
S24	A2-8	109	3612		Box Culvert	2-10'w x 4.5'd[8]	80 LF	
S24	A2-8	110	----	Channel		6'w x 5'd, cl	600 LF	
S24	A2-8	111	----	Pipeline		3-57" dia, rc	700 LF	
S24	A2-8	112	3613		Channel	6'w x 5'd, cl	2,500 LF	
S24	A2-8	113	3614		Box Culvert	2-8'w x 5'd, rc	60 LF	
S24	A2-8	114	----	Channel		10'w x 6.5'd, cl	1,100 LF	
S24	A2-8	115	3615		Box Culvert	2-8'w x 5'd, rc	80 LF	
S24	A2-8	116	----	Channel		10'w x 6.5'd, cl	1,000 LF	
S24	A2-8	117	3616		Channel	6'w x 5'd, cl	700 LF	
S25	A2-8	79	3617		Pipeline	48" dia, rc	2,700 LF	
S25	A2-8	80	3618		Pipeline	60" dia, rc	3,400 LF	
S25	A2-8	81	3619		Channel	4'w x 3'd, cl	1,400 LF	
S25	A2-8	82	3620		Box Culvert	9'w x 5'd, rc	200 LF	
S25	A2-8	83	----	Channel		4'w x 3'd, cl	1,500 LF	No Freeboard
S25	A2-8	84	3621		Box Culvert	9'w x 5'd, rc	100 LF	
S25	A2-8	85	----	Channel		4'w x 3'd, cl	1,000 LF	No Freeboard
S25	A2-8	86	3622		Box Culvert	9'w x 5'd, rc	100 LF	
S25	A2-8	87	----	Channel		8'w x 4'd, cl	1,000 LF	
S25	A2-8	88	3623		Box Culvert	10'w x 5'd, rc	60 LF	

[5] Add 54" reinforced concrete pipe to existing 3-51" dia, rc pipeline
[6] Add 54" reinforced concrete pipe to existing 3-51" dia, rc pipeline
[7] Add 42" reinforced concrete pipe to existing 5-48" dia, rc pipeline
[8] Double wide, reinforced concrete

TABLE 3-10 (concluded)

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
S25	A2-8	89	3624		Channel	6'w x 4.5'd, cl	1,700 LF	
S25	A2-8	90	3625	Box Culvert	Pipeline	36" dia, RC	1,100 LF	Add to 10'w x 4'd, rc Box Culvert
S25	A2-8	91	----		Pipeline	3-42" dia, rc	1,200 LF	
S25	A2-8	92	3626		Box Culvert	12'w x 5'd, rc	3,600 LF	
S26	A2-7	85	3031		Dike	72" w x 10'h, l/ul	2,000 LF	See footnote 9
S26	A2-8	66	3031		Dike	72'w x10'h, l	2,000 LF	
S26	A2-8	67	3031		Det. Basin	220 acre-ft	10 AC	Tropicana Det. Basin
S27	A2-8	52	3057		Bridge	67'w x 8'd, cs	100 LF	

[9] Diversion to Tropicana Detention Basin

TABLE 3-11

SOUTHWEST LAS VEGAS VALLEY 10-YEAR CONSTRUCTION PROGRAM

FACILITY GROUP NO	STRUCTURE GROUP NO	CUMULATIVE THROUGH CURRENT FY	FY 88-89 YEAR 1	FY 89-90 YEAR 2	FY 90-91 YEAR 3	FY 91-92 YEAR 4	FY 92-93 YEAR 5	FY 93-94 YEAR 6	FY 94-95 YEAR 7	FY 95-96 YEAR 8	FY 96-97 YEAR 9	FY 97-98 YEAR 10	10-YEAR TOTALS	CUMULATIVE TOTAL THROUGH FY 97-98
S1	3009	$375,000	$2,895,000	$2,454,000	$1,041,000								$6,390,000	$6,765,000
S2	3010	$65,000	$5,000		$1,125,000								$1,130,000	$1,195,000
S3	3018								$1,296,000				$1,296,000	$1,296,000
S4	3500-02											$156,000	$156,000	$156,000
S6	3004							$2,099,000	$1,250,000				$3,349,000	$3,349,000
S9	3017									$502,000	$1,180,000	$1,182,000	$2,864,000	$2,864,000
S10	3012								$50,000	$1,492,000			$1,542,000	$1,542,000
S11	3560										$132,000		$132,000	$132,000
S12	3052									$373,000			$373,000	$373,000
S15	3062									$78,000			$78,000	$78,000
S17	3512										$64,000		$64,000	$64,000
S18	3515											$17,000	$17,000	$17,000
S19	3523											$45,000	$45,000	$45,000
S20	3518-19											$34,000	$34,000	$34,000
S21	3505											$67,000	$67,000	$67,000

TABLE 3-11 (concluded)

FACILITY GROUP NO	STRUCTURE GROUP NO	CUMULATIVE THROUGH CURRENT FY	FY 88-89 YEAR 1	FY 89-90 YEAR 2	FY 90-91 YEAR 3	FY 91-92 YEAR 4	FY 92-93 YEAR 5	FY 93-94 YEAR 6	FY 94-95 YEAR 7	FY 95-96 YEAR 8	FY 96-97 YEAR 9	FY 97-98 YEAR 10	10-YEAR TOTALS	CUMULATIVE TOTAL THROUGH FY 97-98
S22	3503											$181,000	$181,000	$181,000
S23	3534-35					$682,000							$682,000	$682,000
S24	3600-16	$70,000	$75,000				$593,000		$634,000				$1,302,000	$1,372,000
S25	3617-26	$150,000	$1,031,000			$1,130,00	$1,339,000	$1,272,000		$400,000			$5,172,000	$5,322,000
S26	3031									$200,000	$790,000	$1,874,000	$2,864,000	$2,864,000
S27	3057										$1,029,000		$1,029,000	$1,029,000
	TOTALS	$660,000	$4,006,000	$2,454,000	$2,166,000	$1,812,000	$1,932,000	$3,371,000	$3,230,000	$3,045,000	$3,195,000	$3,556,000	$28,767,000	$29,427,000

TABLE 3-12

BOULDER CITY

FACILITY GROUP DESCRIPTION, CONSTRUCTION SCHEDULE, AND STRUCTURE GROUP NUMBERS

FACILITY GROUP NUMBER	DESCRIPTION	CONSTRUCTION SCHEDULE FISCAL YEAR STARTING	STRUCTURE GROUP NUMBERS
B1	Bootleg Canyon Diversion Dike	———	4100
B2	Hemenway Wash Crossings	1989	4111
B3	Ville Drive Channel	1989-90	4112
B4	Hemenway Wash Channel	1991-92	4113
B5	Buchanan Boulevard Channel	1988	4107
4108	Georgia Wash Channel	1988, 94-96	4108
4109	Cemetery Wash Channel	1997	4109
4110	Hemenway Wash Floodway	1993-94	4110
4114	Hemenway Wash Debris Basin	———	4114

TABLE 3-13

BOULDER CITY 10-YEAR PLAN FACILITIES

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
B1	A2-14	4	4100		Dike	70'w x 10'h, ul	700 LF	
B1	A2-14	5	4100		Dike	70'w x 10'h, l	650 LF	
B2	A2-14	35	4111		Box Culvert	6-36" dia, rc	200 LF	Add 2 Culverts
B3	A2-14	39	4112		Channel	10'w x 5'd, l	2,800 LF	
B4	A2-14	36	4113		Channel	25'w x 5'd, l	2,000 LF	
B4	A2-14	41	4113		Channel	50'w x 5'd, l	3,000 LF	
B4	A2-14	44	4113		Channel	80'w x 5'd, l	4,000 LF	
B5	A2-14	21	4107	Channel		8'w x 3.5'd, l	8,000 LF	Concrete Line Existing Channel
B5	A2-14	22	4107	Channel		8'w x 4'd, l	See A2-14, #21	Concrete Line Existing Channel
4108	A2-14	23	4108		Channel	8'w x 4'd, l	2,500 LF	
4108	A2-14	24	4108		Channel	25'w x 3'd, l	9,000 LF	
4108	A2-14	26	4108		Floodway	50'w w/3' dikes	5,000 LF	
4108	A2-14	45	4108		Bridge	50'w, supported	100 LF	
4109	A2-14	28	4109		Floodway	50'w w/3' dikes	15,500 LF	
4110	A2-14	30	4110		Floodway	100'w w/10' dikes	4,000 LF	
4110	A2-14	40	4110		Culvert	4-54" dia, rc	100 LF	
4110	A2-14	43	4110		Culvert	4-60" dia, rc	100 LF	Add 1 Culvert
4114	A2-14	31	4114		Debris Basin	5 acre-ft[1]	10 AC	

[1] 800 cfs outlet capacity (illustrated in MP as 5 AC)

LEGEND

AC - acre	h - high	w - wide
d - deep	LF - linear feet	rc - reinforced concrete
dia - diameter	ul - unlined	

TABLE 3-14

BOULDER CITY 10-YEAR CONSTRUCTION PROGRAM TOTALS

FACILITY GROUP NO	STRUCTURE GROUP NO	CUMULATIVE THROUGH CURRENT FY	FY 88-89 YEAR 1	FY 89-90 YEAR 2	FY 90-91 YEAR 3	FY 91-92 YEAR 4	FY 92-93 YEAR 5	FY 93-94 YEAR 6	FY 94-95 YEAR 7	FY 95-96 YEAR 8	FY 96-97 YEAR 9	FY 97-98 YEAR 10	10-YEAR TOTALS	CUMULATIVE TOTAL THROUGH FY 97-98
B1	4100	$54,000											$0	$54,000
B2	4111			$54,000									$54,000	$54,000
B3	4112			$200,000	$313,000								$513,000	$513,000
B4	4113	$205,000				$486,000	$547,000						$1,033,000	$1,238,000
B5	4107		$300,000										$300,000	$300,000
4108	4108		$300,000						$229,000	$488,000	$259,000		$1,276,000	$1,276,000
4109	4109											$467,000	$467,000	$467,000
4110	4110							$238,000	$238,000				$476,000	$476,000
4114	4114	$145,000											$0	$145,000
	TOTALS	$404,000	$600,000	$254,000	$313,000	$486,000	$547,000	$238,000	$467,000	$488,000	$259,000	$467,000	$4,119,000	$4,523,000

TABLE 3-15

HENDERSON

FACILITY GROUP DESCRIPTION, CONSTRUCTION SCHEDULE, AND STRUCTURE GROUP NUMBERS

FACILITY GROUP NUMBER	DESCRIPTION	CONSTRUCTION SCHEDULE FISCAL YEAR STARTING	STRUCTURE GROUP NUMBERS
H1	Boulder Highway Detention Basin	1995-97	2703-04, 06-08
H3	Pittman Wash Channel from Union Pacific Railroad to Las Vegas Wash	1988-90	2606, 08, 10, 12-13, 16-17
2618	Channel Parallel to Union Pacific Railroad	1990-91	2618
S29	Pittman Detention Basin	1988, 91-94	3200
S30	West Tributary of Pittman Wash	1994-95	3204
Green Valley Bridge (GVBR)	Green Valley Bridge	1988	----
Green Valley Box (GVBX)	Green Valley Box	1988	----

TABLE 3-16

HENDERSON 10-YEAR PLAN FACILITIES

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
H1	A2-12	14	2703		Det. Basin	650 acre-ft	75 AC	Boulder Hwy Det. Basin
H1	A2-12	11	2704		Channel	5'w x 6'd, cl	3,200 LF	
H1	A2-12	13	2704		Channel	5'w x 6'd, cl	See A2-12, #11	
H1	A2-12	12	2706/2707		Box Culvert	8'w x 4'd rc	100 LF	
H1	A2-12	10	2708		Channel	10'w x 6'd, cl	4,000 LF	
H3	A2-11	56	2606		Channel	25'w x 8'd, cl	9,000 LF	
H3	A2-9	31	2608		Bridge	72'w x 8'd, cs	400 LF	
H3	A2-9	16	2610	Channel		40'w x 8'd, cl	9,800 LF	
H3	A2-9	18	2610	Channel		40'w x 8'd, cl	See #16, A2-8	
H3	A2-9	17	2612		Bridge	10'w x 8'd, rc (four)	400 LF	
H3	A2-9	12	2613		Box Culvert	10'w x 8'd, rc (four)	400 LF	Two Bridges at Boulder Hwy
H3	A2-9	13	2616		Channel	40'w x 8'd, cl	7,400 LF	
H3	A2-9	15	2616	Channel		40'w x 8'd, cl	See #13, A2-9	
H3	A2-9	14	2617		Box Culvert	10'w x 8'd, rc	100 LF	
2618	A2-11	57	2618		Channel	5'w x 6'd, cl	11,000 LF	
S29	A2-11	37	3200		Dike	72'w x 10'h, l	2,000 LF	
S29	A2-11	38	3200		Det. Basin	1,140 acre-ft	55 AC	See footnote [1]
S29	A2-11	39	3200		Channel	30'w x 8'd, l	4,200 LF	
S30	A2-11	45	3204		Channel	8'w x 6'd, l	9,200 LF	

[1] Pittman Detention Basin 2,000 cfs to Bypass Channel

LEGEND

AC - acre
cl - concrete lined
cs - clear span
d - deep
h - high
l - lined
LF - linear feet
rc - reinforced concrete
w - wide

TABLE 3-16 (concluded)

FACILITY GROUP NUMBER	FIGURE NUMBER	ID NUMBER	STRUCTURE GROUP NUMBER	EXISTING FACILITY	PROPOSED FACILITY	FACILITY DESCRIPTION	SIZE	COMMENTS/FOOTNOTES
GVBR	A2-11	--	----		Bridge	----	100	Green Valley Bridge
GVBX	A2-11	--	----		Box Culvert	----	100	Green Valley Box

TABLE 3-17

CITY OF HENDERSON 10-YEAR CONSTRUCTION PROGRAM

FACILITY GROUP NO	STRUCTURE GROUP NO	CUMULATIVE THROUGH CURRENT FY	FY 88-89 YEAR 1	FY 89-90 YEAR 2	FY 90-91 YEAR 3	FY 91-92 YEAR 4	FY 92-93 YEAR 5	FY 93-94 YEAR 6	FY 94-95 YEAR 7	FY 95-96 YEAR 8	FY 96-97 YEAR 9	FY 97-98 YEAR 10	10-YEAR TOTALS	CUMULATIVE TOTAL THROUGH FY 97-98
H1	2703-04, 06-08									$1,934,000	$2,500,000	$2,600,000	$7,034,000	$7,034,000
H3	2606,08,10, 12-13,16-17	$917,000	$2,420,500	$1,705,000	$890,000								$5,015,500	$5,932,500
2618	2618				$610,000	$1,590,000							$2,200,000	$2,200,000
S29	3200		$46,000			$408,500	$2,000,000	$2,042,500	$671,000				$5,168,000	$5,168,000
S30	3204								$1,629,000	$500,000			$2,129,000	$2,129,000
GVBR	----	$600,000	$586,000										$586,000	$1,186,000
GVBX	----	$75,000	$76,000										$76,000	$151,000
	TOTALS	$1,592,000	$3,128,500	$1,705,000	$1,500,000	$1,998,500	$2,000,000	$2,042,500	$2,300,000	$2,434,000	$2,500,000	$2,600,000	$22,208,500	$23,800,500

FIGURE 3-1

10-YEAR PLAN FACILITIES

(SEE VOLUME II, OVERSIZE MAPS)

4.1 OVERALL ENVIRONMENTAL CONDITIONS

The climate of Clark County is classified as desert. It is characterized by bright sunshine, small annual precipitation, dry air and large ranges of daily temperature (Ruffner, 1985). This climate is controlled primarily by the state's rugged and varied topography. The prevailing westerlies move warm, moist Pacific air over the western slopes of the Sierra Nevada Range where the air cools, condensation takes place and most of the moisture falls as precipitation. As the air descends the eastern slopes, compressional warming occurs and very little precipitation falls. The result is that the lowlands of Nevada are largely desert or steppes. The number of days with inclement weather varies from year to year. Severe storms and tornados are rare in Clark County.

The project area is located in the central area of Clark County consisting of the entire Las Vegas Valley and Boulder City. Long-term records of meteorological data are available from McCarran International Airport, Nellis Air Force Base, and Boulder City. Air quality data is available from the Clark County Health District Air Pollution Control Division (APCD). The following sections describe the environmental conditions of the project vicinity based on data from these sources.

4.1.1 Meteorology

4.1.1.1 Wind

The prevailing wind direction in Clark County is from the southwest. Winds in this area are generally light in the morning (zero to three miles per hour are most common about 8 a.m.) and stronger (greater than three miles per hour) in the afternoon (Ruffner, 1985). This is due to the differential heating of the ground during the day.

An annual wind distribution for Las Vegas is shown in Table 4-1. The average monthly wind speed varies from 7.2 mph in December to 11.0 mph in April and June. The average wind speed is higher in summer due to the differential heating of the ground noted earlier.

Clark County occasionally experiences strong winds under the influence of large-scale weather patterns or localized thunderstorm activity. Some of this thunderstorm activity have resulted in significant damage to property (Montgomery Engineers, 1986). Dust or sand storms occasionally occur during periods of high winds. The maximum wind gust recorded in Las Vegas was 64 mph (Ruffner, 1985) with an unofficial gust of 100 mph (Montgomery Engineers, 1986).

4.1.1.2 Stability and Mixing Heights

Stability is an atmospheric property that reflects convective overturning and atmospheric mixing. In general, turbulence, atmospheric mixing and dispersion are enhanced in less stable atmospheres.

Low-level inversions are layers of stable air that restrict mixing. The mixing height is the height of the atmospheric layer in which convection and mechanical turbulence promote mixing. Good ventilation results from a high mixing height and at least moderate wind speeds within the mixing area.

A summary of surface atmospheric stability using the Pasquill-Turner classification is shown in Table 4--2 for Las Vegas. Classes A, B, and C represent unstable conditions (Class A the most unstable) with good atmospheric dispersion, D is neutral, Classes E, F, and G are stable (Class G being the most stable) with poor atmospheric dispersion. Stable conditions occur frequently during early morning hours when low wind speeds occur. Unstable conditions generally occur during daylight hours with clear skies and low winds. Neutral conditions generally occur under overcast skies or during strong winds. Stable conditions are prominent year-round in Las Vegas, with records indicating stable conditions over 40 percent of the time during all months of the year peaking at over 66 percent of the time in November and December. Unstable conditions are less frequent, and range from a low of 12.8 percent of the time in January to a high of 32.9 percent of the time in July.

Low-level inversions that restrict mixing height occur frequently above the Las Vegas area during the winter season and during most morning hours in the fall, spring and summer seasons. Inversions near the surface are often formed by nocturnal drainage flow or by nocturnal cooling of the surface under clear skies.

Average mixing heights for Las Vegas are given in Table 4-3. Afternoon mixing heights generally reflect the strong daytime heating of the ground. Morning mixing heights generally reflect the existence of surface cooling or drainage flow.

4.1.1.3 Temperature

Temperatures in Clark County are related to the desert climate. There is strong surface heating during the day and rapid night cooling due to the dry air and clear skies. This generally results in large ranges in daily temperature (Ruffner, 1985).

Table 4-4 summarizes mean monthly maximum and minimum temperatures in Clark County. The highest mean monthly maximum temperatures are 104^{O}F at both Las Vegas and Nellis Air Force Base; the lowest mean monthly minimum temperatures are 33^{O}F at both Las Vegas and Nellis Air Force Base. The warmest month is July and the coolest is January.

4.1.1.4 Precipitation and Severe Storms

Precipitation in the project vicinity is spread fairly uniformly throughout the year with maximums occurring in January and August (Ruffner, 1985). During the winter, the precipitation is primarily associated with storms that move eastward from the Pacific Ocean. During the summer, the precipitation is primarily associated with thunderstorms, some severe, when tropical moisture is advected into the region. Las Vegas averages 23 days with precipitation of 0.01 inch or more (Ruffner, 1985).

Table 4-4 summarizes mean monthly precipitation in the Las Vegas Valley and Boulder City. The average annual rainfall at Las Vegas is 4.19 inches (Ruffner, 1985); at Nellis Air Force Base 4.00 inches (Nellis Air Force Base, 1988); and at Boulder City it is 5.72 inches (Ruffner, 1985). Snowfall is rare in the project vicinity.

Most of Clark County's flash flood events result from severe thunderstorms. Thunderstorms are observed in Las Vegas an average of fourteen times per year (Ruffner, 1985). In general, the production of severe flash flood producing storms can be described as follows (Montgomery Engineers, 1986):

1) From the surface to about 10,000 feet a steady flow of very moist sub-tropical air can be found. This unstable air is converged into the region by low level wind fields. These wind fields can be either topographically induced or caused by large-scale weather systems.

2) The unstable air is lifted to its condensation level by surface heating and further organized by the approach of a mid-level weather disturbance into large organized bands of thunderstorms. These storm systems are focused up the Las Vegas Valley by prevailing southerly or southwesterly winds.

These organized thunderstorm systems may originate in Arizona or California and persist for periods of 6-72 hours as they cross the Western United States. It is speculated that many of the most intense flash floods in Clark County are produced by this storm system type.

Even though most of these storm systems have tracked from the south or southwest, there have been notable exceptions. These would include the Las Vegas Valley storm of July 3, 1975, which remained relatively stationary over the northwestern foothills and the Moapa Valley storm of August 10, 1981, which tracked to the South (Montgomery Engineers, 1986).

An important characteristic of these flash flood producing storms is that they are accompanied by other forms of severe weather over 75 percent of the time (Montgomery Engineers, 1986). These other forms of severe weather would include straight-line winds of 55-75 miles per hour, hail, and in very rare cases tornadoes. About two-thirds of the flash flood events since 1959 occurred in either July or August (Montgomery Engineers, 1986). In general, the flash flood season can be considered to begin in June and to conclude in September.

A final characteristic of these storms is their peak rainfall production. Observations of rainfall during these severe storms at McCarran Field and Nellis Air Force Base suggest that intense rainfall generally lasts 30 minutes or less but could persist for up to 90 minutes (Montgomery Engineers, 1986). Observations and predictions of peak storm rainfall suggest that many of these storms produce over 2.00 inches of rain with a high end approaching 4.00 inches.

Currently, there are only two official recording rain gages in South Nevada: Las Vegas and Searchlight (Montgomery Engineers, 1986). The lack of a consistent, organized precipitation and runoff measuring network in Clark County can cause difficulties in verifying meteorological conditions associated with flood events. If a storm managed to elude the Las Vegas or Searchlight recording rain gages, verification depends upon data collected by rain bucket surveys.

A study done for the Clark County Regional Flood Control District (Montgomery Engineers, 1986) developed a four phase approach to rainfall data collection dependent on the availability of funds and the perceived public urgency and necessity. The data collection system could be established in the following phases (Montgomery Engineers, 1986):

1) PHASE 1: Implementation of a county-wide automated weather station network to measure key pre-storm weather parameters. Implementation of a data management system and archiving of the radar histories of significant rainfall events.

2) PHASE 2: Implementation of rain and stream gage networks in each of the existing Clark County watersheds based on impacts to population and property.

3) PHASE 3: Development of rain and stream gage networks concurrent with development in flood-prone areas.

4) PHASE 4: Implementation of weather station, rain gage and stream gage networks in the popular recreation areas.

4.1.2 Air Quality Standards

Air quality is determined primarily by the type and amount of contaminants emitted into the atmosphere, the size and topography of the air basin and the meteorological conditions. In Clark County, stable atmospheric conditions, low mixing heights and light winds common during nighttime and morning hours provide opportunities for contaminants to accumulate as emissions are produced. Atmospheric dispersion of pollutants generally improves by mid-afternoon.

The effects of the ambient air quality within an air basin depend mainly on the characteristics of the receptors and the type, amount, and duration of exposure. Air quality standards specify the concentration and duration for which pollutants may cause adverse health effects.

National primary ambient air quality standards define levels of air quality, with an adequate margin of safety, to protect the public health. National secondary ambient air quality standards define levels of air quality, with an adequate margin of safety, to protect the public welfare from any known or anticipated adverse effects of a pollutant.

Establishment of ambient air quality standards in Clark County is the responsibility of the United States Environmental Protection Agency, the State of Nevada, and the Clark County Health District. Air quality is generally considered acceptable if pollutant levels are less than or equal to established standards on a continuous basis. Where differences in local and national standards exist, the more stringent standards apply. The Clark County air quality standards are shown in Table 4-5.

The Clark County Health District maintains a regional emissions inventory by source category and specific major sources of criteria pollutants within Clark County. The pollutants tabulated by Clark County Health District include: carbon monoxide (CO), total suspended particulates (TSP), nitrogen dioxide (NO_2) and volatile organic compounds (VOC). Pollutant source emissions are regulated by the APCD pursuant to the Clark County Air Pollution Control Regulations. Limitations on pollutant emissions are delineated in Section 12 (Preconstruction Review For New or Modified Sources) and in Section 14 (New Source Performance Standards) of the Regulations.

Table 4-6 lists the estimated annual average emissions for Clark County. The major sources of CO are motor vehicles and titanium manufacturing. Timet Corporation in Henderson is a major titanium manufacturer. The major sources of NO_2 are motor vehicles and power plants. Nevada Power operates two power plants in metropolitan Las Vegas, Clark Station and Sunrise Station, both east-southeast of the city center. The major sources of TSP are fugitive dust and gravel crushing and screening. Gravel crushing and screening operations are dispersed throughout Clark County. The major sources of VOC are motor vehicles and gasoline stations.

Air quality data for ozone, CO, NO_2, TSP and visibility are available for the Las Vegas Valley (Clark County Health District, 1988a). Air quality data for sulfur dioxide and sulfates are not available for the Las Vegas Valley. Air quality data does not exist for Boulder City.

4.1.2.1 Ozone

Ozone is formed in the atmosphere in the presence of sunlight by a series of chemical reactions involving oxides of nitrogen and reactive hydrocarbons. For this reason, the distribution of ozone is more regional in nature than that of the other air contaminants. Ozone is measured at two locations: metropolitan Las Vegas and Henderson. The summary of the data is shown in Table 4-7. The maximum ozone concentration recorded during 1987 was 0.116 ppm in Henderson which did not exceed the Clark County standard of 0.12 ppm. The EPA redesignated the Las Vegas Valley as attainment for ozone in November 1986.

4.1.2.2 Carbon Monoxide

The primary source of CO is motor vehicles. CO concentrations in Clark County are normally highest in the fall and winter when night and early morning surface-based inversions are most frequent and when ventilation is stagnant. CO is measured at two locations in metropolitan Las Vegas. The summary of the data is shown in Table 4-8. The maximum 1-hr CO concentration recorded in Las Vegas during 1987 was 20.7 ppm which did not exceed the Clark County standard of 35.0 ppm. The maximum 8-hr CO concentration recorded in Las Vegas during 1987 was 16.7 ppm which did exceed the Clark County standard of 9.0 ppm. Note that during the period of record the Las Vegas Valley experienced 24 violations of the 8-hr CO standard.

4.1.2.3 Nitrogen Dioxide

NO_2 is an indirect product of fuel combustion in industrial sources, motor vehicles and other mobile sources such as trains and airplanes. NO_2 is measured at two locations in metropolitan Las Vegas. The summary of the data is shown in Table 4-9. The maximum annual mean NO_2 concentration during 1987 was 0.029 ppm which did not exceed the Clark County standard of 0.05 ppm.

4.1.2.4 Sulfur Dioxide and Sulfate

Fossil fuel combustion at industrial operations is the primary source of sulfur dioxide. Maximum sulfur dioxide concentrations generally occur in the proximity of these sources. Suspended particles containing sulfate have both man-made and natural sources. Sulfates can result from the oxidation of sulfur dioxide, an industrial effluent. Sulfates are also natural components of soils and ocean-generated aerosols. As was noted earlier, there is no air quality data for sulfur dioxide and sulfate. Since there is little industrial fossil fuel combustion in Clark County it is expected that sulfur dioxide and sulfate concentrations would be low.

4.1.2.5 Total Suspended Particulates

Windblown fugitive dust is the primary source of suspended particulates in Clark County. Secondary sources of suspended particulates in Clark County would include industrial processes and vehicular traffic. High concentrations of particulates may occur during strong wind conditions in which particulates are advected over large distances. TSP are measured at six locations, five in metropolitan Las Vegas and one in Henderson. The summary of the data is shown in Table 4-10. The maximum geometric mean total suspended particulate concentration recorded during 1987 was 104.7 ug/m^3 in Las Vegas which did exceed the Clark County Las Vegas Valley standard of 75 ug/m^3. The maximum 24-hr total suspended particulate concentration recorded during 1987 was 208 ug/m^3 in Las Vegas which did not exceed the Clark County Las Vegas Valley standard of 260 ug/m^3.

EPA promulgated in July 1987 ambient air quality standards for particulate matter with an aerodynamic diameter equal to or less than 10 microns (PM10). Clark County has identified all study areas, with the exception of Boulder City, as non-attainment for PM10. The Las Vegas Valley airshed has been categorized as Group One Area by having a 95 percent non-attainment probability. An estimated 95 percent of total PM10 emissions have been attributed to fugitive dust. The largest single contributor of fugitive dust in the Las Vegas Valley is naturally occurring background sources which accounts for 40 percent of the total PM10. Combustion related particulates from motor vehicles and wood burning contribute over 30 percent of the total PM10 emissions (Clark County APCD, 1988).

4.1.2.6 Visibility

Visibility is affected by both particulates and gases. Clark County classifies a haze day as an average measurement for one hour or more between 5:00 AM and 11:00 AM when the visual range is less than 12 miles (Clark County Health District, 1988). Haze is classified as intense if the visual range for one hour is less than 4.8 miles. The highest haze levels tend to occur in the late fall and winter when night and early morning surface-based inversions are most frequent and when ventilation is relatively stagnant. Visibility is measured at two locations: metropolitan Las Vegas and Henderson. The summary of the data is shown in Table 4-11. The maximum number of haze days recorded during a one-year period in Henderson and Las Vegas was 194 and 157, respectively. The maximum number of intense haze days recorded during a one-year period in Henderson and Las Vegas was 93 and 30, respectively. There is no county standard for visibility. The data indicates that visibility is improving in Henderson but is deteriorating in metropolitan Las Vegas.

4.2 SUMMARY OF SPECIFIC ENVIRONMENTAL CONDITIONS BY SUBAREA

The following sections describe environmental conditions unique to each subarea. This includes the effects of topography and degree of urbanization on the criteria pollutants. The Clark County Health District emissions inventory was reviewed (Table 4-6) to define industrial sources such as power plants and titanium mining.

The five different subareas can be grouped into two regions, Las Vegas Valley and outside of the valley. Las Vegas Valley combines Northern Las Vegas Valley, Central Las Vegas Valley, Southwest Las Vegas Valley, and Henderson into one region. The Boulder City subarea is considered outside of Las Vegas Valley. The APCD has designated Las Vegas Valley as non-attainment (exceeded District standards) for CO and TSP only. Even though no air quality data exists for the Boulder City subarea, the APCD has designated all of Clark County outside of the Las Vegas Valley in attainment for all criteria pollutants. EPA has also designated the Las Vegas Valley for non-attainment of PM10.

4.2.1 Northern Las Vegas Valley

The Northern Las Vegas Valley subarea has been designated by APCD as non-attainment for CO and TSP. For all other criteria pollutants, the Northern Las Vegas Valley is considered in attainment.

The Northern Las Vegas Valley subarea consists of relatively flat desert with some urbanization in the eastern third. The northeast boundary of Las Vegas and Nellis Air Force Base are in this eastern third. Highway 95 bisects the western half of the subarea from northwest to southeast. Highway 93 and Interstate-15 (I-15) bisects the eastern third of this subarea from southwest to northeast. Since this area is sparsely populated, vehicular traffic is limited. Small quantities of CO are expected to be emitted locally in this subarea along highways 93 and 95, and I-15. TSP are of concern because this subarea includes cleared areas, unpaved and paved roads, and other natural fugitive emitting sources.

4.2.2 Central Las Vegas Valley

The Central Las Vegas Valley subarea has been designated by APCD as non-attainment for CO and TSP. For all other criteria pollutants, the Central Las Vegas Valley subarea is considered in attainment.

The Central Las Vegas Valley subarea consists of a ridge in the western perimeter, then relatively flat desert with the City of Las Vegas located in the eastern half. Highways 93, 95 and I-15 intersect in Las Vegas. Gravel pits are located just west of the city boundary and at Lone Mountain in the northwest sector of this subarea. Vehicle traffic is the major contributing source of air emissions in this subarea.

CO is of concern in central Las Vegas due to heavy vehicular traffic and relatively stagnant meteorological conditions during the early morning. TSP are also a concern in this subarea. In the city of Las Vegas, TSP are emitted from motor vehicles and paved roads. Outside the city of Las Vegas, TSP are emitted from unpaved and paved roads, gravel crushing and screening and natural sources. A potential concern could be ozone. According to Clark County Health District, ozone has been in compliance with the Federal standard for the past four years. However, since maximum ozone levels are slightly below attainment level an increase in vehicular traffic, particularly in Las Vegas, has the potential to increase ozone levels above the Clark County standard.

4.2.3 Southwest Las Vegas Valley

The Southwest Las Vegas Valley subarea has been designated by APCD as non-attainment for CO and TSP. For all other criteria pollutants, the Southwest Las Vegas Valley subarea is in attainment.

The Southwest Las Vegas Valley subarea is hilly along the western and southern perimeter changing to relatively flat desert further north and east. The northeast quadrant of this subarea encompasses the southern half of Las Vegas and McCarran International Airport. I-15 bisects the eastern third of this subarea from north to south. Gravel pits are situated along the north-central boundary of this subarea.

CO emissions in this subarea are small (except for the urban area in the northeast quadrant during stagnant conditions) and along I-15. TSP are of concern in this subarea. In the northeast quadrant, TSP are emitted from motor vehicles and paved roads. Elsewhere, TSP are emitted from cleared areas, gravel crushing and screening, unpaved and paved roads, and other natural sources.

4.2.4 Boulder City

The Boulder City subarea consists of an urban area (Boulder City) surrounded by desert. To the north of Boulder City are hills. Highway 93 bisects the subarea from the west, then curves northeastward. The Municipal Airport is southwest of the city center. Nevada Power substation is on the south-central border of the region. Southwest of Boulder City is the Eldorado Valley.

The Boulder City subarea has been designated in attainment for all criteria pollutants. Based on our review of the Clark County Health District inventory, there are no apparent major industrial sources in this subarea. Total suspended particulate sources in this subarea would include paved and unpaved roads and other natural sources. Even though the District and Federal standards for TSP have been met for this subarea, APCD has designated that Boulder City will be handled as if it is non-attainment.

4.2.5 Henderson

The Henderson subarea has been designated by APCD as non-attainment for CO and TSP. For all other criteria pollutants, the Henderson subarea is in attainment.

The Henderson subarea consists of the City of Henderson in the center. To the south and southwest of Henderson is the McCullough Range. To the west and northwest is Las Vegas. From the north through southeast is open desert, which is relatively flat. The major industries in this subarea are a power plant operated by Nevada Power and a titanium facility. These facilities are sources of sulfur dioxide, NO_2 and CO.

During stagnant meteorological conditions and high vehicular traffic, CO could also be a potential problem. TSP from the fugitive dust would be of concern in this subarea. Sources of TSP include cleared areas, paved and unpaved roads and natural sources. A potential concern could be ozone. Although ozone has been in compliance with District and Federal standards for the past four years, maximum levels are only slightly below the attainment level. An increase in vehicular traffic or industrial growth in this subarea has the potential to increase ozone levels above the Clark County standard.

4.3 SIGNIFICANT RESOURCES AND POTENTIAL ENVIRONMENTAL IMPACTS

The attainment/non-attainment status for criteria pollutants in Las Vegas Valley and Boulder City is shown in Figure 4-1. The sensitivity map in Figure 4-1 show that Clark County has designated Las Vegas Valley as non-attainment for CO and TSP. The CO "footprint" (number of violation days) is also shown in Figure 4-1. Figure 4-1 illustrates that the greatest number of CO violation days are concentrated downtown. This is due to heavy vehicular traffic during relatively stagnant meteorological conditions in the early morning.

4.3.1 ·Carbon Monoxide

CO is an invisible, odorless, and colorless gas caused mostly by motor vehicles using leaded or unleaded gasoline. Clark County has designated Las Vegas Valley as non-attainment for CO. The relative contributions of pollution sources are shown in Table 4-12. In the winter months, concentrations exceeding District and Federal air quality standards are measured in the east central portion of the Las Vegas Valley (Clark County Health District, 1988b).

The Federal Clean Air Act, passed in 1977, requires that the CO standard is to be attained in all metropolitan areas by the end of 1987. Clark County has not been able to achieve this level in the Las Vegas Valley. In order to reach attainment, CO emissions in the east central Las Vegas area will need to drop by approximately 45 percent from 1987 levels (Clark County Health District, 1988b). In January 1988, the State strengthened the Vehicle Inspection/Maintenance testing, repair, and waiver requirements. This will achieve approximately one-third of the necessary 45 percent reduction. In addition, Clark County oxygenated gasoline fuels program could further reduce CO emissions by an additional 10 to 15 percent. The process of quantifying benefits of various control measures, including the Federal motor vehicle control program for new car manufacturers, the state inspection/maintenance program and the regional computerized traffic signal system has been difficult for Clark County.

For projects not considered under the 10-year plan, further environmental analysis of CO and application of mitigation measures may be appropriate with respect to project-specific environmental reviews, for projects within 1 mile of the mapped CO exceedence zone. Even though CO levels have dropped approximately 40 percent during the last 10 years despite a 40 percent growth in vehicle traffic

(Clark County Health District, 1988b), Clark County is still significantly above District and Federal air quality standards. Because the entire Las Vegas Valley has been designated non-attainment, emissions increases in any part of the valley are considered potentially significant. CO emissions increases in the Central Las Vegas Valley subareas are of particular concern, since current emissions levels are the highest in this area.

4.3.2 Total Suspended Particulates

Windblown fugitive dust is the primary source of suspended particulates in Clark County. Clark County has designated Las Vegas Valley as non-attainment for TSP. The relative contributions of particulate sources are shown in Table 4-13. The data in Table 4-13 show that construction activities are the single largest source contributor to fugitive dust.

Particles causing brown or grey wintertime haze in Las Vegas consist of soot directly emitted by fuel combustion sources including older cars using leaded gasoline, diesel vehicles and woodburning in fireplaces (Clark County Health District, 1988b). Although particulates from vehicles using leaded gasoline have been dropping for several years, particulates from diesel vehicles and from residential woodburning are increasing each year.

For projects not considered under the 10-year plan, further environmental analysis of TSP may be justified for any project-specific environmental review, for projects within a TSP nonattainment area. With the potential increase in windblown fugitive dust from construction activities and the particulate increase from diesel vehicles and residential woodburning, Clark County has the potential to remain above District and Federal standards. Because the entire Las Vegas Valley is currently designated non-attainment, and APCD treats Boulder City as if it was not in attainment, any activities expected to increase fugitive dust or combustion particulate emissions are considered potentially significant.

4.4 GENERAL ENVIRONMENTAL EFFECTS

Construction and operation of flood control facilities would result in emissions of pollutants to the atmosphere in all subareas. Equipment and activities that would emit pollutants during construction include project related commuter traffic, rerouted traffic due to construction, material transport truck traffic, material receiving activities, operation of construction and maintenance equipment and fugitive particulate matter.

Emissions from activities associated with the direct operation of flood control facilities would occur. These emissions would be associated with equipment and traffic required to service and maintain the facilities and fugitive dust associated with sediment removal operations. Indirect and cumulative impacts could also occur associated with emissions resulting from traffic detours (i.e., bridge crossing and new intersections) required to bypass flood control structures and the growth accommodating effect of flood protection.

The following subsections summarize the pollutants which are likely to be emitted during each project activity. Both project subarea and alternative in which air quality impacts are likely to occur are presented below.

4.4.1 Construction

Sources contributing to construction phase air emission impacts would include diesel and gasoline powered mobile construction equipment, automobiles, trucks, and additional wind-blown fugitive dust related to increased construction activities.

The equipment used during construction of flood control facilities are listed in Table 4-14 along with representative emissions rates. On a daily basis several thousand gallons of diesel fuel will be consumed. A lesser amount of gasoline will also be consumed. Thousands of cubic yards of soil will be disturbed along with thousands of cubic yards of material handled daily. These activities will lead to increases of facility related emissions. The increased emission to the environment will occur daily during work hours between 7:00 a.m. to 3:30 p.m. Traffic related emission increases both from facilities work force commute and increased traffic congestion related to the project construction activity. In subregions where medium to high density residential areas exist localized higher concentrations of traffic related pollutants such as CO would be most prevalent during commute hours (i.e., 6:30 a.m. - 4:30 p.m., 3:30 p.m. - 5:30 p.m.). In subregions where traffic is required to service commercial and industrial operations, traffic related pollutants will be increased throughout the normal work week hours (i.e., 6:30 a.m. - 5:30 p.m.). These specific subregions are identified more fully in Section 4.5.

Internal combustion engines used during construction activities would emit VOCs, nitrogen oxides, sulfur dioxide, CO, total suspended particulate matter, trace amounts of aldehyde, benzene and lead emissions would also result from combustion of leaded and unleaded fuels. These emissions are expected to be less than significant under most circumstances, but may be considered significant in areas already exceeding CO standards. Trucks and automobiles used at the project site and traveling to and from the site would also emit similar pollutants. Fugitive dust would be emitted from earth/soil disturbing activities, such as clearing, grading, and use of unpaved surfaces (i.e., dirt or gravel) for vehicle travel. These fugitive dust emissions are considered potentially significant. These sources and their related pollutants are summarized on Table 4-15.

4.4.2 Direct Operation

Sources contributing to direct operation activity air quality impact would include diesel and gasoline powered vehicles and mobile equipment required to service and maintain the project facility. The vehicles and equipment would be primarily used to remove sediment and debris collecting at open culverts and basins, to make maintenance repairs and inspections. Fugitive dust associated with maintenance activities would contribute to ambient total suspended particulate levels.

No emission will result from the direct operation of the facility structures since flood gates are automatically mechanically triggered. No combustion source is involved directly or indirectly with their operation.

It is currently anticipated that cleanout would occur in the debris basins once every 8 to 10 years. In the All Conveyance alternative this will result in 30 cleanouts every 10 years, and 20 cleanouts every 10 years in the Detention/Conveyance alternative. General air quality impacts generated from this activity should be minimal compared with the baseline inventory for the areas affected. These sources and their related pollutants are summarized on Table 4-16.

4.4.3 Indirect Impacts

Sources contributing to indirect operation activity air emission impact include diesel and gasoline powered vehicles. Emissions may be caused by traffic congestion which may result from temporary traffic detours. In each subarea, new crossings will be constructed, and overall effects of traffic detours are expected to be minimal. However, the magnitude of this effect may become significant if multiple projects are constructed simultaneously in the same subarea.

4.5 ENVIRONMENTAL EFFECTS BY ALTERNATIVE

This section presents a comparative analysis of the principal differences between the alternative flood control programs under consideration. As indicated in Table 4-18, the two principal Master Plan alternatives could cause similar types of impacts. The principal differences between these alternatives are associated with the location and overall magnitude of the impacts anticipated. Because TSP and CO have been identified as pollutants of primary concern throughout the study area, the comparison of alternatives (including the No Project alternative) presented below focuses on these pollutants.

4.5.1 Detention/Conveyance Alternative

4.5.1.1 Construction

Construction of facilities associated with the Detention/Conveyance alternative involves the installation of major detention basins in upper reaches of major drainage systems, generally small channels through existing developed area, and some small debris basins and detention basins at various locations throughout the study area. Overall construction activity associated with this alternative would be less than that associated with the All Conveyance alternative, with major earthwork occurring primarily at detention basin sites located far from the existing developed areas in the Las Vegas Valley.

In the vicinity of basin construction, fugitive particulate matter impacts due to road dust, wind blown soil dust, and construction generated dust are likely to occur. Construction of detention basins, lined and unlined channels, and other flood control facilities through undeveloped areas would increase TSP and CO levels in areas of construction.

Air pollution impacts outside the construction basin would include CO emissions from construction vehicles and fugitive particulate matter. CO equipment emissions during hours of construction would increase, however, this would only be a contributing factor to air quality standard exceedences when inversion layers are prominent. Off-site fugitive dust from wind blown excavation sites, construction equipment, and road dust may carry considerable distances when high winds occur, contributing to visibility impairment.

Air quality impacts in the vicinity of basin construction and outside of basin construction are considered to be significant since CO and PM are non-attainment for this airshed. Mitigation measures will need to be considered for the reduction of CO and PM for this alternative.

4.5.1.2 Operation

Facilities maintenance activities during project operation require sediment and debris removal from detention basins and debris basins once every eight to ten years. In general, this activity will involve more sediment and associated fugitive particulate matter emissions with respect to the Detention/Conveyance alternative, but the emissions associated with this activity would be localized and of short duration. Overall, fugitive PM emissions associated with facilities operation are not considered significant.

CO emissions associated with vehicle and equipment operation associated with facilities maintenance would represent a very minor component of the basin-wide emissions inventory. Overall, emissions associated with the operation of the Detention/Conveyance alternative and not considered significant.

4.5.2 All Conveyance Alternative

4.5.2.1 Construction

Construction of facilities associated with the All Conveyance alternative involves the installation of major lined conveyance channels throughout the study area with associated debris basins and existing detention basins. Overall construction activity associated with this alternative would be greater than that associated with the Combined Detention/Conveyance alternative, with earthwork spread uniformly along drainages throughout the study area.

Substantial fugitive particulate matter and CO emissions would occur during the construction of major channels, some of which would occur in the vicinity of major population centers. These increases may represent a substantial local nuisance, and are considered potentially significant because they will occur in an area presently designated non-attainment for TSP and CO. Facility-specific analysis and mitigation is appropriate prior to the approval of individual projects.

4.5.2.2 Operation

Facilities maintenance activities during project operation require sediment and debris removal once every 8 to 10 years. In general, these activities would involve less sediment, and less associated particulate matter emissions, than that associated with the Combined Detention/Conveyance alternative. The extensive use of lined channels associated with this alternative would reduce windblown fugitive dust from existing unimproved channels. Overall, fugitive particulate matter emissions associated with facilities operation are not considered significant.

CO emissions associated with vehicle and equipment operation required for facilities maintenance would represent a very minor component of the basin-wide emissions inventory. CO emissions associated with the operation of the All Conveyance alternative are not considered significant.

4.5.3 No Project Alternative

The No Project alternative assumes that no new flood control facilities would be installed according to a regional plan. Air quality impacts associated with this alternative could be associated with traffic congestion and major repair activities following flood events that could be significant on a short-term basis, but are probably not significant in the long-term. Although flood-related constraints to development would not be eliminated, growth in the Las Vegas Valley in the recent past suggests that this constraint does not effectively limit growth. As a result, the No Project alternative is not expected to result in any cumulative air quality impacts.

4.6 PROGRAMMATIC MITIGATION MEASURES

The activities associated with either alternative may directly impact all subareas in which the existing ambient air quality exceeded national standards for CO and TSP. A qualitative assessment of the short-term and long-term air quality impacts along with the attainment/non-attainment status of the subareas have been discussed in previous sections. This section addresses the potential need for programmatic mitigation measures should the principal pollutants of concern, namely TSP and CO continue to exceed the national standards. Mitigation is categorized for this EIR into two distinct phases: emission reductions (first-phase mitigation) and construction management (second-phase mitigation). If, pursuant to first phase mitigation, facility construction is still considered potentially significant due to relative location to residential areas or pollutant exceedence zones, then second-phase mitigation would be implemented.

On a lesser degree, NO_2 and VOC pollutants have also been evaluated since their direct role in the formation of ozone is of probable concern in the near future. Ozone has been in compliance with the District and Federal standard for the past four years but maximum levels are only slightly below the NAAQS (Clark County Health District, 1988).

Even though ozone is currently in compliance with the District and Federal standards further environmental analysis of ozone precursors (NO_2 and VOC) may be required for future facility proposals if standards are exceeded when the facilities are to be installed. The presence of solar radiation (sunlight) with continued growth in vehicular congestion and traffic has the potential to contribute to ozone formation and thus to exceedences of District and Federal standards in the future. In addition, a new lower ozone AAQS may be implemented by EPA soon. Therefore, ozone should be evaluated in any future environmental review.

It is important to note that the Las Vegas Valley Air Quality implementation Plan (AQIP) is currently undergoing a significant revision. Any mitigation measures presented in the revised AQIP could supersede the mitigation discussed in this EIS.

4.6.1 Fuel-Combustion Emissions

During construction activities, diesel and gasoline powered mobile construction equipment, automobiles, and trucks account for the majority of VOC, NO_x and CO project related emissions. These pollutants are emitted daily during construction periods. The potential for adverse impacts on existing air quality, when cold temperatures and stagnant conditions do not allow adequate air mixing. In these situations localized CO "hotspots" (elevated CO concentrations) may occur.

Although no long-term impacts are expected, short-term impacts could be minimized through the implementation of first-phase mitigation measures for the reduction of air quality pollutant emissions from construction equipment could be implemented. This could be implemented by inspection and maintenance of equipment to insure conformance with existing tail pipe exhaust standards, avoid unnecessary idling of equipment, vapor recovery control methods, the usage of Caterpillar design heavy-duty prechamber engines which reduce NOx, optimizing air-to-fuel ratios, and retarded ignition timing on construction vehicles.

If it appears that CO standards will be exceeded and a news alert is issued, CCRFCD will coordinate with the Health District to determine if construction activities could directly contribute to a violation in the CO standards (assuming the activity is within 1 mile of the mapped CO exceedence zone). CCRFCD will implement second-phase mitigation through curtailment of construction activities or modification of the construction schedule pursuant to Health District directive.

By controlling public access use of construction roads and controlling unnecessary entry into the construction areas, the non-attainment pollutants could be reduced. If necessary, construction equipment activities could be managed such that hours of regularly high CO emissions due to commuter traffic would be avoided. During this time-frame other construction activities not involving equipment emission could take place.

If ozone exceedences are experienced or anticipated in the future, refuelling activities for mobile vehicles could utilize vapor recovery systems such as those used in California (Bay area and the South Coast) to reduce VOC releases. In addition, oxygenated fuels are required and will be used during the period defined by the Clark County Health District to reduce unburned hydrocarbons associated with the operation of many internal combustion engines.

4.6.2 Fugitive Dust Emissions

Evaluation of PM sources and methods to reduce PM in the Las Vegas Valley was the focus of a working paper prepared by the APCD (1988). This study assessed both man-made and natural sources of PM in the Las Vegas Valley and proposed methods to reduce PM. Primary PM sources include unpaved roads, cleared areas, natural areas, and construction activities. Minor sources include vehicle exhaust, fireplaces, natural gas, and brakes and tire wear. Mitigation measures listed below follow recommendations made in the report. Note that current Clark County regulations prohibit the generation of visible fugitive dust at offsite locations. It is anticipated that the mitigation measures provided below will achieve this offsite fugitive dust restriction.

4.6.2.1 Local Fugitive Dust from Unpaved Roads

As a first-phase mitigation, frequently used unpaved maintenance roads should be covered with a cold-mix asphalt material if required by APCD. Infrequently used roads, or roads with gates to discourage public access should not be subject to this requirement. In an effort to minimize re-suspended road dust, construction vehicles will pass through a dust removal media prior to entering a paved highway. The dust removal media may consist of a gravel-or asphalt-based road section or a roller system. If a gravel or asphalt media is utilized, the length of roadway would be approximately 50 feet and would be removed upon completion of construction.

4.6.2.2 Construction Site Fugitive Dust Control

Impacts of fugitive particulate matter emissions could be reduced in several ways through first-phase mitigation. A 50 percent reduction would be experienced by employing a water truck to spray the excavated areas during construction. Furthermore, a 70 percent reduction of fugitive particulates would be experienced through the use of approved dust suppressants. Dust suppressants should be reapplied at the end of construction activities.

Through the management of construction activities (second-phase mitigation), earth moving activities could be postponed when wind speeds equal or exceed 15 miles per hour when construction is taking place within 1000 feet of residential areas.

4.6.2.3 Sifting and Screening Activities Fugitive Dust Control

As first-phase mitigation, contractors shall install temporary wind screens prior to soil screening or sifting activities. Sifting and screening activities would not be allowed under second-phase mitigation when the wind speeds equal or exceed 15 miles per hour and construction is within 1000 feet of residential areas.

4.6.2.4 Stockpile Windscreens Fugitive Dust Control

Temporary windscreens shall be installed around stockpiled materials (first-phase mitigation only). Suggested windbreak sizing shall follow guidelines set forth by APCD.

4.6.2.5 Covered Haul Materials

All vehicles operating on County highways and roads unless the vehicle is constructed, covered, or leaded to prevent its cargo from spilling (first-phase mitigation only).

4.6.2.6 Cleared Areas Fugitive Dust Control

Dust suppressants should be applied to cleared areas at the completion of construction (first-phase mitigation), with repeat application if dust generation problems are identified during project operation (second-phase mitigation).

TABLE 4-1

ANNUAL WIND DISTRIBUTION AT LAS VEGAS (1951-1980)
(30-YEAR MEAN)

MONTH	MEAN SPEED (MPH)	PREVAILING DIRECTION	HIGHEST RECORDED SPEEDS (MPH)	WIND DIRECTION
January	7.4	W	52	SW
February	8.4	SW	60	NW
March	10.0	SW	52	NW
April	11.0	SW	52	SW
May	10.9	SW	54	SW
June	11.0	SW	52	SW
July	10.2	SW	64	NE
August	9.5	SW	62	NE
September	8.8	SW	54	NW
October	8.0	WSW	52	NW
November	7.5	W	63	S
December	7.2	W	54	SW
Annual	9.1	SW	64	NE

Source: Ruffner, 1985

TABLE 4-2

SURFACE-LAYER STABILITY CLASS FOR LAS VEGAS (1978-1987)
(MONTHLY FREQUENCY EXPRESSED IN PERCENTAGE)
(10-YEAR MEAN)

	PASQUILL STABILITY CLASS						
MONTH	A	B	C	D	E	F	G
January	0.0	2.9	9.9	21.5	24.9	16.2	24.2
February	0.1	5.7	10.6	21.2	23.2	16.1	23.0
March	0.1	8.6	10.5	21.5	22.5	13.9	22.7
April	1.2	9.5	13.7	22.4	17.5	14.2	21.4
May	2.9	11.6	17.0	18.5	16.4	13.2	20.3
June	2.4	12.3	17.9	20.5	11.9	13.6	21.3
July	2.9	12.2	17.8	19.8	11.6	12.3	23.2
August	2.1	13.1	15.3	17.3	10.6	12.4	29.1
September	0.5	12.0	11.6	19.1	13.6	14.5	28.7
October	0.4	10.1	12.8	16.6	13.2	14.9	31.8
November	0.1	5.0	11.2	17.1	19.6	17.5	29.5
December	0.0	3.6	9.7	20.0	20.5	16.6	29.4

Source: National Weather Service, 1988

TABLE 4-3

AVERAGE SEASONAL MIXING HEIGHTS FOR LAS VEGAS (1960-1964)

SEASON (MONTHS)	HEIGHTS IN METERS MORNING	AFTERNOON
Winter (Dec., Jan., Feb.)	321	1152
Spring (Mar., Apr., May)	433	2785
Summer (Jun., Jul., Aug.)	292	3693
Fall (Sep., Oct., Nov.)	276	2106
Annual	331	2434

Source: Holzworth, 1972

TABLE 4-4

MONTHLY MEAN TEMPERATURES AND PRECIPITATION (1951-1980)
(30-YEAR MEAN)

MONTH	LAS VEGAS[1] Mean Monthly Temperatures Max. (°F)	Min. (°F)	Total Precipitation (inches)	NELLIS AFB[2] Mean Monthly Temperatures Max. (°F)	Min. (°F)	Total Precipitation (inches)	BOULDER CITY[3] Mean Monthly Temperatures Max. (°F)	Min. (°F)	Total Precip. (inches)
January	56	33	0.50	57	33	0.40	54	38	0.58
February	62	38	0.46	63	38	0.40	60	43	0.53
March	68	42	0.41	69	44	0.40	67	46	0.72
April	77	50	0.22	78	52	0.20	76	52	0.36
May	87	59	0.20	88	61	0.10	85	61	0.25
June	99	69	0.09	98	69	0.10	96	70	0.10
July	104	76	0.45	104	76	0.50	102	76	0.49
August	102	74	0.54	102	75	0.50	99	74	0.80
September	95	66	0.32	95	66	0.30	93	68	0.50
October	82	54	0.25	82	53	0.20	80	58	0.41
November	66	41	0.43	67	41	0.40	65	46	0.54
December	57	34	0.32	58	33	0.40	56	39	0.44
Annual Average	80	53	4.19	80	53	4.00	78	56	5.72

[1] Source: Ruffner, 1985
[2] Source: Nellis Air Force Base, 1988
[3] Source: Ruffner, 1985

TABLE 4-5

AMBIENT AIR QUALITY STANDARDS

POLLUTANT	AVERAGING TIME	CLARK COUNTY STANDARDS	NATIONAL STANDARDS
Sulfur Dioxide	Annual arithmetic mean	60 u/m^3 (0.02 ppm)	80 u/m^3 (0.03 ppm)
	Maximum 24-hr. concentration	260 u/m^3 (0.10 ppm)	365 u/m^3 (0.14 ppm)
	Maximum 3-hr. concentration	1300 u/m^3 (0.50 ppm)	
Carbon Monoxide	Maximum 8-hr. concentration	10 u/m^3 (9.00 ppm)	10 u/m^3 (9.00 ppm)
	Maximum 1-hr. concentration	40 u/m^3 (35.00 ppm)	40 u/m^3 (35.00 ppm)
Ozone	Maximum 1-hr. concentration	235 u/m^3 (0.12 ppm)	235 u/m^3 (0.12 ppm)
Nitrogen Dioxide	Annual arithmetic mean	100 u/m^3 (0.05 ppm)	100 u/m^3 (0.05 ppm)
Lead	Arithmetic mean per calendar quarter	1.5 u/m^3	1.5 u/m^3
Total Suspended Particulates	Annual geometric mean	75 u/m^3	
	Maximum 24-hr. concentration for Las Vegas Valley	260 u/m^3	
	Maximum 24-hr. concentration elsewhere in Clark County	150 u/m^3	
Inhalable Particles (PM_{10})	Maximum 24-hr. concentration		150 ug/m^3
	Annual geometric mean		50 ug/m^3

The following measurement definitions apply:

u/m^3 means micrograms of air contaminant per cubic meter of air
ppm means parts of air contaminant by volume per million parts of air by volume

Source: Clark County Health District, 1988a

TABLE 4-6

DISTRICT EMISSIONS BY SOURCE CATEGORIES

1979 ANNUAL AVERAGE
(TONS/YEAR)

SOURCE CATEGORY	CO	TSP	NOx	VOC
CHEMICAL PROCESS				
Industries	146	50	--	220
METALLURGICAL INDUSTRIES				
Titanium	10,000	53	346	4
Manganese Dioxide	18	22	44	--
MINERAL AND MINING				
Lime Manufacturing	160	90	241	--
Asphalt Plants	1	35	8	22
Gravel Mining	--	86	--	--
Concrete Ready Mix	--	22	--	--
Gravel Crushing and Screening	--	912	--	--
COMBUSTION OF FUELS				
Power Plants	914	195	7,684	13.5
Large Commercial	45	23	226	18
Fireplaces	300	60	--	25
Residential and Small Commercial	79	39	394	32
Other Industrial	101	15	395	36
WASTE BURNING				
Incinerator	Negligible	--	--	--
MISCELLANEOUS SOURCES				
Cigarette Smoking	190	--	--	45
Food Preparation	250	--	--	60
MOTOR VEHICLES				
On-Road	110,500	1,540	9,700	14,200
Off-Road	2,400	240	621	500
RAILROADS	360	63	1,500	370
AIRCRAFT		141		
Commercial	2,100	--	900	980
Military	1,600	--	550	440
Piston	851	--	4	30
LARGE APPLIANCE MFR	--	22	2	--

TABLE 4-6 (concluded)

SOURCE CATEGORY	CO	TSP	NOx	VOC
FUGITIVE DUST				
Fires	--	52	--	--
Cleared Areas	--	2,200	--	--
Paved Roads	--	10,600	--	--
Unpaved Roads	--	7,700	--	--
Other Area Sources	--	550	--	--
Construction and Demolition	--	14,700	--	--
Natural Sources (Desert)	--	5,304	--	--
PETROLEUM				
Petroleum Storage	--	--	--	216
Gasoline Stations	--	--	--	1,480
ORGANIC SOLVENT USE				
Surface Coating				191
Painting Spray Booth	--	--	--	172
Architectural Coating	--	--	--	8
Miscellaneous	--	--	--	89
Dry Cleaning	--	--	--	131
Degreasing	--	--	--	
Other				
Cutback Asphalt	--	--	--	97
Printing	--	--	--	36
Miscellaneous	--	--	--	1
TOTAL	130,015	44,714	22,615	19,416.5

Source: Clark County Department of Comprehensive Planning, 1980

TABLE 4-7

OZONE CONCENTRATION IN LAS VEGAS VALLEY (1987)

SITE	1ST HIGH	DATE HOUR	2ND HIGH	DATE HOUR	3RD HIGH	DATE HOUR	4TH HIGH	DATE HOUR
559 N. 7th, .094 ppm	.107 ppm	8/28 9 a.m.	.105 ppm	5/8 8 a.m.	.096 ppm	10/18 4 p.m.	Las Vegas	7/7 1 p.m.
545 Lake Mead Drive, Henderson	.116 ppm	9/26 9 a.m.	.106 ppm	7/5 12 p.m.	.100 ppm	7/6 1 a.m.	.099 ppm	7/6 2 a.m.

Source: Clark County Health District, 1988a

TABLE 4-8

CARBON MONOXIDE CONCENTRATIONS IN LAS VEGAS VALLEY (1987)

SITE	1ST 1-HR HIGH	DATE HOUR	2ND 1-HR HIGH	DATE HOUR	1ST 8-HR HIGH	DATE HOUR	2ND 8-HR HIGH	DATE HOUR	TIMES EXCEEDED 1-HR	TIMES EXCEEDED 8-HR
559 N. 7th, Las Vegas	15.0 ppm	10/16 7 a.m.	14.8 ppm	10/21 7 a.m.	9.0 ppm	12/2 1 a.m.	8.4 ppm	2/8 8 a.m.	0	1
2850 East Charleston, Las Vegas	20.7 ppm	12/10 10 p.m.	20.3 ppm	12/10 9 p.m.	16.7 ppm	12/11 2 a.m.	14.9 ppm	11/20 1 a.m.	0	24

Source: Clark County Health District, 1988a

TABLE 4-9

NITROGEN DIOXIDE CONCENTRATIONS IN LAS VEGAS VALLEY (1987)

SITE	1ST 1-HR HIGH	DATE HOUR	2ND 1-HR HIGH	DATE HOUR	1ST 24-HR HIGH	DATE	2ND 24-HR HIGH	DATE	ANNUAL MEAN
559 N. 7th, Las Vegas	.130 ppm	6/9 10 a.m.	.119 ppm	6/11 1 a.m.	.047 ppm	2/1	.046 ppm	7/25	.029 ppm
2850 East Charleston, Las Vegas	.302 ppm	12/4 9 a.m.	.237 ppm	12/22 1 a.m.	.083 ppm	12/4	.072 ppm	12/3	.029 ppm

Source: Clark County Health District, 1988a

TABLE 4-10

TOTAL SUSPENDED PARTICULATE CONCENTRATIONS IN LAS VEGAS VALLEY (1987)

SITE	CONCENTRATIONS IN UG/M^3					
	Geometric Mean	1st High	Date	2nd High	Date	No. of 24-hr Violations
215 East Bonanza, Las Vegas	68.4	115	9/10	112	7/18	0
East Vegas Valley Drive, Las Vegas	104.7	188	4/1	181	1/25	0
2801 East Charleston, Las Vegas	77.8	147	7/18	139	11/27	0
2500 Paradise Road, Las Vegas	76.9	184	7/6	156	8/5	0
1239 North Boulder Highway, Las Vegas	91.9	208	6/24	196	4/1	0
1414 East Lake Mead Drive, Henderson	70.9	142	1/31	119	1/1	0

Source: Clark County Health District, 1988a

TABLE 4-11

LAS VEGAS VALLEY HAZE DAYS

	POWERLINE (HENDERSON) MONITORING STATION		EAST CHARLESTON (LAS VEGAS) MONITORING STATION	
YEAR	Haze Days	Intense Haze Days	Haze Days	Intense Haze Days
1981	194	93	48	0
1982	142	62	40	3
1983	162	68	69	2
1984	131	24	56	2
1985	127	22	116	13
1986	98	22	157	28
1987	115	17	128	30

Source: Clark County Health District, 1988a

TABLE 4-12

CARBON MONOXIDE SOURCES (1987)

SOURCE	PERCENT CONTRIBUTION
Leaded Motor Vehicles	57
Unleaded Motor Vehicles	39
Residential Woodburning	2
Other	2

Source: Clark County Air Pollution Control Division, 1988a

TABLE 4-13

VALLEY-WIDE PARTICULATE MATTER SOURCES (1987)

SOURCE	SOURCE TYPE	PERCENT CONTRIBUTION
Freeways	F	0.3
Major Streets	F	16.4
Collector Streets	F	4.5
Local Streets	F	8.0
Brake/Tire Wear	F	0.7
Unpaved Roads	-	5.9
Construction Activities	F	35.2
Cleared/Vacant Areas	F	15.6
Motor Vehicle Exhaust	C	0.7
Fireplaces	C	0.5
Other	-	--
Natural Background	F	12.3

Source Types:
F = Fugitive Dust
C = Combustion particulate

Source: Clark County Health District, 1988b

TABLE 4-14

CONSTRUCTION EQUIPMENT EMISSION FACTORS

		EMISSION FACTORS (G/HP-HR)					
FACILTIY/ACTIVITY	EQUIPMENT REQUIRED	ROC	NOX	SO2	CO	PM	AP-42 CATEGORY, TABLE 11-7.1 (4TH ED)
DETENTION BASINS/ EXCAVATION	BULLDOZER	0.71	7.81	0.85	2.15	2.15	HD DIESEL CONSTRUCTION TRACK-TYPE TRACTOR
	GRADER	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	LOADER	0.92	8.81	0.86	2.71	0.81	HD DIESEL CONSTRUCTION WHEELED LOADER
	HAULING TRUCKS	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	GRADE ALL	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	COMPACTOR	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	SCRAPERS	0.52	7.46	0.90	2.45	0.79	HD DIESEL CONSTRUCTION SCRAPER
	WATER TRUCK	0.35	8.15	0.89	2.28	0.50	HD DIESEL CONSTRUCTION OFF-HIGHWAY TRUCK
DEBRIS BASINS/ EXCAVATION	BULLDOZER	0.71	7.81	0.85	2.15	2.15	HD DIESEL CONSTRUCTION TRACK-TYPE TRACTOR
	GRADER	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	LOADER	0.92	8.81	0.86	2.71	0.81	HD DIESEL CONSTRUCTION WHEELED LOADER
	HAULING TRUCKS	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	GRADE ALL	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	COMPACTOR	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	SCRAPERS	0.52	7.46	0.90	2.45	0.79	HD DIESEL CONSTRUCTION SCRAPER
	WATER TRUCK	0.35	8.15	0.89	2.28	0.50	HD DIESEL CONSTRUCTION OFF-HIGHWAY TRUCK
BRIDGE/ EXCAVATION	BACKHOE	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	LOADER	0.92	8.81	0.86	2.71	0.81	HD DIESEL CONSTRUCTION WHEELED LOADER
	HAULING TRUCKS	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	WATER TRUCK	0.35	8.15	0.89	2.28	0.50	HD DIESEL CONSTRUCTION OFF-HIGHWAY TRUCK
FLOODWAYS/ EXCAVATION & SHAPING	BULLDOZER	0.71	7.81	0.85	2.15	2.15	HD DIESEL CONSTRUCTION TRACK-TYPE TRACTOR
	GRADER	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	LOADER	0.92	8.81	0.86	2.71	0.81	HD DIESEL CONSTRUCTION WHEELED LOADER
	HAULING TRUCKS	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	GRADE ALL	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	COMPACTOR	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	SCRAPERS	0.52	7.46	0.90	2.45	0.79	HD DIESEL CONSTRUCTION SCRAPER
	WATER TRUCK	0.35	8.15	0.89	2.28	0.50	HD DIESEL CONSTRUCTION OFF-HIGHWAY TRUCK
CONCRETE BOX/ EXCAVATION & SHAPING	EXCAVATOR	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	LOADER	0.92	8.81	0.86	2.71	0.81	HD DIESEL CONSTRUCTION WHEELED LOADER
	HAULING TRUCK	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	CRANE	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION

TABLE 4-14 (concluded)

FACILTIY/ACTIVITY	EQUIPMENT REQUIRED	EMISSION FACTORS (G/HP-HR) ROC	NOX	SO2	CO	PM	AP-42 CATEGORY, TABLE 11-7.1 (4TH ED)
PIPELINE/PIPE PLACEMENT	EXCAVATOR	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	LOADER	0.92	8.81	0.86	2.71	0.81	HD DIESEL CONSTRUCTION WHEELED LOADER
	HAULING TRUCK	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
UNLINED CHANNELS/ EXCAVATION & SHAPING	BULLDOZER	0.71	7.81	0.85	2.15	2.15	HD DIESEL CONSTRUCTION TRACK-TYPE TRACTOR
	GRADER	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	LOADER	0.92	8.81	0.86	2.71	0.81	HD DIESEL CONSTRUCTION WHEELED LOADER
	HAULING TRUCKS	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	GRADE ALL	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	WATER TRUCK	0.35	8.15	0.89	2.28	0.50	HD DIESEL CONSTRUCTION OFF-HIGHWAY TRUCK
LINED CHANNELS/ EXCAVATION & SHAPING	BULLDOZER	0.71	7.81	0.85	2.15	2.15	HD DIESEL CONSTRUCTION TRACK-TYPE TRACTOR
	GRADER	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	LOADER	0.92	8.81	0.86	2.71	0.81	HD DIESEL CONSTRUCTION WHEELED LOADER
	HAULING TRUCKS	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	GRADE ALL	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	WATER TRUCK	0.35	8.15	0.89	2.28	0.50	HD DIESEL CONSTRUCTION OFF-HIGHWAY TRUCK
UNLINED DIKES/ EXCAVATION & SHAPING	BULLDOZER	0.71	7.81	0.85	2.15	2.15	HD DIESEL CONSTRUCTION TRACK-TYPE TRACTOR
	GRADER	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	LOADER	0.92	8.81	0.86	2.71	0.81	HD DIESEL CONSTRUCTION WHEELED LOADER
	HAULING TRUCKS	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	GRADE ALL	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	COMPACTOR	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	SCRAPERS	0.52	7.46	0.90	2.45	0.79	HD DIESEL CONSTRUCTION SCRAPER
	WATER TRUCK	0.35	8.15	0.89	2.28	0.50	HD DIESEL CONSTRUCTION OFF-HIGHWAY TRUCK
LINED DIKES/ EXCAVATION & SHAPING	BULLDOZER	0.71	7.81	0.85	2.15	2.15	HD DIESEL CONSTRUCTION TRACK-TYPE TRACTOR
	GRADER	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	LOADER	0.92	8.81	0.86	2.71	0.81	HD DIESEL CONSTRUCTION WHEELED LOADER
	HAULING TRUCKS	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	GRADE ALL	0.34	7.14	0.87	1.54	0.63	HD DIESEL CONSTRUCTION MOTOR GRADER
	COMPACTOR	0.96	11.01	0.93	4.60	0.90	MISCELLANEOUS HD DIESEL CONSTRUCTION
	SCRAPERS	0.52	7.46	0.90	2.45	0.79	HD DIESEL CONSTRUCTION SCRAPER
	WATER TRUCK	0.35	8.15	0.89	2.28	0.50	HD DIESEL CONSTRUCTION OFF-HIGHWAY TRUCK

TABLE 4-15

POLLUTANTS EMITTED FROM CONSTRUCTION ACTIVITIES

SOURCE TYPE	Subarea	POLLUTANT VOCs	NO_x	SO_2	CO	TSP	Aldehyde	Benzene	Lead
IC CONSTRUCTION EQUIPMENT									
Diesel Powered	All		X	X		X	X		
Gasoline Powered	All	X	X		X		X	X	
Leaded Fuel	All	X	X		X			X	X
Unleaded Fuel	All	X	X		X			X	
Diesel Fuel	All		X	X		X			
CONSTRUCTION ACTIVITIES									
Grading	All					X			
Clearing	All					X			
Earth/Soil Disturbance						X			

TABLE 4-16

POLLUTANTS EMITTED FROM DIRECT OPERATION

SOURCE TYPE	Subarea	POLLUTANT							
		VOCs	NO_x	SO_2	CO	TSP	Aldehyde	Benzene	Lead
MAINTENANCE ACTIVITIES									
Diesel Powered Vehicles	All		X	X		X	X		
Gasoline Powered Vehicles (Unleaded)	All	X	X		X		X	X	
Earth/Soil Disturbance	All					X			

TABLE 4-17

INDIRECT AND CUMULATIVE EMISSIONS

		POLLUTANT							
SOURCE TYPE	Subarea	VOCs	NO_x	SO_2	CO	TSP	Aldehyde	Benzene	Lead
Diesel Powered Automobiles and Trucks	All		X	X		X	X		
Gasoline Powered Automobiles and Trucks (Unleaded)	All	X	X		X			X	
Fugitive Dust	All					X			

TABLE 4-18

POTENTIAL ENVIRONMENTAL EFFECTS
BY ALTERNATIVE AND PROJECT ACTIVITY

	DETENTION/CONVEYANCE	ALL CONVEYANCE	NO PROJECT
TSP[1]			
Construction	Yes	Yes	No
Direct Operation	Yes	Yes	No
Indirect Operation	Yes	Yes	No
CO[2]			
Construction	Yes	Yes	No
Direction Operation	Yes	Yes	No
Indirect Operation	Yes	Yes	No
OZONE[3]			
Construction	Yes	Yes	No
Direct Operation	No	No	No
Indirect Operation	No	No	No

---

1 See discussion in Section 3.5.1.3 & 3.5.2.3
2 See discussion in Section 3.5.1.3 & 3.5.2.3
3 See discussion in Section 3.5.1.2 & 3.5.1.3
3.5.2.2 & 3.5.2.3

FIGURE 4-1

AIR QUALITY CONSTRAINTS MAP

(SEE VOLUME II, OVERSIZE MAPS)

5.1 GEOLOGIC ENVIRONMENT

5.1.1 Physiography

The majority of the proposed flood control facilities are located in the Las Vegas Valley, a valley in the Great Basin region of the Basin and Range physiographic province of southern Nevada. Several proposed flood control facilities are located southeast of Las Vegas Valley in the northern portion of Eldorado Valley and in a small unnamed valley north of Boulder City.

5.1.1.1 Las Vegas Valley Physiography

The Las Vegas Valley is surrounded by steep, rugged mountain ranges. Surface elevations in the Las Vegas Valley range from approximately 1,800 to 2,400 feet above mean sea level (msl). The basin is bordered on the north by the Las Vegas Range, crest elevation approximately 7,000 feet, and on the east by the Frenchman, Sunrise, and River Mountains, with crest elevations ranging between 3,000 and 4,000 feet. The western boundary of the valley is formed by the Spring Mountains, which attain a maximum elevation of 11,912 feet at Charleston Peak. The southeastern boundary is the McCullough Range with a 5,000 foot crest elevation. Low hills and the Bird Spring Range bound the basin on the southwest.

Extensive coalescing alluvial fans extend from the surrounding mountain ranges to the floor of Las Vegas Valley. These fan surfaces have gentle slopes of about 1.5 to 3 percent. The valley floor is relatively flat with a slope of less than one percent to the southeast. Three major and numerous minor escarpments trending north-south and northwest-southeast cut through or border the valley. These escarpments vary in relief from approximately 5 to 150 feet, with the lower side generally on the east or northeast.

Several major drainage channels (washes) dissect the Las Vegas Valley and have locally eroded channels up to 30-feet deep into the bajada and valley floor alluvium. These washes include Duck Creek, Tropicana Wash, Flamingo Wash, and Las Vegas Wash. They are tributaries of Las Vegas Wash, which drains from north to south near the eastern edge of the valley floor and extends to the southeast out of the basin to Lake Mead (Figure 5-1). Surface water flow in the basin occurs only locally, due to waste water discharges and runoff from urban areas, except during periods of torrential runoff due to thunderstorms in the basin or surrounding mountains.

5.1.1.2 Boulder City Area Physiography

Proposed flood control facilities in the Boulder City area are located in the northernmost portion of Eldorado Valley and the small unnamed valley north of Boulder City. The Eldorado Valley is bounded by the River Mountains to the north, the Eldorado Mountains to the east, and the McCullough Range to the west. Surface elevations in the vicinity of proposed flood control facilities located near Boulder City range from 2,000 to 3,200 feet above mean sea level (Figure 5-1).

Coalescing alluvial fans extend from the River Mountains, McCullough Range, and Eldorado Mountains into Eldorado Valley. The fans on the north and west sides of the valley have relatively steep surfaces in comparison to those on the east. The valley floor consists of an alluvial fault and playa which is located in the northwest portion of the valley. The small valley north of Boulder City is floored by coalescing alluvial fans emanating from the northern portions of the Eldorado and River mountains.

Several major ephemeral washes are present in the Boulder City area. The two largest washes are located in the mountains north of Boulder City, however, several minor drainages flow from Boulder City toward the south. Bootleg Wash flows out of the River Mountains area to the south towards Boulder City and into Hemmenway Wash. Hemmenway Wash drains the northern half of Boulder City and empties into Lake Mead. Some of the washes have meandering or braided morphologies, suggesting lateral migration during wash development, while others have incised channels.

5.1.2 Stratigraphy

Two major geologic units; bedrock and valley-fill sediments characterize the geology of the project region (Figure 5-2). The mountain ranges on the east, west, and north sides of Las Vegas Valley consist primarily of Paleozoic and Mesozoic sedimentary rocks including limestones, siltstones, sandstones, and fanglomerates. The mountain ranges on the south and southeast sides of the valley consist primarily of Tertiary volcanic rocks including basalts, andesites, rhyolites, and intrusive rocks that overlie Precambrian metamorphic and granitic rocks. The valley-fill sediments predominantly consist of Miocene to Holocene age fine to coarse clastic sediments (Matti and Bachhuber, 1985; Bingler, 1977) and surface distribution of stratigraphic units in the Las Vegas Valley area is shown on the regional geologic map (Figure 5-3).

5.1.2.1 Bedrock

The predominant bedrock units in the mountain ranges surrounding the Las Vegas Valley are Paleozoic in age. These rocks occur in the Spring Mountains, Frenchman Mountain, Las Vegas Range, and Sheep Range. Limestone and dolomite are the most common Paleozoic rock types. Clastic rocks such as conglomerate, quartzite, sandstone, and shale also occur locally. Surface distribution of Paleozoic rocks suggests that these rocks underlie much of the northern Las Vegas Valley and some of the southern part of the valley (Plume, 1984). Permian, Triassic, and Jurassic age sandstone, conglomerate, shale, and limestone occur on the lower slopes of the Spring Mountains, and on the slopes of the Frenchman and Sunrise Mountains. The surface distribution of these rocks suggests that they underlie valley fill in the middle and southern parts of Las Vegas Valley (Longwell et al., 1965).

Cretaceous-Tertiary age intrusive rocks occur as scattered dikes in the mountains at the southeastern end of the Las Vegas Valley and quartz monzonitic intrusive rocks crop out at the southwestern end of the valley. Volcanic rocks of Tertiary age also occur in these areas (Longwell et al., 1965; Plume, 1984). Volcanic rocks north and east of Henderson consist of flows and flow breccias of dacite, andesite, and basalt that range from early to middle Miocene in age (Bell and Smith, 1980).

The most predominate bedrock units in the Boulder City area consist of Tertiary volcanic and intrusive rocks. These rocks occur in Boulder City and to the north, east, and southeast of the city. The volcanic rocks primarily consist of andesite, basalt, and rhyolite flows. Intrusive rocks range in composition from diorite to granite (Stewart and Carlson, 1978).

5.1.2.2 Valley Fill Deposits

<u>Late Cenozoic Basin Deposits</u>

Miocene clastic deposits occur on the lower slopes of the north, south and east sides of the Frenchman Mountains, northeast of Henderson at the base of the River Mountains, and on the lower slopes of the Las Vegas Range. These deposits include the Thumb, Horse Spring, and Muddy Creek formations, and unnamed clastic rocks in the Las Vegas Range (Longwell et al., 1965).

The Thumb Formation is composed of interbedded siltstone, sandstone, conglomerate, claystone, fresh-water limestone, gypsum beds, and lava flows (Bell and Smith, 1980). The Horse Spring Formation is composed of fresh-water limestone with interbeds of sandstone, siltstone, magnesite, gypsum, and lava flows (Bell and Smith, 1980; Longwell et al., 1965). The unnamed clastic rocks at the south end of the Las Vegas Range are composed of conglomerate with interbeds of sandstone and tuffaceous sediments (Longwell et al., 1965). These deposits are similar to deposits in the Horse Spring Formation, although sufficient evidence does not exist to establish correlation. These Miocene age clastic deposits are estimated to range from 6,000 to 7,000 feet thick east of Las Vegas Valley and are approximately 5,000 feet thick north of the valley (Longwell et al., 1965). They appear to occur in logs of wells completed in the thick sedimentary section underlying Las Vegas Valley, but often these formations are difficult to recognize in the subsurface (Bell, 1981).

The Muddy Creek Formation and overlying younger deposits are generally thought to comprise the valley fill of Las Vegas Valley. However, Maxey and Jameson (1948) and Bell (1981) suggested that the basal part of the valley fill may be composed of older units.

The Miocene and Pliocene age Muddy Creek Formation crops out in many of the basins in the Lake Mead-Las Vegas area. The lithology of the Muddy Creek Formation varies and includes poorly to well consolidated clayey silt and silty clay; interbedded gravel, sand, silt, and clay; fanglomerates; and fine sandstone, siltstone, and clay (Bingler, 1977; Bell and Smith, 1980; Longwell et al., 1965). The deposits of the Muddy Creek Formation are generally coarser grained near the mountains and become progressively finer grained toward the center of the valleys (Longwell et al., 1965).

The top of the Muddy Creek Formation is not well defined in the Las Vegas Valley and several interpretations exist regarding the depth of its upper contact. Early interpretation of driller's logs placed the upper contact at a depth ranging from ground surface in the southern part of the valley to more than 1,000 feet below ground surface at Las Vegas (Domenico et al., 1964; Mindling, 1965; Malmberg, 1965). Several other authors, including Bell and Smith (1980), Longwell et al., (1965), and Dinger (1977), suggest that some of the alluvial fans in the valley may be pediments consisting of coarse-grained Muddy Creek Formation overlain by a thin veneer of younger alluvium. These interpretations suggest that sediments of the Muddy Creek Formation might be at or near ground surface in much of the Las Vegas Valley.

<u>Younger Tertiary and Quaternary Basin Fill Deposits</u>

Quaternary age gravel, sand, silt, and clay deposits, and Tertiary and Quaternary conglomerates with a combined thickness of as much as 1000 feet overlie the Muddy Creek Formation in Las Vegas Valley (Bell, 1981). These deposits contain abundant carbonate clasts and consist of units of predominantly coarse-grained deposits, units of predominantly fine-grained deposits, and thinly bedded units of interbedded coarse- and fine-grained deposits.

Coarse-grained deposits generally occur on alluvial fans and pediments near the valley margins and along Las Vegas Wash. Most of the deposits are Quaternary in age and consist of poorly sorted, unconsolidated to cemented gravel and sandy gravel on alluvial fan pediments, and fine sand along Las Vegas Wash (Haynes, 1967; Bingler, 1977; Dinger, 1977; Bell and Smith, 1980). In the Henderson area, sand along Las Vegas Wash is less than ten feet thick, and coarse-grained deposits on alluvial fans and pediments are generally less than 30 feet thick (Bell and Smith, 1980).

The northwest and north-central parts of the Las Vegas Valley are underlain by fine-grained deposits of white to light brown sandy silt and mudstone that range in age from 14,000 to 30,000 years (Haynes, 1967). Longwell et al., (1965) named these deposits the Las Vegas Formation. The formation was originally thought to have been deposited in a lacustrine environment (Longwell and others, 1965; Haynes, 1967); however, more recent evidence suggests that the formation was deposited within a playa, possibly one with localized marshes (Mifflin and Wheat, 1979).

The valley floor is composed of alluvial silt, sand, and gravel and lacustrine mudstone beds interfingered with alluvial fan sediments (Haynes, 1967). These light-colored heterogeneous deposits consist of a mixture of coarse and fine-grained material that includes silty fine sand and interbedded silt, sand, and gravel.

5.1.3 Geologic Structure

Major orogenic activity in southern Nevada began in Cretaceous time and continued into Tertiary time. Geologic units were folded and offset by thrust faulting during the late Mesozoic and by normal and strike-slip faults during the Miocene and Pliocene (Plume, 1984). In addition, a series of low-angle extensional "detachment" faults began forming in Miocene time. These "detachment" faults are locally present in the mountain ranges surrounding the project site (Longwell et al., 1965; Guth, 1981; Wernicke et al., 1984; Guth, 1988). The valleys in the site region were created by this extension and were subsequently infilled with Miocene and younger age clastic deposits. Displacement on several of the mountain-bounding faults has continued into the late Pleistocene. Several of the major faults and surficial structures in the project region are discussed in the following paragraphs and are shown on Figures 5-3 and 5-4.

5.1.3.1 Frenchman Mountain Fault

The generally north-south trending Frenchman Mountain fault bounds the eastern side of Las Vegas Valley (Figure 5-4). It separates basin fill deposits to the west from the basement rocks exposed on Frenchman and Sunrise mountains. Several fault scarps in Quaternary alluvial deposits are present along the mapped trace of the fault, especially near its northern terminus (Matti and Morton, 1982). The Frenchman Mountain fault has been active since middle Miocene time when right lateral strike-slip was the principal motion on the fault. From late Miocene through late Pleistocene time normal movement has been dominant, causing down drop of the basin with respect to the mountains (Bell, 1981). This steeply dipping fault is approximately 14 miles long and can be subdivided into two segments. The northern nine miles of the Frenchman Mountain fault is a north-south trending normal fault (Matti and Morton, 1982). The southern five miles of the Frenchman Mountain fault trends northwest-southeast and exhibits evidence for right lateral strike-slip movement. The fault displaces alluvial deposits of probable late Pleistocene age (Bell and Smith, 1980). The Frenchman Mountain fault is located approximately two miles from the nearest proposed flood control facility.

5.1.3.2 Las Vegas Valley Shear Zone

The Las Vegas Valley shear zone is a northwest-trending major structural zone (Figure 5-3). Deviation and oroflexural bending of structural features near the shear zone relative to the regional trend suggest offset by both right lateral strike-slip faulting and block rotation. Isopach studies along the shear zone indicate right-lateral displacement of 17-19 miles, although deviation of structural features from the regional trend suggests displacement may have been as much as 45 miles (Fleck, 1970). The Las Vegas Valley shear zone has a possible length of about 65 miles within the Las Vegas Valley. Although the shear zone is not known to exist northwest of the valley, rocks in that area are also strongly flexed in a right bend (Longwell et al., 1965; Bohannon, 1979). The Las Vegas Valley shear zone is not known to extend to the southeast further than the Lake Mead area.

Geologic structures in strata along the shear zone which is 15 million years (m.y.) in age are rotated amounts equal to those in Paleozoic strata, indicating a Miocene or younger age for the shear zone. Volcanic rocks overlying and undeformed by the shear zone, have been dated at 10.7 m.y. (Bohannon, 1984). Consequently movement on the shear zone appears to have occurred during a 5-7 m.y. period in late Miocene and early Pliocene time.

5.1.3.3 Lake Mead Fault System

The Lake Mead fault system is a series of generally southwest-northeast trending faults (Figure 5-3). These faults exhibit demonstrable left-slip or well-developed left-separation and fault drag. This fault system extends northeast from beneath the alluvium of southern Las Vegas Valley to the Virgin River Valley. The location of the fault system northeast of the Virgin River Valley is uncertain, but it may continue north beneath the alluvium of the Virgin River Valley into southwestern Utah (Bohannon, 1984). The Lake Mead fault system has offset several geologic features of Miocene age by as much as 40 miles (Bohannon, 1984). This fault system was active during the same time period as the Las Vegas Valley shear zone and the two fault zones probably interacted within a large region of coeval crustal extension in the Lake Mead region (Bohannon, 1984). The Lake Mead fault system is not currently believed to be potentially active (Bohannon, 1989).

5.1.3.4 Valley-Fill Faults

The geologic structure within the Plio-Pleistocene age basin fill deposits in the Las Vegas Valley is characterized by a series of generally north-south trending faults (Figure 5-4). These linear and curvilinear escarpments are typically termed "compaction faults" (Bell, 1981; Maxey and Jameson, 1948). Several major escarpments cross the central valley floor. These escarpments are as much as 100-feet high, range in length from one to ten miles, and are up to one-half mile wide due to erosion and scarp retreat (Bell, 1981). Consequently the escarpment base may not actually mark the original fault trace. Short, discontinuous segments are probably part of longer, formerly continuous features that have been considerably modified by erosion (Bell, 1981). All of these escarpments, except those flanking Frenchman Mountain, exhibit movement down to the east and many occur en echelon. Displacement across some of these faults is reported to be as much as 150 feet (Maxey and Jameson, 1948) to 200 feet (Domenico et al., 1964).

Faulting within basin fill in the project area has generally been attributed to differential compaction and consolidation of basin fill sediments due to natural and induced dewatering (Bell, 1981). However, the origin of these structures is still controversial. The magnitude of displacement is greater than what could have been achieved through differential compaction and some of these faults are currently believed to have a tectonic origin. The trend of these faults closely parallels the bedrock structure in the surrounding mountain ranges and some of the faults do not coincide with subsurface lithologic changes (Bell, 1981). Interpreted bedrock depths from gravity profiles across the fault scarps by the U.S. Geological Survey (Bell, 1981) suggest that basement faults occur beneath some scarps. Large displacements observed in the field, along with the extremely large artesian pressure declines as great as 180 feet, indicate that faulting has been due to a combination of compaction and tectonic activities (Bell, 1981).

Several major escarpments of possible tectonic origin in Las Vegas Valley have been identified, including those designated by Conwell (1965) as Scarps I, II, and III and the Eglington Scarp (Haynes, 1967, Figure 5-4). These escarpments are located in the northern and central areas of the valley and are shown on Figure 5-4. Scarps I, II, and III are approximately six, nine, and five miles long respectively. These faults displace valley-fill deposits of late to middle Pleistocene age (Weide, 1982; Bell, 1981). The Eglington Scarp is approximately six miles long and is believed to be tectonic since the fault appears to displace only coarse grained alluvial-fan deposits (Haynes, 1967). Tufa outcrops along the Eglington Scarp dated by Haynes (1967) at approximately 13,500 years ago may date a period of faulting in the scarp area.

In addition, a series of major north-northwest trending en echelon escarpments are present in the Whitney Mesa area in the south-central portion of the Las Vegas Valley and are herein referred to as the Whitney Mesa fault zone. Several of these faults are believed to be of tectonic origin (Bell, 1978). The Whitney Mesa fault zone has a total length of approximately 9 miles and displaces valley-fill deposits of middle to late Pleistocene age (Bell, 1978). Undisturbed deposits, possibly greater than 0.5 m.y. old, overlie the faults in the Whitney Mesa area (Bingler, 1977; Bell, 1978, 1981).

5.1.3.5 Fissures

Earth fissures occur at several locations in the Las Vegas Valley (Figure 5-4). Fissures are cracks in the soil which have been widened and deepened by erosional processes. They commonly have dimensions of as much as six feet wide and nine feet deep. These usually short, discontinuous features may link to form a single, semi-continuous crack as much as one-half mile long (Bell, 1981). Bell (1981) indicates the fissures originate as tensional fractures at some depth below the ground surface. The tensile stresses responsible for fracturing may originate from surface flexure related to subsidence, from dewatering of sediments, or from lateral migration of ground water. Subsurface infiltration of water causes subsequent erosion of the fissures and eventually may cause slumping of wall material and collapse of overlying sediments. In the Las Vegas Valley, fissures are proximal to high yield ground-water extraction wells and "compaction" subsidence faults. It is likely that fissure development is directly related to these faults and to ground-water extraction.

5.1.4 Seismicity and Historic Earthquakes

The southern Great Basin has a relatively low level of historic seismicity in comparison to the central and northern portions of the Great Basin. The major seismo-tectonic faults and structural zones in the site region are shown on Figure 5-5. Historical seismicity for the southern Great Basin from September 4, 1868 through July 29, 1978 is shown on Figure 5-6. Most of the earthquakes shown on this figure were recorded subsequent to 1956. The increased recorded seismicity is due in part to underground nuclear testing at the Nevada Test Site (NTS) and an increase in the number of seismograph stations in the southern Great Basin which allow detection of lower magnitude events (Meremonte and Rogers, 1987). Since 1979, a 47-station seismic network has been operated by the U.S. Geological Survey to locate and study earthquakes in the vicinity of the NTS (Rogers et al., 1987). The pattern of regional seismicity recorded between 1978 and 1986 does not differ significantly from the pre-1978 seismicity (Harmsen and Rogers, 1987; Rogers et al., 1987).

Historic seismicity in the project region is characterized by earthquakes with M_L magnitudes of less than 4.0. Areas of relatively high seismicity include an east-west trending zone between latitude 36^oN and 38^oN and the Lake Mead area. The east-west trending zone is in part due to nuclear testing at the NTS but also is related to a number of naturally seismic subzones (Rogers et al., 1987). Seismicity in the Lake Mead area is in part induced as a result of filling Lake Mead (Rogers and Lee, 1976; Bohannon, 1989). Other areas of potentially significant seismicity include south of Lake Mead in the Eldorado Valley (Harmsen, 1988). The largest historical earthquake in the site region was the 1872

Owens Valley earthquake (M=7.8) which was located approximately 180 miles northwest of the site and caused extensive surface fault rupture (Figure 5-5). In addition, an earthquake with an estimated magnitude of approximately six occurred in Death Valley in 1908 (Meremonte and Rogers, 1987).

As discussed in Section 5.1.3, the potentially active Frenchman Mountain and Eglington faults are potentially significant near-source seismic sources. In addition, the following active and potentially active faults also have a potential to generate seismicity which could generate significant strong ground motion in the project area.

5.1.4.1 Southern Death Valley Fault Zone

The Southern Death Valley fault zone, located approximately 80 miles west of the project area, is a northwest trending, two-mile wide fault zone composed of two major faults and numerous folds and minor faults (Stamm, 1986). Matching of an offset alluvial fan gravel with its source area indicates 12-22 miles of right lateral strike-slip movement on the southern Death Valley fault zone during the last 10-12 million years (Butler, 1986; Wright, 1988). Most of this slip took place prior to 0.9 million years ago along the western most traces of the fault zone. During the last 0.9 million years, eastern fault traces have been active and are characterized by dominantly normal slip, with a lateral component of only a few hundred meters. This recent movement has resulted in normal faults and tight isoclinal folds that have uplifted fan gravel and lacustrine sediments as much as 100 meters above the modern alluvial fan surface. The average lateral-slip rate along the Southern Death Valley fault zone was two to three km per million years prior to 0.9 million years ago but has been an order of magnitude less during the last 0.9 million years. The observed differences in slip rates for the eastern and western subzones is probably related to interaction with the eastern termination, of the left-lateral Garlock fault zone, located about a mile south of the Death Valley fault zone (Butler, 1986).

5.1.4.2 Death Valley-Furnace Creek Fault Zone

The Death Valley-Furnace Creek Fault zone is a northwest-trending right-lateral fault zone which occupies the depression formed by northern Death Valley and Furnace Creek Wash and probably terminates in Fish Lake Valley to the northwest (Stewart, 1967; Albers, 1967). This fault zone is located approximately 100 miles northwest of the project area. This Quaternary fault zone is approximately 100 miles long (Wright and Troxel, 1967; Jennings, 1975). Estimates of the amount of right lateral displacement along the zone differ widely. A limit of several miles of total right lateral displacement has been suggested by Wright and Troxel (1967, 1970), while Stewart (1967) and McKee (1968) propose displacements of as much as 50 and 30 miles respectively.

McKee (1968) proposes that the Death Valley-Furnace Creek fault zone has been active since Middle Jurassic time and that, based on reconstruction of a Pliocene drainage system, there may have been 3,000 feet of right-lateral offset since that time. Wright and Troxel (1970) suggest that it is possible that right-lateral displacement along the fault zone may become greater northwestward along the fault zone, and that although little offset exists at the southeast end of the fault zone, an offset of 10 to 20 miles is possible and could be attributed to differential extension on opposite sides of the fault zone. As discussed in Section 5.1.3, the potentially active Frenchman Mountain and Eglington faults are the most influential seismic sources to the proposed flood control facilities.

5.1.4.3 Pahranagat Shear Zone

The Pahranagat Shear Zone is a northeast trending fault zone which exhibits left-lateral strike-slip displacement of Miocene age volcanic rocks (Ekren et al., 1977). This fault zone is located approximately 55 miles north of the northern boundary of the project area (Figure 5-5). Alluvial deposits of Quaternary age are displaced by the faults within this zone (Rogers et al., 1987). Historic seismicity with a magnitude of 5+ has occurred along this fault (Figure 5-6) and the fault zone is currently seismically active (Rogers et al., 1987).

5.1.5 Soils

Soils in the Las Vegas Valley are generally composed of loamy gravels, aeolian sands, and fine grained silts and clays (Table 5-1; Speck, 1980). Characteristics of soils in the Las Vegas Valley and Boulder City areas which are pertinent to this project are summarized on Table 5-1. The information in this table and the following sections were summarized from the soil survey of Las Vegas Valley area, Nevada (Speck, 1980). The primary source of soil material is bedrock exposed in nearby mountain ranges. Soil development ranges from thin soils with minor development of pedogenic soil horizons to stratified soils with well developed subsoils and accumulations of calcium carbonate (caliche deposits). Desert pavement, consisting of a residual concentration of closely packed pebbles and rock fragments on the ground surface mantles much of the area. Soils in the project area are typically susceptible to slight water erosion except on steep slopes along the banks of channels or areas where the soils have been disturbed by grading. Susceptibility of soils to wind erosion is high; especially when protective desert pavement is removed exposing soils which are easily mobilized and dispersed by wind. Wind erosion is a primary concern in the Las Vegas Valley where strong, turbulent winds are common.

Soils surrounding Boulder City are primarily deposited on recent and relict alluvial fans in the north and on extensive, several feet thick sand sheets in the south (Bell and Smith, 1980). Sand sheets are formed from aeolian sands deposited on pluvial lake beaches. Rock outcrops with very shallow soils or no soils are abundant, especially to the northwest and northeast of Boulder City. Soils deposited on alluvial fans are generally deep and consist of gravelly fine sandy loams. Fine sandy loams with no associated gravels are typically found on the sand sheets. The Boulder City area is subject to weaker winds than those which occur in the Las Vegas Valley (Ayres, 1989).

Limiting factors for successful soil reclamation include soil depth, percentage of rock fragments, salinity, alkalinity, low available water capacity, and slope. Soils filled with cobbles prove difficult to grade and those with a desert pavement may be subject to erosion when the pavement is disturbed. The salinity and alkalinity of the soils may inhibit plant re-establishment. Many of the soils have a low available water capacity (droughty) requiring frequent irrigation if vegetation is going to be established on disturbed soils. Steep slopes create problems for soil stability, especially if the soils are disturbed (Table 5-1).

5.1.5.1 Origin and Composition

Soils in the Las Vegas Valley range from gravelly, cobble-filled soils at the edges of the basin to fine grained silty to clayey loams toward the valley's center. Steep slopes and shallow soils predominate at the edges of the valley and rock outcrops are common in and near the mountains. Deep soils abut the mountains to the east and north of Las Vegas Valley, whereas shallow soils are found over much of the western half of the basin. Soils on alluvial fans contain pebbles and cobbles derived from proximal mountains. Therefore soils near the eastern, western, and northeastern edges of the valley have abundant calcareous cobbles, whereas those in the southern part of the valley are mostly volcanic.

Soils in the Boulder City area are generally coarser northward. They change from fine sandy loams in the Eldorado Valley vicinity to gravely sand loams near the McCullough and River mountains. Soils are principally derived from the proximal ranges and exposed bedrock in the Boulder City area, and contain between 10 and 35 percent rock fragments.

Dissolution and redeposition of carbonate material in the soils has resulted in a calcareous hardpan (caliche) over much of the project area (Figure 5-7). Soils in the southern part of the Las Vegas Valley, where gravels are primarily volcanic, also have some calcium carbonate cementation. The influx of carbonate in the south is probably due to aeolian transport of material from the carbonate-rich soils in other portions of the valley. In the central part of the Las Vegas Valley, the alluvial flats are covered by very deep, silty, gypsum-rich soils (Figure 5-7). The gypsum is probably transported to the valley in fluids percolating through gypsum rich rocks in mountains to the east. Gypsum precipitates in the valley soils as the water evaporates (Cibor, 1983). Calcium carbonate cementation is weakly to strongly developed in Boulder City soils. Although some gypsum rich soils (Aztec) are located in the Boulder City project area, none directly underlie the proposed facilities.

5.1.5.2 Mapped Soil Units

<u>Hills and Mountains</u>

Soils formed on hills and side slopes of mountains, generally above 2,000 feet elevation, include the Akela, St. Thomas, and Hobog soils. These soils are shallow to very shallow and well drained. Rock outcrop is abundant and usually the soils are thin and poorly developed. These soils are directly derived from the nearby bedrock and contain abundant rock fragment characteristic of parent rock materials. In the south, the rock fragments are predominantly porous volcanics, whereas to the east, west and northeast igneous and metamorphic rocks fragments as well as limestones and dolomite fragments predominate. These cobbly, gravelly, and loamy soils are usually covered with rock fragments similar in lithology to the cobbles in the underlying soils. Slopes vary from 5 to 50 percent. Reclamation of soils found on hills and mountains is commonly difficult because these soils tend to have a low available water capacity and contain small or large stones throughout. In addition, soils may be unstable on steep slopes.

<u>Erosional Fans (Fan Remnants)</u>

Soils located on erosional fans include the Aztec, Destazo, Goodsprings, Grapevine, Knob Hill, Pittman, Tencee and Weiser soils. The shallow to very shallow soils (Aztec, Destazo, Grapevine, Knob Hill, Pittman, and Weiser) are well drained to somewhat excessively drained. The surface layer is generally extremely stony or gravelly with 70-90 percent of the surface area covered with rock fragments or hardpan pebbles. Below the surface, the soils vary from gravelly loam to fine sandy loam. The gravels and stones are derived from nearby mountain ranges and are characteristic of parent rock materials. In the south, these deposits are composed of predominantly porous volcanic material, whereas to the east, west, and northeast these deposits are derived from igneous and metamorphic rocks as well as limestone and dolomite. Locally, a caliche horizon is developed in the Goodsprings and Tencee soils. Gypsum-rich soils include the Grapevine and Weiser units. Slopes are shallow to moderate (generally between zero and eight percent) except for the Aztec soils which may be on slopes as steep as 30 percent, and the Destazo soils which are locally found on slopes up to 15 percent.

Reclamation is generally difficult for all soils on erosional fans because these soils are extremely stony and gravelly, except for the Grapevine and Knob Hill soils. Knob Hill soils are droughty but irrigation makes them easily reclaimable. Grapevine soils generally present no reclamation problems. In addition, the Aztec soils have steep slopes and the Weiser soils are droughty.

<u>Erosional Flats, Dissected Piedmonts, and Basin Floor Remnants</u>

Soils characteristic of erosional flats, dissected piedmonts, and basin floor remnants include Bracken, Caliza, Casaga, Cave, Destazo, Grapevine, Las Vegas, Nickel, and Pittman. All but the Cave and Las Vegas soils are deep to very deep soils that are well drained to somewhat excessively drained.

The Cave and Las Vegas are shallow to very shallow and are also well drained soils. These soils consist of fine sandy loam with some gravelly fine sandy loam. The soils are locally stratified with a well developed subsoil. Accumulations of calcium carbonate are common in Caliza, Cave, and Las Vegas soils, and gypsum occurs in Bracken, Casaga, and Grapevine soils. Slopes are generally between zero and eight percent except for the Aztec and Bracken soils, which may be located on slopes as great as 30 percent, and the Destazo and Nickel soils locally occur on slopes of up to 15 percent.

All soils formed on erosional flats, piedmonts, and basin floor remnants present severe reclamation problems except for the Grapevine soils. The Bracken, Caliza, Cave, Destazo, Nickel, and Pittman soils all contain small or large stones and the Bracken and Nickel soils are also quite droughty. Casaga and Las Vegas soils contain excess salts and high sodium concentrations.

<u>Recent Alluvial Fans, Inset Fans, and Channels</u>

Soils on recent alluvial fans and inset fans include Arizo, Canutio, Dalian, Jean, McCullough, and Paradise soils. These soils are deep to very deep, generally excessively drained, and consist of fine sandy loam to silty loam with some stratification. Accumulation of calcium carbonate has created a caliche horizon in the Canutio soil. Ariso soils contain abundant Gypsum. All of these soils are located on nearly level to moderate slopes (zero to eight percent) with the exception of Canutio soils which may be found on fairly steep slopes (0 to 30 percent). Much (40 to 65 percent) of the soil surface is covered by rock fragments originally derived from the nearby basin flanking mountains.

The Arizo, Canutio, Dalian, and Jean soils have a low available water capacity and contain small stones, therefore reclamation is difficult. The Canutio soils present moderate reclamation difficulties because they are droughty and contain fewer small stones than the Arizo, Canutio, Dalian, and Jean soils..

<u>Recent and Relict Alluvian Flats, Flood Plains, Fan Piedmonts</u>

The Bluepoint, Glencarb, Land, McCarran, Skyhaven, and Spring soils are deposited on recent and relict alluvial flats, flood plains, and fan piedmonts. These deep to very deep soils are well drained to somewhat excessively drained. These soils are composed of silty clay loam (Glencarb, Land, Spring), fine sandy loam (Bluepoint), and cobbly fine sandy loam (McCarran). The Land, Spring, and McCarran soils contain abundant gypsum and sodium sulfate. The Land soil type formed as a gypsiferous lacustrine sediment while salt in the other soils is derived from dissolution of gypsiferous sediments in mountainous areas to the east, transport, and deposition. The Skyhaven soil contains a well developed caliche horizon. Slopes range from 0 to 8 percent for all soils but the Bluepoint soils which are found on slopes as steep as 15 percent.

The primary constraint to reclamation of soils formed on alluvial flats, flood plains, and fan piedmonts is excess salts. The Glencarb, Land, McCarran, Skyhaven, and Spring soils are all salt-rich. In addition, the Glencarb and McCarran soils are droughty and contain small stones. Reclamation of the Bluepoint soils is moderately difficult because small stones are present. The soils are droughty and commonly deposited on moderate slopes.

5.1.6 Mineral Resources

The primary mineral resource in the project area is sand and gravel. The mining and processing of these nonmetallic minerals exceeds that of the mineral resources located in surrounding mountain ranges in both tonnage and value (Longwell et al., 1965). Deposits of sand and gravel are used as construction and building material in the Las Vegas Valley and are also exported, primarily to Southern

California. This material is principally derived from alluvium and alluvial fans of recent and possible Pleistocene age within the Valley. Locations of known gravel pits are shown on Figure 5-7.

Gypsum deposits are abundant in the project area and several of these deposits have been mined since the early 1900's. Locations that have produced small quantities of gypsum, but are no longer mined include the North and East Rainbow Gardens, the White Eagle, Arden, and Bard Mines (Papke, 1987). The Apex and Blue Diamond Mines, located within the project area, currently produce large quantities of calcined gypsum, most of which is used to manufacture wallboard. The Apex Mine, located in the northeast corner of the project area, is owned by Pacific Coast Building Materials and provides gypsum from the Muddy Creek formation. The Blue Diamond Mine, located near the southwest corner of the project area, is owned by Genstar Gypsum Products and produces gypsum from the Kaibab limestone. Reserves at this location are quite large (Papke, 1987).

Sporadic patches and veins of potash and iron alum in lightly altered flows are reported in several areas one mile west and three miles east of Boulder City (Longwell et al., 1965). These reserves, scarcely 100 acres in total extent, were considered by Longwell to be too small to warrant development.

Numerous oil and gas wells have been drilled in the project area, but none have become producers (Longwell et al., 1965) and most wells are currently abandoned (Garside et al., 1988). First exploration began in the late 1920s and some sporadic drilling occurred in the 1940s. More serious exploration efforts began in 1950 when exploration throughout Nevada increased significantly. Although a number of these exploration wells have reported oil shows, the lack of a discovery resulted in few wells being drilled in Clark County until the early 1980s. Some of these recent wells were drilled to investigate the possibility of "overthrust belt" oil fields, although none of these were successful (Garside et al., 1988).

5.2 POTENTIAL GEOLOGIC HAZARDS

5.2.1 Strong Ground Motion

The seismotectonic setting and historic seismicity of the project are discussed in Section 5.1.4. The project area is located in a tectonically active area that can be expected to experience seismicity and resulting strong ground motion during the lifetime of the proposed project. Possible sources include moderate earthquakes ($5<M<6$) from local potentially active faults such as the Frenchman Mountain and Eglington faults or more distant large magnitude ($M>6$) earthquakes on major fault zones such as the Southern Death Valley and Death Valley-Furnace Creek faults (Figure 5-5).

The term maximum credible earthquake (MCE) is defined as the largest earthquake than a fault or fault zone can reasonably be expected to generate. A MCE in the project area was estimated assuming a nine mile rupture length for the Frenchman Mountain fault and a six mile rupture length along the Eglington scarp. These rupture lengths were based on portions of the mapped length of these faults which are characterized by similar styles of displacement and along which late Pleistocene deposits are displaced (Bell, 1981; Converse Consultants, 1985; Wele, 1989). There is currently no evidence to suggest that these entire fault lengths have ruptured in a single event. Therefore, we consider these estimates to be conservative. Empirical relationships by Bonilla et al., (1984) and Slemmons (1982) based on historical earthquakes, were used to estimate on earthquake magnitude for these rupture lengths. The relationships based on data from events on normal faults and North American events on all fault types yielded magnitudes ranging from 6.4 to 6.6 for the Frenchman Mountain fault and 6.2 to 6.4 for the Eglington fault. Based on these estimates and our professional judgement, a reasonable magnitude for the MCE on these faults is 6.5 and 6.25, respectively. The probability of an MCE occurring on either the Frenchman Mountain or Eglington faults during the project lifetime is very low.

The distance of the closest and furthest proposed flood control facility to the Frenchman Mountain or Eglington faults are zero and 22 miles and zero and 29 miles respectively. Based on these distances and attenuation relationships by Donovan and Becker (1986), the estimated peak ground accelerations associated with MCE's on these faults are on the order of 0.1 to 0.5g depending on the distance from a particular facility. These estimated ground accelerations represent a worst case incident.

As discussed in Section 5.1.4, other potential seismic sources which might yield larger earthquakes are present in the project region. However, the expected ground accelerations at proposed flood control facilities associated with MCE's on these faults would probably be less due to the greater distance of these sources from the project area.

The project area is situated within Uniform Building Code (UBC) seismic zone 2B according to the 1988 edition of the code. The UBC for seismic zone 2B recommends that structures be designed using an estimated peak ground acceleration of greater than 0.1 g and less than 0.2 g.

5.2.2 Surface Fault Rupture

As discussed in section 5.1.3, several potential sources of ground surface rupture have been identified in the project area. The primary sources of surface rupture are potentially active tectonic faults. Compaction faults and subsidence related fissures are discussed in Section 5.2.4. Surface displacement could cause significant damage to structures situated on or directly adjacent to these areas.

The Frenchman Mountain and Eglington faults are potentially active faults of tectonic origin. Based on available data, the probability of surface fault rupture or reactivation of faults by ground-water extraction along mapped traces of these faults is considered to be low during the project lifetime.

The Frenchman Mountain fault is a potentially active fault of tectonic origin. Other structures within the project area, such as the Eglington scarp, are likely a result of tectonic forces and differential compaction (Bell, 1981). Because scarps associated with the Frenchman Mountain fault are present in late Pleistocene alluvium (Converse Consultants, 1985; Wele, 1989) and because movement along the Eglington Scarp is believed to have occurred about 14,000 years ago (Haynes, 1967), these faults are considered to be potentially active. Based on available data, the probability of tectonic surface fault rupture along mapped traces of these faults is considered to be low.

5.2.3 Slope Instability

Areas with potential serious slope instability problems, such as major known landslide terrains, have not been identified in the project area. The proposed facilities are generally located in gently sloping areas with no mapped landslides. The potential for minor slope instability exists along valley fill-fault scarps described in Sections 5.1.3 and 5.2.2 and on side slopes of incised drainage channels.

5.2.4 Subsidence

Subsidence commonly occurs as a result or a decrease in hydrostatic pressure due to extraction of ground water. Subsidence can also result from differential compaction of soils. These processes may result in the formation of small scale topographic changes, fault scarps, and zones of fissuring.

Subsidence may result in significant settlements of soils that may potentially adversely affect structures supported on them.

Scarps I, II, and III, and other smaller valley-fill faults (Figure 5-4) may be attributable to both tectonics and differential compaction; however, movement along these scarps is believed to have taken place in the middle to late Pleistocene (Bell, 1978, 1981). Therefore, these faults are not considered to be potentially active, although reactivation by ground-water extraction is possible. Subsidence also occurs across the Eglington fault, a potentially active fault believed to be of tectonic origin.

A leveling study across fault scarps in the Las Vegas Valley was conducted from 1978 to 1987 (Varnum, 1987). Results of this study indicated that differential movement as great as 1.26 feet across a distance of about 2,000 feet had occurred across some of the scarps. Differential movement as great as 0.39 feet across a distance of about 250 feet had occurred across the Eglington scarp during the study. The differential movement is thought to be controlled by local subsidence, regardless of the pre-existing fault movements. It is thought that these vertical movements are accommodated by extension and warping over large areas rather than discrete displacement of near-surface sediments (Varnum, 1987). In addition, ground-water extraction in these areas is decreasing (Brothers and Katzer, 1988), therefore subsidence due to ground rupture due to renewed movement on these faults is considered to be low.

Fissuring associated with differential subsidence on or near fault scarps in the valley fill has caused damage to structures (Bell, 1981; Converse Consultants, 1985). Fissures may measure up to six feet deep and nine feet wide and they may link to form semi-continuous cracks up to a half mile long. Fissures typically originate as fractures at some depth beneath the ground surface, and continued infiltration of water and erosion of the crack walls causes an increase in fissure dimensions (Bell, 1989). This process may lead to well developed fissures beneath an apparently coherent ground surface. The known areas of fissuring are shown on Figure 5-4.

5.2.5 Expansive Soils

Expansive soils are earth materials with relatively high percentages of expandable clay materials (such as montmorillonite or illite) which are prone to volumetric changes due to variation in water content. These volumetric changes in foundation materials composed of expansive soils can cause differential movements of surficial materials, which present a potential hazard to engineered structures founded on such material. Expansive soils are common in the city of Las Vegas (Cibor, 1983) and several mapped soil units, including the Casaga, Glencarb, Land, Spring, Las Vegas, and Skyhaven soils, which are located in the central and eastern part of the valley, contain significant quantities of clay, and have a potential for expansion which can cause damage to structures. Mapped soil units in the Boulder City area are not clay rich (Speck, 1980).

Soils which are susceptible to salt heave (chemical heave) are also present in the project area. Salt heave generally occurs in fine-grained soils with at least 15 percent clay and which contain 0.2 percent or more soluble sodium sulfate salts (Converse Consultants, 1985). At temperatures less than 55^{O}F, these salts hydrate. Alternating cycles of warm and cool temperatures cause alternating cycles of salt dissolution and recrystallization that results in increasing salt concentrations as moisture is drawn into the hydration cycle. Damage may occur when soils supporting light loads are exposed to significant temperature changes. Because these salts are highly soluble, they are most likely to occur where drainage is poor. Sodium sulfate soils are known to be present in an area parallel to and along the northeast side of Boulder Highway from north of Lake Mead Drive to south of Las Vegas Boulevard and in a smaller area southwest of Boulder Highway (Cibor, 1983).

5.2.6 Collapsing Soils (Hydrocompaction)

Hydrocompaction is a phenomenon typically associated with granular soils where the loose, dry structure of the sand grains, held together by clay binder or other cementing agent, collapses upon introduction of water. Soil collapse may result in significant settlements that could adversely affect structures supported by these soils.

Soils which are subject to hydrocompaction in the project area include porous, unconsolidated silty clay and clayey silt that are typically found in the Lower valley elevations and are generally concentrated in the eastern portion of Las Vegas Valley.

Thick gypsiferous soils are common in the project area and are also susceptible to hydrocompaction. Hydrocompaction can occur when the gypsum dissolves, creating voids accompanied by a corresponding loss of shear strength and an increase in compressibility. Gypsum rich soils (Arizo, Aztec, Bracken, and McCarran) are located primarily in the central and eastern parts of the Las Vegas Valley. Areas where gypsum-bearing soils are present are shown on Figure 5-7. No highly gypsypherous soil units are located in the Boulder City area (Speck, 1980).

5.2.7 Liquefaction

Soil liquefaction is a process by which the shear strength of granular, saturated soils is reduced due to an increase in pore pressure during seismic shaking. Requisite conditions for liquefaction to occur include saturated granular soils with a loose packed grain structure capable of progressive rearrangement of soil grains during repeated cycles of seismic loading.

Soils in the Las Vegas Valley are generally not known to be loose (Converse Consultants, 1985), and are generally not considered to have a high liquefaction potential. However, liquefaction may be a potential hazard in areas of the Las Vegas Valley underlain by a shallow water table if loose soils are locally present. Ground water in the Boulder City area occurs at depths greater than 300 feet bgs (Anderson, 1977).

5.2.8 Erosion and Sedimentation

Potential erosion and deposition hazards within the project area occur by sheet flow, channel erosion, and sedimentation during and after heavy rains, and wind erosion. Soils in the project area are generally slightly susceptible to water erosion (Speck, 1980). The low precipitation in the project area minimizes the potential for sheet flow erosion; however, channels are susceptible to erosion and bank degradation during high intensity floods. Incised channels are common in the central and northern subareas. Bank erosion in the Lower Las Vegas Wash is of particular concern.

Deposition of sediment typically occurs as debris flows or in response to a decrease in velocity during surface flow in channels. Debris flows occur within alluvial fans near the mountain fronts and typically occur during a high intensity rain storm event (Weide, 1982). Sedimentation typically occurs near the base of surrounding mountain ranges, on active alluvial fans, and within drainage channels.

In addition, subsidence related fissures (see Section 5.2.4) may be greatly exaggerated by erosion (Bell, 1981). Fissures originate as small tension cracks which may or may not extend to the surface. Subsurface runoff and infiltration enlarge the crack through subsurface piping. As piping continues, fissures appear at the surface and enlarge as the tunnel roof collapses. Enlargement continues as fissure walls are widened and extensive slumping and side-stream gullying occur. Fissures eventually may become filled with slump and runoff debris, but may become reactivated upon renewal of tensile stress (Bell, 1981).

Soils in the project area are highly susceptible to wind erosion (Speck, 1980). Winds in the project area are strongest in the central portion of the alluvial valleys and weaker near the mountain ranges.

5.2.9 Potential Geologic Constraints

5.2.9.1 Caliche

Caliche is not a geologic hazard, but may be considered a geologic constraint because it can be difficult to excavate and when excavated may occur as large, rock-like chunks. Caliche is a rock-like material that occurs discontinuously in alluvial deposits throughout the Las Vegas Valley and Boulder City areas. Caliche deposits vary in thickness, hardness, and lateral extent. Presence of caliche in construction areas may result in increased expense of excavation, vibration damage caused by excavation methods, and construction delay.

5.2.9.2 Corrosion

Evaporite deposits, including gypsum and sodium sulfate salts, occur throughout the project area. Some types of cement and reinforcing steel are particularly susceptible to corrosion by these deposits (Converse Consultants, 1985).

Corrosion by these deposits causes a molecular chemical change in concrete and metal which decreases their strength. Corrosive soils may cause damage to structures founded within or on them.

5.3. GEOLOGY OF SUBAREAS

5.3.1 Northern Las Vegas Valley

5.3.1.1 Geologic Units

Surficial geologic units in the Northern Las Vegas Valley subarea are composed primarily of Quaternary alluvium, fan deposits, consolidated sediments and Precambrian and Paleozoic bedrock (Matti and Morton, 1982; Bell, 1981; Longwell et al., 1965). The Quaternary deposits consist of late to Middle Pleistocene valley fill deposits and Holocene to late Pleistocene cemented fan deposits. These deposits occur over most of the subarea. The late to middle Pleistocene valley fill deposits are primarily composed of a mixture of interbedded lake silt, fluvial sand and gravel, buried eolian deposits, and sand to silt-size material deposited at the distal edges of alluvial fans. The Holocene to late Pleistocene fan deposits are primarily composed of a mixture of sand to boulder size material with as much as 3.5 feet of surficial calcium carbonate cementation (Weide, 1982).

Precambrian gneissic and granitic rocks and Paleozoic carbonate rocks (primarily limestone), shales, and sandstones occur near the eastern boundary of the subarea at the base of the Frenchman Mountains. Paleozoic sedimentary rocks occur near the western boundary of the subarea at the base of the Spring Mountains. These units are typically composed of limestone and dolomite with beds of sandstone, shale, and gypsum (Matti and Morton, 1982; Longwell et al., 1965).

5.3.1.2 Structure

Several escarpments are present near the southcentral boundary of the Northern Las Vegas subarea (Bell, 1981). The largest of these scarps is the Eglington scarp which extends six miles northeast from the vicinity of Alexander Road and Jones Boulevard (Figure 5-4). Displacement on this scarp is down to the east. The Eglington scarp is believed to be of tectonic origin and is believed to have formed about 14,000 years ago (Haynes, 1967). Several other small valley-fill faults are present along the southern boundary of the subarea, west of Nellis Air Force Base (Figure 5-4). These faults are generally one to two miles long and are downdropped to the east (Bell, 1981).

In addition to the valley-fill faults, the northern portion of the Frenchman Mountain fault is located near the eastern boundary of the northern subarea (Matti and Morton, 1982; Longwell et al., 1965; Stewart and Carlson, 1978) (Figure 5-4). Several lineaments and scarps in Quaternary alluvium are present near the northern end of this fault.

5.3.1.3 Soils

Soils in the Northern Las Vegas Valley subarea can be divided into three groups based on their geographic distribution and soil characteristics. In the western portion of the subarea soils occur on alluvial fan remnants (Speck, 1980). These soils consist of shallow and very shallow loamy soils and soil units include the Cave, Las Vegas, and Goodsprings soils. In the eastern portion of the subarea soils occur on alluvial flats and floodplains. These very deep, well drained silty soils include the Glencarb soil group. At the perimeter of the valley soils occur on fan remnants, fan skirts, and inset fans. These primarily gravelly and loamy soils are very deep and well drained and include the Weiser and Dalian soils.

The Glencarb, Cave, Las Vegas, and Goodsprings soils are susceptible to wind erosion (Speck, 1980). Removal of desert pavement increases susceptibility to wind erosion. The Cave, Las Vegas, and Goodsprings soils, located in the western part of the subarea, contain a thick carbonate layer.

5.3.2 Central Las Vegas Valley

5.3.2.1 Geologic Units

Surficial geologic units in the Central Las Vegas Valley subarea are composed primarily of Quarternary alluvium, consolidated sediments, and Paleozoic sedimentary rocks (Matti, et al., 1987; Longwell et al., 1965). Quaternary alluvial deposits occur over most of the subarea and generally consist of alluvium of active washes, older alluvial fans, and consolidated sediments. Alluvium of active washes is typically unconsolidated sand to pebble to cobble gravel locally cemented by petrocalcic carbonate and detrital gypsum. Older alluvial fan deposits are typically composed of moderate to well consolidated, locally cemented pebble to small cobble gravel with some pebble-bearing sand. Localized petrocalcic horizons at or near the surface are common. Consolidated sediments are typically composed of moderate to well consolidated, fine sand interstratified with silt, pebbly sand, pebble to small cobble gravel, and clay. Fibrous and encrusting gypsum and strongly cemented layers of carbonate are common throughout the unit.

Paleozoic sedimentary rocks occur near the western boundary of the subarea at the base of the Spring Mountains. These units are typically composed of limestone and dolomite with beds of sandstone, shale, and gypsum.

5.3.2.2 Structure

Numerous north-northeast trending valley-fill faults, including Scarps I, II, and III (Figure 5-4), occur in the eastern half of the central subarea. These faults, which range in length from one to nine miles, are down-dropped to the east and can be attributed to both tectonic forces and differential compaction (Bell, 1981). Scarp I is generally located west of Decatur Boulevard between Tropicana Avenue and Las Vegas Drive. The southern portion of Scarp II is located in the vicinity of Valley View Road and it extends northeast to Alexander Road. This scarp trends northeast near Lake Mead

Boulevard. Scarp III is located in the vicinity of Maryland Parkway between Desert Inn Road and Cheyenne Avenue (Figure 5-4).

The northern portion of a north-south trending range-bounding fault along the base of the Spring Mountains occurs in the western portion of the central subarea. This fault is present in bedrock units and is not currently believed to be potentially active.

5.3.2.3 Soils

Soils in the Central Las Vegas subarea can be divided into three groups based on geographic distribution and soil characteristics (Table 5-2). In the western part of the subarea soils occur on alluvial fan remnants (Speck, 1980). These soils consist of shallow to very shallow loamy soils including the Cave, Las Vegas, and Goodsprings soil units. These soils typically contain a thick caliche layer. Overlying these soils are recent alluvial fans with Jean and Arizo soils which are predominantly gravelly to fine-sandy loamy soils.

In the eastern part of the subarea, alluvial flats are covered with deep, well drained silty soils (Glencarb). Soils in the southern part of the central Las Vegas subarea occur on alluvial flats. These very deep, well-drained, gypsum-rich soils consist of silty loams to clayey loams and include the Land and Spring soil units.

5.3.3 Southwest Las Vegas Valley

5.3.3.1. Geologic Units

Surficial geologic units in the southwest Las Vegas Valley subarea are primarily composed of Quaternary alluvium and pediment-deposits and Paleozoic sedimentary rocks (Bingler, 1977; Longwell et al., 1965). Quaternary deposits occur over most of the subarea and generally consist of alluvial deposits, sediment deposits, and Plio-Pleistocene sands. Alluvial deposits typically consist of unconsolidated, large boulder, cobble, pebble gravel and gravelly sand, sand, and silt. Local cementation by pedogenic calcite is common. Plio-Pleistocene deposits are typically composed of silty fine sand with abundant caliche nodules and fragments that grade laterally into dense, very hard, massive caliche horizons.

Paleozoic sedimentary rocks occur in the Spring Mountains near the western boundary of the subarea. These rocks are typically composed of limestone and dolomite with beds of sandstone, shale, and gypsum.

5.3.3.2 Structure

Many northwest-trending valley-fill faults are present in the northeast portion of the southwest subarea (Figure 5-4). Most of these faults are located south of McCarren International Airport and some extend to the northwest between Interstate 15 and Decatur Boulevard. The valley-fill faults are downdropped to the east and are likely attributable to both tectonic forces and differential compaction (Bell, 1981).

The northern portion of the Whitney Mesa fault zone is located in the eastern part of this subarea. This fault zone trends north-northeast and generally lies between Nellis Boulevard and Pecos Road. This zone consists of a series of en echelon faults which are downdropped to the east and are characterized by multiple parallel scarps as much as 75 feet high in the Whitney Mesa area. This fault zone is thought to be attributable to both tectonic forces and differential compaction (Bell, 1981).

5.3.3.3 Soils

Soils in the Southwestern Las Vegas subarea can be divided into four groups based on geographic distribution and soil characteristics (Table 5-2). In the western part of the subarea soils form on alluvial fan remnants. These soils consist of shallow to very shallow loamy soils and include the Cave, Las Vegas, and Goodsprings soil units. Many alluvial units have well developed pedogenic caliche horizons at or near the top of the unit and local calcium carbonate cementation is common throughout. Pediment deposits are typically composed of gravelly fine sand to sandy gravel with pedogenic gypsum throughout. In the northern and eastern portion of the subarea very deep gypsiferous soils are present on alluvial flats. These consist of silty to clayey loamy soils and include the Glencarb, Land, and Spring soil units. In the central portion of the subarea soils occur on basin floor remnants. These consist of deep, fine sand and cobbly soils and include the McCarren soil unit. Throughout the subarea recent alluvial fans are deposited at the base of main drainages. Soils on alluvial fans consist of very deep gravelly to fine sandy loamy soils and include the Jean and Arizo soils units.

Soils in the subarea are susceptible to wind erosion except on recent alluvial fans and in the Land and Spring soils.

5.3.4 Boulder City

5.3.4.1 Geologic Units

Surficial geologic units in the Boulder City subarea are composed primarily of Quaternary alluvium, Tertiary sedimentary rocks, and Tertiary intrusive and volcanic rocks (Anderson, 1977; Stewart and Carlson, 1978). Quaternary alluvial deposits occur primarily in the southern part of the subarea. These alluvial deposits are generally composed of unconsolidated to consolidated, poorly sorted silts, sands, gravel, and cobbles (Anderson, 1977).

The Tertiary age Muddy Creek Formation is present in the eastern part of the subarea. The Muddy Creek Formation is composed of fine grained sandstone, siltstone, and clay with gypsum (Longwell et al., 1965). Tertiary intrusive and volcanic rocks are present in the northern part of the subarea. Intrusive rocks are composed of granite, quartz, monzonite, granodiorite, and diorite (Longwell et al., 1965). Volcanic rocks principally consist of andesite, basalt, and rhyolite flows (Stewart and Carlson, 1978).

5.3.4.2 Structure

Numerous small bedrock faults occur in the Tertiary rocks in the Boulder City subarea. The Lake Mead fault zone is present in the northern portion of the subarea (Figure 5-3).

5.3.4.3 Soils

Soils in the Boulder City subarea can be divided into four groups based on geographic distribution and soil characteristics (Table 5-2). In the Central portion of the subarea soils occur on fan remnants and consist of very deep gravelly loams. These soils include the Caliza-Aztec soil units. In the southern portion of the subarea deep well drained to excessively drained soils occur on sand sheets. These soils (Bluepoint and Knob Hill units) are sandy throughout and susceptible to wind erosion. Northeast of Boulder City soils occur on recent alluvial fans. These soils consist of deep gravelly to fine sandy loams and include the Jean and Arizo soil units. In addition, rock is exposed on hills and mountains that surround Boulder City.

5.3.5 Henderson

5.3.5.1 Geologic Units

Surficial geologic units in the Henderson subarea are composed primarily of Quaternary alluvium, pediment and fan deposits, and mid-Tertiary volcanic rocks (Bell and Smith, 1980). The Quaternary alluvial deposits occur throughout the central portion of the Henderson subarea. Quaternary deposits generally consist of poorly sorted silty, sandy, pebble to cobble gravel predominantly composed of dacite clasts with locally high concentrations of tuff, basalt, and sedimentary clasts derived from the River Mountain and McCullough Range areas. These deposits are locally rich in reworked and pedogenic gypsum. Discontinuous horizons moderately cemented by calcium carbonate are present locally in these deposits.

Mid-Tertiary age volcanic rocks occur in the McCullough Range and the River Mountains, which are located at the western and eastern boundaries of the Henderson subarea, respectively. These volcanic rocks principally consist of a thick pile of dacite flows, breccias, and fanglomerates.

5.3.5.2 Structure

The southern portion of the Whitney Mesa fault zone is present in the northwestern corner of the Henderson subarea (Figure 5-4). The fault zone trends primarily north-northwest in this area. This series of en echelon faults is downdropped to the east and is characterized by multiple, parallel scarps approximately 50-75 feet high. Several probable faults or fault-line scarps of tectonic origin are also present in the subarea (Bell, 1978). An approximately two-mile long curvilinear escarpment trends west from the Whitney Mesa area then turns northwest near the Paradise Valley Country Club. Another east-southeast trending fault is present west of Whitney Mesa near Barhum Road (Figure 5-4). This fault is approximately 0.8 mile long and may continue to the west (Bell, 1978). Last movement on these faults is thought to have occurred in the middle to late Pleistocene. In addition, several small (approximately 0.5-0.7 mile long) fault scarps of tectonic origin are mapped south of Henderson near Gibson Boulevard and Lake Mead Drive (Bell, 1978). Last movement on these faults is thought to have occurred in the late Pleistocene (Bell, 1978).

5.3.5.3 Soils

Soils in the Henderson subarea can be divided into four general groups based on geographic distribution and soil characteristics (Table 5-2). In the central part of the subarea soils occur on fan remnants. These soils are very deep gravelly loams and they include the Caliza and Aztec soil units. In the western portion of the subarea basin floor remnants are covered with very deep fine sandy to cobbly loams (McCarren soil unit). Recent alluvial fans occur at the base of major drainages. These fans are covered by the very deep well drained gravelly to fine sandy loams characteristic of the Jean-Arizo soil units. Rock outcrops with extremely shallow soils are present in hills and mountains around Henderson.

5.4 SIGNIFICANT RESOURCES AND NEED FOR ENVIRONMENTAL ANALYSIS

5.4.1 Strong Ground Motion

As discussed in Section 5.2.1, the project area is located in a seismically active area that can be expected to experience seismicity and resulting strong ground shaking during the lifetime of the proposed project. Seismic events may cause strong ground motion. A probabalistic seismic risk analysis should be developed as part of final design of detention basins and bridges.

5.4.2 Surface Rupture

As discussed in Section 5.2.2, several sources of potential surface rupture have been identified in the project area. These sources include potentially active tectonic fault traces, compaction faults, and subsidence related features. Site-specific investigations of proposed flood control facility locations, including mapping, should be conducted by a qualified engineering geologist as part of final design activities. If sources of potential surface rupture are identified at the proposed facility location, further investigation such as exploratory trenching, should be conducted in order to establish the existence, location, nature, and, to the extent possible, age of these features in order to assess potential hazard/constraint to the proposed facility.

5.4.3 Slope Instability

Areas with potential serious slope instability problems, such as major known landslide terrains, have not been identified in the project area (Section 5.2.3). However, site-specific investigations of proposed flood control facility locations should be conducted by a qualified geotechnical engineer or engineering geologist as part of final design activities.

Areas of localized sources of slope instability, such as steep slopes at escarpments or channel sideslopes are present in some portions of this study area, however. Channel sideslope instability occurs in some portions of the lower Las Vegas Wash. Facilities proposed in theses areas (including structures that modify flows into these areas) should be reviewed for potential changes in sideslope scour and designed to minimize adverse effects. Facilities crossing or discharging into other channels with unstable side slopes or escarpments should also be reviewed for potential increases slope instability.

5.4.4 Expansive Soils

As described in Section 5.2.5 expansive soils are locally present in the project area. Site-specific geotechnical investigations of proposed flood control facility locations should be conducted by a qualified geotechnical engineer as part of final design activities. Evaluation of subsurface soils for expansive properties should be conducted as part of the site-specific geotechnical investigation.

5.4.5 Collapsing Soils

As described in Section 5.2.6, collapsible soils are locally present in the project area. Site-specific geotechnical investigations of proposed flood-control facility locations should be conducted by a qualified geotechnical engineer prior to design and construction. Evaluation of subsurface soils for collapsing properties should be conducted as part of the site-specific geotechnical investigation. In addition, the site-specific investigation should include an examination of the site by an engineering geologist for any subsidence related features such as scarps or fissures.

5.4.6 Liquefaction

Although requisite conditions for liquefaction are not common in the project area, site-specific geotechnical investigations of proposed flood control facility locations should be conducted by a qualified geotechnical engineer as part of final design activities (Section 5.2.7). Evaluation of subsurface soils for density and moisture content should be conducted as part of the site-specific geotechnical investigation. In addition, it should be taken into consideration that some of the proposed facilities, such as unlined detention basins, may cause soils underlying them to become saturated.

5.4.7 Erosion and Deposition

As discussed in Section 5.2.8, potential erosion and deposition hazards within the project area include erosion and subsequent deposition from sheet flow, channel erosion (including indirect effects associated with the modification of discharges into natural channels), and wind erosion. Site-specific geologic and hydrologic investigations of proposed flood control facility locations should be conducted by a qualified engineering geologist and/or engineer as part of final design activities. Evaluation of the extent of erosion and deposition currently occurring in the area should be included in the investigation in order to evaluate what impacts proposed facilities may have on existing erosional and depositional conditions.

5.4.8 Other Geologic Constraints

As discussed in Section 5.2.9, caliche and corrosive soils are common in the project area. Site-specific geotechnical investigations of proposed flood control facility locations should be conducted as part of to final design activities. Evaluation of the presence and, if present, the extent and nature of these deposits will allow a more accurate determination of construction constraints, including costs, for facilities at specific locations.

5.5 GENERAL ENVIRONMENTAL EFFECTS

The potential effects of geologic hazards and constraints in the project area on the proposed project are summarized in Tables 5-3 and 5-4. These are discussed in more detail in the following sections.

5.5.1 Construction

5.5.1.1 Strong Ground Motion

Potential impacts associated with strong ground motion during construction include damage to equipment and possible injury to construction personnel from falling debris. Construction of individual proposed flood control facilities is expected to occur over a brief period of time thereby creating a relatively short seismic time exposure window for each individual facility. However, construction of all proposed flood control facilities over a more than 50-year time period increases the time of potential seismic exposure. The project area is located in a seismically active area that may experience seismicity and resulting strong ground motion during the lifetime of the proposed project. However, the probability that a large earthquake will occur on one of the potential seismic sources outlined in Section 5.1.4 during the next 50 to 100 years is considered to be low. Based on these considerations, the probability that a major event would occur during construction of an individual facility is very low and there is a low probability that a major event would occur during the construction period of all facilities.

5.5.1.2 Surface Fault Rupture

Potential impacts associated with surface fault rupture during construction include damage to equipment and possible injury to construction personnel from falling debris. Very few proposed flood control facilities overlie potentially active faults and construction of these facilities is expected to occur over a brief period of time thereby creating a relatively short time exposure window for surface rupture during construction. Based on these considerations, it is considered unlikely that surface rupture would occur during construction of proposed flood control facilities which overlie potentially active faults.

5.5.1.3 Slope Instability

Potential impacts associated with slope instability during construction include damage to equipment and possible injury to construction personnel from falling debris and possible increased instability associated with the disturbance of incised drainage channels and other steep escarpments. Very few proposed flood control facilities overlie areas of potential slope instability and construction of these facilities is expected to occur over a brief period of time, thereby creating a relatively short time exposure window for slope instability during construction. Following construction, areas temporarily disturbed by construction activities, but outside areas of flood control improvements, may experience increased instability in existing unstable areas. Based on these considerations, it is unlikely that slope instability would occur during construction of proposed flood control facilities and construction related instability following the completion of construction is expected to be limited to incised channels or other steep escarpments disturbed by construction activities.

5.5.1.4 Subsidence

Potential impacts associated with subsidence during construction include damage to equipment and possible injury to construction personnel due to collapse of subsurface fissures. Few proposed flood control facilities overlie areas of fissuring. In addition, areas of fissuring can frequently be identified by surficial features enabling areas of potential collapse to be identified prior to commencement of construction activities. Based on the above considerations it is unlikely that collapse of subsurface fissures would occur during construction of proposed flood control facilities.

5.5.1.5 Other Geologic Constraints

Many of the proposed flood control facilities are located in areas where caliche is present. Caliche may require special excavation techniques that could significantly increase construction costs of facilities.

5.5.1.6 Erosion and Deposition

Construction activities may induce wind erosion by disturbing surficial soils and increasing the quantity of airborne deposits or water erosion if a rainstorm occurred during construction. These potential impacts are significant, but mitigable as discussed in Section 5.7.

5.5.1.7 Mineral Resources

Many of the proposed flood control facilities are located in existing gravel quarries. Construction activities to modify quarries on federal lands for use as detention basins will require that the mining claimant relinquish his claims and, subsequent approval of BLM to construct the basins. The existing quarries are mined for gravel and do not represent unique features or rare mineral resources that are not found elsewhere in the project area. Therefore, the loss of mineral resources due to construction activities is not considered to be a significant environmental impact. Relinquishment of mining claims could be promoted as discussed in Section 5.7.10.

5.5.1.8 Topographic Alteration

Construction activities for proposed flood control facilities may potentially affect the local geologic conditions. Topographic alteration, including excavation of debris and detention basins, construction of dikes/levees, and enlargement of existing channels and gravel pits, would be required for construction of the proposed facilities. However, no unique or special topographic features would be altered by the proposed project. Thus, impacts of construction on the local geology due to topographic modification are expected to be adverse, but insignificant.

5.5.2. Direct Operation

5.5.2.1 Mineral Resources

Many of the proposed detention facilities are located in existing gravel quarries. Use of these quarries for detention facilities would preclude quarry operation during direct use of the facilities. The existing quarries are mined for gravel and do not represent unique features or rare mineral resources that are not found elsewhere in the project area. The removal of these quarries from current use is therefore not expected to create a significant environmental impact. Fair compensation to claimants will be required prior to the installation of facilities in these areas if, claims cannot be declared null-and-void, or if the claims can pass a validity examination, as discussed in Section 5.7.10.

5.5.2.2 Erosion and Deposition

Many of the proposed detention structures are located at sites where deep excavations do not currently exist such as gravel quarries. Excavation of detention basins at these locations may potentially alter the baseline flow of surface water which could result in increased erosion or sedimentation upstream and/or downstream of the facilities. Facilities which decrease water velocity and/or increase sediment load may decrease erosion and increase sedimentation. An increase in velocity and/or decrease in sediment load can increase the erosive potential and decrease sedimentation in the areas where the change occurs.

5.5.2.3 Geologic Hazards and Constraints

Potential impacts associated with strong ground motion and surface fault rupture include damage to facilities not specifically designed and constructed to withstand such motion and displacement, and possible failure of detention facilities which could result in downstream flooding and damage to downstream properties if present. Potential impacts associated with slope instability, subsidence, collapsing soils, expansive soils, liquefaction, erosion and deposition, and corrosive soils include damage to facilities or structures not specifically designed and constructed to withstand the effects of these hazards and constraints. Accomplishment of proper engineering, including the incorporation of recommendations of a qualified engineering geologist following onsite inspection, is expected to reduce the potential impacts associated with these hazards to insignificant levels.

5.5.3 Indirect Operation

5.5.3.1 Mineral Resources

The installation of detention facilities and debris basins, in areas currently used as gravel quarries, could result in the increased operation of other existing quarry sites or, installation of new quarries to meet the demand currently accommodated by the quarries affected. The potential significance of this indirect effect cannot be evaluated because it is not clear where or if such new quarries would actually begin operation.

5.5.3.2. Erosion and Deposition

Project operations could modify erosion and deposition patterns in off-site areas if sediment loads or flow velocities are modified in areas of discharge into unimproved channels or if facilities cause increased erosion or deposition upstream of these facilities. This is a particular concern with respect to discharges into the lower Las Vegas Wash, where existing erosion problems currently exist.

5.5.3.3 Slope Instability

Project operations could increase slope instability in off-site areas as a result of increased erosion associated with modified sediment loads and/or flow velocities at the base of existing unstable areas. This indirect effect could be particularly important if construction activities include disturbance of unstable areas without the application of appropriate erosion control and/or stability measures.

5.6 ENVIRONMENTAL EFFECTS BY ALTERNATIVE

A summary of geologic impacts, hazards, and constraints by alternative are presented in Table 5-3. Proposed flood control facilities for the All Conveyance and Detention/Conveyance alternatives are generally similar and differ primarily in size and capacity. As a result, both alternatives are expected to create similar impacts due to construction and operation of the proposed facilities.

5.6.1 Detention/Conveyance Alternative

As discussed in Section 5.5 potential environmental effects on the proposed project and/or resulting from the proposed project include strong ground motion, surface fault rupture, slope instability, subsidence, expansive soils, collapsing soils, liquefaction erosion and sedimentation, caliche, corrosive soils, topographic alteration, and reduced mineral resource production or establishment of new or expanded quarry operations.

Although most environmental effects are the same for the All Conveyance and Detention/Conveyance alternatives, several potential impacts related to the construction and operation of detention basins and levees/dikes are greater for the Detention/Conveyance alternative. Construction of the larger number of detention facilities may cause more topographic alteration than the All Conveyance alternative. Construction and operation of these facilities would require a reduction of mineral resource production at facility locations that are currently occupied by operating gravel quarries or inactive quarries with additional reserves. In addition, direct operation of detention facilities has a greater potential to alter baseline surface water flow and therefore potentially increase or decrease erosion and sedimentation upstream and downstream of the facilities in comparison to the All Conveyance alternative. In most cases erosion potential would likely be decreased by the Detention/Conveyance alternative as a result of lower flow velocities. Indirect impacts associated with scour and resulting slope instability near facilities discharges into natural channels could also be reduced by this alternative.

5.6.2 All Conveyance Alternative

As discussed in Section 5.5 potential environmental effects on the proposed project and/or resulting from the proposed project include strong ground motion, surface fault rupture, slope instability, subsidence, expansive soils, collapsing soils, liquefaction erosion and sedimentation, caliche, corrosive soils, topographic alteration, and reduced mineral resource production.

There is a potential for all of these environmental effects with All Conveyance alternative with the exception of reduced mineral resource production. Potential effects associated with caliche and topographic alteration are only likely during the construction phase and topographic alteration associated with modifications of channel morphology are considered to be minor.

5.6.3 No Project Alternative

The No Project alternative would not have any new impacts to the geologic environment beyond the existing impacts related to the current flood control facilities or lack thereof. Potential benefits of the flood control facilities (such as reduced scour and channel slope instability associated with Detention/Conveyance or All Conveyance discharges into natural channels) would also not occur.

5.7 PROGRAMMATIC MITIGATIONS

In general, mitigation of geologic impacts, hazards, and constraints can be accomplished by relocation, removal of the hazard or constraint if feasible, or by engineering design. During the evaluation process, if it is determined that relocation of the proposed facility is a superior and feasible alternative, the process should be implemented relative to an alternate location. The following procedure is recommended prior to construction of proposed flood control facilities

Information in this EIS should be reviewed during conceptual planning of proposed flood control facilities in order to identify geologic impacts, hazards, and constraints that are known to be present at or near a specific location. After review of the EIS, additional existing information should be collected and reviewed. This information could include more recent geologic data and reports, information obtained during investigation and construction of existing nearby flood control or other facilities and site-specific data such as geotechnical reports. The procedure outlined in Section 13.0 of this EIS should then be followed to evaluate the potential environmental impact of the proposed facility and identify appropriate facility-specific mitigation measures. The results of this analysis should be used to determine if additional environmental investigation is required to comply with NEPA.

In addition to any NEPA studies required, detailed facility engineering studies should include a site-specific geologic and geotechnical investigation and conducted at each proposed flood control facility by a qualified engineering geologist or geotechnical engineer. This investigation should include, but not be limited to, detailed geologic mapping, subsurface soil sampling, and laboratory testing of soil samples. If faults, subsidence features, or fissures are identified during the geologic mapping, trenches should be excavated across the mapped trace of the fault or feature and the attitude, extent, and age, if possible, should be determined. Geometry and bedding attitude in areas of potential slope instability should be noted.

The subsurface investigation should consist of soil borings at pertinent locations throughout the area of a proposed facility. The purpose of the borings would be to determine subsurface stratigraphy, to retrieve samples for subsequent laboratory testing, and to determine whether water is present in the shallow subsurface. Laboratory testing of appropriate physical characteristics and soils for the type of planned facility should be conducted on soil samples. These characteristics would typically include such as moisture content, dry density, grain size distribution, Atterberg limits, laboratory compaction, unconfined compression and/or confined compression, consolidation, and corrosivity.

Based on the results of the site-specific investigation and the laboratory testing, appropriate engineering recommendations, such as relocation, structural design, and soil modification can be developed and implemented. General mitigations for geologic impacts, hazards, and constraints are shown on Table 5-6. Presented in the following subsections are discussions of mitigations for specific impacts, hazards, and constraints.

5.7.1 Strong Ground Motion

Facilities may be relocated to avoid or minimize unfavorable soil conditions that would amplify effects of strong ground motion. Impacts due to seismic shaking could be generally reduced to insignificance by proper design and construction of proposed flood control facilities. Development of pertinent seismic design parameters, based on an evaluation of strong ground motion at the site and consistent with criteria used for similar facilities, should reduce to insignificant levels the potential impacts from earthquake induced strong ground motion to proposed flood control facilities. Minor damage to facilities such as lined and unlined channels, dikes/levees, and debris basins could be mitigated by routine repair procedures.

5.7.2 Surface Fault Rupture

Mitigation of surface fault rupture hazards in areas where flood control facilities are proposed can generally be accomplished by establishing appropriate setback requirements from potentially active faults. Appropriate design modification and construction of facilities to allow for movement of the magnitude likely to occur during the lifetime of a facility could also reduce potential impacts from surface fault rupture. Set backs and design modifications should be based on the results of the site-specific investigation, recommendations of a qualified engineering geologist or geotechnical engineer, and approval by appropriate agencies.

5.7.3 Slope Instability

Mitigation of potential slope instability in areas where flood control facilities are proposed can be accomplished by relocating facilities to avoid areas of potential slope instability. Potential slope instability can also be mitigated using standard engineering methods such as slope modification or buttressing. The methods implemented should be based on the results of the geotechnical investigation and recommendations of a qualified geotechnical engineer or engineering geologist. Indirect effects associated with modified flow velocities and sediment loads at discharges into natural channels with unstable sideslopes should be mitigated as described in Section 5.7.8.

5.7.4 Subsidence

Mitigation of subsidence related hazards in areas of proposed flood control facilities can generally be accomplished by relocating facilities to areas not susceptible to subsidence. Potential subsidence related hazards can also be mitigated using standard engineering methods developed by a qualified geotechnical and/or structural engineer based on the results of the site-specific investigation.

5.7.5 Collapsing Soils

Mitigation of potential hazards associated with collapsing soils in areas where flood control facilities are proposed can be accomplished by relocation of the proposed facilities to areas with more favorable soil conditions. Collapsing soils may also be mitigated by use of standard engineering measures such as overexcavation and recompaction of soils or other measures to minimize potential for saturation of these soils. Recompaction serves as both a method of soil improvement and protection against water infiltration. It should be noted that in rare cases distress to structures has been known to occur despite proper recomposition beneath foundations (Cibor, 1983). Bridge foundations can be supported by piles or piers which extend beyond the expansive soils. Potentially collapsible gypsiferous soils may be excavated and replaced with import fill or processed in selected ratios with non-gypsiferous soils prior to recompaction. In addition, collapsing soils should be protected against future saturation. Appropriate engineering measures for mitigation of collapsing soils should be developed by a qualified geotechnical engineer and be based on the results of the site-specific geotechnical investigation.

5.7.6 Expansive Soils

Mitigation of potential hazards associated with expansive soils in areas where flood control facilities are proposed can be accomplished by relocation of the proposed facilities to areas with more favorable soil conditions. Use of standard engineering measures, such as overexcavation and recompaction or replacement of expansive soils, can also be implemented to mitigate potential hazards. In addition, potential hazards associated with salt heave can be mitigated by removal of one to two feet of soil and placement of a thermal blanket composed of open-graded gravel (Cibor, 1983). Appropriate mitigation measures should be developed by a qualified geotechnical engineer and be based on the results of the site-specific geotechnical investigation.

5.7.7 Liquefaction

Mitigation of potential liquefaction hazards in areas where flood control facilities are proposed can be accomplished by relocation of the proposed facilities to areas with more favorable soil conditions. Mitigation of potential liquefaction hazards can also be accomplished by use of standard engineering measures such as replacement or over-excavation and recompaction of loose soils or dewatering. Appropriate engineering measures for mitigation of potentially liquefiable soils should be developed by a qualified geotechnical engineer and be based on the site-specific geotechnical investigation.

5.7.8 Erosion and Deposition

Mitigation of potential erosion and deposition hazards in areas where flood control facilities are proposed can be accomplished by relocation of the proposed facilities to areas with more favorable conditions or engineering design modifications.

Wind erosion hazards can be reduced by minimizing soil disturbance (particularly in areas where desert pavement is present and the existing wind erosion potential is low), use of water or chemical suppressants on disturbed areas during construction, and by compaction and revegetation of disturbed areas immediately following construction. One way to minimize disturbance of sensitive areas is to use small pieces of construction equipment and/or manual labor to the extent possible.

Channel erosion hazards at locations where cross structures are situated can be mitigated by use of standard engineering measures developed by a qualified geotechnical engineer. Erosion of surficial soils disturbed during construction can be minimized by limiting the disturbed area, avoiding soils that are highly susceptible to erosion, conducting construction activities during periods with a low potential for rainfall, and reclamation or revegetation of disturbed soils shortly after completion of construction.

Indirect erosion impacts can be mitigated by designing outflow structures to direct flows in a manner that will reduce scour of unstable channel sides or by selecting project designs that reduce flow velocities. In particular, flood control structures which reduce flow velocities could be constructed along the lower portions of major tributary channels to Lower Las Vegas Wash to minimize the potential for increased erosion where these channels enter Lower Las Vegas Wash. Erosion control structures could also be installed on affected unstable channel sideslopes.

Deposition hazards can be mitigated by relocation of proposed facilities or engineering design modifications to minimize changes in deposition upstream and/or downstream of proposed facilities. Deposition within the facilities can be mitigated by routine maintenance and removal of accumulated sediment.

5.7.9 Caliche

Mitigation of constraints associated with caliche in areas where flood control facilities are proposed could be accomplished by relocation of the proposed facilities to areas where less caliche is present or caliche is absent, if feasible. Caliche classified as very stiff, dense, or slightly to moderately hard can generally be excavated with conventional equipment and use of a ripper tooth. Excavation of caliche classified as hard to very hard usually requires the use of heavy excavation equipment such as a Ho-Ram or headache ball, or excavation by blasting (Cibor, 1983).

5.7.10 Corrosion

Mitigation of constraints associated with corrosive soils in areas where flood control facilities are proposed could be accomplished by relocation of the proposed facilities to areas where soil conditions are more favorable, or treating or removing the corrosive soils. Engineering modifications that could be implemented include use of sulfate resistant Type V cement or equivalent for concrete in contact with corrosive soils or use of Type II cement where concrete is underlain by a moisture barrier of gravel and a waterproof membrane could mitigate corrosion of facilities. In addition, high density concrete, low water/cement ratio, and smooth concrete finish can also provide added resistance to concrete corrosion. Cathodic protection or protective coatings may be used to mitigate corrosion of steel in contact with corrosive soils.

5.7.11 Mineral Resources

Mitigation of loss of mineral resources in areas where flood control facilities are proposed can be accomplished by relocating facilities to areas where existing quarries are not present or by construction of an All Conveyance system, which would not require use of quarries as detention facilities. In addition, quarry owners could be fairly compensated for the loss of mineral resources.

5.7.12 Topographic Alteration

Because topographic alteration is considered an insignificant impact and is essential to the proper function of the flood control facilities, no mitigation measures to reduce this impact are considered necessary.

TABLE 5-1

CHARACTERISTICS OF SOIL UNITS IN THE LAS VEGAS AND BOULDER CITY AREAS[1]

SOIL-UNIT	NAME	TEXTURE	SLOPE PERCENT	DEPTH	PERMEABILITY	EROSION POTENTIAL WATER	EROSION POTENTIAL WIND	SUBSIDENCE (GYPSUM-RICH SOILS)	CORROSIVITY (SALT-RICH SOILS)	RECLAMATION FOR LANDSCAPING POTENTIAL LIMITATIONS
105	McCullough-Jean-Bluepoint complex		0-4	v. deep	moderate	low	high			slight
107	Arizo	extremely stony loamy	0-4	v. deep	rapid	low	low			severe-sm. stones; lg. stones; droughty
112	Arizo	very gravelly loamy sand, flooded	0-4	v. deep	rapid	low	high			severe-sm. stones; droughty
113	Arizo	very gravelly fine sandy loam, gypsiferous substratum	2-8	v. deep	rapid	low	mod	high	high	severe-sm. stones; droughty
117	Arizo	very gravelly fine sandy loam	2-8	v. deep	v. rapid	low	mod			severe-sm. stones; droughty
120	Bluepoint	fine sandy loam, wet	0-2	v. deep	rapid	low	high			moderate-droughty
127	Bluepoint	loamy fine sand	0-2	v. deep	rapid	low	high			moderate-droughty
128	Bluepoint	gravelly loamy fine sand	2-4	v. deep	rapid	low	high			moderate-sm. stones; droughty
129	Bluepoint	loamy fine sand	4-15	v. deep	rapid	low	high			moderate-droughty, slope
130	Bracken-Destazo Complex		2-15	deep	mod-rapid	low	mod-low	high	high	severe-sm. stones, lg. stones; droughty
132	Bracken	very gravelly fine sandy loam	2-8	deep	mod-rapid	low	mod-low	high	high	severe-sm. stones; droughty
133	Bracken-Rock outcrop complex		8-30	deep	mod-rapid	low	mod-low	high	high	severe-sm. stones; droughty; slope
134	Bracken	very gravelly fine sandy loam	4-30	deep	mod-rapid	low	mod-low	high		severe-sm. stones; droughty; slope

TABLE 5-1 (continued)

SOIL-UNIT	NAME	TEXTURE	SLOPE PERCENT	DEPTH	PERMEABILITY	EROSION POTENTIAL WATER	EROSION POTENTIAL WIND	SUBSIDENCE (GYPSUM-RICH SOILS)	CORROSIVITY (SALT-RICH SOILS)	RECLAMATION FOR LANDSCAPING POTENTIAL LIMITATIONS
140	Casaga	very gravelly sandy clay loam	0-8	v. deep	slow	low	mod-low		high	severe-excess salt; excess sodium; thin layer
150	Cave	very stony sandy loam	0-4	v.shallow	moderate	low	mod			severe-large stones; thin layer
151	Cave	loamy fine sand	2-8	shallow	moderate	low	high			severe-thin layer
152	Cave	gravelly fine sandy loam	0-4	shallow	moderate	low	high			severe-thin layer
155	Cave	gravelly fine sandy loam	4-15	shallow	moderate	low	high			severe-thin layer
160	Destazo	cobbly fine sandy loam	0-2	v. deep	mod-slow	low	low			severe-lg. stones
181	Caliza-Pittman	extremely stony fine sandy loam	2-8	v. deep	mod-rapid	low	mod-low			severe-sm. stones; lg. stones; droughty
182	Caliza-Pittman-Arizo complex		0-8	v. deep	rapid	low	mod-low			severe-sm. stones; lg. stones; droughty
183	Caliza	very cobbly loamy sand	4-8	v. deep	mod-rapid	low	mod			severe-sm. stones; lg. stones; droughty
184	Caliza	very gravelly sandy loam	2-8	v. deep	mod-rapid	low	mod			severe-sm. stones; droughty
187	Caliza	extremely fine sandy loam	2-8	v. deep	mod-rapid	low	mod-low			severe-sm. stones; lg. stones; droughty
190	Dalian	very gravelly fine sandy loam	2-4	v. deep	mod-rapid	low	mod			severe-sm. stones
191	Dalian	very cobbly fine sandy loam	2-8	v. deep	mod-rapid	low	low			moderate-sm. stones; droughty
192	Dalian-McCullough complex		0-4	v. deep	mod-rapid	low	mod			severe-sm. stones
200	Glencarb	silt loam		v. deep	mod-slow	low	high			severe-sm. stones
206	Glencarb	silt loam, flooded		v. deep	mod-slow	low	mod-low			moderate-excess salt, droughty; flooding
222	Glencarb	silty clay loam wet		v. deep	mod-slow	low	mod-low			moderate-excess salt; droughty

TABLE 5-1 (continued)

SOIL-UNIT	NAME	TEXTURE	SLOPE PERCENT	DEPTH	PERMEABILITY	EROSION POTENTIAL WATER	EROSION POTENTIAL WIND	SUBSIDENCE (GYPSUM-RICH SOILS)	CORROSIVITY (SALT-RICH SOILS)	RECLAMATION FOR LANDSCAPING POTENTIAL LIMITATIONS
236	Glencarb	very fine sandy loam, saline		v. deep	mod-slow	low	high			moderate-excess salt
237	Glencarb	very fine sandy loam, caliche in substratum		deep	mod-slow	low	high			slight
240	Goodsprings	gravelly fine sandy loam	2-4	shallow	moderate	low	high			severe-thin layer
252	Grapevine	very fine sandy loam	0-2	v. deep	moderate	low	mod		high	slight
255	Grapevine	loamy fine sand	2-4	v. deep	moderate	low	high		high	slight
260	Jean	gravelly loamy fine sand	2-4	v. deep	rapid	low	mod-low			severe-droughty
262	Jean-Goodsprings complex		2-4	v. deep	rap-mod	low	mod-low			severe-droughty
263	Jean complex		2-4	v. deep	rapid	low	mod-low			severe-droughty
264	Jean	very gravelly loamy fine sand	2-4	v. deep	rapid	low	low			severe-sm. stones; droughty
270	Land	silt loam, drained		v. deep	mod-slow	low	mod-low		high	severe-excess salt
278	Land	very fine sandy loam, wet		v. deep	mod-slow	low	high		high	severe-excess salt
282	Land	silty clay loam		v. deep	mod-slow	low	mod-low		high	severe-excess salt
300	Las Vegas	gravelly fine sandy loam	0-2	shallow	mod-slow	low	high			severe-thin layer
301	Las Vegas	gravelly fine sandy loam	2-4	shallow	mod-slow	low	high			severe-thin layer
302	Las Vegas-McCarran Grapevine complex		0-4	shallow	mod-slow	low	high			severe-thin layer
305	Las Vegas-Destazo complex		0-2	shallow	mod-slow	low	high			severe-thin layer
307	Las Vegas-Skyhaven complex		0-4	shallow	mod-slow	low	high		high	severe-thin layer
325	McCarran	fine sandy loam	0-4	v. deep	mod-slow	low	high	high	high	severe-excess salt; thin layer

TABLE 5-1 (continued)

SOIL-UNIT	NAME	TEXTURE	SLOPE PERCENT	DEPTH	PERMEABILITY	EROSION POTENTIAL WATER	EROSION POTENTIAL WIND	SUBSIDENCE (GYPSUM-RICH SOILS)	CORROSIVITY (SALT-RICH SOILS)	RECLAMATION FOR LANDSCAPING POTENTIAL LIMITATIONS
326	McCarran	very cobbly fine sandy loam	2-8	v. deep	mod-slow	low	mod	high	high	severe-sm. stones; lg. stones; droughty
341	Paradise	silt loam		v. deep	moderate	low	mod-low			severe-excess salt
360	Rock outcrop St. Thomas complex		15-30	shallow	mod-rapid	mod	low			severe-sm. stones; lg. stones; droughty
380	Skyhaven	very fine sandy loam	0-4	mod.deep	mod-slow	low	high		high	moderate-excess salt; thin layer
390	Spring	clay loam		v. deep	slow	low	mod-low		high	severe-excess salt
400	Tencee	very gravelly fine sandy loam	2-8	shallow	moderate	low	low			severe-sm. stones; thin layer
415	Aztec	very gravelly sandy loam	2-8	v. deep	mod-slow	low	mod-low		high	severe-sm. stones
417	Aztec-Rock outcrop complex		8-30	v. deep	mod-slow	low	mod-low		high	severe-slope; sm. stones
418	Aztec-Nickel-Knob Hill complex		2-15	v. deep	mod-slow	low	high		high	moderate-slope; sm. stones
419	Aztec-Bracken complex		4-30	v deep	mod-slow mod-rapid	low	high			moderate-slope; sm. stones
430	Knob Hill	loamy sand	0-4	v. deep	mod-rapid	low	high			moderate-droughty
440	Nickel	very gravelly fine sandy loam, bedrock substratum	2-8	deep	mod-slow	low	mod			severe-sm. stones; droughty
450	Cave Variant	very cobbly very fine sandy loam	4-30	shallow	mod-rapid	mod	mod			severe-sm. stones, lg. stones; slope
481	Hobog	loamy fine sand	15-50	shallow	moderate	high	high			severe-slope; twin layer
484	Hobog	very cobbly fine sandy loam	15-50	shallow	moderate	mod	low			severe-lg. stones; slope; twin layer
500	Canutio-Akela complex		2-15	deep	mod-rapid	mod	low			severe-sm. stones; lg. stones; droughty
501	Canutio	gravelly fine sandy loam	0-2	v. deep	mod-rapid	mod	high			moderate-sm. stones; lg. stones; droughty
502	Canutio-Cave	gravelly fine sandy loam	2-8	v. deep	mod-rapid	mod	high			moderate-sm. stones; lg. stones; droughty

TABLE 5-1 (concluded)

SOIL-UNIT	NAME	TEXTURE	SLOPE PERCENT	DEPTH	PERMEABILITY	EROSION POTENTIAL WATER	EROSION POTENTIAL WIND	SUBSIDENCE (GYPSUM-RICH SOILS)	CORROSIVITY (SALT-RICH SOILS)	RECLAMATION FOR LANDSCAPING POTENTIAL LIMITATIONS
505	Canutio-Akela complex		15-50	deep	mod-rapid	mod	low			severe-sm. stones; lg. stones; droughty
510	Akela-Rock outcrop complex		15-50	shallow	moderate	mod	mod			severe-droughty
540	Weiser	extremely gravelly fine sandy loam	2-8	v. deep	mod-rapid	low	mod			severe-sm. stones; droughty
542	Weiser-Aztec complex		2-8	v. deep	mod-slow	low	mod			severe-sm. stones; droughty
545	Weiser-Good-springs complex		2-4	v. deep	mod-rapid	low	mod			severe-sm. stones; thin layer
600	Slickens									
605	Dumps									
610	Pits	gravel								
615	Urban land									
630	Badland									
635	Rock outcrop	limestone								
640	Rock outcrop	sandstone								
645	Pits	quarry								
999	Waterbody									

[1] Source: Speck, R. L., 1980. Wind erodibility based on wind erodibility groups (WEG);
Low = 8 WEG, not subject to wind erosion
Moderate to low = 6-7 WEG, very slightly erodable
Moderate = 5 WEG, slightly erodable
High = 1-4 WEG, erodable and highly erodable soils

TABLE 5-2

CHARACTERISTIC SOILS IN THE PROJECT SUBAREAS[1]

AREA	PREDOMINANT SOILS	CHARACTERISTICS	GYPSUM CONCENTRATION	CALICHE CONTENT	POTENTIAL ERODIBILITY WATER/WIND	RECLAMATION DIFFICULTY
North Las Vegas	Cave, Las Vegas, Goodsprings	Shallow to very shallow soils on alluvial remnants		High	High	High
	Glencarb	Very deep soils on floodplains & alluvial flats			High	Med
	Weiser Dalian	Very deep soils on fan remnants, fan skirts, & inset fans	Med	Med	Med	High
Central Las Vegas	Cave, Las Vegas, Goodsprings	Shallow to very shallow soils on alluvial remnants		High	High	High
	Glencarb	Very deep soils on floodplains & alluvial flats			High	High
	Land, Spring	Very deep soils on alluvial flats	High		Med	High
	Jean, Arizo	Very deep soils on recent alluvial fans	Med		Med	High
South Las Vegas	Cave, Las Vegas, Goodsprings	Shallow to very shallow soils of alluvial remnants		High	High	High
	McCarren	Very deep soils on basin floor remnants			High	
	Jean, Arizo	Very deep soils on recent alluvial fans	Med		Med	High
	Land, Spring	Very deep soils on alluvial flats	High		Med	High
Henderson	Caliza, Aztec	Very deep soils on fan remnants			Med	High
	Jean, Arizo	Very deep soils on recent alluvial fans	Med		Med	High
Boulder City	Caliza, Aztec	Very deep soils on fan remnants			Med	High
	Rock Outcrop-St. Thomas, Akela	Rock outcrop and shallow to very shallow soils on hills and mountains			Med	High
	Jean, Arizo	Very deep soils on recent alluvial fans	Med		Med	High
	Bluepoint, Knob Hill	Very deep soils on sand sheets			High	Med

[1] Source: Speck, 1980

TABLE 5-3

POTENTIAL EFFECTS ASSOCIATED WITH GEOLOGIC CONDITIONS

GEOLOGIC RESOURCE/CONSTRAINT	POTENTIAL EFFECTS: Facility Struct. Damage/Special Design Require.	Routine Facil. Operational Prob.	Construction[1] Difficulty	Increased Erosion	Off-site Surface Changes/Potential Structural Prob.	Interference w/ Mineral Prod.	Increased Demand[2] Mineral Prod.
Strong Ground Motion	X						
Surface Rupture	X						
Slope Instability	X	X			X		
Subsidence	X	X					
Expansive Soils	X	X					
Collapsing Soils	X	X					
Liquefaction	X						
Erosion and Sedimentation	X	X		X	X		
Caliche			X				
Corrosive Soils	X						
Mineral Claims/Active Mines						X	X
Indirect Erosion/Instability	X			X	X		

[1] Construction difficulty requiring special construction practices (including blasting)

[2] Increased demand for new or expanded mineral production

TABLE 5-4

GEOLOGIC RESOURCES AND CONSTRAINTS
POTENTIALLY AFFECTED BY FLOOD CONTROL FACILITIES

AFFECTED RESOURCES AND CONSTRAINTS

FACILITY TYPE	Strong Ground Motion	Surface Rupture	Slope Instability	Subsidence	Expansive Soils	Collapsing Soils	Liquefaction	Erosion & Sedimentation	Caliche	Corrosive Soils	Mineral Claims/ Active Mines	Indirect Erosion/ Instability
Reinforced Concrete Pipeline		X	X	X				X	X	X		X
Unlined Channels								X	X			X
Lined Channels		X	X	X	X			X	X	X		X
Box Conduits/Culverts		X		X				X	X	X		X
Detention Basins	X	X	X	X	X	X	X	X	X	X	X	X
Debris Basins	X	X	X	X	X	X	X	X	X	X	X	X
Floodway								X	X			X
Bridge Structures	X	X	X	X	X	X	X	X	X	X		
Spillways	X	X	X	X	X	X	X	X	X	X		X
Outlet Works	X	X	X	X	X	X	X	X	X	X		X
Drop Structures	X	X	X	X	X	X	X	X	X	X		X
Dikes				X				X				

TABLE 5-4 (continued)

RESOURCES AND CONSTRAINTS DESCRIPTION AND LOCATION[1]

KEY

RESOURCE/CONSTRAINT	DESCRIPTION/LOCATION
Strong Ground Motion	All portions of study area
Surface Rupture	Crossings of active faults
Slope Instability	Valley-fill faults scarps Incised drainage channel sideslopes
Subsidence	Soils susceptible to subsidence, particularly: Arizo, Bracken-Destazo complex, Bracken-Rock outcrop complex, Bracken, McCarran, and land soil types; also areas of high ground water extraction are of particular concern
Expansive Soils	Expansive soils of particular concern include Casaga, Glencarb, Land, Spring, Las Vegas, and Skyhaven soil types
Collapsing Soils	Collapsing soils of potential concern include porous, unconsolidated silty clay and clayey silt including Arizo, Bracken-Destazo complex, Bracken-Rock outcrop complex, Bracken, McCarran, and Land soil types
Liquefaction	Areas with loose, granular soils in areas of near-surface groundwater, conditions presenting a high liquefaction potential were not identified within the study area
Erosion and Sedimentation	Surface/sheet flow erosion - soils with high water erosion potential include: McCullough-Jean-Bluepoint complex, Arizo, Bluepoint, and Hobog soil types Wind erosion - temporary surface disturbances of high wind erosion potential soils including McCullough-Sean-Bluepoint complex, Arizo, Bluepoint, Cave, Glencarb, Goodsprings, Grapevine, Land, Las Vegas-McCarran-Grapevine complex, Las Vegas-Destazo complex, Las Vegas-Skyhaven complex, McCarran, Skyhaven, Aztec-Nickel-Knob Hill complex, Aztec-Bracken complex, Hobog, Canutio, and Canutio-Cave complex soil types

[1] This key should be used in conjunction with Figures 5-4 and 5-7 to identify the approximate location of potential geologic resources and constraints

TABLE 5-4 (concluded)

RESOURCE/CONSTRAINT	DESCRIPTION/LOCATION
	Slope Erosion - incised drainage channels and subsidence fissures are susceptible to erosion from alterations in drainage flow deposition - occurs in response to flow velocity reduction and affects the function and maintenance of detention and debris basins, and may be a concern in natural channels and floodways (especially the Las Vegas Wash)
Caliche	Discontinuous throughout study area, refer to Figure 5-7 to locate identified significant caliche deposits
Corrosive Soils	Areas of evaporite deposits and corrosive soils, including Arizo, Bracken-Destazo complex, Bracken, Bracken-Rock outcrop complex, Grapevine, Land, Las Vegas-Skyhaven complex, McCarran, Skyhaven, and Aztec-Nickel-Knob Hill complex soil types
Mineral Claims/Active Mines	Areas of existing mining claims
Indirect Erosion/Slope Instability	Areas where proposed facilities discharge flows into areas of potential erosion and slope instability (see discussions above)

TABLE 5-5

ENVIRONMENTAL EFFECTS BY ALTERNATIVE

	DETENTION/CONVEYANCE	ALL CONVEYANCE	NO PROJECT
STRONG GROUND MOTION			
Construction	Yes	Yes	No
Direct Operation	Yes	Yes	No
Indirect Operation	Yes	Yes	No
SURFACE RUPTURE			
Construction	Yes	Yes	No
Direct Operation	Yes	Yes	No
Indirect Operation	Yes	Yes	No
SLOPE INSTABILITY			
Construction	Yes	Yes	No
Direct Operation	Yes	Yes	No
Indirect Operation	Yes	Yes	No
SUBSIDENCE			
Construction	Yes	Yes	No
Direct Operation	Yes	Yes	No
Indirect Operation	Yes	Yes	No
EXPANSIVE SOILS			
Construction	Yes	Yes	No
Direct Operation	Yes	Yes	No
Indirect Operation	Yes	Yes	No

TABLE 5-5 (continued)

	DETENTION/CONVEYANCE	ALL CONVEYANCE	NO PROJECT
COLLAPSING SOILS			
Construction	Yes	Yes	No
Direct Operation	Yes	Yes	No
Indirect Operation	Yes	Yes	No
LIQUEFACTION			
Construction	Uncertain	Uncertain	No
Direct Operation	Uncertain	Uncertain	No
Indirect Operation	Uncertain	Uncertain	No
EROSION AND SEDIMENTATION			
Construction	Yes	Yes	No
Direct Operation	Yes	Yes	No
Indirect Operation	No	No	No
CALICHE			
Construction	Yes	Yes	No
Direct Operation	No	No	No
Indirect Operation	No	No	No
CORROSIVE SOILS			
Construction	Yes	Yes	No
Direct Operation	Yes	Yes	No
Indirect Operation	Yes	Yes	No

TABLE 5-5 (concluded)

	DETENTION/CONVEYANCE	ALL CONVEYANCE	NO PROJECT
TOPOGRAPHIC ALTERATION			
Construction	Yes	Yes	No
Direct Operation	Uncertain	No	No
Indirect Operation	No	No	No
MINERAL RESOURCES			
Construction	Yes	No	No
Direct Operation	Yes	No	No
Indirect Operation	No	No	No

TABLE 5-6

MITIGATION MEASURES

GEOLOGIC HAZARD/CONSTRAINT	MITIGATION
Strong Ground Motion	C, D
Surface Fault Rupture	B, C, D
Slope Instability	B, G
Subsidence	B, C, D
Expansive Soils	B, C, D
Collapsing Soils	B, C, D
Liquefaction	B, C, D
Erosion and Sedimentation	B, C, E
Caliche	B, H
Corrosive Soils	B, D, I
Topographic Alteration	A
Mineral Resources	F, B

A) No mitigation
B) Relocate to avoid hazard/constraint or impacted resource
C) Engineering design modifications
D) Modification of existing soil conditions as appropriate
E) Minimize soil disturbance, use of water or chemical suppressants, revegetation, line channels
F) Allow discretionary mineral extraction activities to continue during dry periods; fair compensation to owners for loss of mineral resources
G) Modification and/or buttress of unstable slopes, design discharge outlets to minimize effects on unstable channel sideslopes
H) Use specialized heavy equipment or blasting techniques to excavate
I) Use corrosive resistant materials for construction of facilities

FIGURE 5-1

PHYSIOGRAPHIC MAP OF THE LAS VEGAS VALLEY AREA

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AGE				THICK-NESS (feet)	LITHOLOGY	OCCURENCES	GENERAL HYDROLOGIC PROPERTIES
QUATERNARY	PLEISTOCENE AND HOLOCENE	VALLEY FILL	Surficial Deposits	50±	Unconsolidated gravel, sand, silt, and clay.	Occurs throughout area of valley fill. Exposures not continuous but are limited to area of Holocene and Late Pleistocene deposition. On alluvial fans, unit consist of stream-channel and slope-wash deposits. In lower parts of valley, unit ocurs as fairly extensive deposits of sand, silt, and gravel.	Generally above the zone of saturation on alluvial fan. In the southeast part of valley, saturated deposits may form a thin water-table aquifer. Estimated average horizontal hydraulic conductivity of these deposits in the Henderson-East Las Vegas area to be about 400 gpd/ft^2
QUATERNARY	PLEISTOCENE	VALLEY FILL	Lake and Playa Deposits (includes Las Vegas Formation)	300±	Predominately clay, silt, and fine sand. Contains some regular, thin-bedded layers of sand and gravel.	Exposed at base of alluvial fans along west side of valley; as prominent lake-bed deposits at northwest end of valley; and as irregularly exposed deposits in central part of valley. Well logs indicate upper valley-fill deposits in central part of valley commonly consist of a sequence of silt, clay and caliche.	When saturated, fine grained deposits may store appreciable quantities of water but have low permeability and transmit water poorly. Unit acts as a confining layer. When water is removed from storage, compaction and land subsidence may result. Unit yields some water to domestic wells.
QUATERNARY	PLEISTOCENE	VALLEY FILL	Fanglomerate and Valley Floor Deposits	1000±	On alluvial fan, predominately gravel and sand with some silt and clay. Deposits may be well cemented with caliche. On valley floor, generally silt and clay with interbedded sand and gravel. Lithology similar to overlying lake-bed and playa deposits. Upper contact arbitrarily located at top of first significant water-producing sand or gravel.	Occurs throughout area of valley fill. Exposed as alluvial fans but generally concealed by surficial deposits or lake and playa deposits on valley floor.	Gravel deposits along lower parts of fans transnit water readily and form most productive aquifers in valley. Finer gravel deposits in central part of valley produce adequate supplies for domestic wells and moderate-capacity industrial and public supply wells. Heavy pumping in area of fine-grained deposits may result in land subsidence.
QUATERNARY / TERTIARY	PLEISTOCENE	VALLEY FILL	Muddy Creek Formation	4000±	Silt, clay, and sandstone, with some lenses of pebble conglomerate. Locally contains salt and gypsum beds. Interstratified basalt flows in some areas.	Forms prominent bluffs in southeast part of valley. Also exposed north and south of Frenchman Mtn. Probably underlies Quaternary valley-fill deposits throughout much of valley.	Low-permeability deposits which do not readily yield water to wells. Gypsum and salt may affect ground-water quality.
TERTIARY		CONSOLIDATED ROCKS	Volcanic Rocks	- -	Complex assemblage of andesitic lava flows, volcanic breccia, and associated rocks. Includes some intrusive porphyritic rocks.	Southwest of Las Vegas Valley floor, in McCullough Range and River Mtns. Includes small area of intrusive rocks in the McCullough Range.	Impermeable except where highly fractured; probably forms barrier to ground-water movement.
TRIASSIC TO CRETACEOUS		CONSOLIDATED ROCKS	Noncarbonate Sedimentary Rocks	3500-8000	Sandstone, shale, and conglomerate. Some interbedded limestone and gypsum.	Exposed on Frenchman Mtn. and along southwest border of area. Includes Thumb Formation, Aztec Sandstone, Chinle Formation, and Moenkopi Formation.	Generally impermeable; may transmit moderate amounts of water where fractured. Gypsum may affect sulfate content of ground water.
PRECAMBRIAN TO PERMIAN		CONSOLIDATED ROCKS	Gypsiferous Sedimentary Rocks	2000±	Limestone, dolomite, shale, conglomerate, and sandstone. Sequence contains significant amounts of gypsum.	Exposed on Frenchman Mtn. and along southwest border of area. Includes Kaibab Limestone, Toroweap Formation, and red beds.	Generally impermeable; may transmit moderate amounts of water where fractured or where fractures have been enlarged by solution. Gypsum may affect sulfate content of ground water.
PRECAMBRIAN TO PERMIAN		CONSOLIDATED ROCKS	Non-gypsiferous Sedimentary Rocks	20000±	Limestone, dolomite, shale sandstone, and quartzite.	Exposed on Frenchman Mtn., the Sheep Range, and Spring Mtns. Includes Bird Spring Formation, Monte Cristo and Sultan Limestones, Lone Mountain and Ely Springs Dolomites, Eureka Quartzite, Pogonip Limestone, Chisholm Shale, Lyndon Limestone, Pioche Shale, and Tapeats Sandstone.	Generally impermeable except where solution has caused a secondary enlargement of joints and fractueres. May transmit large quantities of ground water in these areas.

FIGURE 5-2

GENERALIZED STRATIGRAPHIC COLUMN FOR THE LAS VEGAS AREA

Source: Modified After Harrill, 1976

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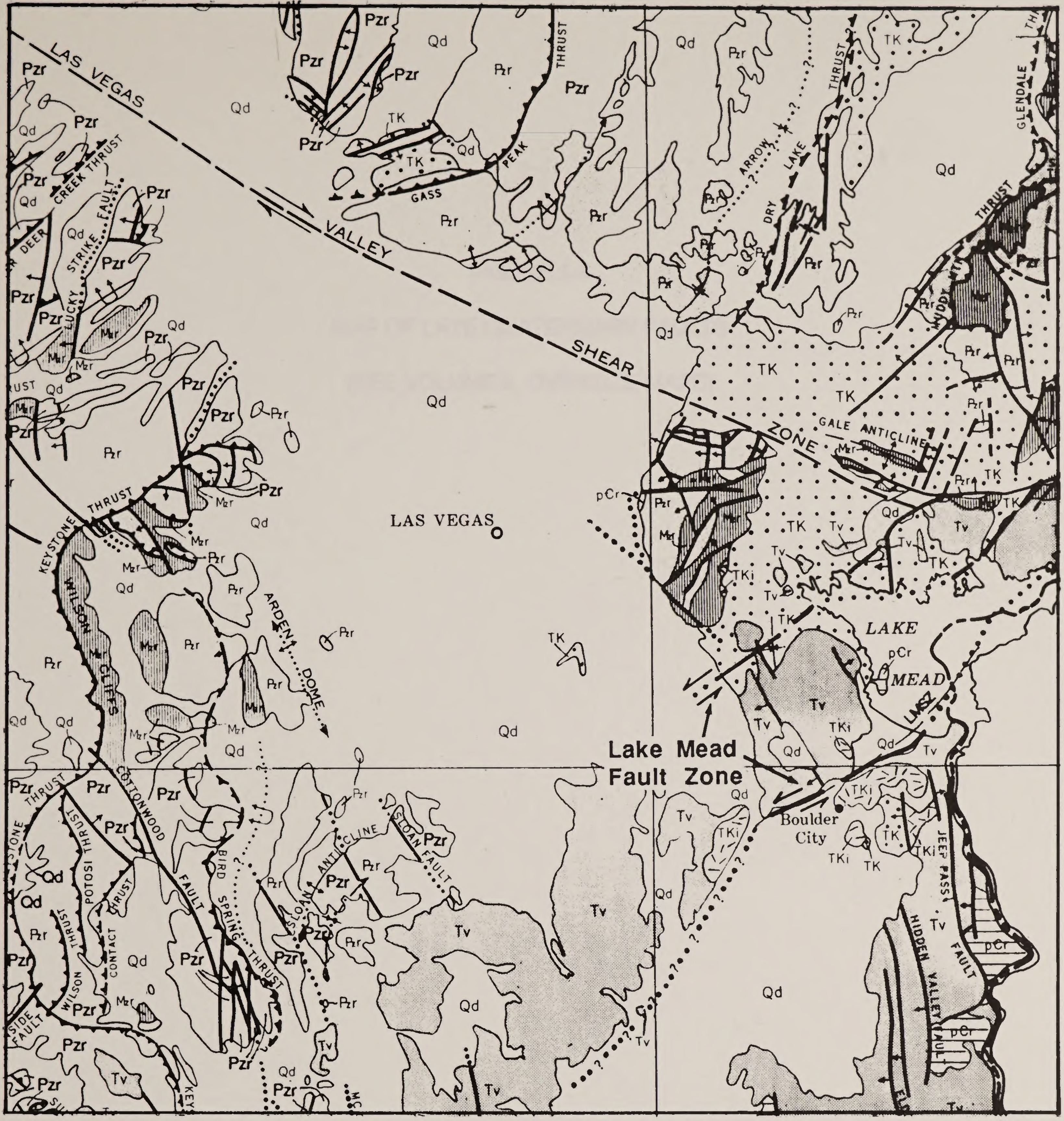

EXPLANATION

Qd	Quaternary Deposits
TK	Tertiary Sedimentary Rocks
Tv	Tertiary Volcanic Rocks
TKi	Terciary and Cretaceous(?) Intrusive Rocks
Mzr	Mesozoic Rocks
Pzr	Paleozoic Rocks
pCr	Precambian Rocks

0 5 10 15 MILES

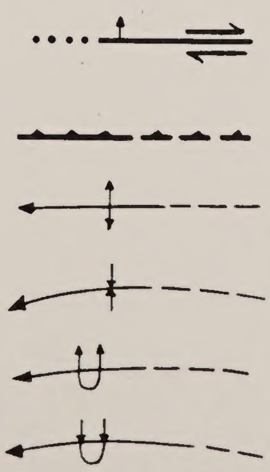

FIGURE 5-3

GENERALIZED GEOLOGIC MAP OF THE LAS VEGAS VALLEY AREA

Source: Modified from Longwell et al.,1965 and Bohannon, 1979

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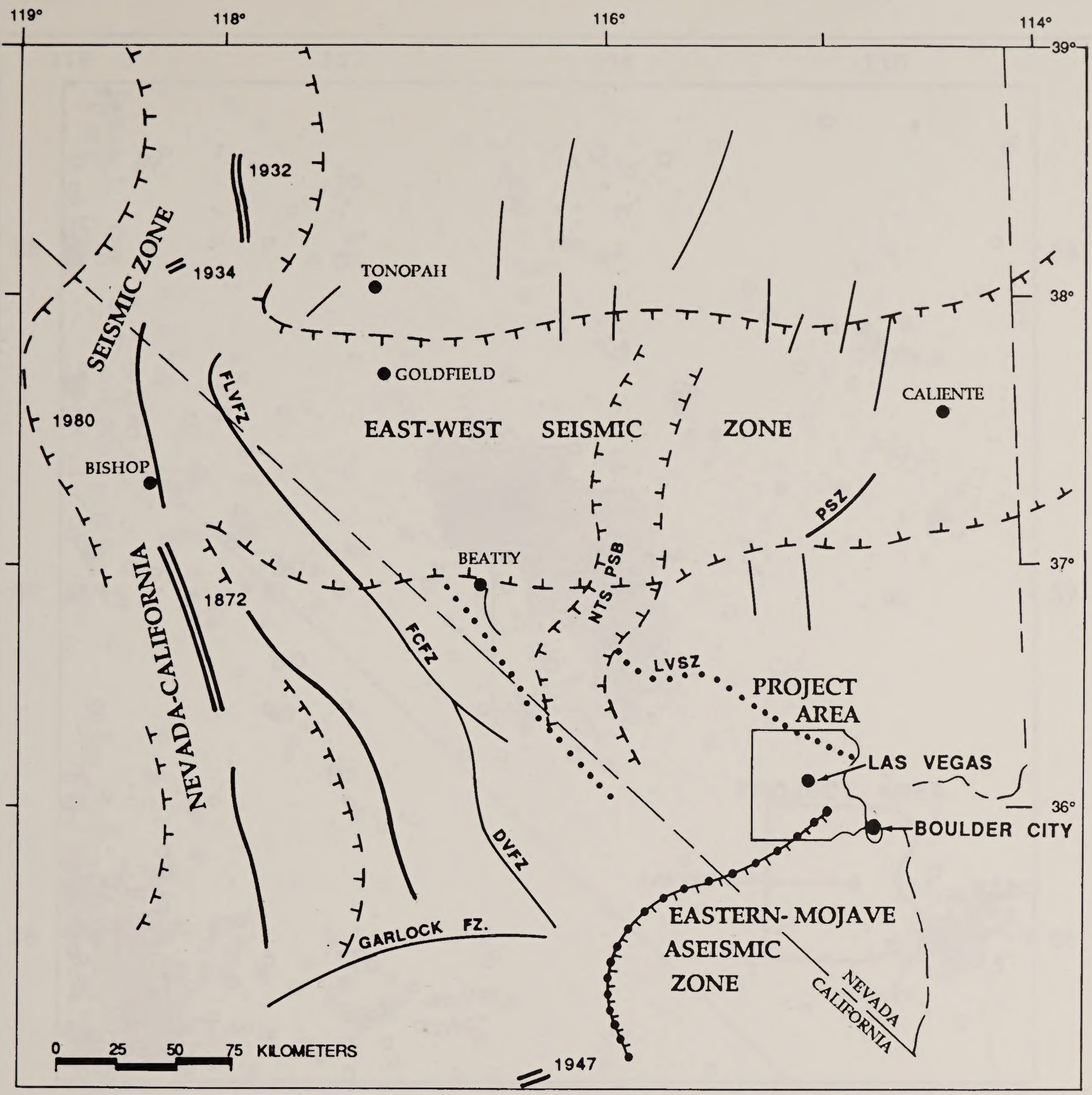
FIGURE 5-4

MAP OF LATE QUATERNARY FAULTS

(SEE VOLUME II, OVERSIZE MAPS)



LEGEND

1872 HISTORIC RUPTURE, YEAR

SEISMICALLY ACTIVE WITH QUATERNARY FAULTS

SEISMICALLY INACTIVE WITH QUATERNARY FAULTS

SEISMICALLY INACTIVE WITHOUT QUATERNARY FAULTS

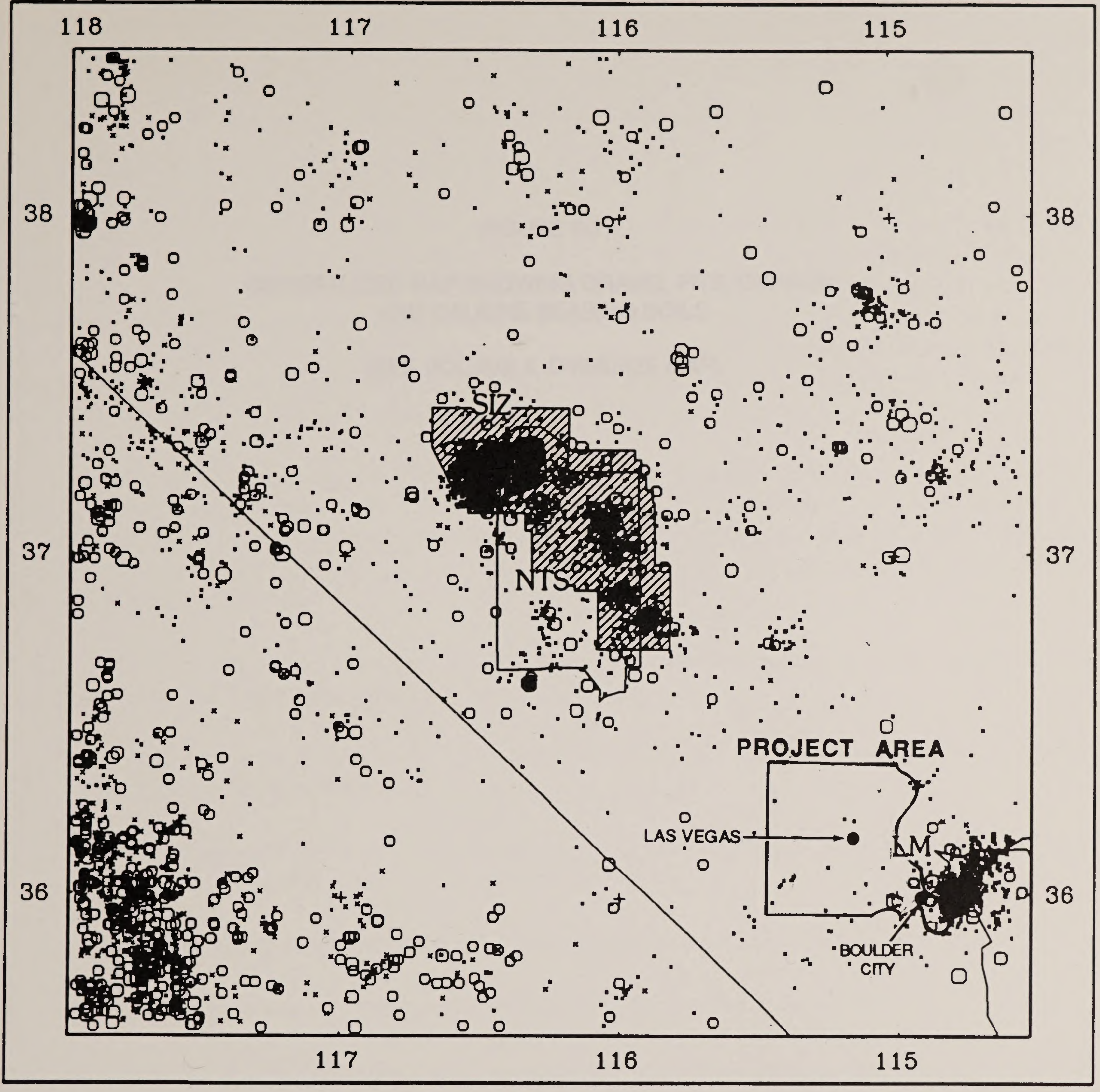
EASTERN MOJAVE ASEISMIC AREA

FLVFZ	FISH LAKE VALLEY FAULT ZONE
FCFZ	FURNACE CREEK FAULT ZONE
DVFZ	DEATH VALLEY FAULT ZONE
LVSZ	LAS VEGAS VALLEY SHEAR ZONE
PSZ	PAHRANAGAT SHEAR ZONE
NTSPSB	NEVADA TEST SITE PALEOSEISMIC BELT
FZ	FAULT ZONE

FIGURE 5-5

GENERALIZED SEISMIC ZONES AND TECTONIC FEATURES IN THE SOUTHERN GREAT BASIN

Source: Meremonte and Rogers, 1987



<u>**LEGEND**</u>

SIZ	ZONE OF POTENTIALLY INDUCED SEISMICITY
NTS	NEVADA TEST SITE
LM	LAKE MEAD

·	0.00 <= MAGNITUDE < 2.00
×	2.00 <= MAGNITUDE < 3.00
○	3.00 <= MAGNITUDE < 4.00
○	4.00 <= MAGNITUDE < 5.00
○	5.00 <= MAGNITUDE < 8.00

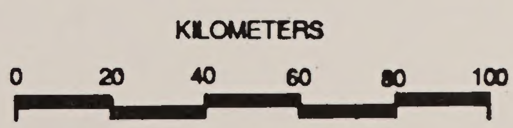


FIGURE 5-6

HISTORICAL SEISMICITY OF THE SOUTHERN GREAT BASIN FROM SEPT. 4, 1868 TO JULY 29, 1978

Source: Meremonte and Rogers, 1987

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FIGURE 5-7

GENERALIZED MAP SHOWING GRAVEL PITS, GYPSUM, AND CALICHE BEARING SOILS

(SEE VOLUME II, OVERSIZE MAP)

6.1 GENERAL ENVIRONMENTAL CONDITIONS

6.1.1 Hydrogeologic Setting

The majority of the proposed flood control facilities are located in the Las Vegas Valley alluvial basin, which is an intermontane structural depression in the Basin and Range physiographic province. The basin is bounded to the west by the Spring Mountains, to the north by the Sheep and Las Vegas Ranges, to the east by Frenchman and Sunrise Mountains, and to the south by the River Mountains and the McCullough Range (Plume, 1984). Boulder City is located outside of the Las Vegas basin and is situated between the Las Vegas Valley to the northwest and the Eldorado Valley to the southwest. The hydrogeologic setting of Boulder City is described in detail in Section 6.2.4.

Las Vegas Valley basin is filled with a complex sequence of interfingered and intermixed deposits of boulders, gravels, sands, silts, and clays, which reach thicknesses of up to 5,000 feet in parts of the valley (Harrill, 1976). The valley fill is derived from carbonate and clastic sedimentary rocks from the north, west, and east; volcanic and intrusive igneous rocks from the south; and metamorphic rocks from the east (Noack, 1988).

Ground water in the Las Vegas Valley occurs in four general aquifer systems as follows (Van Denburgh et al., 1982; Brothers and Katzer, 1988):

- Shallow aquifers are defined as being 0-50 feet below ground surface where ground water is within 20 feet of ground surface.

- Near-surface reservoir is defined as being 0-200 feet below the water table where the water table is greater than 20 feet below ground surface.

- Principal aquifers (generally greater than 200 feet below the water table).

- Regional carbonate aquifers (occurring at depths of several thousand feet).

Ground water used for drinking water is generally produced at a depth of about 700 to 1100 feet below ground surface (bgs) from course alluvium within the principal aquifer system on the west side of the valley (Kaufmann, 1978). These alluvial deposits are more permeable and therefore more productive than the fine-grained sediments in the central and eastern portions of the valley (Dettinger, 1987).

Generally, ground water moves down gradient from the west and northwest to the east and southeast across the valley (Van Denburgh et al., 1982). Hydraulic head and water quality vary with depth and location because water flows both horizontally and vertically in the Las Vegas valley. Horizontal water flow occurs more easily than vertical water flow because the flatlying strata are interlayed with impermeable or low permeability sediments.

6.1.2 Hydrogeologic Units

6.1.2.1 Shallow Aquifers

The shallow aquifers occur in the central portion of the valley, in the vicinity of Alta Drive to the north and Sunset Road to the south; and Decatur Boulevard to the west and Frenchman and Sunrise

Mountains to the east (Brothers and Katzer, 1988; Cibor, 1983; Converse Consultants, 1985; Harrill and Katzer, 1980; Katzer et al., 1985; and Van Denburgh et al., 1982). The approximate distribution of the shallow aquifers is shown in Figure 6-1. The aerial extent of the shallow aquifers in other parts of the valley is currently unknown. The occurrence of phreatophytes in the valley, including mesquite, indicate a shallow water table of less than 50 feet bgs. Mesquite taps ground water in the valley up to a depth of 50 feet. Most other phreatophytes in the valley are restricted to areas where the water table is within a few feet of the land surface or along surface drainages with relatively continuous surface flows (Converse Consultants, 1985).

The shallow aquifers consist primarily of silts and clays interbedded with sand, gravel, and caliche layers (Kaufmann, 1978). These aquifers are generally unconfined; however, confined to semi-confined conditions exist locally (Dettinger, 1987). The shallow aquifer is 0 to 30 feet thick, where the water table occurs within 20 feet of the land surface (Brothers and Katzer, 1988).

6.1.2.2 Near-Surface Reservoir

The near-surface reservoir is present under approximately 50 percent of the valley. It generally extends from north of Tule Spring in the northwest corner of the valley to north of Nellis Air Force Base, southward to Henderson and westward to west of I-15. Figure 6-2 shows the approximate extent and thickness of the near-surface reservoir as determined by Harrill (1976).

As in the shallow aquifers, the near-surface reservoir is composed primarily of silts and clays with interstratified deposits of sands, gravels, and caliche layers (Kaufmann, 1978). Ground water in the near-surface reservoir is also primarily unconfined and generally parallels land surface (Dettinger, 1987). The thickness of the near-surface reservoir is reported to be in the range of 0 to 200 feet (Brothers and Katzer, 1988; Van Denburgh et al., 1982; and Maxey and Jameson, 1948). Harrill (1976) noted that the near-surface reservoir is sometimes difficult to delineate, because where it is unconfined, there are no distinct lithologic boundaries between it and the shallow zone of the principal aquifers (see below).

6.1.2.3 Principal Aquifers

The principal aquifer system underlies the entire Las Vegas Valley and consists of three indistinct confined aquifer zones, including a shallow, middle, and deep zone (Maxey and Jameson, 1948). These aquifers generally consist of sand and gravel interbedded with lesser amounts of silt and clay (Kaufmann, 1978). Because of decreasing quantities of sand and gravel from west to east across the valley, aquifers in the eastern two-thirds of the valley yield progressively less water (Kaufmann, 1978). The approximate potentiometric surface of the principal aquifer system is shown on Figure 6-3.

The shallow zone of the principal aquifer system generally lies below a depth of about 200 feet bgs. This zone is present to depths of approximately 450 feet bgs and is underlain by a 10 to 60 foot thick, blue clay horizon (Kaufmann, 1978; Broadbent, 1980) The middle zone, which underlies the blue clay layer, occurs at depths of about 500 to 700 feet bgs. The deep zone of the principal aquifers is defined as those aquifers present at depths greater than about 700 feet bgs.

6.1.2.4 Regional Carbonate Aquifers

Hess and Mifflin (1978) proposed that the Las Vegas Valley is underlain at several thousand feet bgs by a regional carbonate aquifer system. Ground water in the aquifer is believed to move into the valley from the northeast. Well logs indicate that the regional carbonate aquifer is separated from the principal aquifers by approximately 2,700 feet of aquitard (Noack, 1988). Because little is known regarding this aquifer, no additional discussion is presented in the following sections.

6.1.3 Ground-Water Occurrence and Flow

6.1.3.1 Shallow Aquifers

Generally, all shallow ground water in the valley discharges to Las Vegas Wash and its tributaries. As a result, the ground water in the shallow aquifers generally flows to the southeast, however, in the southeast part of the valley, shallow ground water flows northeast towards Las Vegas Wash (Converse Consultants, 1985).

6.1.3.2 Near-Surface Reservoir

The water table in the near-surface reservoir generally slopes eastward toward the base of Frenchman Mountain, the lowest point in Las Vegas Valley (Malmberg, 1961; and Dinger, 1977). Thus, the movement of ground water in the near-surface reservoir is primarily towards the east. However, the amount of water moving through the unit is believed to be small due to the low transmissivity of the sediments (Malmberg, 1961).

6.1.3.3 Principal Aquifers

Based on potentiometric maps of the alluvial aquifers compiled by Broadbent (1980) (Figure 6-3), ground water in the northwestern portion of the valley flows southeast at a gradient ranging from approximately 0.005 to 0.024. Ground water in the eastern half of the valley generally flows eastward and southward at a gradient of 0.006 to 0.016. Ground water in the southwestern portion of the valley flows to the northwest at a gradient of 0.004 to 0.016.

Under prepumping conditions, the potentiometric surface in the principal aquifers was above the water table in the overlying aquifers throughout most of the central part of the valley. By 1975, the potentiometric surface had declined as much as 180 feet due to over pumping, significantly reducing the artesian recharge of the overlying aquifers (Broadbent, 1980).

The primary producing horizons in the shallow zone of the principal aquifer system occur in several sand and gravel lenses at approximate depths of 200 feet, 300 feet, 350 feet, 400 feet, and 450 feet bgs (Broadbent, 1980). Prior to 1940, the shallow zone was the principal source of ground water in the Las Vegas Valley. However, the middle zone is currently the principal source (Broadbent, 1980). Only small quantities of ground water are withdrawn from the deep zone aquifers because they are thin and generally contain considerable silt and clay (Maxey and Jameson, 1948; Broadbent, 1980).

Zones of highest transmissivity in the principal aquifer system occur in the west-central portion of the Las Vegas Valley from approximately T19S, R60E to T21S, R60E (Harrill, 1976). The main well field of the Las Vegas Valley Water District (LVVWD) produced approximately 60 percent of all the ground water extracted in the valley until 1973 (Figure 6-1). Since the late 1960's, ground-water production by the LVVWD and City of North Las Vegas has shifted to the north utilizing deeper wells with higher yields (Kaufmann, 1978).

6.1.4 Ground-Water Quality

6.1.4.1. Shallow Aquifers

The natural water quality of the shallow aquifers is poor. Water quality in the shallow aquifers has been further degraded by infiltration of irrigation waters and surface runoff containing fertilizers, organics, and other contaminants (Nevada Division of Environmental Protection, 1987; Brothers and Katzer, 1988).

Total dissolved solids (TDS) concentrations in the shallow ground water are up to approximately 8,000 milligrams per liter (mg/l) in the eastern portion of the valley (Table 6-1, Figure 6-1). These concentrations have increased significantly over the past eight years, apparently a result of secondary recharge to the shallow aquifer from landscape irrigation (Brothers and Katzer, 1988). However, some of the degradation could be due to seasonal fluctuations in the water levels of the shallow aquifers. Ground-water levels are typically higher in the winter and lower in the summer (Converse Consultants, 1985). Evaporation during the summer season causes salts to be precipitated in the unsaturated zone and increase TDS concentrations in the ground water (Converse Consultants, 1985; Brothers and Katzer, 1988). Downward migration of poor quality water from the shallow aquifer into the near surface reservoir and principal aquifer systems can potentially degrade water quality from the near surface reservoir and principal aquifer systems (Brothers and Katzer, 1988).

6.1.4.2 Near-Surface Reservoir

Generally, poor quality ground water in the near-surface reservoir is not used for drinking water (Brothers and Katzer, 1988). Representative water quality data and the location of some of these wells are presented in Table 6-1 and Figure 6-1. In parts of North Las Vegas, the near-surface reservoir contains high levels of nitrates, which are concentrated at depths of about 80-100 feet bgs (Hess and Patt, 1977). These high nitrate concentrations are believed to be from natural mineral sources (Hess and Patt, 1977). High nitrate concentrations also occur in the eastern parts of the valley and are thought to be closely related to waste disposal activities in the Henderson area (Kaufmann, 1978). Poor water quality in the near-surface reservoir is also a result of urbanization and associated irrigation, which have resulted in downward leaching of salts from the soil profile (Kaufmann, 1978).

In the southeastern portion of the valley, an extensive shallow water table has developed due to return flows from nonpoint sources such as unlined irrigation ditches and industrial and sanitary waste discharges (Kaufmann, 1978). The prevailing ground-water flow is eastward, thus the saline, nitrate laden ground water tends to discharge in the eastern portion, or low point of the valley, along Las Vegas Wash (Kaufmann, 1978).

Thirty-five ground-water samples collected from the near-surface reservoir showed average chloride and TDS concentrations of 311 mg/l and 2,824 mg/l, respectively (Dinger, 1977). These concentrations exceed EPA secondary drinking water standards, 250 mg/l and 500 mg/l, respectively. Shallow wells in the near-surface reservoir in the central and southeastern portions of the valley show TDS concentrations ranging from approximately 2,000 to 7,000 mg/l (Dettinger, 1987). Representative water quality data and the location of some of these wells are presented in Table 6-1 and Figure 6-1.

6.1.4.3 Principal Aquifers

Ground-water quality in the principal aquifer underlying the project area becomes progressively poorer to the south. Representative water quality data and the location of some of these wells are presented in Table 6-1 and Figure 6-1. TDS ranges from 200 to 400 mg/l in the north and northwest part of the valley, whereas ground water in the south contains TDS concentrations ranging from 700 to 1500 mg/l (Dettinger, 1987). In addition, the lithology of the hydrogeologic unit typically influences ground-water chemistry. Ground water that occurs in the principal aquifer in the northern and western parts of Las Vegas Valley, an area composed primarily of carbonate rocks, consists of calcium-magnesium-bicarbonate water (Weaver, 1982). Similarly, ground water in the southern and southeastern portions of the valley, an area composed of primarily volcanic rocks, is sodium-potassium-bicarbonate type. The east, southeast, and southwest portions of the valley contain a mixed-cation sulfate type water, typical of the Horse Spring and Muddy Creek Formations from which it was derived. Ground water in this area is generally of poor quality (Lyles et al., 1987).

The potential exists for the quality of water in the principal aquifer system to decrease in the valley as a result of infiltration of poor quality water in the overlying aquifers. With the historic decrease of the potentiometric surface in the principal aquifers, the potential for degradation of ground-water quality in the principal aquifer is significant (Brothers and Katzer, 1988).

6.1.5 Ground-Water Recharge and Discharge

Prior to the development of Las Vegas and the surrounding communities, ground water flowed to the valley from the recharge areas west and northwest of the valley. Ground water discharged through Las Vegas Springs on the west-central side of the valley and into Las Vegas Creek, Kyle Springs, and Whitney Mesa Springs (Noack, 1988, Figure 6-4). Artesian conditions in the principal aquifers caused ground water to flow upwards and recharge the overlying aquifers, which discharged into Las Vegas Wash through seeps and springs and by evapotranspiration (Figure 6-5).

The near-surface reservoir, formerly recharged by upward flow from the principal aquifers, is now recharging the principal aquifers (Figure 6-6). As the population of Las Vegas grew and ground-water pumpage increased, the potentiometric surface in the principal aquifers and the water levels in near-surface reservoirs declined. Concurrently, the shallow aquifer system (water table within 20 feet of the land surface) was rising as a result of increased irrigation. For several decades, the ground water from the principal aquifer system in Las Vegas Valley was pumped at a rate two to three times the natural recharge rate, causing the decline in potentiometric surface. As a result, the natural hydraulic gradient has been reversed.

Declining ground-water levels in the principal and near-surface aquifers have caused subsidence problems in several parts of Las Vegas Valley. Since 1955, the ground-water levels have dropped 180 feet in the principal aquifers. Associated land subsidence, approximately 3.8 feet, has been documented in proximity to the main ground-water pumping areas (Cibor, 1983). In the vicinity of the LVVWD main well field, water levels have declined approximately 300 feet, creating a large depression in the potentiometric surface. This depression has caused water from the southwest and northwest to be deflected toward the main well field and a ground-water barrier to develop in the central part of the valley, east of the main well field (Weaver, 1982). Water level declines in the North Las Vegas and Nellis Air Force Base well field have not been as pronounced.

6.1.5.1 Shallow Aquifers

The shallow aquifers are recharged primarily by irrigation and urban runoff. The volume of water from both sources has increased significantly as a result of the extensive development in Las Vegas Valley. Water levels in the shallow aquifers are subsequently rising (Brothers and Katzer, 1988; Converse Consultants, 1985). Converse Consultants (1985) reported recharge to the shallow aquifers from domestic irrigation increased from 1,662 acre-feet per year in 1974 to 3,264 acre-feet per year in 1982. Brothers and Katzer (1988) projected that the shallow ground water will extend further westward as development continues in the western portions of the valley. The shallow aquifers discharge by direct evaporation, transpiration from phreatophytes, and discharge into Las Vegas Wash and its tributaries. Water from the shallow aquifers also infiltrates downward to the near-surface reservoir (Brothers and Katzer, 1988). The estimated configuration of the shallow aquifer water table is shown in Figure 6-1.

Significant direct infiltration of precipitation to aquifers in the valley does not occur, as the arid climate of Las Vegas Valley generally yields less than five inches of annual precipitation and has approximately 80 inches of potential evaporation (Dinger, 1977).

6.1.5.2 Near-Surface Reservoir

Currently, the principal sources of recharge to the near-surface reservoir includes irrigation return flows, septic tank and sewage treatment plant effluents, industrial effluent ditches and disposal ponds, and infiltration from the shallow aquifers (Kaufmann, 1978; Blegen, 1988; Brothers and Katzer, 1988). Natural discharge in the near-surface reservoir is from evapotranspiration, and discharge to surface water courses, primarily the Las Vegas Wash (Kaufmann, 1978).

Prior to ground-water development, which effectively began in 1907 and constituted an overdraft by the 1940's, recharge to the near-surface reservoir was principally by upward movement from underlying aquifers. As a result of pumping from deeper aquifers, the gradient in the near-surface reservoir has reversed, causing the potential for ground water from the near-surface reservoir to discharge into underlying aquifers (Kaufmann, 1978).

6.1.5.3 Principal Aquifers

Recharge to the principal aquifers is primarily a result of infiltration of precipitation in surrounding mountainous recharge areas. Rainfall and snowmelt in the Spring Mountains, and to a lesser extent, in the Las Vegas and Sheep Ranges, infiltrates directly into the bedrock through fractures and joints and recharges the principal aquifers at the soil/bedrock interface. Recharge to the principal aquifer from infiltration into alluvial fans is considered to be insignificant (Katzer, 1989). Minor recharge occurs in the McCullough Range and from the Frenchman-Sunrise block east of the valley (Kaufmann, 1978). Between 25,000 and 35,000 acre-feet/year is recharged to the principal aquifers under natural conditions (Brothers and Katzer, 1988). Discharge from the principal aquifers occurs by pumping, which amounted to about 67,000 acre-feet in 1987 (Coache, 1987). Discharge from the principal aquifer is estimated to be approximately twice the natural recharge in the Las Vegas Valley. The principal aquifers may discharge a minor amount to the near-surface reservoir near Las Vegas Wash as a result of upward artesian flow (Malmberg, 1961; Kaufmann, 1978).

In an attempt to minimize depletion of ground water in the principal aquifers and to fully utilize the allotted Colorado River water of 300,000 acre-feet/year, research has been conducted to evaluate the feasibility of artificially recharging the principal aquifer system with Colorado River water (Broadbent, 1980; Weaver, 1982). Broadbent (1980) modelled the different artificial recharge locations and determined that the LVVWD well field area was best suited for artificial recharge (Figure 6-1). Weaver (1982) calculated saturation indices for different minerals in the ground water in the valley and determined that calcite ($CaCO_3$) may precipitate when the river water is artificially recharged into the principal aquifers. The first attempt at artificial recharge was conducted in the valley in 1987 when two acre-feet of potable river water was injected into the ground-water basin (Coache, 1987). The river water was successfully injected and calcite precipitation apparently did not occur. Katzer and Brothers (1989) concluded that artificial recharge of the principal aquifers in the Las Vegas Valley was a viable method to increase recharge to the principal aquifers.

6.1.6. Ground-Water Usage

6.1.6.1 Shallow Aquifers

Due to the high TDS concentrations in the ground water of the shallow aquifer, the unit is not used for drinking water (Brothers and Katzer, 1988). Brothers and Katzer (1988) suggested that the shallow aquifer ground water could be used for irrigation in the central and eastern portions of the valley to assist in conserving potable water supplies currently used for irrigation and to reduce the rising shallow water table.

6.1.6.2 Near-Surface Reservoir

In 1976, Harrill reported that approximately five percent of the developed ground water in the Las Vegas Valley came from the near-surface reservoir. However, LVVWD indicated that the ground water in the near-surface reservoir is not used at present because of poor quality (Katzer, 1989).

6.1.6.3 Principal Aquifers

The total water use from all sources for Las Vegas Valley in 1987 was approximately 241,000 acre-feet (Coache, 1987). Approximately 28 percent or 67,000 acre-feet/year of the public water supply for Las Vegas Valley was obtained from wells completed in the principal aquifer. The remaining 72 percent or 174,000 acre-feet/year was from surface water imports from the Colorado River via Lake Mead (Coache, 1987). Until Southern Nevada uses its entire allocation of Colorado River water of approximately 299,000 acre-feet/year a reliance on ground water is projected to continue to decrease and the use of Lake Mead water will increase.

A breakdown of the 67,000 acre-feet/year of ground water produced in Las Vegas Valley during 1987 is described below. The North Las Vegas Well Field produced 5,635 acre-feet; the LVVWD Well Field produced 37,145 acre-feet; and the Nellis Air Force Base Well Field produced 1,855 acre-feet. An additional 22,643 acre-feet of ground water was estimated to be produced from all permitted and domestic wells in the valley.

6.2 SPECIFIC ENVIRONMENTAL CONDITIONS BY SUBAREA

This section contains a discussion of ground water in the valley by subareas. Specific parameters of concern to the proposed project are related to recharge and discharge to the shallow and primary aquifers.

6.2.1 Northern Las Vegas Valley Subarea

6.2.1.1 Hydrogeologic Units

The hydrogeologic units of the shallow, near-surface, and principal aquifer systems in the valley are similar to the units in other parts of the valley as described in Section 6.1.2.

6.2.1.2 Ground-Water Occurrence and Flow

Shallow Aquifers

The shallow aquifers in this subarea are projected to occur between Las Vegas Wash and the Frenchman-Sunrise Block (Cibor, 1983). Although the ground water in the Las Vegas Valley generally flows to the southeast, ground water in this subarea flows southwest towards Las Vegas Wash (Figure 6-1). Section 6.1.3.1 contains more details on the occurrence and flow of shallow ground water in the subarea.

Near-Surface Reservoir

The near-surface reservoir is present in the northern subarea from north of Tule Spring southeast to Nellis Air Force Base and south to Las Vegas Wash (Harrill, 1976). Flow direction is primarily to the southeast (see Section 6.1.3.2).

Principal Aquifers

The entire subarea is underlain by the principal aquifers. Ground water in the aquifers flows generally towards the southeast. Section 6.1.3.3 contains more details on the occurrence and flow of the ground water in the principal aquifers in the valley.

6.2.1.3 Ground-Water Quality

Shallow Aquifer

The water quality of the shallow aquifers in the subarea is generally poor with high levels of TDS and nitrates being of greatest concern. Section 6.1.4.1 contains more details on the overall water quality of the shallow aquifers in the valley.

Near-Surface Reservoir

Ground-water quality of the near-surface reservoir is described in Section 6.1.4.2. Elevated nitrate levels occur in near-surface ground water in the west-central part of the subarea (Hess and Patt, 1977).

Principal Aquifers

The ground-water quality of the principal aquifers in the subarea is generally good as described in Section 6.1.4.3.

6.2.1.4 Ground-Water Recharge and Discharge

Shallow Aquifers

Shallow aquifers are recharged primarily through irrigation and urban runoff as described in Section 6.1.5.1. In this subarea, the shallow aquifers are projected to occur near the east bank of Las Vegas Wash (Cibor, 1983), and are recharged by irrigation and runoff from the developed area between the Wash and Frenchman Mountain. The shallow aquifers discharge into Las Vegas Wash and its tributaries, through evaporation, and through transpiration from phreatophytes. Section 6.1.5.1 contains more details on shallow aquifer recharge and discharge.

Near-Surface Reservoir

Recharge and discharge of ground water in the near-surface reservoir aquifers in the subarea are as described in Section 6.1.5.2.

Principal Aquifers

Recharge to the principal aquifers occurs primarily in the mountainous western and northern parts of the subarea as described in Section 6.1.5.3. The principal aquifers in the subarea discharge through pumpage, which occurs at Tule Spring, Nellis Air Force Base Well Field, and also at numerous domestic and permitted wells in the valley.

6.2.1.5 Ground-Water Usage

Shallow Aquifers

Due to its poor quality as described in Section 6.1.6.1, the ground water in the shallow aquifers is not used for drinking water in the valley (Brothers and Katzer, 1988).

Near-Surface Reservoir

The ground water in the near-surface reservoir is generally not used for drinking water in the valley because of its poor quality (Section 6.1.6.2).

Principal Aquifers

The State Engineer's Office reported ground-water pumpage from the Nellis Air Force Base Well Field to be 1,855 acre-feet in 1987. Domestic wells, most of which are in the western part of the subarea, pumped 6,103 acre-feet in 1987 (Coache, 1987).

6.2.2. Central Las Vegas Valley Subarea

6.2.2.1. Hydrogeologic Units

The hydrogeologic units of the shallow, near-surface, and principal aquifer systems in this subarea are similar to the units in other parts of the valley as described in Section 6.1.2.

6.2.2.2 Ground-Water Occurrence and Flow

Shallow Aquifers

Shallow aquifers are present in the Central Las Vegas Valley subarea and known to occur from near Alta Drive southward to the boundary of the subarea. The aquifers occur as far west as Decatur Boulevard and east to Las Vegas Wash. The shallow aquifers may extend further west in the subarea than available data indicates. Brothers and Katzer (1988) projected that the shallow ground water will extend westward as development continues in the western part of the valley. Shallow ground water generally flows southeastward towards Las Vegas Wash.

Near-Surface Reservoirs

According to Harrill (1976), the near-surface reservoir extends across the eastern half of the subarea, from approximately James Boulevard to Las Vegas Wash. The ground water flows southeastward towards Las Vegas Wash.

Principal Aquifers

The entire subarea is underlain by the principal aquifers, and ground water in the aquifers generally flows eastward and southeastward across the area (see Section 6.1.3).

6.2.2.3 Ground-Water Quality

Shallow Aquifers

The water quality of ground water in the shallow aquifers in the valley is generally poor, as described in Section 6.1.4.1. In the eastern part of the subarea, Dettinger (1987) found concentrations of TDS, chloride, magnesium, and sulfate in shallow ground water that exceeded EPA Secondary Drinking Water Standards.

Near-Surface Reservoir

As discussed in Section 6.1.4.2, water in the near-surface reservoir is of poor quality. Water from the near-surface reservoir in this subarea contains TDS concentrations ranging from 2,000 to 7,000 mg/l (Dettinger, 1987). Ground water from this unit is not used for drinking water.

Principal Aquifers

The ground water in the principal aquifers in the western part of the subarea is of good quality and meets the EPA Primary Drinking Water Standards (Section 6.1.4.3). The eastern part of the subarea contains poorer quality water with high natural sulfate levels (Weaver, 1982).

6.2.2.4 Ground-Water Recharge and Discharge

Shallow Aquifers and Near Surface Reservoirs

The shallow and near-surface aquifers are recharged and discharged as described in Section 6.1.5.1. The developed areas that recharge the aquifers by over-irrigation are generally in the eastern part of the subarea. The shallow aquifers discharge to the underlying near-surface reservoir and to Las Vegas Wash and its tributaries to the east. The aquifers also discharge through evaporation and transpiration from phreatophytes growing along Las Vegas Creek and Las Vegas Wash.

Principal Aquifers

Recharge to and discharge from the principal aquifers in the valley is described in Section 6.1.5.3. The principal aquifers in the subarea are recharged in the Spring Mountains in the western part of the area and through infiltration of runoff into the alluvial fans near Lone Mountain. The aquifers discharge through pumpage at the LVVWD well field (Figure 6-1), North Las Vegas well field and through permitted and domestic wells throughout the subarea.

6.2.2.5 Ground-Water Usage

Shallow Aquifers and Near-Surface Reservoir

As discussed in Section 6.1.6.1, ground water in the shallow and near-surface aquifers is not used for drinking water in this area.

Principal Aquifers

In 1987, the North Las Vegas well field in this subarea pumped 16,540 acre-feet of ground water from the principal aquifers, and the LVVWD well field pumped 37,145 acre-feet of water. An unknown number of permitted and private wells pumped the ground water in this subarea in 1987 (see Section 6.1.6.3).

6.2.3 Southwest Las Vegas Valley Subarea

6.2.3.1 Hydrogeologic Units

The hydrogeologic units of the shallow, near-surface, and principal aquifer systems in this subarea are similar to the units in other parts of the valley as described in Section 6.1.2.

6.2.3.2 Ground-Water Occurrence and Flow

Shallow Aquifers

The shallow aquifers in this subarea occur between approximately I-15 and Las Vegas Wash which encompasses the eastern third of the subarea (Figure 6-1). The ground water flows eastward towards Las Vegas Wash, and as evidenced by the occurrence of phreatophytes, some of the shallow ground water enters Tropicana and Flamingo Washes, which flow east-northeast across the subarea towards Las Vegas Wash.

Near-Surface Reservoir

The near-surface reservoir underlies the eastern half of the subarea from about Jones Boulevard to the west to Las Vegas Wash (Harrill, 1976). The ground water in the reservoir flows east-northeast towards Las Vegas Wash.

Principal Aquifers

The entire subarea is underlain by the principal aquifers in which ground water generally flows toward the east-northeast.

6.2.3.3 Ground-Water Quality

Shallow Aquifers

The water quality of the shallow aquifers in this part of the valley is generally poor with highest TDS, chloride, magnesium, and sulfate concentrations in the northwest section of the subarea (Dettinger, 1987; see Section 6.1.4.1).

Near-Surface Reservoir

The near-surface reservoir ground water in this subarea contains natural sulfate levels that are higher than in central Las Vegas Valley subarea.

Principal Aquifers

Ground water in the central part of this subarea is a calcium-magnesium-bicarbonate-sulfate type (Lyles et al., 1987; Katzer and Brothers, 1989), whereas water entering the subarea from the north is a calcium-magnesium bicarbonate type (Weaver, 1982). The ground water recharging the area from the south is a sodium-potassium bicarbonate type (Dettinger, 1987). The water quality in this subarea is of poorer quality for drinking than ground water from the principal aquifer in the northern and central Las Vegas Valley subareas (see Section 6.1.4.3).

6.2.3.4 Ground-Water Recharge and Discharge

Shallow Aquifers and Near-Surface Reservoir

The shallow and near-surface aquifers recharge and discharge in the subarea as described in Section 6.1.5. Both units discharge shallow ground water to Las Vegas Wash.

Principal Aquifers

Ground water recharges the principal aquifers in the Spring Mountains on the west side of the subarea. Ground water discharges from several springs in bedrock along the westside of the area (Longwell et al., 1965) and from the spring at Whitney Mesa, located on the eastern boundary of the subarea. This spring contains flowing ground water (Brothers and Katzer, 1988).

6.2.3.5 Ground-Water Usage

Shallow Aquifers and Near-Surface Reservoir

As discussed in Sections 6.1.6.1 and 6.1.6.2, the ground water in the shallow and near-surface aquifers is probably not used for drinking water in this subarea.

Principal Aquifers

There are no public well fields in this subarea; however, numerous permitted and domestic wells produce water in this subarea, primarily from the principal aquifers (Nevada Division of Water Resources, 1989).

6.2.4 Boulder City Subarea

6.2.4.1 Hydrogeologic Units

Part of Boulder City subarea overlies the bedrock divide between the River Mountains to the north and the Eldorado Mountains to the south. The southern part of the city is located on alluvial deposits in the northeast corner of Eldorado Valley. The bedrock consists of Tertiary volcanic rocks that are fairly impermeable (Rush and Huxel, 1966).

6.2.4.2 Ground-Water Occurrence and Flow

The ground water in the northern part of Eldorado Valley generally flows south and southeastward through the volcanic rocks towards the Colorado River at depths greater than 300 feet (Rush and Huxel, 1966).

6.2.4.3 Ground-Water Quality

The ground-water quality in the subarea is reported to be poor, with high salinity and TDS concentrations (Rush and Huxel, 1966). There are no ground-water wells in Boulder City, and the closest producing well is located at Railroad Pass, between Eldorado and Las Vegas Valleys (Coache, 1988).

6.2.4.4 Ground-Water Recharge and Discharge

Ground water in this area is recharged by infiltration of precipitation from the surrounding mountains and from downward percolation of surface waters discharged by Boulder City. The city discharges used river water to the sewage treatment plant southwest of Boulder City where it evaporates or percolates into the alluvium (Rush and Huxel, 1966). The drinking water supply for Boulder City is imported from the Colorado River via Lake Mead, with the average import for 1987 being approximately 6302 acre-feet (Coache, 1987).

6.2.4.5 Ground-Water Usage

Ground water is not used for drinking water in Boulder City (Coache, 1988).

6.2.5 Henderson Subarea

6.2.5.1 Hydrogeologic Units

The hydrogeologic units of the shallow, near-surface, and principal aquifer systems in this subarea are as described in Section 6.1.2. The shallow and near-surface aquifers overlie the Muddy Creek Formation in the subarea, and the depth to the formation varies from about 20 to 50 feet (Blegen, 1988).

6.2.5.2 Ground-Water Occurrence and Flow

Shallow and Near-Surface Aquifers

Ground water occurs at depths of 0 to 30 feet bgs over much of the Henderson subarea (Blegen, 1988). The aquifers generally flow east-northeast towards Las Vegas Wash, although shallow ground water also enters Pittman Wash, which flows northeast to Las Vegas Wash (Figure 6-6).

Principal Aquifers

The principal aquifers underlie the entire subarea, and the ground water in this area occurs at depths of around 200 feet with flows toward Las Vegas Wash in the northeast part of the subarea (Blegen, 1988).

6.2.5.3 Ground-Water Quality

Shallow Aquifers and Near-Surface Reservoir

In the Henderson subarea, the ground water of the shallow and near-surface aquifers is of poor quality with high levels of TDS, chloride, and sulfate due to discharge from irrigation ditches, and industrial and sanitary waste disposal sites (Kaufmann, 1978). Several of these sites are listed as Uncontrolled Hazardous Waste Sites by EPA (Dettinger, 1987). The poor quality ground water flows towards Las Vegas Wash, which is the low point in the subarea (Kaufmann, 1978).

Principal Aquifers

Ground-water quality in this subarea is generally similar to ground water in the Southwest Las Vegas Valley subarea, as described in Section 6.2.3.3.

6.2.5.4 Ground-Water Recharge and Discharge

Shallow Aquifers and Near-Surface Reservoir

An extensive shallow water table has developed in the Henderson subarea due to return flows from irrigation water and from sewage treatment and industrial effluent water. Discharge from the aquifers is from seepage into Las Vegas Wash, by transpiration through phreatophytes, and through evaporation (Blegen, 1988).

Principal Aquifers

The principal aquifers in the area receive minor recharge from the McCullough Mountains to the south and the River Mountains to the east. There are no public well fields in this subarea. However, many permitted and domestic wells in this subarea produce ground water from the principal aquifer (Nevada Division of Water Resources, 1989)

6.2.5.5 Water Usage

Shallow Aquifers and Near-Surface Reservoir

The ground water in the shallow and near-surface aquifers is not used for drinking water in this subarea.

Principal Aquifers

There are no public well fields in this subarea; however, numerous permitted and domestic wells produce water primarily from the principal aquifers (Nevada Division of Water Resources, 1989).

6.3 GROUND WATER CONSTRAINTS AND NEED FOR ENVIRONMENTAL ANALYSIS

As described below in Section 6.4, the presence of shallow ground water may impact portions of the proposed project. In the Las Vegas Valley shallow aquifer, shallow water is encountered within 20 feet of ground surface. The shallow aquifer system extends to a maximum depth of 50 feet below ground surface. The vertical and aerial extent of the shallow ground water in portions of the valley is currently being monitored by a network of wells shown on Figure 6-1. There is uncertainty as to the occurrence of the shallow ground water in other parts of the valley. In order to further define the actual extent of shallow ground water in the valley, the monitoring network would have to be expanded.

The shallow aquifers are recharged primarily by poor quality water from domestic irrigation and urban runoff in the valley. As a result, the ground water contains high concentrations of total dissolved solids, nitrates, and other contaminants, and is not used for domestic water supply. The shallow ground water typically flows to the east-southeast and generally discharges into the washes, primarily Las Vegas Wash.

6.4 GENERAL ENVIRONMENTAL EFFECTS

6.4.1 Construction

Excavation and placement of materials during construction of proposed flood control facilities may be impacted by the presence of shallow ground water. The majority of the facilities proposed to be constructed in areas of shallow ground water are concrete lined channels. These channels typically extend to depths of approximately four to fifteen feet below ground surface which may intersect shallow ground water in some areas. Excavation of channels and placement of materials such as concrete in areas of shallow ground water may require special engineering measures including dewatering or placement of special shoring.

6.4.2 Direct Operation

6.4.2.1 Recharge of Shallow Aquifer

Although the shallow aquifer generally discharges to unlined channels, recharge to the shallow aquifer or possibly other aquifers from unlined channels may occur during precipitation events. Therefore, proposed lining of channels and box conduits may result in a minor reduction in recharge to the shallow aquifer or possibly other aquifers. However, such a reduction in recharge is inferred to be an insignificant amount of total recharge in the area (see Section 6.1.5.1).

Any potential decrease in recharge to aquifers that might occur due to lining of channels would likely be offset by increased recharge to aquifers through percolation at unlined detention facilities. Therefore, the effects of the proposed facilities on recharge to the shallow aquifer or other aquifers are considered to be insignificant.

Recharge of principal aquifers used for local water supplies would not be affected, since recharge of these aquifers principally occurs in surrounding mountains, as described in Section 6.1.5.

6.4.2.2 Discharge of Ground Water From Shallow Aquifer

Proposed lining of channels or washes may potentially decrease discharge of ground water from the shallow aquifer. Currently, shallow ground water discharges into existing unlined channels and washes in the central and eastern parts of the valley. Lining of channels and washes in this area could restrict discharge of ground water from the shallow aquifer. Such restrictions may result in a significant increase in water levels within the shallow aquifer in the vicinity of the lined channel. Such a water level increase could potentially result in the following impacts.

- Geotechnical problems including damage to foundations or seepage into subsurface structures such as parking garages.

- Damaged root systems in landscaped areas due to a rise in water level of poor quality ground water.

- Increased potential for discharge of poor quality shallow ground water to underlying aquifers due to increased head from a water level rise.

- Decreased baseflow downstream, which may potentially impact wetland vegetation in areas such as lower Las Vegas Wash.

Las Vegas City Engineering Department (Dorbin, 1989) reports that problems associated with a water table rise have apparently not occurred in areas of existing lined channels. The lack of observed water level increases may be a result of discharge of shallow ground water to unlined channel areas since lined channels are discontinuous and not extensive. However, the proposed lining of nearly all the channels in areas of shallow ground water could result in a water level rise.

Although it is considered likely that some increase in water levels in the shallow aquifer would occur due to lining of channels and washes, it is also possible that water levels would not rise because discharge could occur at other locations downstream of lined areas or to the underlying aquifers.

However, because of the uncertainty in predicting the amount of water level rise which could occur due to channel lining, potential impacts associated with such a rise should be considered potentially significant unless appropriate mitigation measures are incorporated into project design.

6.4.3 Indirect Operation

Environmental effects associated with indirect operation of the project are the same as those described in Section 6.4.2.

6.5 ENVIRONMENTAL EFFECTS BY ALTERNATIVE

Environmental effects discussed in Section 6.4 are specifically discussed for each alternative in this section. A summary of these effects is presented in Table 6-2.

6.5.1 Detention/Conveyance Alternative

6.5.1.1 Construction

Discharge of ground water into excavations for proposed flood control facilities in areas of shallow ground water may impact the construction of facilities under the Detention/Conveyance alternative. Thus effects are discussed in Section 6.4.1.

6.5.1.2 Direct Operation

Environmental effects of lined and contained flood control facilities on ground-water recharge are expected to be insignificant for the Detention/Conveyance alternative (Section 6.4.2.1).

The direct operation of the lined channels may decrease shallow ground-water discharge, resulting in a possible rise in water levels in the shallow aquifer. Impacts associated with such a possible water level rise are discussed in Section 6.4.2.2.

6.5.1.3 Indirect Operation

The environmental effects associated with indirect operation of the Detention/Conveyance alternative are the same as those discussed in Section 6.5.1.2.

6.5.2 All Conveyance Alternative

There is no significant difference in impacts associated with either the All Conveyance or Detention/Conveyance alternative. A summary of these effects is presented in Table 6-2.

6.5.2.1 Construction

Environmental effects associated with construction of the All Conveyance alternative are the same as those discussed in Section 6.5.1.1.

6.5.2.2 Direct Operation

Environmental effects associated with direct operation of the All Conveyance alternative are the same as those discussed in Section 6.5.1.2.

6.5.2.3 Indirect Operation

Environmental effects associated with indirect operation of the All Conveyance alternative are the same as those discussed in Section 6.5.1.2.

6.5.3 No Project Alternative

No environmental effects related to ground water are expected if the No Project alternative is implemented.

6.6 PROGRAMMATIC MITIGATIONS

This section describes measures to be taken to mitigate potential impacts associated with encountering shallow ground water during construction and impacts associated with potential reduction in discharge from the shallow aquifer.

6.6.1 Mitigation For Impacts of Ground Water on Construction

In order to mitigate the potential impacts of shallow ground water on construction/excavation of a specific facility, the following measures are recommended. These measures are summarized on Figure 6-7.

- Review EIS document with regard to the known or possible presence of shallow ground water in a given area (Figure 6-1). If the proposed facility is outside the area of possible shallow ground water, no further mitigation measures would be required. If the proposed facility is within the area of possible shallow ground water, proceed with investigation.

- Conduct a site-specific geotechnical investigation to evaluate whether shallow ground water is present at a depth which could affect excavation or placement of materials during construction. If the investigation results indicate that ground water will not affect excavation or placement of materials, no further mitigation is required. If the investigation results indicate that ground water could affect excavation or placement of materials, proceed with investigation/design.

- Conduct additional investigations and/or design special measures to minimize impact of shallow ground water on excavation or placement of materials. Such design measures may include local dewatering of aquifer or excavation, or placement of shoring to restrict entry of shallow ground water to excavation.

6.6.2 Mitigations for Impacts Associated with Reduction in Discharge from the Shallow Aquifer

In order to mitigate the potential impacts associated with the lining of channels or washes in areas where ground-water discharge from the shallow aquifer may occur, the following measures outlined below are recommended. These measures are summarized in Figure 6-8.

- Review EIS document with regard to the known or possible presence of shallow ground water in a given area (Figure 6-1). If the proposed channel/wash lining project is outside the area of possible shallow ground water, no further mitigation measures would be required. If the proposed channel/wash lining project is within the area of possible shallow ground water, proceed with investigation.

- Gather available site-specific information regarding conditions in vicinity of proposed channel/wash lining. This information may include water level data, land use information, previous geotechnical investigations and data regarding similar channel/wash lining in the area. Information obtained should be used to evaluate whether the proposed channel/wash lining has the potential to cause water level rises in the project vicinity and whether water level rises have the potential to cause impacts in that area. If the data indicate that no water level rises will occur or that impacts will not be significant, no further mitigations are necessary. If data indicate that the potential for impacts from water level rise are significant in the area, proceed with investigation.

- Conduct a site-specific geotechnical investigation to evaluate whether shallow ground water discharges to, or has the potential to discharge to, the channel/wash in question. Based on potential water level fluctuations, shallow ground water may have the potential to discharge to the channel if it is within two feet of the channel bottom. If the investigation indicates that the shallow ground water does not have the potential to discharge to the channel/wash, no further investigations are necessary. If the investigation indicates that shallow ground water may discharge to the channel/wash and that such discharge has the potential to cause impacts outlined in Section 6.5, proceed with investigation/mitigation.

- Recommended mitigation measures to be implemented if data indicate that the project could cause significant impacts from water level rise include: 1) resite project into an area where impacts will not occur or 2) design lining to allow discharge to occur by including weep holes, drainage blanket, sections of unlined channel, use of floodways or unlined channels in extreme cases.

- Monitoring of ground water levels would be conducted by periodic observation of water levels in nearby wells completed in the shallow aquifer. If such wells are not available, they may have to be constructed. If monitoring indicates that water level increases are occurring as a result of the project and that these increases could cause adverse impacts in the area, post construction modification to the lining such as installation of weep holes to allow discharge of ground water could be conducted.

- If it is undesirable to conduct long term monitoring of water levels in the area, the lining should be designed to accommodate ground water discharge. Such design measures might consist of weep holes or drainage blankets. In extreme cases use of unlined channels or floodways could be substituted for lined channels. Measures employed should accommodate the same amount of discharge that would occur under natural conditions.

Table 6-1

Representative Water Quality Data of Wells in Las Vegas Valley

Subregion	Well	Location	Total Depth	Date	TDS	Ca	Mg	Na	K	Cl	SO_4	HCO_3	F	$NO_3(N)$	SiO_2	Source
Shallow Aquifers																
North LVV	FF	20-61-27 BDAA1	15	7/82	756	100	70	55	17	252	120	410	0.46	2.0	26	Brothers & Katzer 1988
Central LVV	C	21-61-04 ABC1	17	5/87	4650	470	447	226	40.7	206	2810	377	0.20	9.82	48	Brothers & Katzer 1988
Southwest LVV	GG	21-61-17 BADD1	45	11/87	2760	340	194	167	14.4	224	1440	246	---	10.2	22	Brothers & Katzer 1988
Henderson	EE	21-62-26 DBA2	31	6/87	7640	619	426	1130	111	1520	3280	290	1.62	1.6	72	Brothers & Katzer 1988
Near-Surface Reservoir																
North LVV	HH	20-61-01 ACCD	300	5/87	222	46.6	24.8	6.4	1.3	3.6	34.8	235	0.20	0.21	17	Brothers & Katzer 1988
Central LVV	F	20-61-36 DDD1	100	6/87	2600	205	231	188	31.8	232	1350	215	0.36	0.22	32	Brothers & Katzer 1988
Southwest LVV	II	22-61-07 BCB1	400	5/87	759	125	58.6	12.6	2.9	12.8	396	191	0.28	1.43	14	Brothers & Katzer 1988
Henderson	JJ	21-63-29 BBB1	80	5/87	6940	589	390	883	74.7	1140	3280	69.7	0.71	4.85	19	Brothers & Katzer 1988
Principal Aquifers																
North LVV	KK	20-61-06 CB	998	11/3/86	355	44	22.4	6.8	1.3	2.8	29.5	231	0.17	0.36	15	Noack 1988
Central LVV	LL	21-61-10 BCAD1	1000	5/19/82	429	49	38	11	3.8	17	140	230	---	0.93	15	Dettinger 1987
Southwest LVV	MM	21-60-21 DD	800	5/13/86	991	161	69.1	14.7	3.1	12.8	518	192	0.27	0.56	15	Noack 1988
Henderson	NN	22-62-04 DCC1	780	8/22/82	664	46	22	140	14	110	180	140	0.75	1.2	66	Dettinger 1987

TABLE 6-2

ENVIRONMENTAL EFFECTS BY ALTERNATIVE

IMPACTS	DETENTION/ CONVEYANCE	ALL CONVEYANCE	NO PROJECT
RECHARGE OF AQUIFERS			
Construction	No	No	No
Direct Operation	No	No	No
Indirect Operation	No	No	No
SHALLOW GROUND WATER LEVEL INCREASES ASSOCIATED WITH OBSTRUCTION OF DISCHARGE OF GROUND WATER FROM THE SHALLOW AQUIFER			
Construction	Yes	Yes	No
Direct Operation	Yes	Yes	No
Indirect Operation	Yes	Yes	No

FIGURE 6-1

DEPTH TO GROUND WATER IN SHALLOW AQUIFER

(SEE VOLUME II, OVERSIZE MAPS)

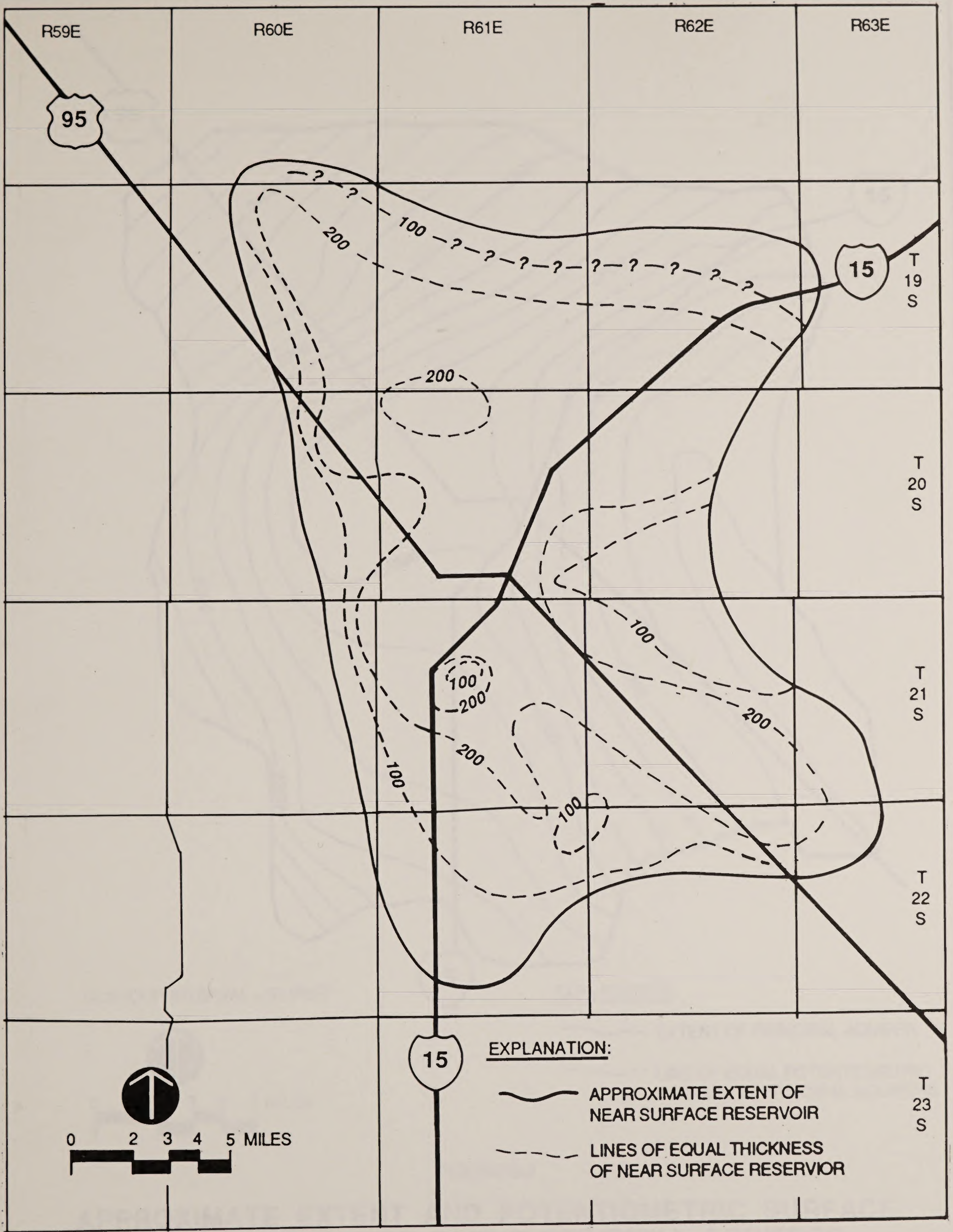

FIGURE 6-2

APPROXIMATE EXTENT AND THICKNESS OF NEAR-SURFACE RESERVOIR

Source: Harrill, 1976

DAMES & MOORE

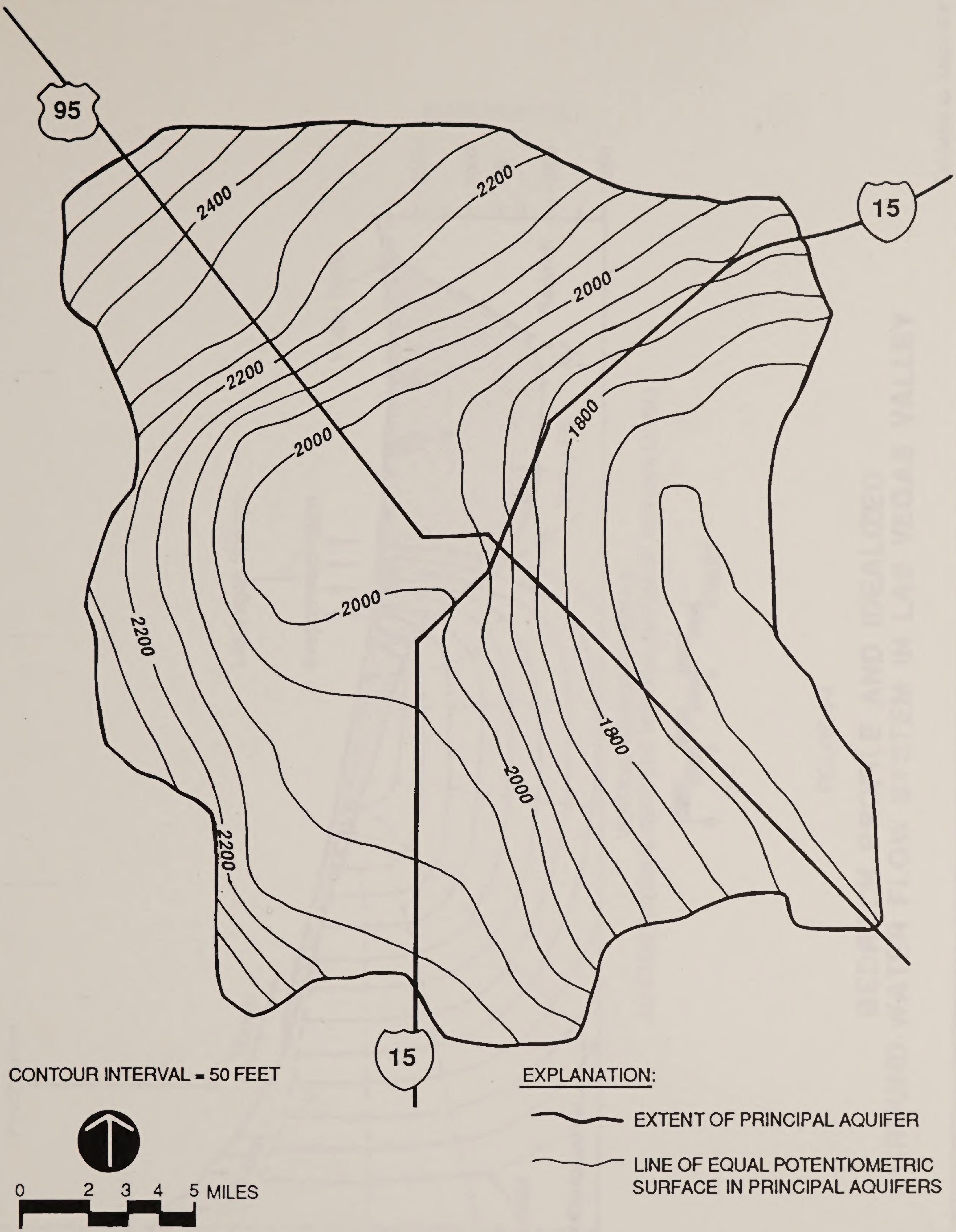

FIGURE 6-3

APPROXIMATE EXTENT AND POTENTIOMETRIC SURFACE OF GROUND WATER IN THE PRINCIPAL AQUIFERS JANUARY 1978

Source: Broadbent, 1980

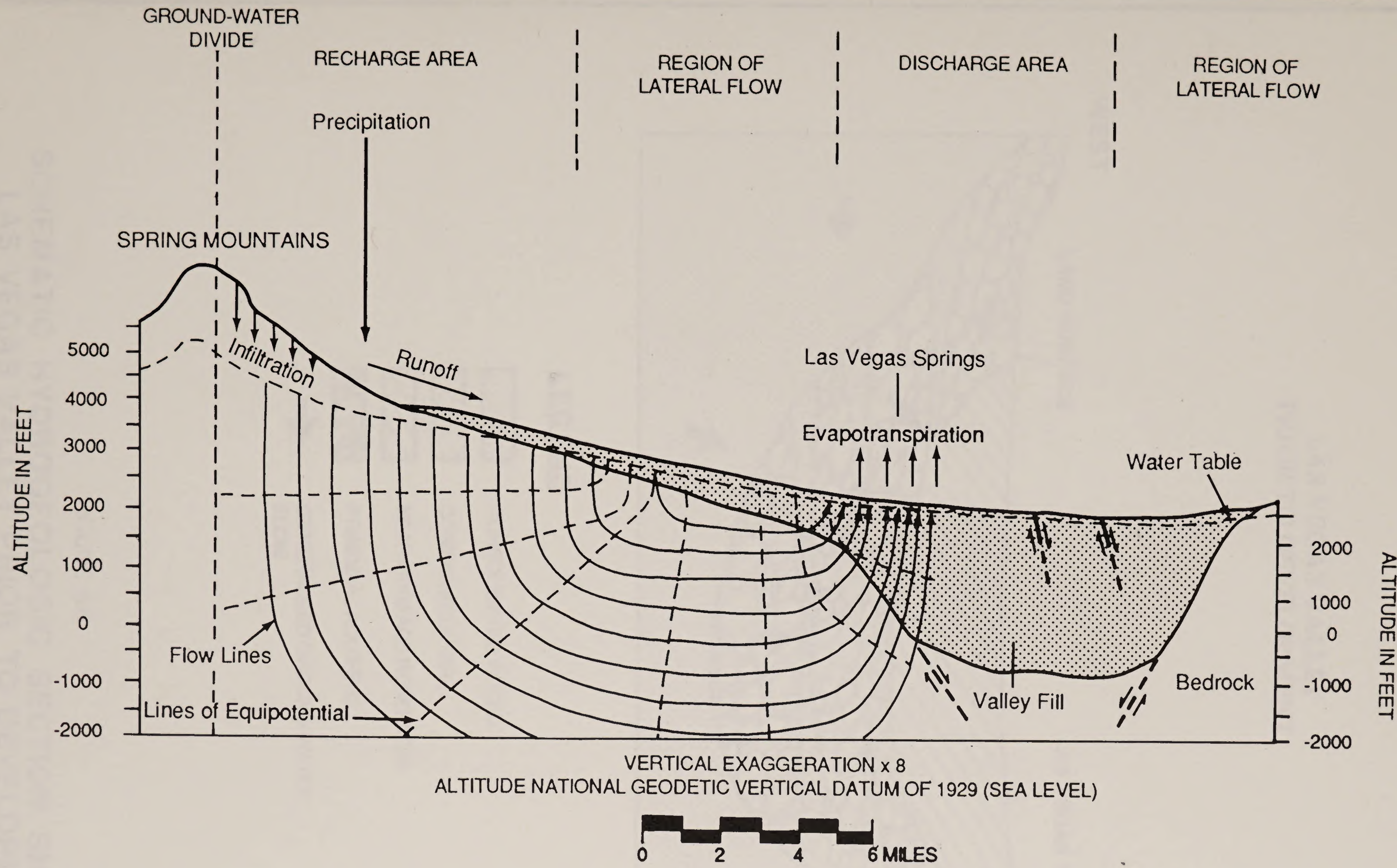

FIGURE 6-4

BEDROCK PROFILE AND IDEALIZED GROUND-WATER FLOW SYSTEM IN LAS VEGAS VALLEY

Source: Noak, 1988

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LAS VEGAS VALLEY
PRIOR TO DEVELOPMENT

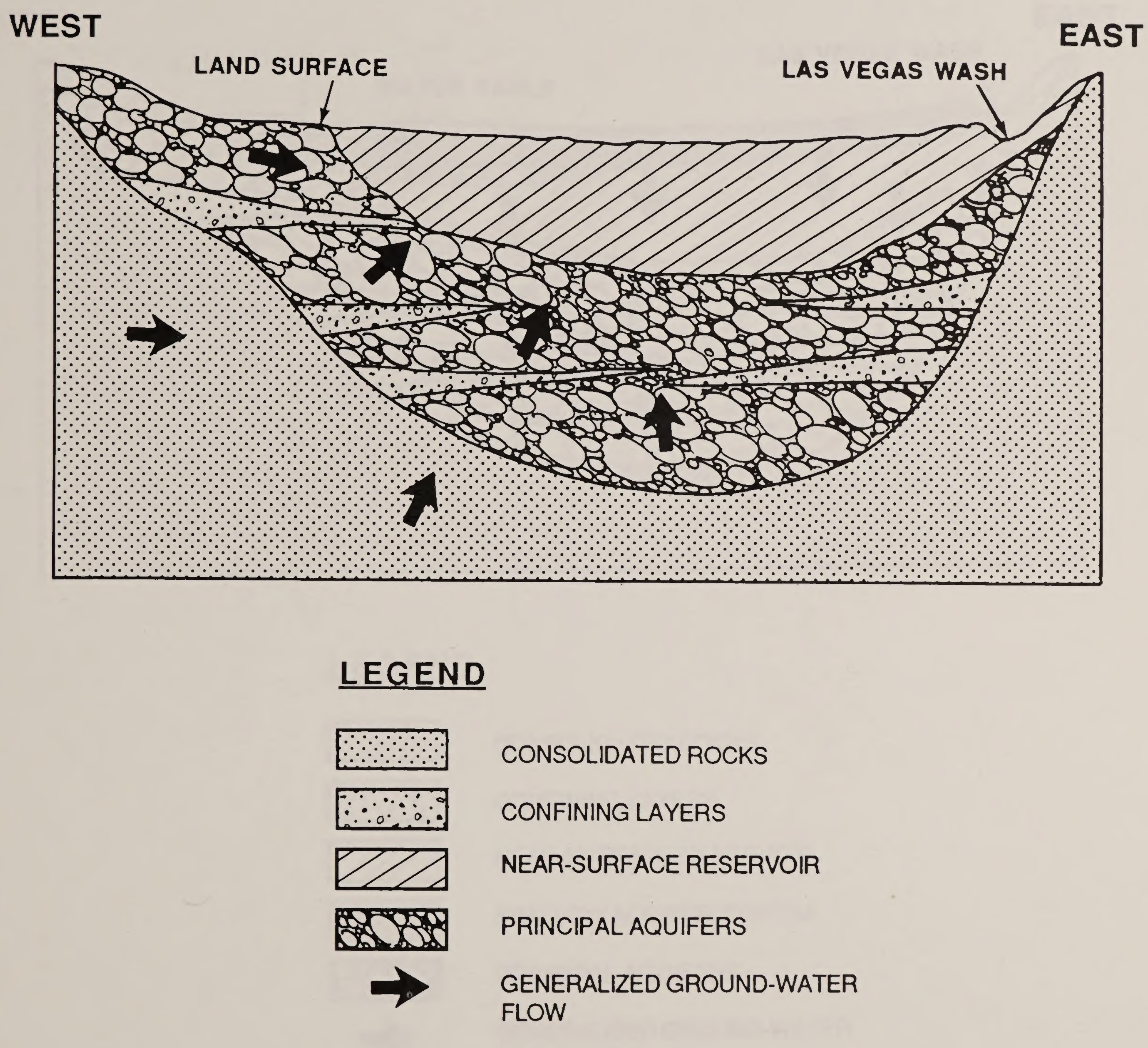

FIGURE 6-5

SCHEMATIC HYDROGEOLOGIC SECTION SHOWING LAS VEGAS VALLEY PRIOR TO DEVELOPMENT

Source: Brothers and Katzer, 1988

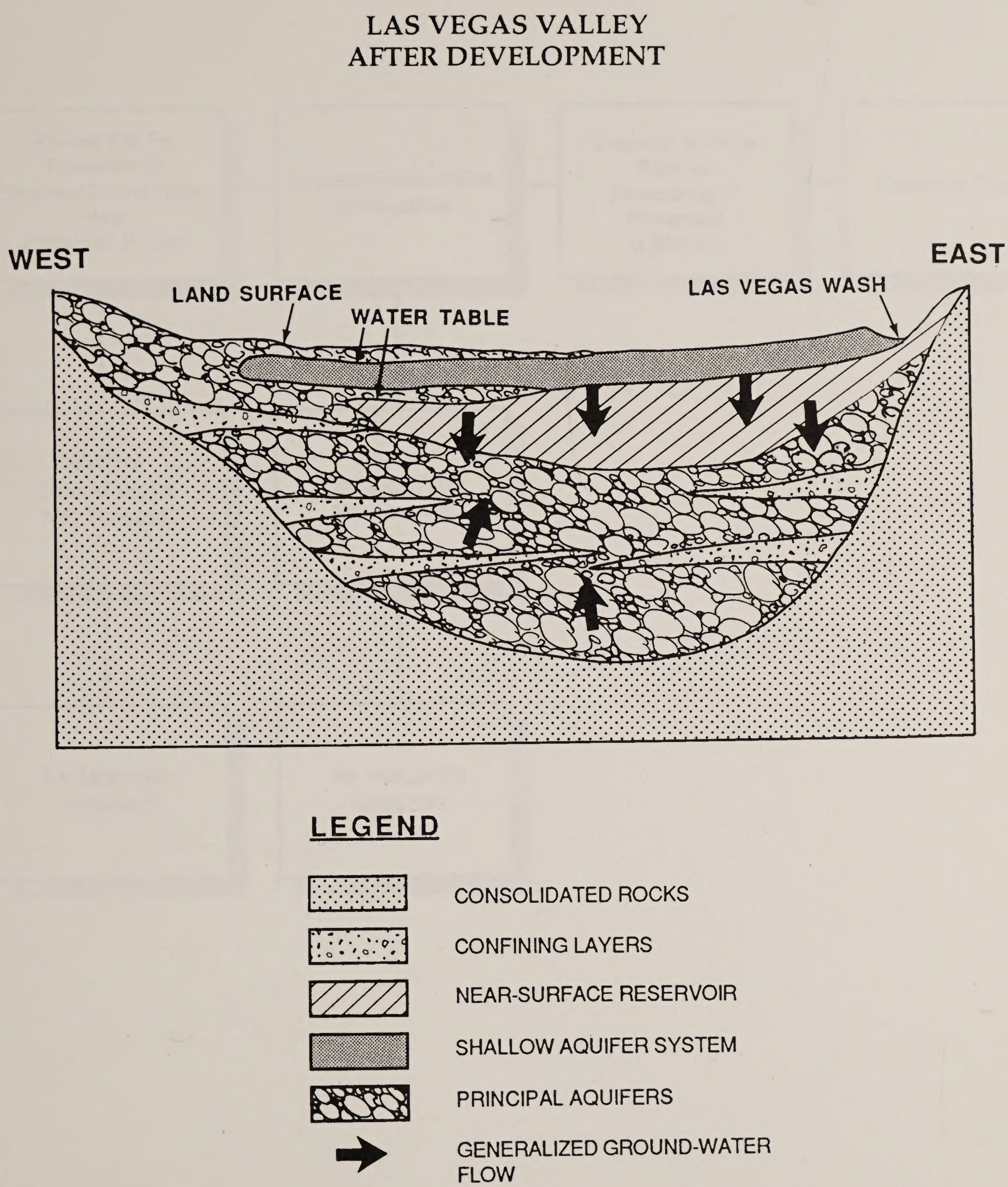

FIGURE 6-6

SCHEMATIC HYDROGEOLOGIC SECTION SHOWING LAS VEGAS VALLEY AFTER DEVELOPMENT

Source: Brothers and Katzer, 1988

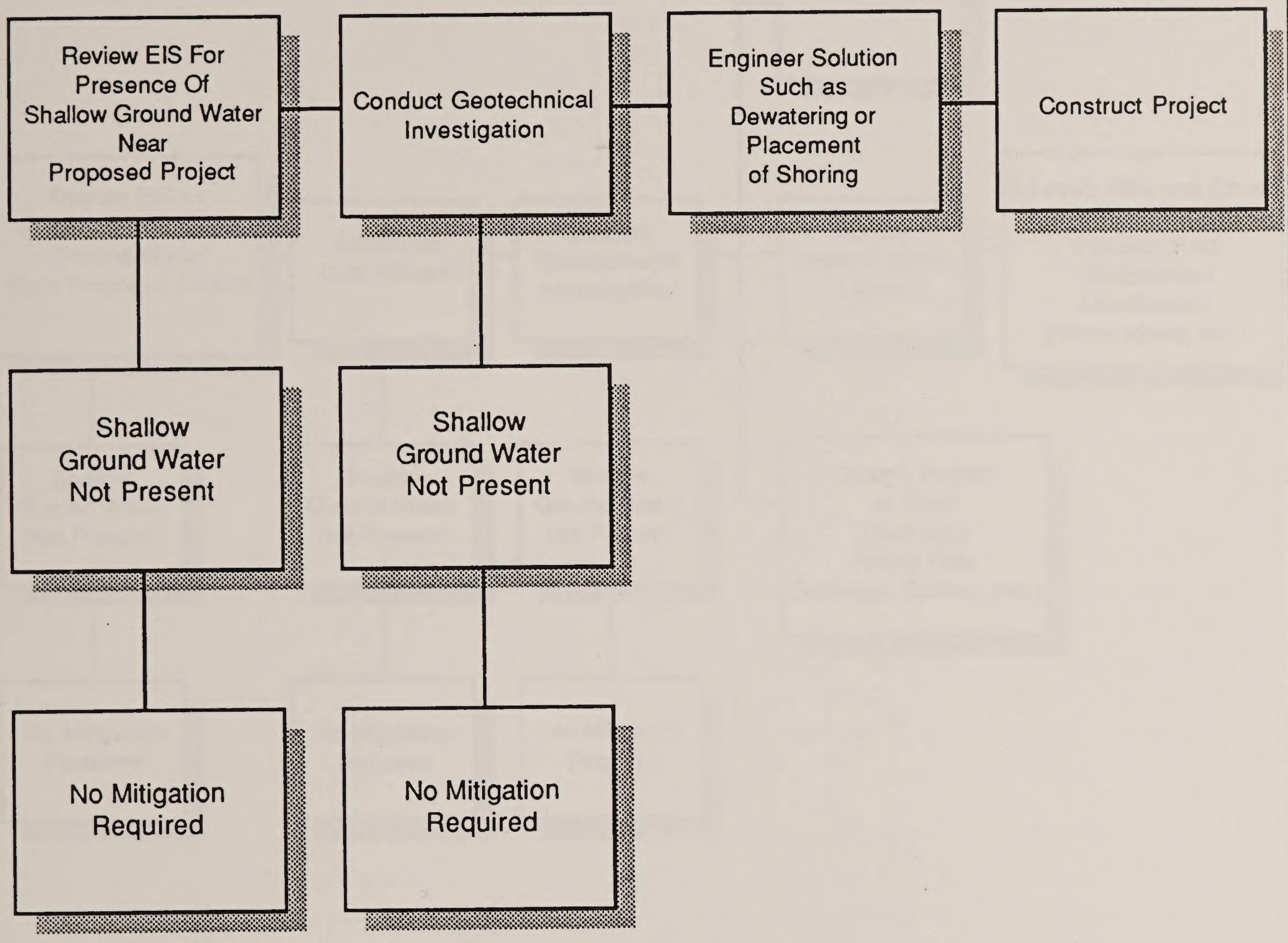

FIGURE 6-7

FLOW CHART FOR MITIGATION OF IMPACTS OF GROUND WATER ON CONSTRUCTION

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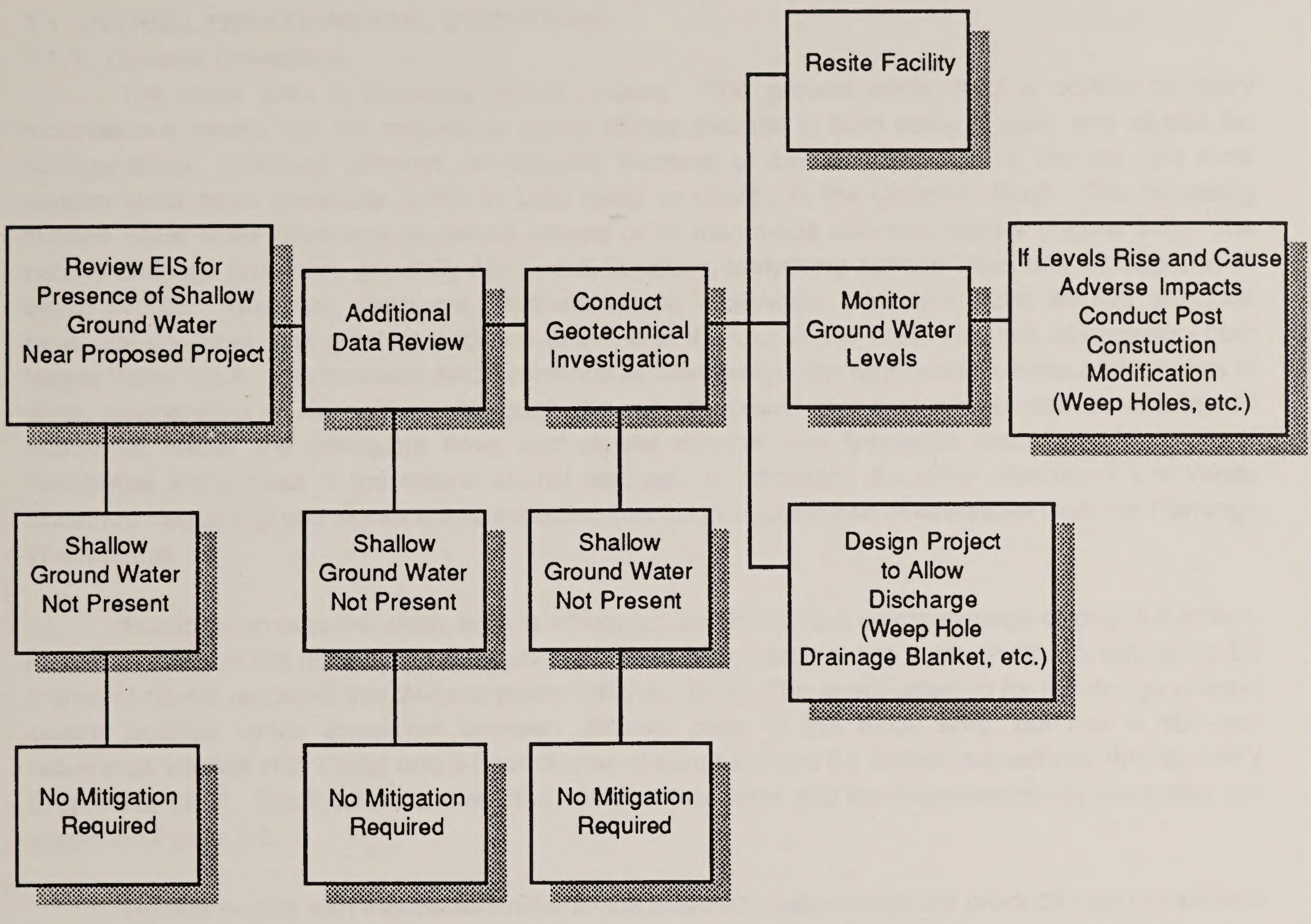

FIGURE 6-8

FLOW CHART FOR MITIGATION OF IMPACTS ASSOCIATED WITH LINING CHANNELS IN AREA OF SHALLOW GROUND WATER

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7.1 OVERALL ENVIRONMENTAL CONDITIONS

7.1.1. General Conditions

The study area is generally arid in nature. The ground consists of a portion of rocky mountainous terrain, but the majority is sandy alluvial material in both valley bottom and alluvial fan configurations. Drainage patterns are complex because of the alluvial nature of the soil, but most surface water flows eventually outfall to Lake Mead or directly to the Colorado River. The remaining surface water flows discharge to natural playas or to man-made retention basins (Figure 7-1). The natural drainage paths are generally ephemeral in nature, conveying surface flows only in response to storm events. However, there are locations where wastewater treatment plant effluent supports perennial low flows. The greatest evidence of this is in the Las Vegas Wash reaches downstream from Vegas Valley Drive. The channels show evidence of lateral migration with braided areas and reaches of either downcutting or deposition. Although the overall general drainage system can be considered somewhat stable, the infrequent flows and alluvial channel and floodplain materials support local instabilities along most of the natural alluvial reaches. In particular, the lower reaches of Las Vegas Wash are degrading and significant headcutting has been experienced downstream from the Flamingo Wash outfall.

Precipitation over the study area is infrequent and totals to a yearly average of only 4.4 inches. However, much of the rainfall occurs as short duration, high intensity late summer storms with up to 2.6 inches of rainfall recorded in a 24-hour period (NOAA, 1974). The storm selected for the design of flood control facilities varies somewhat between different parts of the study area, but has a 100-year recurrence interval and 1-hour and 3-hour depths of about 2.7 and 3.1 inches respectively (Montgomery Engineers, 1986). The location of predicted 100-year flow rates and the proposed facility capacities are shown on Figure 7-2.

Rainfall events with intensities similar to the selected design storm will produce rapid runoff and "flash" flooding of downslope areas, especially if the storm cell is moving in the downslope direction. Alluvial channels cannot normally contain runoff from such severe storms and overbank flows result often covering the entire floodplain. However, since both the channel and the floodplain are often poorly defined in alluvial areas, the storm runoff patterns can be significantly altered between flows (by man's activities) and more importantly, during flows. As a result, shallow flooding can be expected just about anywhere except on the higher ground or where upslope flood control facilities are in place and operating correctly.

Sediment movement can be extensive during major flows and can be quite significant even during one or more minor flows. Lateral channel migration can occur with flows approaching man-made facilities from different angles or increasing peak flow rates in adjacent channels. Sediment deposition can occur, reducing channel conveyance capacity and widening the floodplain. Alternatively, channel downcutting can occur as general channel degradation or as headcutting from downstream steeper reaches.

The water quality for the storm water runoff is probably mostly a function of human activity in the tributary areas. As the watershed is developed, the occurrence and concentrations of contaminants associated with rural and urban areas can be expected to increase in the storm water runoff. The interaction between the storm water runoff and sewage effluent can be considered both harmful and beneficial. The storm runoff water quality may be degraded by mixing with the effluent. However, the storm runoff may also dilute and help treat the effluent.

7.1.2 Surface Flows Subject to COE Review

The application of the COE regulatory process involves the review of potential effects of the discharge of dredged or fill material directly into areas identified as waters of the United States (including intermittent drainages, perennial flowing streams, and areas of wetland vegetation). The project area is characterized by a complex system of braided channels, including very small (one to two feet wide) watercourses that experience surface flows on an irregular basis. Because the determination of areas subject to COE regulatory review requires judgement concerning the frequency of water flow and vegetation associated with the watercourse, a field reconnaissance survey was conducted with COE personnel to evaluate the characteristics of a range of watercourses in the study area. This survey resulted in the determination that the areas considered waters of the United States for the purposes of COE review will include defined channels and areas of wetland or stream-related vegetation identifiable on the Flood Control Master Plan Facility maps (scale 1":2000'), including all known major washes in the study area and several small unnamed intermittent drainages.

The area of direct effect on waters of the United States includes the entire facility construction site, and potential indirect effects could occur up to 1000 feet downstream of facilities that would intercept and divert flow of intermittent drainages. No diversion of perennial flows is proposed. Areas of direct and indirect effects subject to review by the COE in association with the Section 404 permit process are indicated on Figures 7-3 to 7-16. Areas of major washes in developed urban areas, including some characterized by well-developed wetland vegetation, are identified in these Figures and are also subject to COE review.

7.1.3 Summary of Significant Resources and Conditions

There are a variety of significant resources and issues related to the categories of surface water and water resources facilities. These significant water resources issues and facilities are summarized by subarea in Table 7-1. In general, the pattern of flow, flow rate, velocity, and water quality of flowing surface water are of principal concern in this section of the EIS. Clearly all water flowing or ponded on the surface should be classified as surface water resources. This includes storm water runoff and wastewater treatment plant (WWTP) effluent.

In addition to the surface waters, natural and man-made facilities which help to manage the surface waters are included in this consideration of surface water resources. This includes ponds, lagoons, detention/retention basins, channels, and washes. The category of water resources facilities has been included in this assessment because these facilities are significant and may not otherwise be included in the assessment. Other water resources facilities that are not related to flood control including: water development and processing facilities such as well heads, water treatment facilities, domestic water storage and conveyance facilities; wastewater collection and conveyance facilities; wastewater treatment plants and effluent conveyances; are also addressed in this section to evaluate potential impacts to these facilities. Any plans to manage flood flows in the study area will encounter these facilities at numerous locations.

The existing drainage facilities themselves are also surface water resources. The channels provide for both channel and overbank storage which attenuate peak runoff flow rates and reduce the potential for downstream flooding (although the overbank storage experienced in some areas may represent an existing flooding problem). In addition, the unlined channels and overbanks areas induce natural ground-water recharge during runoff periods and some may act as groundwater discharge areas at other times. Potential effects of flood control facilities on shallow groundwater are addressed in Section 6.0 of this EIS, and that topic is not repeated in this section..

Under existing conditions, much of the surface water occurring during storm events flows to Las Vegas Wash and to Lake Mead. Some portions of these flows may percolate into shallow aquifers, which also drain to Las Vegas Wash and to Lake Mead. As described in greater detail in Section 6.0 of this EIS, many of the tributary washes in the Las Vegas Valley act as discharge areas for shallow ground water during much of the year. As a result of these ground water discharges and WWTP discharges of effluent to these washes, perennial low flows and shallow subsurface flows are noted along the lower reaches of some of the washes. For this EIS, perennial low flows are defined as both continuous surface flows and the discontinuous pools of water which are connected by shallow subsurface flows down the washes. With this definition, perennial low flows have been identified along the lower Las Vegas Wash below the WWTP facility.

In 1987 the Las Vegas Valley obtained 176,000 acre-feet of water from Lake Mead. The maintenance of allocations from Lake Mead is in part dependent upon Colorado River return-flow credits allowed for the discharge of surface and near-surface waters into Lake Mead from Las Vegas Wash. Return flow credits are based on a return of a portion of water discharged by wastewater treatment plants to Lake Mead reservoir.

7.2 SUMMARY OF SPECIFIC ENVIRONMENTAL CONDITIONS BY SUBAREA

The majority of the water resources environmental evaluations for the study area relate to the existing system to manage stormwater runoff. This system is mainly comprised of natural and man made open channel conveyances and the pedestrian, vehicle and utility crossings of these conveyances. Additional system facilities include the three detention basins, some closed storm water conveyances and the wastewater treatment plants located adjacent to the washes. A description of each of the subareas and its water resources environmental conditions is presented in the following sections. The selection of drainage area boundaries for this study area is somewhat subjective due to the alluvial nature of the ground surface and how flows are affected by man-made facilities in the developed areas. The subarea boundaries assumed in this analysis are identical to those presented in the Master Plan (Montgomery Engineers, 1986). The boundaries of these subareas are shown on Figure 7-1 and specific conditions within each subarea are described below. A summary of significant surface water resources and water resource facilities by study subareas is presented in Table 7-1. Detailed descriptions of the drainage patterns presented in the following sections were taken from the Master Plan (Montgomery Engineers, 1986).

7.2.1 Northern Las Vegas Valley

7.2.1.1 Subbasin Drainage Patterns

The general drainage patterns include collection of runoff from tributary areas to upper Las Vegas Wash and conveyance of these flows to the southeast to eventually outfall to the Las Vegas Bay of Lake Mead (Figure 7-1). This study area includes mostly undeveloped land except for the very urbanized southernmost portion where the flow passes near the center of North Las Vegas and though a variety of residential and commercial areas. From the point where Las Vegas Wash outfalls from this study area, it is only about six miles flow distance to Lake Mead.

The upper Las Vegas Wash drainage collects stormwater runoff from the Sheep Mountains, Spring Mountains, and alluvial fans north of the City of North Las Vegas. The Spring Mountain runoff flows overland to the east from Kyle Canyon. The flows on the north side of the Kyle Canyon Road route across the Tonopah Highway and enter the head of upper Las Vegas Wash. The flows from Sheep Mountain on the east travel westerly to the confluence with the northern Kyle Canyon and Lee Canyon flows. At a point in the upper Las Vegas Wash just north of the Floyd B. Lamb State Park, the flow splits into two main paths. The northern branch continues southeasterly along upper Las Vegas Wash. The southern branch flows south at this point onto the alluvial fan south of the state park. The flow split at the confluence previously addressed has not been accurately defined due to limits in available topographic mapping. The soils at this location are unstable and allow the flood flows to change routing at will. For the purpose of the future land use the routing at this point was assumed to be in the northern reach of upper Las Vegas Wash. These flows continue southeasterly in the existing wash, eventually reaching the diversion for the North Las Vegas Detention Basin.

Flows from the north on this section of wash are routed through the North Las Vegas Detention Basin (a 1,650 acre-ft. facility). The basin diverts up to 9,000 cfs from the wash and reduces it to a 4,500 cfs outflow. Flows from storms higher than the 100-year frequency event cause some overtopping of the diversion berm in the wash. This flow continues southeasterly undetained along the wash. The flows collect on the north side of the railroad and flow southwesterly along the tracks to the existing head of "A" Channel. Flows enter the wash at this location and follow the alignment with some overflows out of channel diversions along the wash at undersized bridge structures.

The existing improved conveyance system on the lower Las Vegas Wash is comprised of an earthen channel extending from Interstate-15 (I-15) just south of Craig Road through the incorporated areas of North Las Vegas and Las Vegas, ending in the County just south of Vegas Valley Drive. Road crossings have been constructed across the wash at all major transportation routes. These crossings vary in sophistication from simple roadway dip sections and corrugated pipe culvert crossings to free span bridges.

The western tributary of Range Wash begins in the drainage on the eastern side of Sheep Mountains in the north central part of the valley. Flood waters are generated in the mountains and flow onto a large upland alluvial fan. Due to the alluvial nature of the fan, stormwater flows can move to any number of locations on the fan. In the Master Plan, the existing routing was assumed to be south from the apex of the fan. These flows are routed overland and through small braided washes, finally being collected along the Union Pacific Railroad tracks to the south.

Flows then route along the railroad tracks to existing cross culverts under the tracks. The flows are again routed south to I-15 in small washes. These flows are then routed through culverts under the freeway and converge at two major concentration points, one at the Vandenburg Street channel and the other at the north branch of the Sloan Channel. The Vandenburg Channel brings the flows to the west branch of the Sloan Channel at Las Vegas Boulevard. The west branch and north branch combine in a newly upgraded channel (Sloan Channel) west of Nellis Air Force Base (AFB). The storm waters are then directed along the western border of the AFB to the confluence with eastern Range Wash tributaries. The combined flows then route south through the existing Sloan Channel to the confluence with Las Vegas Wash.

Eastern Range Wash flows are generated in the mountains in the northeastern part of the valley and conveyed overland or through existing washes to the confluence with Sloan Channel. Flows in the northeastern Range Wash area route overland to the Union Pacific Railroad. Small culverts carry the flows through the railroad right-of-way. The flows then continue overland to the freeway and Las Vegas Boulevard where the flows are again routed southwesterly along these road systems to cross culverts. Under the existing routing conditions the flows split into two flow paths. The first path continues southwesterly along I-15 and along Las Vegas Boulevard to other culverts which eventually bring the flows to the head of the new Sloan Channel improvements as previously described. The other flow path is southerly through the culverts at I-15 and Las Vegas Boulevard. Waters are routed on each side of the AFB through existing channels. The flow on the west travels through a small unlined channel traversing the AFB and entering Sloan Channel at the west base entrance. The eastern flows enter a small channel diverting the flows around the eastern end of the AFB runway. This channel enters East Range Wash just above the Range Wash confluence with Sloan Channel. The East Range Wash flows are generated in the Sunrise Mountains and the lower alluvial plains east of the AFB, and are conveyed in the natural wash westward to the confluence with the northern branch. This combined flow routes southward to the confluence with the west branch of Sloan Channel. The two flows combine at this point and the resulting peak flow is routed south through the existing Range Wash reaches to the confluence with Las Vegas Wash.

7.2.1.2 Design Flows

The design flows for this study area were developed during the Master Plan preparation and are presented in Table 7-2. These are flow rates that may be experienced during 100-year storm events with existing flood control facilities assuming a storm centered over a 200-square mile area.

7.2.1.3 Water Quality Issues

Water quality issues fall into two general categories; water-borne contaminants and sediments. The water-borne contaminants include the dissolved, suspended, or floating chemicals and debris which the water may come in contact with as it moves. As a general rule, storm water runoff is not sampled and tested for contamination and little is known about the quality of the storm water runoff in the study area. It is suspected that some contamination of the storm water runoff occurs under existing conditions and that this problem will get worse as additional urbanization of the tributary area occurs.

Water quality relevant to water-borne sediments is a complex issue. Flowing surface water has the capacity to erode and deposit large quantities of soil and rock during a single storm event. The water will attempt to establish an equilibrium sediment transport load as sediments are available and depending on a variety of flow parameters such as velocity, depth, and temperature. Some portions of the tributary area are made up of or covered (armored) with more coarse sands and gravels which are too large for the flowing water to move. As the flows are concentrated in downslope reaches, the flow rates, and often the depths and velocity, are increased. In alluvial areas, the flatter valley floors are often comprised of the smaller fractions of the soils. This combination of increasing flow parameters and decreasing soil sizes produces large scale sediment transport across the valley floor. There are significant reaches of channel banks and bottom erosion (degradation) and also reaches of sediment deposition (aggradation). This is further complicated by the fact that an area where degradation occurs for one flow rate may aggrade for a different flow rate.

7.2.1.4 Areas of Perennial Low Flows

Perennial low flows are defined in this EIS as both continuous surface flows and the discontinuous pools of water which are connected by shallow subsurface flows down the washes. These low flows may be supported by discharge from shallow ground water or excess irrigation of lawn in urban areas in several locations along Las Vegas Wash and from WWTP effluent discharge along the washes (Figure 7-1).

7.2.1.5 Flood Control Facilities

Major existing flood control facilities in this study area include the North Las Vegas Detention Basin, a levee east of AFB, several miles of lined channel on the southwest side of the AFB and numerous culverts and bridges. Detailed evaluation of each of these facilities was a part of the most recent study, (Montgomery Engineers, 1986) and it is suspected that many of these existing facilities cannot pass the runoff from the presently accepted 100-year design storm (Sutko, 1988).

7.2.1.6 Wastewater Treatment Plants and Effluent

The Northern Las Vegas Wash subarea includes two wastewater treatment plants located along the west bank of Las Vegas Wash just downstream of the Flamingo Wash outfall. Excess effluent from these is released to the wash where it supports both ponded water and low flows in the reaches downstream. A separate WWTP serves Nellis Air Force Base and is located south of the base facilities.

7.2.2 Central Las Vegas Valley

7.2.2.1 Subarea Drainage Patterns

The general drainage pattern is from the mountainous areas on the west to Las Vegas Wash along the eastern edge of the study area. The eastern portion of this study area is heavily urbanized and includes the downtown area of Las Vegas. The main stem of Las Vegas Wash is included in this study area from the -15 crossing downstream to the Flamingo Wash outfall.

The physical characteristics of this subarea can be divided into three land types: the steep La Madre Mountains at the western boundary; the broad alluvial apron connecting the mountains and the valley floor; and the gently sloping valley floor. The valley floor is the location of the major urban development presently found in the study area. In this subarea, development has begun encroaching onto the alluvial apron. The alluvial apron is presently comprised of scattered urban development and numerous natural drainage channels. Development throughout the alluvial apron and the valley floor has encroached upon the natural floodplains and drainage channels found in the subarea. The mountain region of the study area is capable of generating large flow rates and volumes of runoff from thunderstorms that frequent the area during summer months. Stormwater runoff from these thunderstorm events is generated largely by the steep mountain slopes having soils with low permeability rates and poor vegetative cover, and by portions of the alluvial apron and valley floor areas having scattered caliche deposits which severely reduce the soil permeability rate.

The Central Las Vegas Valley subarea is divided into eight major drainage networks: Angel Park detention basin drainage area; Gowan Road detention basin drainage area; Gravel Pit drainage area; Carey Avenue drainage area; Cedar Avenue drainage area; Washington Avenue drainage area; Charleston Avenue drainage area; and the main stem of Las Vegas Wash. Stormwater flows for the drainage areas are generated from the La Madre Mountains, alluvial apron, and the valley floor. Runoff from the mountain region flows across the alluvial fans prior to entering the presently developed urban areas of the City of Las Vegas. Major flow barriers exist at the Gregson Highway, Rancho Road, I-15, and the Union Pacific Railroad tracks.

The Angel Park detention basin drainage network is comprised of all of the area naturally tributary to the existing basin, and includes a drainage area of 14.6 square miles. Presently the Angel Park drainage system is comprised of mountain watersheds and undeveloped alluvial fans. The Angel

Park detention basin is a below surface detention basin originally designed as a retention facility. For purposes of the Master Plan study, the Angel Park basin was modeled as a detention facility.

The Gowan Road detention basin drainage network is comprised of 51.5 square miles. It includes the area tributary to a proposed detention basin west of the intersection of Gowan Road and the Gregson Highway. If the Angel Park detention basin drainage system is routed through the Gowan Road basin, the total drainage area to this facility increases to 66.1 square miles. The Gowan Road drainage network is comprised of mountain watersheds and alluvial fans, with scattered rural development beginning to occur.

The third detention basin drainage network is referred to as the Gravel Pit detention basin network. The Gravel Pit basin network is comprised of 3.3 square miles. The drainage system is comprised of a newly developing urban area tributary to a proposed detention site near the intersection of Spring Mountain Road and Buffalo Road. The detention basin would utilize a portion of an existing gravel pit.

The Cedar Avenue drainage network is comprised of a drainage area of 4.4 square miles. All of the Cedar Avenue drainage system is comprised of urban development and undeveloped land within the existing limits of development. The existing Cedar Avenue drainage structure is a concrete-lined trapezoidal channel that discharges into Las Vegas Wash on the eastern border of the study area.

The Washington Avenue storm drainage network consists of a drainage area of 26.8 square miles. The existing Washington Avenue drainage system is comprised of connected sections of open channel and pipeline. The Washington Avenue drainage system discharges stormwater flows into Las Vegas Wash approximately one mile upstream from the confluence of Las Vegas Wash and the Cedar Avenue storm drain.

The Carey Avenue drainage area is comprised of a total drainage area of 69.7 square miles. This area also includes the area east of Rancho Road and the system tributary to the Gowan Road detention basin site. The Carey Avenue drainage area east of the Gregson Highway is 18.2 square miles. The Carey Avenue drainage network consists of a storm drainage conduit and open channel. Like the Cedar Avenue and Washington Avenue systems, the Carey Avenue drainage network discharges stormwater flows to the Las Vegas Wash. The Carey Avenue drainage network collects flows in a conduit system at Carey Avenue where it connects with an open channel system that is aligned parallel to I-15 in a northeasterly direction to its confluence with Las Vegas Wash.

The Charleston Avenue drainage network is comprised of a drainage area of 29.1 square miles. The existing drainage network consists of urban and commercial development with no major drainage facilities. Local road systems presently pass stormwater flows through the drainage area.

The main stem of Las Vegas Wash is the final drainage system in the Central Basin study area. Las Vegas Wash acts as the major system for transporting runoff through the Las Vegas Valley, with ultimate outfall to Lake Mead.

7.2.2.2 Design Flows

The design flows for this study area were developed during the Master Plan preparation and are presented in Table 7-3.

7.2.2.3 Water Quality Issues

Water quality issues fall into two general categories; water-borne contaminants and sediments. The water-borne contaminants include the dissolved, suspended, or floating chemicals and debris which the water may come in contact with as it moves. As a general rule, storm water runoff is not sampled and tested for contamination and little is known about the quality of the storm water runoff in the study area. It is suspected that some contamination of the storm water runoff occurs under existing conditions and that this problem will get worse as additional urbanization of the tributary area occurs.

Water quality relevant to water-borne sediments is a complex issue. Flowing surface water has the capacity to erode and deposit large quantities of soil and rock during a single storm event. The water will attempt to establish an equilibrium sediment transport load as sediments are available and depending on a variety of flow parameters such as velocity, depth, and temperature. Some portions of the tributary area are made up of or covered (armored) with more coarse sands and gravels which are too large for the flowing water to move. As the flows are concentrated in downslope reaches, the flow rates, and often the depths and velocity, are increased. In alluvial areas, the flatter valley floors are often comprised of the smaller fractions of the soils. This combination of increasing flow parameters and decreasing soil sizes produces large scale sediment transport across the valley floor. There are significant reaches of channel banks and bottom erosion (degradation) and also reaches of sediment deposition (aggradation). This is further complicated by the fact that an area where degradation occurs for one flow rate may aggrade for a different flow rate.

7.2.2.4 Areas of Perennial Surface Flow

Perennial low flows are defined in this EIS as both continuous surface flows and the discontinuous pools of water which are connected by shallow subsurface flows down the washes. These low flows may be supported by discharge from shallow ground water or excess irrigation of lawn in urban areas along Las Vegas Creek (Figure 7-1).

7.2.2.5 Flood Control Facilities

Major flood control facilities in this study area include the Angel Park detention basin, several miles of lined channel and numerous bridge and culverts. Detailed evaluation of each of these facilities was a part of the most recent study (Montgomery Engineers, 1986) and it is suspected that many of these existing facilities cannot pass runoff from the presently accepted 100-year design storm (Sutko, 1988).

7.2.2.6 Wastewater Treatment Plants and Effluent

There are no major wastewater treatment facilities in this subarea.

7.2.3 Southwest Las Vegas Valley

7.2.3.1 Subarea Drainage Patterns

The general drainage pattern is from the mountainous areas on the west to Las Vegas Wash at the eastern edge of the study area. The eastern portion of the study area is heavily urbanized and includes a large portion of the Las Vegas commercial area.

The Southwest Las Vegas Valley subarea is comprised of the full drainage areas of Red Rock Wash, Flamingo Wash, Tropicana Wash, Blue Diamond Wash, Duck Creek and Pittman Wash. Together these washes drain the entire southwest portion of Las Vegas Valley, conveying runoff to Las Vegas Wash. Nearly all of this study area is in unincorporated Clark County, with the exception of the northernmost parts of Red Rock Wash and Flamingo Wash, which are in the City of Las Vegas, and the easternmost parts of Duck Creek and much of the downstream portion of Pittman Wash which are in the City of Henderson.

In general, the hydrologic characteristics of the subarea can be divided into three regions: the steep mountains to the west and south; the relatively flat valley floor; and the broad alluvial apron which connects the mountains with the valley floor. The mountain region generates large volumes and rates of runoff due to its steep slopes, lack of vegetation and low permeability. The valley floor supports the majority of the present urban development in this study area. This development has largely encroached upon the natural floodplains, and in many cases has entirely obliterated the natural channel system. The alluvial apron is comprised of several coalescing alluvial fans which are in a fairly early stage of geological development. These fans have alternating areas of high and low permeability soils, the latter being the result of extensive and variable caliche deposits.

Red Rock Wash and Tropicana Wash are both tributary to Flamingo Wash. All three washes flow in a general west-to-east direction out of the mountains. The Red Rock Wash-Flamingo Wash confluence is located near the intersection of Flamingo Road and Buffalo Road, above which Red Rock Wash has a drainage area of 71 square miles and Flamingo Wash has a drainage area of 17 square miles. A large portion of Red Rock Wash is in the mountain region (54 square miles), whereas a larger portion of Flamingo Wash is on the alluvial apron. The Tropicana Wash-Flamingo Wash confluence is located just west of Maryland Parkway, above which Tropicana Wash has a drainage area of 14 square miles. Flamingo Wash outfalls to Las Vegas Wash south of the Winterwood Golf Course, and has a maximum drainage area of 130 square miles.

Blue Diamond Wash is located south of the Flamingo Wash system. It has a 55.5 square mile area in the mountains which empties onto a large alluvial fan. Below the fan apex the flow divides, with all or a portion of the flow going into Tropicana Wash or into lower Blue Diamond Wash (and eventually into Duck Creek). There is no single definable Blue Diamond Wash channel below the entrenched channel near the apex of the alluvial fan. The area bounded by the Flamingo Wash basin on the north, the Duck Creek basin on the south, Las Vegas Wash on the east and I-15 on the west has been included as the Lower Blue Diamond Wash in the Master Plan, although there is a little continuity of flow between this area and the alluvial fan apex.

Duck Creek is located south of Blue Diamond Wash, and flows in a generally northeasterly direction. Unlike the washes to the north, Duck Creek does not have a well-defined alluvial fan, although alluvial aprons do separate the steep mountains from the valley floor. Several major tributaries (all unnamed) flow out of the hills and combine, along with a portion of the flows from Blue Diamond Wash, at a location about one mile east of I-15. At this location the total drainage area is about 154 square miles, excluding the Blue Diamond Wash area above the alluvial fan. Duck Creek outfalls to Las Vegas Wash east of East Las Vegas and has a total drainage area of 168 square miles.

Pittman Wash is located southeast of Duck Creek, and likewise flows in a northeasterly direction. It is similar in many respects to Duck Creek in terms of the mountainous nature of most of the basin and the lack of a well-defined alluvial fan. The majority of the Pittman Wash flow enters Duck Creek just upstream of Boulder Highway; the remainder crosses Boulder Highway and enters Las Vegas Wash. The total drainage area of Pittman Wash is 95 square miles. Because it has a more north-south orientation than the other major drainages in this subarea, Pittman Wash is more susceptible to large flood events caused by thunderstorms moving rapidly downstream along the same orientation as the watershed.

7.2.3.2 Design Flows

The design flows for this study area were developed during the Master Plan preparation and are presented in Table 7-4.

7.2.3.3 Water Quality Issues

Water quality issues fall into two general categories; water-borne contaminants and sediments. The water-borne contaminants include the dissolved, suspended, or floating chemicals and debris which the water may come in contact with as it moves. As a general rule, storm water runoff is not sampled and tested for contamination and little is known about the quality of the storm water runoff in the study area. It is suspected that some contamination of the storm water runoff occurs under existing conditions and that this problem will get worse as additional urbanization of the tributary area occurs.

Water quality relevant to water-borne sediments is a complex issue. Flowing surface water has the capacity to erode and deposit large quantities of soil and rock during a single storm event. The water will attempt to establish an equilibrium sediment transport load as sediments are available and depending on a variety of flow parameters such as velocity, depth, and temperature. Some portions of the tributary area are made up of or covered (armored) with more coarse sands and gravels which are too large for the flowing water to move. As the flows are concentrated in downslope reaches, the flow rates, and often the depths and velocity, are increased. In alluvial areas, the flatter valley floors are often comprised of the smaller fractions of the soils. This combination of increasing flow parameters and decreasing soil sizes produces large scale sediment transport across the valley floor. There are significant reaches of channel banks and bottom erosion (degradation) and also reaches of sediment deposition (aggradation). This is further complicated by the fact that an area where degradation occurs for one flow rate may aggrade for a different flow rate.

7.2.3.4 Areas of Perennial Surface Flow

Perennial low flows are defined in this EIS as both continuous surface flows and the discontinuous pools of water which are connected by shallow subsurface flows down the washes. These low flows may be supported by discharge from shallow ground water or excess irrigation of lawn in urban areas along Flamingo Wash and Duck Creek (Figure 7-1).

7.2.3.5 Flood Control Facilities

The only notable existing flood control facilities in this study area are the Red Rock Wash detention basin, a couple of lined channel sections and the numerous bridges and culverts for the road crossings of the washes. Detailed evaluation of each of these facilities was a part of the most recent study (Montgomery Engineers, 1986) and it is suspected that many of these existing facilities cannot pass runoff from the presently accepted 100-year design storm (Sutko, 1988).

7.2.3.6 Wastewater Treatment Plants and Effluent

There are no major wastewater facilities in this subarea.

7.2.4 Boulder City

7.2.4.1 Subarea Drainage Patterns

The general drainage pattern includes drainage to the north in Hemenway Wash to Lake Mead and drainage to the south towards Dry Lake. The Boulder City subarea is comprised of the full drainage areas of Bootleg Canyon Wash, Buchanan Wash, Georgia Wash, Cemetery Wash, and Hemenway Wash. Nearly all of this hydrologic drainage basin is in the incorporated limits of Boulder City, with the exception of the upper part of the Bootleg Canyon Wash which is located in Clark County. The area of concern is the incorporated portion of the drainage area in the City of Boulder City. In general, the hydrologic characteristics of the subarea can be divided into three regions: the mountainous area to the north, the alluvial apron upon which portions of the City of Boulder City are located, and the flat wash bottoms of Hemenway Wash and the washes to the south of the subarea.

The mountain region generates large volumes and rates of runoff due to its steepness, lack of vegetation, large areal extent and low permeability. The alluvial apron supports some present urban development. This development has largely encroached upon the natural floodplains of all of the washes.

Each of the major wash systems (Bootleg Canyon, Buchanan, Georgia, Cemetery, and Hemenway washes) comprise individual and independent drainage basins. The Bootleg Canyon Wash flows out of the mountainous region in a north-to-south direction. The Buchanan/Georgia/Cemetery Wash system flows out of the urbanized portions of the City of Boulder City in a north-to-south direction. The Hemenway Wash flows in a south-to-north direction and drains the northern portions of the City of Boulder City. The drainage areas for these washes are:

Bootleg Canyon Wash	1.3 square miles
Buchanan Wash	0.7 square miles
Georgia Wash	1.4 square miles
Cemetery Wash	3.0 square miles
Hemenway Wash	4.2 square miles

Each of these drainages then flow through the City of Boulder City in unlined natural channels.

7.2.4.2 Design Flows

The design flows for this study area were developed during the Master Plan preparation and are presented in Table 7-5.

7.2.4.3 Water Quality Issues

Water quality issues fall into two general categories; water-borne contaminants and sediments. The water-borne contaminants include the dissolved, suspended, or floating chemicals and debris which the water may come in contact with as it moves. As a general rule, storm water runoff is not sampled and tested for contamination and little is known about the quality of the storm water runoff in the study area. It is suspected that some contamination of the storm water runoff occurs under existing conditions and that this problem will get worse as additional urbanization of the tributary area occurs.

Water quality relevant to water-borne sediments is a complex issue. Flowing surface water has the capacity to erode and deposit large quantities of soil and rock during a single storm event. The water will attempt to establish an equilibrium sediment transport load as sediments are available and depending on a variety of flow parameters such as velocity, depth, and temperature. Some portions of the tributary area are made up of or covered (armored) with more coarse sands and gravels which are too large for the flowing water to move. As the flows are concentrated in downslope reaches, the flow rates, and often the depths and velocity, are increased. In alluvial areas, the flatter valley floors are often comprised of the smaller fractions of the soils. This combination of increasing flow parameters and decreasing soil sizes produces large scale sediment transport across the valley floor. There are significant reaches of channel banks and bottom erosion (degradation) and also reaches of sediment deposition (aggradation). This is further complicated by the fact that an area where degradation occurs for one flow rate may aggrade for a different flow rate.

7.2.4.4 Areas of Perennial Surface Flow

Perennial low flows are defined in this EIS as both continuous surface flows and the discontinuous pools of water which are connected by shallow subsurface flows down the washes. No areas of low flow have been noted in this subarea but may be supported by discharge from shallow ground water or excess irrigation of lawn in urban areas.

7.2.4.5 Flood Control Facilities

The only notable existing flood control facilities in this study area are a few dikes and lined channels and a few culverts and bridges for the road crossings at the washes.

Detailed evaluation of each of these facilities was a part of the most recent study (Montgomery Engineers, 1986) and it is suspected that many of these existing facilities cannot pass runoff from the presently accepted 100-year design storm (Sutko, 1988).

7.2.4.6 Wastewater Treatment Plant and Effluent

The Boulder City WWTP is located about three miles southwest of the center of the city. The effluent is conveyed to evaporation ponds located adjacent to the WWTP.

7.2.5 Henderson

7.2.5.1 Subarea Drainage Patterns

The general drainage pattern is to Las Vegas Wash to the north from the mountainous areas which surround the City of Henderson. The Henderson subarea is comprised of the full drainage areas from the mountains around the City of Henderson. It includes the following drainages: Duck Creek, Whitney Wash, Pittman Wash, and "B" drainages and "C" drainages within the City. Together these washes drain the entire hydrologic basin creating stormwater flows within the City of Henderson. All of these conveyance systems collect storm runoff from the upper reaches and convey it to Las Vegas Wash.

In general the hydrologic characteristics within this study area can be divided into three regions: 1) steep mountains to the east and south; 2) the broad alluvial fans extending from these mountains to the lower valley; and 3) the valley floor comprised of the areas around Las Vegas Wash to the north. The mountain regions generate the largest volumes and rates of runoff due to the steep slopes, lack of vegetation and low permeability within these areas. The alluvial fan supports the majority of the present urban development in this study area. Development is somewhat sparse, but has started to encroach upon the natural drainages within the subarea. The City of Henderson is only approximately 30 percent developed at present and has significant room for growth in the future.

The Las Vegas Wash collects flows from all major drainages throughout the Las Vegas Valley. The Duck Creek drainage extends through the western portion of the city and conveys flows from the areas west of the city to the Las Vegas Wash. The flows from Pittman Wash impact the city significantly with flows coming from the southwest. These flows are conveyed through an existing wash system which is poorly defined and conveys flows through new developments which are being constructed along Sunset Road. This area has experienced flood damage in the past. Whitney Wash provides drainage for a local area to the southwest of Sunset Road. These flows route overland and are collected in some small braided channels which carry the flow to small culverts on Sunset Road and eventually combine with Pittman Wash to the east.

A channel collecting flows from the west side of the city has been designated as "B" Channel. This drainage collects waters from the mountains to the south and conveys them through existing and man-made improved channels to Lake Mead Highway. From there they are carried to the northeast crossing Boulder Highway through a structure and eventually flow through unimproved washes combining with other local flows. The area outfalls to Las Vegas Wash just downstream from the Pittman Wash confluence.

The eastern portion of the city is drained by a channel designated as the C-1 Channel. This channel and its tributaries collect flows from the mountains to the south and the east conveying them to a channel on the east side of the town. This channel runs almost due north to Las Vegas Wash and provides the most downstream confluence with Las Vegas Wash in this subarea.

7.2.5.2 Design Flows

The design flows for this study area were developed during the Master Plan preparation and are presented in Table 7-6.

7.2.5.3 Water Quality Issues

Water quality issues fall into two general categories; water-borne contaminants and sediments. The water-borne contaminants include the dissolved, suspended, or floating chemicals and debris which the water may come in contact with as it moves. As a general rule, storm water runoff is not sampled and tested for contamination and little is known about the quality of the storm water runoff in the study area. It is suspected that some contamination of the storm water runoff occurs under existing conditions and that this problem will get worse as additional urbanization of the tributary area occurs.

Water quality relevant to water-borne sediments is a complex issue. Flowing surface water has the capacity to erode and deposit large quantities of soil and rock during a single storm event. The water will attempt to establish an equilibrium sediment transport load as sediments are available and depending on a variety of flow parameters such as velocity, depth, and temperature. Some portions of the tributary area are made up of or covered (armored) with more coarse sands and gravels which are too large for the flowing water to move. As the flows are concentrated in downslope reaches, the flow rates, and often the depths and velocity, are increased. In alluvial areas, the flatter valley floors are often comprised of the smaller fractions of the soils. This combination of increasing flow parameters and decreasing soil sizes produces large scale sediment transport across the valley floor. There are significant reaches of channel banks and bottom erosion (degradation) and also reaches of sediment deposition (aggradation). This is further complicated by the fact that an area where degradation occurs for one flow rate may aggrade for a different flow rate.

7.2.5.4 Areas of Perennial Surface Flow

Perennial low flows are defined in this EIS as both continuous surface flows and the discontinuous pools of water which are connected by shallow subsurface flows down the washes. These low flows may be supported by discharge from shallow ground water or excess irrigation of lawn in urban areas in several locations along Las Vegas Wash and or from WWTP effluent discharge along the washes (Figure 7-1).

7.2.5.5 Flood Control Facilities

The only notable existing flood control facilities are a section of lined channel and the numerous culverts and bridges across the smaller washes. Detailed evaluation of each of these facilities was a part of the most recent study (Montgomery Engineers, 1986) and it is suspected that many of these existing facilities cannot pass runoff from the presently accepted 100-year design storm (Sutko, 1988).

7.2.5.6 Wastewater Treatment Plants and Effluent

There are two located to the north of Henderson towards Las Vegas Wash. Effluent from these is conveyed to evaporation ponds located away from the Las Vegas Wash channel.

7.3 SIGNIFICANT RESOURCES AND ENVIRONMENTAL ISSUES

The various water resources and water resource facilities have varying value and significance in the study area. Each of the resources or issues identified in Table 7-1 is further discussed below along with a discussion of the environmental sensitivity associated with that resource. Environmental changes of potential concern with respect to each of the resource areas discussed below are listed in Table 7-7.

7.3.1 Storm Water Runoff

The storm water runoff flow rates, velocities, and flow patterns contribute to the flood problems, determine the scour and erosion potential of discharges from facilities, affect the size of detention/retention basins and channels, affect the volume of infiltration along drainage paths, and ultimately the volume of water which outfalls from the study area as surface water. The volume of runoff which reaches Lake Mead could be significant to downstream users of Colorado River water. The relationship between the volume of storm water runoff which reaches Lake Mead and the volume which does not because of natural or man-enhanced infiltration could be a water rights concern.

The quality of the storm water runoff is affected by several factors. As the surface flows are produced during a storm event, a variety of dissolved, suspended and floating contaminants or sediments may be introduced to the flows. Flow rates and channel characteristics influence the volume of sediments discharged in surface flows. Contaminants in runoff collected by the flood control facilities also affect the quality of discharged waters. Examples of possible contaminants include fertilizers, pesticides, herbicides, salts, petroleum products, and trash. Shallow ground water of poor quality may be mixed with storm water runoff in the washes with accompanying degradation of the runoff. In the vicinity of and downstream from WWTPs, the potential exists for mixing of runoff and effluent. A major flow could damage the WWTP itself and raw sewage or sludge could be mixed with the runoff. Even short term detention of the runoff can induce physical or chemical processes which leave some contaminants or sediments in the detention basin. Conversely, a flood control system which increases flow velocities may enhance the carrying capacity of the runoff and carry the contaminants or sediments to more downstream locations. The water quality concerns gain significantly in importance if a new flood control system increases the potential for conveying contamination or sediments to a water supply reservoir such as Lake Mead.

7.3.2 WWTP Effluent

Waste water treatment plant effluent is a significant resource. Effluent can be infiltrated, evaporated, used as process water for manufacturing, applied for crop irrigation or discharged to natural drainage paths. The effluent discharge to lower Las Vegas Wash supports perennial flows in the wash which affect sediment movement patterns and support biologic communities downstream from the discharge point. Flood control projects could impact the interactions between the effluent and the natural channel by direct channel modifications or routine maintenance activities in floodways. For instance, a lined channel or cleared floodway would require removal of vegetative material and a series of grade control structures could affect depths to ground water with subsequent impacts to phreatophytic plants. Impacts to WWTP effluent are an environmental concern.

7.3.3 Existing Detention/Retention Basins

Each of the existing three detention/retention basins is a significant resource. This is mostly because of the flood protection which each basin provides for its respective downstream area. The basin area also provides opportunities for recreational and other secondary uses. Potential effects on existing basins are associated with direct modifications. Any modification to a basin should be carefully evaluated to assess changes in the level of flood protection provided and also impacts to secondary uses.

7.3.4 Storm Water Drainage Facilities

The existing storm water drainage facilities are a valuable environmental resource. Both the natural washes and any man-made additions provide a system to convey storm water runoff downslope and away from areas where flooding would otherwise be a problem. The existing system is known to be inadequate to safely manage the 100-year storm runoff. The overbank and off-channel runoff storage capacity of the existing system is seen by most as problem flooding but must also be recognized as storage which attenuates peak flow rates in the present channels. Detailed engineering design of specific flood control facilities should address potential effects on existing storm water drainage facilities, including evaluation of pre- and post-development conditions for areas inundated, depth, velocity, and duration of flow (or ponding), and changes in sediment movement patterns.

7.3.5 Domestic Water System

The existing domestic water system is a significant resource. Because of the many crossings that this system has with the natural drainage system, the domestic water system is an important consideration in the engineering design of flood control improvements to minimize potential construction disturbance of water supply facilities and protect these facilities from potentially damaging flood flows.

7.3.6 Sewage Collection System

The existing sewage collection system is a significant resource. Sewage systems tend to follow the surface contours and the major collector and trunk lines are near the lowest points which is also where the largest washes are located. Because sewer pipes generally operate under gravity flow, their profiles are more fixed than the water supply systems which use pressure flow. As a result, there are more sewer pipes near the washes and the sewer pipes are harder to relocate. Careful consideration should be given to sewage collection systems in the engineering design of flood control facilities to minimize potential construction damage to sewage collection facilities and protect these facilities from potentially damaging flood flows.

7.3.7 Waste Water Treatment Plants

WWTPs are normally located near the lowest part of the urban areas. This places them near the larger washes where major flooding can occur. An environmental assessment of a flood control project must evaluate the interaction between these two facilities to assess whether the flood control facilities and WWTP will affect each other. Potential effects of concern include possible flood damage to the WWTP, and WWTP modifications required to accommodate flood control facilities.

7.3.8 Perennial Low Flow Areas

Areas of perennial low flows and near surface flows under existing conditions are important as a biological and recreational resource. Changes in flow patterns or direct modification of these areas could adversely affect the biological and recreational resource values of these areas. The locations of these areas are further described in Section 8.3 of this EIS. Of particular importance is the Las Vegas Wash and some locations in the Tropicana Wash, Flamingo Wash, Duck Creek, Paradise Valley, Cottonwood Valley, and the Red Rock Canyon Wash.

7.3.9 Colorado River Return Flow Credit

The Las Vegas Valley obtains an average of 174,000 acre-feet per year of its water supply from Lake Mead. Total Colorado River consumptive allocation to southern Nevada is 299,000 acre-feet per year. The maintenance of adequate supplies given this allocation is in part dependent on return-flow credits allowed for the return of water through Las Vegas Wash. Potential effects on WWTP operation, or changes in shallow groundwater levels in the Las Vegas Wash that reduce flows reaching Lake Mead could adversely affect the return flow credit, resulting in limitations on the Las Vegas Valley water supply. As described in Section 6.0, facility-related impacts on groundwater levels can be mitigated to less than significant levels.

7.4 FACILITY-RELATED ENVIRONMENTAL EFFECTS

The evaluation of the environmental impacts and effects of a flood control project which is still in the early design phases must be based upon certain key assumptions. Some of the most significant of these assumptions are that the project will be properly designed, constructed correctly and in the proper sequence, properly operated and will, in fact, do what it is designed to do. The engineering design of flood control facilities was the subject of the Master Plan (Montgomery Engineers, 1986), and is not repeated in this EIS. It is understood that preliminary and final design analysis will further refine the design of the proposed system and that, for any one wash or specific facility, some construction or operational changes may occur to improve the functional effectiveness of individual facilities and incorporate environmental mitigation measures. This analysis of the alternative flood control systems assumes that the principal design characteristics of each final in-place facility will not change significantly from the design currently proposed under each alternative. A summary of the general effects that may occur during facility construction or operation is presented in Table 7-8. These effects are discussed below.

7.4.1 Construction

Construction impacts could be significant especially if a storm occurs during the construction period. It is assumed that proper design and construction will minimize potential impacts to domestic water and sewage collection systems and to WWTPs. However, the possibility exists that construction activities may disrupt normal operation of these facilities. In this case there could be interruptions in service with a period of no domestic water supply or fire protection water in the vicinity of the construction site. An unplanned break in a sewer line would probably not be noticed by most users, but any raw sewage released at the construction site would pose a health hazard to persons at the site and in downstream areas. Construction damage to a WWTP is unlikely but could probably be handled by temporarily using another portion of the WWTP until repairs were completed. Damage to a WWTP could also result in a release of raw sewage, partially treated sewage, or sludge which would be a health hazard to persons at the site or in downstream areas.

Construction impacts to the storm water runoff, detention/retention basins and the storm water drainage facilities could include major modifications to the existing system and a variety of concepts could be employed. The construction areas could be linear for channel improvement or pipe installation or could cover large areas where detention basins are to be installed. The construction activities would disturb the soils and significantly increase the potential for erosion should a storm occur. This could modify sediment movement processes and affect downstream reaches for some distance. The operation of construction equipment provides opportunities for petroleum products to be introduced to the soil and subsequently conveyed by storm water runoff. Construction activities can produce trash which can also become in contact with storm water runoff. Improvements which require subsurface excavation could contact shallow ground water which could then be discharged to the surface if dewatering is necessary or could become mixed with storm water runoff should a storm occur. In general, the construction process can significantly increase the potential for degradation of surface waters which are exposed to the construction area.

Construction impacts to WWTP effluent are expected to be minimal. The effluent would normally be diverted around the construction sites during the construction period. However, the potential exists that effluent could come in contact with the construction site with impacts similar to those for storm water runoff as discussed above.

7.4.2 Direct Operation

Direct impacts of the new flood control system operation should involve major changes in how storm water runoff is routed to its outfalls from the study area. Runoff flowing over the surface should be at shallow depths except where facilities are in place to control concentrated flows. Within these facilities, flow depths and velocities may be more hazardous than before system implementation. Along channel reaches where channel or pipe improvements have reduced or eliminated overbank storage, there will be less peak flow rate attenuation and downstream peak flow rates may be higher. Conversely, along reaches where upstream detention is available, peak flow rates should be lower. Generally for open channels, increases in flow rate are associated with more hazardous conditions and decreases in flow rate are associated with less hazardous conditions. In pipe flow, higher flow rates are not necessarily any more hazardous providing grates or small orifice inlets are used to prevent persons from being swept into the pipe.

Operation of the new flood control system can also potentially initiate significant changes in sediment movement patterns. Storm water detention or retention basins will settle out the coarser fraction of the inflowing water sediment load and subsequently release runoff which is relatively sediment free. These "clear" releases can erode downstream unlined channel reaches. Along reaches where a lined channel has replaced an unlined channel, flow velocities may be increased with an accompanying increase in downstream erosion potential. Changes in channel slope may produce more turbulent flow (hydraulic jump) and transition from one channel slope to a steeper slope can cause higher velocities where more erosion can be expected if the channel is not lined. Some reaches of the new system may silt up during the more frequent, lower flows and then erode during the higher, less frequent events.

Maintenance of the new system will be an ongoing concern. Local scour at channel structures and general aggradation/degradation will have to be monitored. Channel bank protection may require maintenance and smaller conveyances may require periodic clean out at inlet locations.

The quality of the storm water runoff will be affected by implementation of the new flood control system. Basins may trap floating debris. New conveyances may pick up more contamination. Any portion of the system where channel lining reduces infiltration losses and/or flow rates are increased may cause water-borne contaminants to be conveyed further downstream.

7.4.3 Indirect Operation

Indirect impacts to downstream areas could occur as a result of upstream diversion of surface flows by flow collection dikes associated with detention basins and headwaters channels. Although this effect provides downstream flood protection and may be considered beneficial in that respect, it could have an indirect adverse impact on downstream biological habitats in some areas. This potential impact is discussed further in Section 8.0.

7.5 ENVIRONMENTAL EFFECTS BY ALTERNATIVE

To illustrate the general operation characteristics of the Combined Detention/Conveyance alternative, All Conveyance alternative, and No Project alternative, information concerning predicted 100-year flow rates and facility capacities as presented in the Master Plan (Montgomery Engineers, 1986) is presented in Table 7-9 and Figure 7-2 for selected locations in the study area. The information in this table, along with an analysis of resources and potential impacts discussed in Sections 7.1, 7.2, 7.3, and 7.4 were used to develop the summary of potential environmental effects that could be associated with the proposed flood control alternatives presented in Table 7-10.

7.6 PROGRAMMATIC MITIGATION MEASURES

As indicated in the discussion presented in Section 7.4, potentially significant surface water impacts associated with the proposed Master Plan are primarily associated with engineering details of the facilities themselves. Impacts related to increased flood hazard, flow pattern changes, increased erosion, increased sediment load, and other water quality concerns are routinely addressed during final facility design. Since the proper function of the flood control system depends on the adequate consideration of these factors, good engineering practice is expected to reduce potential impacts to levels that are less than significant. Project-specific consideration of these issues in further environmental analyses is appropriate to call attention to facilities that may require an additional level of care during final design, however. Engineers should also be directed to other portions of the EIS which address several of these topics in greater detail, such as erosion and sedimentation in Section 5.0 and indirect effects of diversions on downstream areas in Section 8.0.

TABLE 7-1

SUMMARY OF SIGNIFICANT EXISTING SURFACE WATER RESOURCES AND ISSUES
AND WATER RESOURCE FACILITIES

	NORTHERN LAS VEGAS VALLEY	CENTRAL LAS VEGAS VALLEY	SOUTHWEST LAS VEGAS VALLEY	BOULDER CITY	HENDERSON
Storm Water Runoff (Volume and Quality)	Yes	Yes	Yes	Yes	Yes
WWTP Effluent	Yes	No	No	Yes	Yes
Existing Detention/ Retention Basins	One	One	One	None	None
Storm Water Drainage Facilities	Yes	Yes	Yes	Yes	Yes
Domestic Water System	Yes	Yes	Yes	Yes	Yes
Sewage Collection System	Yes	Yes	Yes	Yes	Yes
WWTPs	Three	None	None	One	Two
Perennial Low Flows	Yes	No	Yes	No	No
Lake Mead Return Flow Credit	Yes	Yes	Yes	No	Yes

TABLE 7-2

SUMMARY OF 100-YEAR, 3-HOUR DESIGN FLOWS AT KEY LOCATIONS IN NORTHERN LAS VEGAS VALLEY[1]

STREAM/LOCATION	AREA (SQ. MILES)	PEAK FLOW (CFS)
LAS VEGAS WASH		
Above N.L.V. Basin	80.10	21,700
I-15 Freeway	733.00	13,700
Pecos Rd/Lake Mead Blvd.	740.00	13,700
Washington Avenue Confluence	768.00	13,700
Flamingo Wash Confluence	800.00	14,500
Duck Creek	1460.00	24,600
RANGE WASH/SLOAN CHANNEL		
West Trib at I-15	78.56	6,260
North East Trib at R/R Tracks	14.79	1,180
At Confluence W/East Range Wash	55.57	6,105

[1] Montgomery Engineers, 1986

TABLE 7-3

SUMMARY OF 100-YEAR, 3-HOUR DESIGN FLOWS AT KEY LOCATIONS IN CENTRAL LAS VEGAS VALLEY[1]

LOCATION	AREA (SQ. MILES)	PEAK FLOWS (CFS)
GOWAN/CAREY AVENUE SYSTEM		
Gowan Road at Gragson Highway	51.5	23,410
Diversion to N. Las Vegas at Gowan & Decatur	53.1	410
Rancho Road at Cheyenne	53.9	23,990
Freeway Channel at Vegas Drive	61.9	17,290
Diversion W6A at Lake Mead	61.9	8,900
Freeway Channel at Las Vegas Wash	69.7	19,660
Las Vegas Blvd. at Cartier	1.3	390
ANGEL PARK SYSTEM		
Angel Park Detention Basin Outflow	14.6	7,210
Las Vegas Creek/Washington Avenue		
Las Vegas Creek at Highland	23.3	2,500
Washington Avenue at Bruce St.	24.1	2,700
Washington Avenue at Las Vegas Wash	26.8	12,020
CHARLESTON AVENUE SYSTEM		
I-15 at Spring Mountain Road	1.2	330
I-15 at Desert Inn	4.1	1,240
Charleston Avenue Underpass	23.4	6,190
Charleston Avenue at Fremont	26.0	6,700
Charleston Avenue at Las Vegas Wash	29.1	7,150
CEDAR AVENUE SYSTEM		
Cedar Avenue Drain at Las Vegas Wash	4.4	850

1 Montgomery Engineers, 1986

TABLE 7-4

SUMMARY OF 100-YEAR, 3-HOUR DESIGN FLOWS AT KEY LOCATIONS IN SOUTHWEST LAS VEGAS VALLEY[1]

STREAM/LOCATION	AREA (SQ. MILES)	PEAK FLOW (CFS)	NOTES
RED ROCK WASH			
Inflow to Detention Basin	53.1	9,370	
Outflow from Detention Basin	53.1	1,400	
Confluence with Flamingo Wash	69.7	3,580	
North Branch at Buffalo Road	5.0	590	
FLAMINGO WASH			
Above Confluence with Red Rock Wash	18.5	4,560	
Decatur Blvd.	94.4	8.640	
Below I-15	96.0	6,210	1
Above Confluence with Tropicana Wash	96.5	6,350	1
Maryland Parkway	110.6	10,300	1
Mojave Road	122.9	13,700	
Boulder Highway	127.7	14,400	
Confluence with Las Vegas Wash	129.8	14,500	
TROPICANA WASH			
North Branch at UPRR	2.6	770	
Central Branch at UPRR	5.5	1,950	
South Branch at UPRR	2.8	6,480	2
Interstate 15	12.3	6,030	2
Confluence with Flamingo Wash	14.1	5,940	2
BLUE DIAMOND WASH			
Fan Apex	55.5	17,100	
I-15 North of Blue Diamond Road Interchange	29.5	4,810	3
I-15 South of Blue Diamond Road Interchange	28.1	4,790	3
DUCK CREEK			
Paradise Road	137.5	20,000	4
UPRR	205.8	25,000	4
Mountain View Street	219.2	24,500	4
Above Boulder Highway	221.4	24,500	4,5
PITTMAN WASH			
Main Branch at Henderson Cutoff	50.6	11,800	
West Tributary at Henderson Cutoff	12.0	1,760	
East Tributary at Henderson Cutoff	7.5	1,910	
UPRR	86.8	16,600	

[1] Montgomery Engineers, 1986

NOTES FOR TABLE 7-4

1) Reduced by upstream overflows due to limited structure capacities

2) This flow and downstream flows generated by diversions from Blue Diamond alluvial fan. Drainage area does not include any of the area upstream of the fan

3) Flows diverted to lower Blue Diamond Wash are divided evenly; drainage area above the fan is also divided evenly

4) Drainage area includes 55.5 square miles from upper Blue Diamond Wash

5) Does not include any contribution from Pittman Wash

TABLE 7-5

SUMMARY OF 100-YEAR, 3-HOUR DESIGN FLOWS AT KEY LOCATIONS IN THE CITY OF BOULDER CITY[1]

STREAM	AREA (SQ. MILES)	PEAK FLOW (CFS)
Bootleg Canyon Wash	3.12	1,630
Cemetery Wash	2.99	650
Georgia/Buchanan Wash	3.07	1,190
Hemenway Wash	4.13	2,350

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[1] Montgomery Engineers, 1986

TABLE 7-6

SUMMARY OF 100-YEAR, 3-HOUR DESIGN FLOWS AT KEY LOCATIONS IN CITY OF HENDERSON[1]

STREAM/LOCATION	AREA (SQ. MILES)	PEAK FLOW (CFS)
PITTMAN WASH		
R/R Tracks in Henderson	86.34	16,600
Sunset Road	87.00 (Est)	16,600
Boulder Highway	88.87	16,600
"B" DRAINAGE		
Lake Mead Highway	5.51	1,220
Sunset Road	12.37	4,180
Boulder Highway	21.44	6,710
"C" DRAINAGE		
South Trib. at Boulder Highway	4.35	1,630
Head of C-1 Channel	22.70	5,290
Lake Mead Highway	38.60	10,160

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[1] Montgomery Engineers, 1986

TABLE 7-7

POTENTIAL ENVIRONMENTAL CONCERNS
SURFACE WATER RESOURCES

	POTENTIAL CONCERNS[1]							
SURFACE WATER RESOURCES[2]	Increased Flood Hazard	Flow Pattern Changes	Increased Erosion	Reduced Groundwater Recharge	Sediment Transport Changes	Water Quality Degradation[3]	Construction Disturbance	Water Rights
Storm Water Runoff	X	X	X	X	X	X		X
WWTP Effluent		X				X	X	
Existing Detention/Retention Basins	X	X					X	
Storm Water Drainage Facilities	X	X	X		X		X	
Domestic Water System							X	
Sewage Collection System							X	
WWTPs	X					X		
Perennial Low Flow Areas		X						
Lake Mead Return Flow Credit				X				X

1 Potential concerns represent potential impacts as discussed in Section 7.3
2 Surface water resources are discussed in Section 7.3
3 Water quality effects considered in this column refer to the increased downstream transport of contaminants other than water-borne sediments

TABLE 7-8

POTENTIAL ENVIRONMENTAL IMPACT
FLOOD CONTROL SYSTEM CONSTRUCTION AND OPERATION

FACILITY CHARACTERISTICS[2]	Increased Flood Hazard	Flow Pattern Changes	Increased Erosion	Reduced Groundwater Recharge	Sediment Transport Changes	Water Quality Degradation[3]	Construction Disturbance	Water Rights
	POTENTIAL IMPACTS[1]							
CONSTRUCTION								
Construction Activities (All Structures)	NI	NI	NS	NI	NS	NS	NS	NI
DIRECT OPERATION								
Closed Conveyances	NI	NS	NI	NS	NS	NI	NS	NS
Lined Channels	S	S	NI	NS	NI	NS	NS	NS
Unlined Channels	NS	NS	S	NI	S	NS	NS	NS
Detention Basins	NS	NS	NI	NI	S	NI	S	NS

1 Potential impacts are categorized according to potential concerns identified in Section 7.3 related to specific water resources
S = significant impact
NS = no significant impact
NI = no anticipated impact

2 Facility characteristics refer to activities, operational characteristics, and facilities that may result in the impacts identified

3 Water quality impacts in this column refers to the increased downstream transport of contaminants other than water-borne sediments

TABLE 7-9

FLOW RATES AND FACILITY CAPACITY (CFS)[1]

DESCRIPTION	LOCATION NUMBER[4]	EXISTING FACILITY Flow[5]	EXISTING FACILITY Capacity[6]	DETENTION/CONVEYANCE[2] Flow	DETENTION/CONVEYANCE[2] Capacity	ALL CONVEYANCE[3] Flow	ALL CONVEYANCE[3] Capacity
Kyle Canyon Outflow/Tonapah Highway Crossing	1	9220	5015	3545	3950	10250	11000
Lone Mountain Area	2	2250	N/A	400	400	2300	2300
Lone Mountain Area	3	750	N/A	1240	1400	2300	2400
Buffalo Road/Tonopah Highway	4	N/A	N/A	100	120	800	1130
Below North Las Vegas Wash Basin	5	21020	N/A	5400	6190	13780	14300
UPRR at West Las Vegas Range Wash	6	4853	4620	360	865	9600	10000
I-15, East Valley	7	1320	3460	500	1290	1320	1440
Las Vegas Boulevard, East Valley	8	1180	N/A	2300	2310	3570	4320
Craig Road at Las Vegas Expressway	9	6105	N/A	1200	1300	1800	1800
Torrey Pines at Gowan	10	23410	N/A	440	500	500	500
Michael Way at Cheyenne	11	24020	N/A	200	200	300	300
Channel North of Smoke Ranch	12	1960	N/A	2100	2300	3900	3900
Smoke Ranch Crossing Below Angel Park Basin	13	1960	N/A	2100	2100	3900	3900
Vegas Drive Crossing Below Angel Park Basin	14	N/A	N/A	1700	1700	1200	1200
Vegas Drive at Jones	15	940	N/A	100	120	200	200
Charleston at Decatur	16	330	N/A	500	500	500	500
Craig Road at North 5th	17	9030	N/A	2700	3250	N/A	3250
UPRR and I-15 Crossing	18	23230	9660	2700	9960	N/A	7200
Below UPRR and I-15 Crossing	19	23230	9660	5400	5700	12700	12820
"N" Channel, I-15 to Cheyenne	20	N/A	2400	1050	1620	1050	1620
Smoke Ranch and Rancho	21	1780	34	200	280	2000	2000
Haddock at Las Vegas Wash	22	24210	8970	5400	6780	13700	14450

1 Peak flow and capacity under full development buildout and saturation conditions as reported in the Flood Control Master Plan (Montgomery Engineers (1986) for a 3-hour, 100-year storm. Table entries were determined using Volume 2, Parts A and B of the Master Plan.

2 Derived from Figures A2-1, A2-2, A2-3, A2-4, A2-5, A2-6, A2-7, A2-8, A2-9, A2-10, A2-11, A2-12, A2-14, and associated tables.

3 Derived from Figures A1-1, A1-2, A1-3, A1-4, A1-5, A1-6, A1-7, A1-8, A1-9, A1-10, A1-11, A1-12, A1-14, and associated tables.

4 Location of table entries are numbered on Figure 7-2.

5 Derived from Figures B-1, B-2, B-3, B-4, B-5, B-6, B-7, B-8, B-9, B-10, B-11, B-12, B-14, and associated tables.

6 Derived from Figures F-1, F-2, F-3, F-4, F-5, F-6, F-7, F-8, F-9, F-10, F-11, F-12, F-14, and associated tables.

TABLE 7-9 (continued)

DESCRIPTION	LOCATION NUMBER	EXISTING FACILITY Flow	EXISTING FACILITY Capacity	DETENTION/CONVEYANCE Flow	DETENTION/CONVEYANCE Capacity	ALL CONVEYANCE Flow	ALL CONVEYANCE Capacity
Washington at Kvilima Road	23	12440	70	3670	3670	6700	6700
Washington at Las Vegas Wash	24	12030	225	3670	3700	6700	670
Charleston West of Main	25	920	N/A	2100	2520	3800	3800
Charleston at Arlington Street	26	23880	34500	5400	12610	15600	16080
Sloan Lake Channel Above Lake Mead	27	7150	1440	1650	2160	16800	17500
Sloan Channel Below Bonanza Road	28	16680	2030	1650	2100	16800	17560
Sloan Channel at Charleston	29	16930	3430	1650	2210	16800	10000
Sahara at Jones	30	360	N/A	300	300	300	300
Desert Inn Near Torrey Pines	31	590	N/A	50	50	300	300
Flamingo Near Torrey Pines	32	170	1400	400	400	300	400
Spanish Trails	33	7970	7800	3740	7800	7960	7800
Flamingo at Industrial	34	2280	5100	1840	5100	8780	8780
Koval at Tropicana Wash	35	5960	2160	1700	2160	5960	5960
Swenson at Flamingo Wash	36	6350	2000	1840	2000	9030	9030
Flamingo Wash at Desert Inn	37	13700	5250	4250	5250	13500	13500
Lamb at Flamingo Wash	38	14400	6120	5140	6100	14500	14500
Nellis Blvd. at Flamingo Wash	39	N/A	6920	5140	6900	8910	2900[7]
Pecos at Duck Creek	40	570	500	570	570	570	570
Rawhide at Duck Creek Wash	41	25210	6700	4540	6700	24500	24500
Sloan Channel Below Las Vegas Wash	42	23830	3000	5570	6230	16800	16900
Lower Las Vegas Wash Inflow	43	500	580	400	1200	400	1200
Lower Las Vegas Wash Inflow	44	740	120	660	660	660	660
Duck Creek Bridge	45	24460	180	6490	6780	24500	25000
Duck Creek Inflow to Lower Las Vegas Wash	46	24460	N/A	6490	7660	24500	25640
Inflow to Lower Las Vegas Wash	47	7490	N/A	1530	2300	7070	8610
C-1 Channel Inflow to Lower Las Vegas Wash	48	10590	N/A	4340	4900	10590	11200
C-1 Channel	49	9730	610	3570	9040	9730	11200
UPRR at Blue Diamond Wash	50	4810	1040	1800	2080	9620	9600
UPRR Near Blue Diamond Road	51	790	500	800	500	800	500
UPRR at Duck Creek	52	1190	5200	1580	5200	11000	11000

7 Facility installed in addition to existing structures. Capacity indicated refers to the new facility only.

TABLE 7-9 (concluded)

DESCRIPTION	LOCATION NUMBER	EXISTING FACILITY Flow	EXISTING FACILITY Capacity	DETENTION/CONVEYANCE Flow	DETENTION/CONVEYANCE Capacity	ALL CONVEYANCE Flow	ALL CONVEYANCE Capacity
I-15 at Blue Diamond Wash	53	2400	300	570	720	4800	4800
Eastern at Duck Creek	54	25000	2740	3300	3300	25000	25000
Pittman Wash	55	16600	N/A	6490	6740	16600	16620
Las Vegas Boulevard at Duck Creek	56	14000	1200	2800	2800	20000	20000
Boulder Highway Near Las Vegas Downs	57	3690	478	440	720	3690	3800
Hemenway Wash Channel	58	2020	N/A	2020	2020	2020	2020
Hemenway Wash Bridge	59	2020	N/A	2020	2020	2020	2020

TABLE 7-10

PROJECT IMPACTS ON SIGNIFICANT RESOURCES

	CONVEYANCE/DETENTION	ALL CONVEYANCE	NO PROJECT
STORM WATER RUNOFF			
Construction	Increased Sediment Load If Storm Occurs	Increased Sediment Load If Storm Occurs	No Impact
Direct Operation	Flow Rates, Depths, Velocities Decrease. Sediment Movement Patterns Change, Flow Duration Increases, and Volume Decreases. Water Quality May Degrade Less Runoff Reaches Outfalls Ponded Water In Detention Basins	Flow Rates, Depths, Velocities Increase. Sediment Movement Patterns Change, Flow Duration Decreases, and Volume Increases. Water Quality May Degrade More Runoff Reaches Outfalls	No Impact
Indirect Operation	More Natural Ground Water Recharge	Less Natural Ground Water Recharge	No Impact
Cumulative Impacts	Significant Reduction of Flooding Potential	Signficant Reduction of Flooding Potential	None
WWTP EFFLUENT			
Construction	Short Term Construction Impacts	Short Term Construction Impacts	No Impact
Direct Operation	No Impact	No Impact	No Impact
Indirect Operation	No Impact	No Impact	No Impact
Cumulative Impacts	None	None	None

TABLE 7-10 (continued)

	CONVEYANCE/DETENTION	ALL CONVEYANCE	NO PROJECT
EXISTING DETENTION/RETENTION BASINS			
Construction	N. Las Vegas Wash Detention Basin Enlarged by 2000 af., Angel Park Detention Basin Minor Modifications, Red Rock Detention Basin Not Changed. Short Term Construction Impacts.	No Impact	No Impact
Direct Operation	Peak Flow Rates Downstream Reduced by Basin Operation	No Impact	No Impact
Indirect Operation	No Impact	No Impact	No Impact
Cumulative Impacts	None	None	None
STORM WATER DRAINAGE FACILITIES			
Construction	Right of Way Needed for New Basins and New Conveyances	Right of Way Needed for New Conveyances	No Impact
	Short Term Increased Erosion Potential	Short Term Increased Erosion Potential	No Impact
Direct Operation	Erosion/Deposition Patterns Change	Erosion/Deposition Patterns Change	No Impact
Indirect Operation	No Impact	No Impact	No Impact
Cumulative Impacts	None	None	None

TABLE 7-10 (continued)

	CONVEYANCE/DETENTION	ALL CONVEYANCE	NO PROJECT
DOMESTIC WATER SYSTEM			
Construction	Short Term Construction Impacts	Short Term Construction Impacts	No Impact
Direct Operation	Increased Protection From Flood Damage	Increased Protection From Flood Damage	No Impact
Indirect Operation	Reduced Risk of Service Disruption	Reduced Risk of Service Disruption	No Impact
Cumulative Impacts	None	None	None
SEWAGE COLLECTION SYSTEM			
Construction	Short Term Construction Impact	Short Term Construction Impact	No Impact
Direct Operation	Increased Protection From Flood Damage	Increased Protection From Flood Damage	No Impact
Indirect Operation	Reduced Risk of Service Disruption	Reduced Risk of Service Disruption	No Impact
Cumulative Impacts	None	None	None
WWTPs			
Construction	No Impact	No Impact	No Impact
Direct Operation	Increased Protection From Flood Damage	Increased Protection From Flood Damage	No Impact
Indirect Operation	Reduced Risk of Service Disruption	Reduced Risk of Service Disruption	No Impact
Cumulative Impacts	None	None	None

TABLE 7-10 (concluded)

	CONVEYANCE/DETENTION	ALL CONVEYANCE	NO PROJECT
PERENNIAL LOW FLOWS			
Construction	Minimal Impact	Minimal Impact	No Impact
Direct Operation	Some Changes in Flows	No Impact	No Impact
Indirect Operation	No Impact	No Impact	No Impact
Cumulative Impacts	None	None	None
COLORADO RIVER RETURN FLOW CREDIT			
Construction	No Impact	No Impact	No Impact
Direct Operation	No Impact	No Impact	No Impact
Indirect Operation	No Impact	No Impact	No Impact
Cumulative Impacts	None	None	None
STORM WATER RUNOFF PATTERNS			
Construction	Minor Changes During Construction	Minor Changes During Construction	No Impact
Direct Operation	Ponding Along Diversion Structures and in Detention Basins	Higher Flow Rates in Conveyances	No Impact
Indirect Operation	No Impact	No Impact	No Impact
Cumulative Impacts	None	None	None

FIGURE 7-1

SURFACE WATER FEATURES

(SEE VOLUME II, OVERSIZE MAPS)

FIGURE 7-2

LOCATION OF PREDICTED 100-YEAR PLAN FLOW RATES
AND FACILITY CAPACITIES

(SEE VOLUME II)

FIGURES 7-3 TO 7-16

INTERMITTENT AND PERENNIAL FLOWS

(SEE VOLUME II, OVERSIZE MAPS)

8.1 OVERALL ENVIRONMENTAL CONDITIONS

The project area is contained primarily within the Las Vegas Valley and a small portion of Eldorado Valley in Clark County, southern Nevada. The Las Vegas Valley is bounded by the Spring Mountains on the west, the Sheep, Las Vegas, and Arrow Canyon ranges on the north, the Muddy Mountains (including Sunrise Mountain, Frenchman Mountain, Lava Butte, and Rainbow Gardens) and River Mountains on the east, and the McCullough Range, Eldorado Valley, Sheep Mountain, and the Bird Spring Range on the south. The project area drains primarily eastward into Lake Mead via the Las Vegas Wash, except in the vicinity of Boulder City. A portion of the Boulder City subarea drains southward into the Eldorado Valley, while the remainder drains northward into Lake Mead.

The project area occurs within the northeastern portion of the Mojavian Floristic/Physiographic Region (Cronquist et al., 1972) which is characterized by moderate to high mountain ranges and intervening valleys arranged generally in a north-south parallel pattern. The Mojave Desert is characterized by hot, dry summers and cool, dry winters (Thorne et al., 1981) with an average annual precipitation in the Las Vegas Valley area between four and five inches (United States Fish and Wildlife Service [USFWS], 1987). Precipitation occurs sporadically from either winter rains or summer thundershowers. In some recent years, summer precipitation events have caused serious flooding problems in the Las Vegas Valley.

The Las Vegas Valley consists of coalescing alluvial fans which form extensive bajadas around the entire valley. Steep, rugged mountain slopes occur immediately above the alluvial fans (bajadas). The project area ranges in elevation from 1,200 feet at the mouth of the Las Vegas Wash (Lake Mead) to over 5,000 feet at several points along the periphery of the valley. The major drainage system is the Las Vegas Wash which drains nearly all of the Las Vegas Valley. It includes the following tributaries: Pittman Wash, Duck Creek, Blue Diamond Wash, Tropicana Wash, Flamingo Wash, Las Vegas Creek (Washington Street Channel), upper Las Vegas Wash, West Las Vegas Range Wash, East Las Vegas Range Wash, and Las Vegas Range Wash (Sloan Channel). Much of the central portion of Las Vegas Valley has been fully developed due to urbanization and includes the cities of Las Vegas, North Las Vegas, and Henderson, as well as Nellis Air Force Base. Boulder City occurs in the southeastern portion of the project area.

8.1.1 Vegetation Types and Wildlife Habitats

The vegetation present in the project area consists of uplands, wetlands, and scattered areas of ruderal vegetation. The upland types occur on gentle slopes of broad bajadas and on steep mountain slopes surrounding Las Vegas Valley. Wetland types occur in lowland areas such as washes, streambeds, dry lake beds, seeps and springs, alkali meadows, impoundments (usually man-made), flood channels, and flat areas possessing a high water table. Ruderal vegetation occupies both upland and wetland areas where substantial disturbance due to development has occurred. The vegetation has been classified according to an adaptation of several vegetation classification systems including those described in: CCDCP (1987), Cowardin et al. (1979), Holland et al. (1979), Holland (1986), Thorne (1976), Thorne et al. (1981), and USFWS (1987).

Wildlife habitats in the project area can also be generally categorized as uplands and wetlands. Although some overlapping of wildlife species occurs among the upland types and among the wetland types, faunal groups associated with each vegetation type are described below, including common, characteristic, and sensitive species.

Information regarding the distribution of wildlife species in the region and occurrence within vegetation types was derived from many sources, including: 1) personal and in litt. communications (Baepler, 1988; Cole, 1988; Hardenbrook, 1988; Jones, 1988; Maley, 1988; Marlow, 1988; O'Farrell, 1987; Padilla, 1988; Pratt, 1988; Slone, 1988; Turner, 1988); 2) museum collections at the University of Nevada, Las Vegas (UNLV) Museum of Natural History and the southern division of the Nevada State Museum; 3) checklists of regional fauna (Baepler, no date; BLM, 1979a, 1979b, no date-a, no date-b; Lawson, 1977; USFWS, 1974, 1984); and 4) theses, publications, and agency reports (Blake, 1978; Burt and Grossenheider, 1976; Clark and Wheeler, 1987; Christensen, 1970; Hall, 1981; Herron et al., 1985; Johnsgard, 1975; Miller, 1974; Ryser, 1985; Schmidt and Gilbert, 1978; Schwartz et al., 1978; Stebbins, 1985; Zeveloff, 1988).

8.1.1.1 Upland

The upland vegetation types and wildlife habitats of the project area consist of low (below 3,000 feet elevation) and high (above 3,000 feet elevation) desert types which are locally influenced by varying edaphic conditions. The two common types encountered in the project area include creosote bush scrub and blackbush scrub/Joshua tree woodland (CCDCP, 1987). Two less common types include: desert calcicolous scrub, which occurs on calcareous substrates; and, pinyon-juniper woodland, which occurs at the western edge of the project area above 4,000 feet (Thorne et al., 1981).

Creosote Bush Scrub

Creosote bush scrub includes the Mojave creosote bush scrub of Holland (1986) and the low desert type of USFWS (1987). This is the most abundant vegetation type of the lower elevation areas of the Mojave Desert, primarily below 3,000 feet. Creosote bush scrub is the predominant vegetation type in the Las Vegas Valley (CCDCP, 1987). It is characterized by widely spaced shrubs with an approximate average vegetative cover of 32 percent in the project area (USFWS, 1987). Two shrub species dominate this vegetation type, creosote bush (Larrea divericata) and burro-weed (Ambrosia dumosa). Other common and characteristic shrubs and perennial herbs of creosote bush scrub in the project area include Shockley goldenhead (Acamptopappus shockleyi), four-wing saltbush (Atriplex canescens), brittle-bush (Encelia farinosa), Mormon tea (Ephedra nevadensis), wild buckwheat (Eriogonum fasciculatum), rattany (Krameria spp.), wolf-berries (Lycium spp.), cholla and beaver-tail cactus (Opuntia spp.), turpentine-broom (Thamnosma montana), and Mojave yucca (Yucca schidigera) (at higher elevations). Numerous annual herbs occur following sufficient rainfall, primarily during the spring.

Creosote bush scrub contains several subtypes which are controlled by differences in soil type (edaphic conditions), slope and moisture gradients, and slope aspect. Two such types occurring in the project area are desert psammophytic scrub and gypsicolous scrub (Thorne et al., 1981).

Desert psammophytic scrub consists of plants which are adapted to survival on sandy substrates, especially sand dunes. While the typical creosote bush scrub species also occupy sandy substrates, many taxa are mostly restricted to these habitats, such as: sand verbenas (Abronia micrantha, A. villosa), onyx flower (Achyronychia cooperi), Mojave croton (Croton californicus var. mohavensis), silky dalea (Dalea mollis), speckle-pod (Dithyrea californica), bindweed heliotrope (Heliotropium convolvulaceum var. californicum), galleta grass (Hilaria rigida), evening-primroses (Oenothera spp.), Indian ricegrass (Oryzopsis hymenoides), Spanish needle (Palafoxia spp.), canaigre

(Rumex hymenosepalus), and tiquilias/coldenias (Tiquilia [Coldenia] spp.) (Holland et al., 1979; Thorne et al., 1981). Sandy areas such as these are fairly restricted in the project area, with the best example occurring in sand dunes of the Las Vegas Dunes Recreation Area northeast of Las Vegas.

Gypsicolous scrub consists of plants adapted to soils high in gypsum content, which is common in the project area. Vegetation on gypsum soils is often sparse or barren (CCDCP, 1987). As with many edaphically controlled vegetation types, many taxa occurring on these substrates are restricted to them, such as golden bear poppy (Arctomecon californica), Merriam's bear poppy (Arctomecon merriamii), pinnate-leaved primrose (Camissonia multijuga), Parry's primrose (Camissonia parryi), large-flowered sunray (Enceliopsis argophylla var. grandiflora), little trumpet (Eriogonum trichopes), Parry's sandpaper plant (Petalonyx parryi), and Palmer's phacelia (Phacelia palmeri) (CCDCP, 1987; Thorne et al., 1981). This type of creosote bush scrub occurs in scattered areas throughout the project area.

The fauna associated with creosote bush scrub includes species adapted primarily to low desert habitats (below 3,000 feet). Because surface water is very scarce and transitory (restricted primarily to small scattered pools immediately following rainstorms), there are no fish and few amphibian species in this habitat. The Great Plains toad (Bufo cognatus) occurs in several desert habitats, including creosote bush scrub. In contrast, the reptilian fauna is relatively diverse. Common and characteristic species include zebra-tailed lizard (Callisaurus dracanoides), long-nosed leopard lizard (Gambelia wislizenii), desert horned lizard (Phrynosoma platyrhinos), western ground snake (Sonora semiannulata), and Mojave rattlesnake (Crotalus scutulatus). Two species of sensitive reptiles are widespread in this habitat, including desert tortoise (Xerobates [=Scaptochelys] [=Gopherus] agassizii) and Gila monster (Heloderma suspectum).

Mammals and birds (especially breeding birds) adapted to creosote bush scrub are quite limited in number. Year-round resident birds include greater roadrunner (Geococcyx californianus), horned lark (Eremophila alpestris), scrub jay (Aphelocoma coerulescens), common raven (Corvus corax), and sage sparrow (Amphispiza belli). Game birds utilize this habitat for all or part of the year, including migratory (mourning dove [Zenaida macroura]) and year-round resident (Gambel's quail [Callipepla gambelii]) species.

Common and characteristic mammals of creosote bush scrub include black-tailed jack rabbit (Lepus californicus), white-tailed antelope squirrel (Ammospermophilus leucurus), desert woodrat (Neotoma lepida), and coyote (Canis latrans). Although little is known about their distributions, several species of bats occur in the region. Two species, spotted bat (Euderma maculatum), and greater mastiff bat (Eumops perotis californicus), are Category 2 federal candidates. Other game and furbearer species in creosote bush scrub include kit fox (Vulpes macrotis) and desert cottontail (Sylvilagus audubonii), both of which are quite common throughout much of the project area.

Blackbush Scrub/Joshua Tree Woodland

Blackbush scrub/Joshua tree woodland includes vegetation types recognized by USFWS (1987) (high desert), Thorne et al. (1981) (blackbush scrub and Joshua tree woodland), and Holland (1986) (sonoran mixed woody and succulent scrub, blackbush scrub, and Joshua tree woodland). This vegetation type consists of an extensive, low, dark, monotonous scrub dominated by blackbush (Coleogyne ramosissima) and occurs mostly on shallow, rocky, or gravelly (usually calcareous) soils of flats, plateaus, and upper bajadas and mountain slopes between 3,000 and 5,000 feet. (Holland et al., 1979; Thorne et al., 1981). Common and characteristic plant species of blackbush scrub/Joshua tree woodland consist of blackbush (Coleogyne ramosissima), winter-fat (Ceratoides lanata), Mormon teas

(Ephedra spp.), hop-sage (Grayia spinosa), cheese-bush (Hymenoclea salsola), creosote bush (Larrea divericata), spiny menodora (Menodora spinescens), bladder-sage (Salazaria mexicana), desert sage (Salvia dorii), turpentine-broom (Thamnosma montana), banana yucca (Yucca baccata), and Joshua tree (Yucca brevifolia). This vegetation type is located primarily on the lower slopes of the Spring Mountains (such as Blue Diamond Ridge and La Madre Mountain) on the western edge of the project area (CCDCP, 1987). It intergrades with pinyon-juniper woodland at higher elevations, creosote bush scrub at lower elevations, and desert calcicolous scrub on rocky calcareous outcrops.

Wildlife species occurring in blackbush scrub/Joshua tree woodland differ somewhat from the fauna of creosote bush scrub. Several widespread species occupy both habitats, such as desert tortoise, side-blotched lizard (Uta stansburiana), lesser nighthawk (Chordeiles acutipennis), common raven, Gambel's quail, cactus mouse (Peromyscus eremicus), Botta's pocket gopher (Thomomys bottae), gray fox (Urocyon cinereoargenteus) and coyote. Others occur more frequently in blackbush scrub/Joshua tree woodland such as desert night lizard (Xantusia vigilis), night snake (Hypsiglena torquata), and Great Basin kangaroo rat (Dipodomys microps). Gila monsters and chukars (Alectoris chukar) utilize this habitat, especially near rock outcrops that provide cover. Bighorn sheep (Ovis canadensis) occur on steep, rocky slopes.

Desert Calcicolous Scrub

Desert calcicolous scrub is azonal and is restricted to limestone and dolomitic substrates (Thorne, 1976; Thorne et al., 1981). It occurs where basic rocks are exposed and consists of sparsely vegetated rock outcrops and slopes of calcareous origin. Common and characteristic plant species of desert calcicolous scrub in the project area include century plant subspecies of (Agave utahensis), brickellias (Brickellia ssp.), intricate buddleya (Buddleja intricatus), little-leaved mountain-mahogany (Cercocarpus intricatus), slender lip-fern (Cheilanthes feei), pincushion cactus (Coryphantha vivipara), Arizona live-for-ever (Dudleya arizonica), Heermann's buckwheat (Erigonum heermannii), forsellesias (Forsellesia spp.), barrel cactus (Ferocactus acanthodes), and large-headed rock-daisies subspecies of (Perityle megalocephala).

Many plant taxa are restricted to this vegetation type, including several sensitive plant species (Table 8-1). Desert calcicolous scrub vegetation occurs on Blue Diamond Ridge, Spring Mountains, La Madre Mountain, Sheep Range, Las Vegas Range, portions of the Muddy Mountains, and the Bird Spring Range within the project area. Since this vegetation type is azonal, it intergrades with many other vegetation types, such as creosote bush scrub at low elevations, blackbush scrub/Joshua tree woodland and pinyon-juniper woodland at higher elevations, and riparian vegetation types at springs and streamsides.

Because exposed rock outcrops occur in desert calcicolous scrub, it is occupied by a relatively unique and diverse fauna. Many desert-adapted wildlife species utilize rocky areas for cover. Two sensitive species (desert tortoise, Gila monster) are found in association with natural crevices. Other reptiles that frequent rock outcrops include banded gecko (Coleonyx variegatus), chuckwalla (Sauromalus obesus), desert night lizard, striped whipsnake (Masticophis taeniatus), and speckled rattlesnake (Crotalus mitchelli). Many of the species of birds that utilize other upland habitats also occur in desert calcicolous scrub. In addition, some species nest among the rock outcrops, such as common raven and rock wren (Salpinctes obsoletus).

The mammalian fauna associated with exposed rock is similar to other, more open desert habitats (creosote bush scrub and blackbush scrub/Joshua tree woodland). Several raptors forage over areas dominated by calcicolous scrub. Among those species are sensitive species, such as Swainson's hawk (Buteo swainsoni), ferruginous hawk (Buteo regalis), and prairie falcon (Falco mexicanus) (Table 8-2).

This habitat is relatively more diverse than creosote bush scrub and blackbush scrub/Joshua tree woodland. Small mammals are especially attracted to these areas. Common species include long-tailed pocket mouse (Perognathus formosus) and canyon mouse (Peromyscus crinitus). Some species of bats, including the small-footed myotis (Myotis leibii), roost in crevices within the rocks.

Pinyon-Juniper Woodland

Pinyon-juniper woodland in the project area has been variously classified as Great Basin pinon-juniper woodland (Holland, 1986), pinyon-juniper woodland (Holland et al., 1979; Munz, 1974; Thorne et al., 1981), and Artemisia-pinyon-juniper (Beatley, 1976). This vegetation type consists of coniferous trees and large shrubs which occupy mountain slopes from about 4,000 feet to 7,000 feet. It is dominated by Utah juniper (Juniperus osteosperma), and single-leaved pinyon pine (Pinus monophylla).

Other common associates of the pinyon-juniper woodland include: blue bunch wheatgrass (Agropyron spicatum), Great Basin sagebrush (Artemisia tridentata), curl-leaved mountain mahogany (Cercocarpus ledifolius), Mojave antelope bush (Purshia glandulosa), northern antelope bush (Pushia tridentata), and Gambel oak (Quercus gambelii). The pinyon-juniper woodland vegetation is restricted to the western edge of the project area on the eastern slopes of the Spring Mountains and La Madre Mountain. It intergrades with blackbush scrub/Joshua tree woodland vegetation at lower elevations.

Wildlife species occurring in pinyon-juniper woodland include those adapted to higher elevations and greater vegetative cover compared to faunas in the other upland vegetation types of the project area. Common and characteristic species include Great Basin spadefoot toad (Scaphiopus intermontanus), banded gecko, night snake, speckled rattlesnake, northern flicker (Colaptes auratus), ash-throated flycatcher (Myiarchus cinerascens), bushy-tailed woodrat (Neotoma cinerea), and badger (Taxidea taxus). Sensitive wildlife occupying pinyon-juniper woodland include several game and furbearer species: gray fox, bobcat (Felis rufus), mule deer (Odocoileus hemionus), bighorn sheep, and possibly, elk (Cervus elaphus) in the northwestern corner of the project area.

8.1.1.2 Wetlands and Aquatic Habitats

The wetland vegetation of the project area consists of four types which are influenced by the level and duration of inundation and/or saturation as well as by the presence or absence of soil salts. The four types can be classified into two major categories, including: 1) wetlands (herbaceous wetland and riparian) and 2) riparian scrub (desert riparian and saltbush/mixed shrub). Riparian scrub are those areas that contain a mixture of facultative upland and wetland plant species, as well as a hydrologic regime that results in them being classified as wetlands, or at least seasonal wetlands, by the USFWS (1987). These areas may not all be considered wetlands under the jurisdiction of the U.S. Army Corps of Engineers (COE).

Herbaceous Wetland

Herbaceous wetland vegetation consists of three subtypes in the project area: persistent emergent wetland, non-persistent wetland, and alkali meadow. Persistent emergent wetland (classified as palustrine persistent emergent wetland by Cowardin et al., 1979) consists of freshwater marsh habitat occurring in flooded or saturated soils with fresh water (less than 0.5 parts per thousand salinity). It is dominated almost entirely by narrowleaf cattail (Typha domingensis), with scattered colonies of various sedges and bulrushes (Scirpus spp.) (Bureau of Reclamation, 1987).

Persistent emergent wetland vegetation occurs along all the perennial water courses of the project area, including channelized washes within and downstream of urban areas of the Las Vegas Valley (such as Flamingo Wash, Tropicana Wash, and Duck Creek). This vegetation type is best developed in the lower Las Vegas Wash where urban runoff from such sources as lawns and golf courses, is concentrated and supplemented by outflow from a sewage treatment plant. Persistent emergent wetland vegetation intergrades with open water habitats in deep water areas and with non-persistent emergent wetland vegetation on seasonally disturbed or exposed habitats and riparian vegetation in drier habitats.

Non-persistent emergent wetland, classified as palustrine non-persistent emergent wetland by Cowardin et al. (1979), consists of short-lived, hydrophytic herbaceous vegetation which occupies permanently or seasonally flooded or saturated soils with fresh water. Common and characteristic plant species within the project area include white amaranth (Amaranthus albus), annual sunflower (Helianthus annuus), smotherweed (Bassia hyssopifolia), white-stemmed goosefoot (Chenopodium album), common horseweed (Conyza canadensis), white sweetclover (Melilotus albus), muhly (Muhlenbergia asperifolia), water- smartweed (Polygonum lapathifolium), rabbitsfoot grass (Polypogon monspeliensis), and cocklebur (Xanthium strumarium). This vegetation type is common along the major drainages of the project area, such as the lower Las Vegas Wash and the channelized portions of Duck Creek, Flamingo Wash, Tropicana Wash, and Las Vegas Creek.

Alkali meadow vegetation is classified as palustrine mixosaline persistent emergent wetland by Cowardin et al. (1979), and alkali meadow by Holland (1986). This wetland type consists of saturated soils which are high in salinity (0.5-30 parts per thousand of salts). Common and characteristic species of alkali meadow vegetation in the project area include yerba mansa (Anemopsis californica), saltgrass (Distichlis spicata), heliotrope (Heliotropium curassavicum var. oculatum), common reed (Phragmites australis), alkali sacaton (Sporobolus airoides), ink weed (Suaeda moquinii), and salt-cedar (Tamarix spp.).

The wildlife of herbaceous wetlands of the project area are quite diverse, due primarily to the occurrence of freshwater marsh habitat in the Las Vegas Wash. No native species of fish presently occur in the project area. The desert dace (Rhinichthys deaconi) formerly occupied springs near Las Vegas but is believed to have become extinct by 1967 (USFWS, 1987). Although up to five species of non-native fish have recently been reported, only the mosquitofish (Gambusia affinis) is thought to be in the project area now, occupying open water of the Las Vegas Wash (CCDCP, 1987; USFWS, 1987).

Unlike most other habitats in the project area, herbaceous wetlands, particularly in the Las Vegas Wash, contain a relatively diverse amphibian fauna. Among the species known to occur are the bullfrog (Rana catesbeiana), Pacific treefrog (Pseudacris regilla), desert toad (Bufo punctatus), and Woodhouse's toad (Bufo woodhousei). In addition, the Vegas Valley leopard frog formerly occurred in the project area. This taxon occupied Tule Springs and other springs northwest of Las Vegas. It is believed to have become extinct due to loss of habitat (Stebbins, 1985; USFWS, 1987). The taxonomy of this frog is poorly understood. It is considered a full species (Rana fisheri) by some, and a subspecies (R. onca fisheri, R. pipiens fisheri) by others (Nevada Natural Heritage Program [NNHP], 1988; Marlow, 1988; Stebbins, 1985). Possible recent sightings of this taxon are probably the lowland leopard frog (R. yavapaiensis) (Pratt, 1988).

Several reptiles also utilize this habitat (primarily the non-persistent emergent wetland and alkali meadow subtypes) in the Las Vegas Wash, including desert spiny lizard (Sceloporus magister), side-blotched lizard, glossy snake (Arizona elegans), and spiny softshell (Trionyx ferox). Two sensitive species, desert tortoise and Gila monster, have been recorded from the Las Vegas Wash.

Despite losses of this habitat during floods in 1975 and 1984, 267 taxa of birds have been observed in the Las Vegas Wash, including many in herbaceous wetland (USFWS, 1987). At least 60 bird species breed in the wash (Miller, 1974). This is also an important area for winter residents, migrants, and transients. Of particular interest are shorebirds and relatively large numbers of waterfowl that occur in herbaceous wetland. Several are sensitive species, including the white-faced ibis (Plegadis chihi), western snowy plover (Charadrius alexandrinus nivosus), and long-billed curlew (Numenius americanus). Of those three species, only the snowy plover occurs on a regular basis. The brown pelican (Pelecanus occidentalis), a federal-listed endangered species, has been reported on rare occasions from the Las Vegas Wash.

Two other federal-listed endangered species that are also state-listed endangered occur in the Las Vegas Wash in low densities during the winter. Those species are the bald eagle (Haliaeetus leucocephalus) and American peregrine falcon (Falco peregrinus anatum), both of which utilize several habitats, including herbaceous wetland for foraging.

Of nearly 50 species of mammals known or thought to occur in Las Vegas Wash, most utilize herbaceous wetland to some extent. Up to 18 species of bats could potentially forage over this habitat. Two are federal candidate species: spotted bat and greater mastiff bat. Other mammals in the Las Vegas Wash include two species more directly associated with freshwater marsh habitat. The muskrat (Ondatra zibethicus) and beaver (Castor canadensis) are reported from the wash, but not elsewhere in the project area.

Riparian Wetland

Riparian vegetation in the project area includes all or portions of the following vegetation types: palustrine broadleaf winter-deciduous (and evergreen) scrub-shrub (and forested) wetland (Cowardin et al., 1979), Mojave riparian forest/Sonoran cottonwood-willow riparian forest (Holland, 1986), desert riparian woodland (Thorne, 1976), and riparian (Holland et al., 1979). This habitat consists of broad-leaved winter-deciduous and broad-leaved evergreen trees and shrubs. In addition, salt-cedar (Tamarix spp.) has invaded these and other habitats extensively. The riparian vegetation of the project area occupies the streambank habitats of drainages with permanent water, such as Duck Creek, lower Las Vegas Wash, and portions of Tropicana and Flamingo washes.

Common and characteristic plant species of the riparian vegetation of the project area include: cat's claw (Acacia greggii), quail bush (Atriplex lentiformis), Emory baccharis (Baccharis emoryi), elm (Celtis sp.), common reed (Phragmites australis), arrowweed (Pluchea sericea), Fremont cottonwood (Populus fremontii), screw bean (Prosopis juliflora), silvery buffalo-berry (Shepherdia argentea), and salt-cedar (Tamarix spp.). Riparian vegetation occurs along the larger drainages such as lower Las Vegas Wash, lower Tropicana Wash (at Boulder Highway), Flamingo Wash (at Eastern Avenue and Maryland Avenue), and lower Duck Creek.

Similar to herbaceous wetland, the abundance and diversity of wildlife species in riparian habitat are high. A large portion of this habitat within the project area occurs in the Las Vegas Wash. At least six amphibians, 29 reptiles and 47 mammals, in addition to the 267 taxa of birds, utilize the wash (USFWS, 1987). Many of those species frequent riparian habitat for at least part of the year.

The avifauna in this habitat is particularly diverse. Raptors known to occur in riparian vegetation of the wash include northern harrier (Circus cyaneus), sharp-shinned hawk (Accipiter striatus), Cooper's hawk (Accipiter cooperii), red-tailed hawk (Buteo jamaicensis), and American kestrel (Falco sparverius), as well as the federal- and state-listed endangered bald eagle and American peregrine falcon. Although there are no recent reports, the western yellow-billed cuckoo (Coccyzus americanus occidentalis), a Category 3 federal candidate species, could potentially occur in riparian vegetation in the project area during migration.

Desert Riparian (Riparian scrub)

Desert riparian vegetation in the project area includes several other classifications, including riverine intermittent streambed (Cowardin et al., 1979; USFWS, 1987), Mojave Desert wash scrub, Mojave wash scrub (Holland, 1986), desert wash scrub (Thorne et al., 1981), and desert riparian (CCDCP, 1987). It consists of a low microphyllous scrub which occupies well-developed, sandy or gravelly washes which are flooded infrequently, usually following localized rainstorms.

This habitat is dominated by deciduous and evergreen phreatophytic shrubs and small trees such as: cat's claw (Acacia greggii), quail bush (Atriplex lentiformis), Emory baccharis (Baccharis emoryi), armed senna (Cassia armata), desert willow (Chilopsis linearis), Mojave croton (Croton californicus var. mohavensis), cheese-bush (Hymenoclea salsola), arrowweed (Pluchea sericea), and screw bean (Prosopis pubescens). Desert riparian vegetation is common throughout the project area in all the larger washes. It intergrades with upland vegetation types outside the wash habitats.

Although found in association with the upland habitats previously described, desert riparian contains a somewhat unique and more diverse fauna. For example, some species of reptiles present in those other habitats are observed more often in dry washes and desert riparian. Included among those species are zebra-tailed lizard, side-blotched lizard, desert horned lizard and speckled rattlesnake. Desert tortoise burrows are often constructed in banks of larger dry washes.

Several species of birds are found in association with larger shrubs and dry wash areas that characterize desert riparian: Gambel's quail, Crissal thrasher (Toxostoma dorsale), sage sparrow, and Scott's oriole (Icterus parisorum). Among the mammals occurring in desert riparian are the kit fox, which utilizes larger wash areas as travel corridors and for den sites (in the banks of the washes).

Saltbush/Mixed Shrub (Riparian scrub)

Saltbush/mixed shrub includes vegetation types classified as saltbush scrub (CCDCP, 1987); salt-bush type (Holland et al., 1979); and mesquite bosque, desert saltbush scrub, desert sink scrub, desert greasewood scrub, and shadscale scrub (Holland, 1986). This habitat occupies lowland habitats which often have moderately shallow water tables and can have alkaline soils as well. It is a diverse type which contains many habitat types such as those referred to above (Holland, 1986).

In the project area, the majority of this type is represented by mesquite bosque which is an open tall scrub vegetation dominated by the drought-deciduous phreatophytic mesquite (Prosopis glandulosa var. torreyana). Other common plant species of this vegetation type include: iodine bush (Allenrolfea occidentalis), saltbush (Atriplex spp.), matchweed (Gutierrezia spp.), greasewood (Sarcobatus vermiculatus), and ink weed (Suaeda moquinii). This vegetation type occurs throughout the lowland areas of the Las Vegas Valley. A major portion of this vegetation type has been eliminated by urbanization in the Las Vegas Valley.

Wildlife species occurring in saltbush/mixed shrub are similar to those described for the other riparian scrub, desert riparian. Among the reptiles that occupy this habitat are federal and state listed species--desert tortoise and Gila monster. Shrubs provide cover for a moderately diverse avifauna, including Gambel's quail, a game species. The mammalian fauna consists primarily of small mammals and several species of predators, including coyote and kit fox.

8.1.1.3 Ruderal

This habitat occurs throughout the project area in association with human-caused disturbance. Ruderal vegetation occupies both upland and wetland areas. Plant species that characterize this vegetation type are primarily non-native species, such as smotherweed (Bassia hyssopifolia), Russian thistle (Salsola australis), and salt-cedar (Tamarix spp.).

Similarly, the fauna occurring in this habitat consists of several non-native species, as well as native species adapted to disturbed areas. Common species include western fence lizard (Sceloporus occidentalis), side-blotched lizard, common raven, European starling (Sturnus vulgaris), house sparrow (Passer domesticus), black-tailed jack rabbit, and house mouse (Mus musculus).

8.1.2 Summary of Sensitive Resources

8.1.2.1 Sensitive Plants

Sensitive plant species in Nevada consist of legally protected species, federal candidates for listing, and species of special concern. Legally protected species include those federal-listed as threatened or endangered (USFWS, 1989a) and/or state-listed as critically endangered, as well as species of cactus and yucca (NDF, 1987a,b). Federal candidate species include taxa which are currently under consideration for federal listing as threatened or endangered and include three categories. Category 1 candidates are taxa for which enough data are on file to support federal listing, while Category 2 candidates are taxa for which threat and/or distribution data are insufficient to support federal listing. Category 3c species are those formerly designated as Category 1 or 2, but subsequently found to be more abundant than previously believed (USFWS, 1990).

Species of special concern are those taxa in any of several categories of sensitivity recognized by the Northern Nevada Native Plant Society (NNNPS) (1987). The categories include (in decreasing order of rarity and vulnerability): 1) species recommended for federal listing; 2) "watch list" plants; and 3) "other rare" plants.

A literature survey for sensitive plants of the region identified 25 taxa potentially occurring in the project area (Beatley, 1976; Holland et al., 1979; Mozingo and Williams, 1980; NNHP, 1987; Nevada State Museum, 1986; NNNPS, 1987; USFWS, 1987, 1989a, 1990; UNLV Herbarium, 1988). Information on these species is provided in Table 8-1. Known locations of these species in the project area are shown in Figure 8-1. Distribution of sensitive plant species by subarea is summarized in Table 8-3.

No federal-listed species are known or expected to occur in the region. The nearest locality for any federal-listed plant species is at Ash Meadows in southwestern Nye County, Nevada.

Six state-listed species are known to or could potentially occur in the project area and include golden bear poppy (Arctomecon californica), three-cornered pod geyer milk-vetch (Astragalus geyeri var. triquetrus), Clokey pincushion cactus (Coryphantha vivipara var. rosea), Las Vegas cryptantha (Cryptantha insolita), LeConte's barrel cactus (Ferocactus acanthodes var. lecontei), and Blue Diamond cholla (Opuntia whipplei var. multigeniculata). In addition, all cactus and yucca species are fully protected under the Nevada Cactus and Yucca Law (NDF, 1987b).

Seven BLM sensitive or federal candidate species are known to, or could potentially, occur in the project area and include Charleston angelica (Angelica scabrida), Spring Mountain milk-vetch (Astragalus remotus), streaked Mariposa lily (Calochrotus striatus), Pahrump Valley buckwheat (Eriogonum bifurcatus), low grease-bush (Forsellesia pungens var. glabra), white-margined beardtongue (Penstemon albomarginatus), and bicolored penstemon (Penstemon bicolor spp. bicolor).

Five species of special concern listed on the NNNP's (1987) "watch list" are known to occur in the project area and include ivory-spined Utah agave (Agave utahensis var. eborispina), Clark Mountain Agave (Agave utahensis var. nevadensis), Merriam's bear poppy (Arctomecon merriamii), Knapp's brickellia (Brickellia knappiana), and Mojave cryptantha (Cryptantha tumulosa). In addition, six other species of special concern listed on the NNNPS's (1987) "other rare" list are known to or could potentially occur in the region and include Shockley rock-cress (Arabis shockleyi), Ackerman's milk-vetch (Astragalus ackermanii), Nye milk-vetch (Astragalus nyensis), Ripley gilia (Gilia ripleyi), intricate large-headed rock-daisy (Perityle megalocephala var. intricata), and A. Nelson phacelia (Phacelia anelsonii).

8.1.2.2 Sensitive Wildlife

Sensitive wildlife species in Nevada consist of legally protected species, federal candidates for listing, and species of special concern. Legally protected species include those federal-listed as threatened or endangered (USFWS, 1989a) and/or state-listed as endangered or rare (NDW, 1984). Federal candidate species (USFWS, 1989b) include taxa which are currently under consideration for federal listing as threatened or endangered. Category 2 federal candidates are taxa for which data on rarity are sufficient for listing, but for which data on threats and/or distribution are insufficient. Species of special concern include those considered to be: 1) sensitive by BLM; 2) fully protected, game, furbearer and other sensitive species by NDW (1984); and 3) birds declining on an a nation-wide basis, and therefore, listed on the National Audubon Society's Blue List (Tate, 1986). Although all raptors are classified as protected species by the State of Nevada, this analysis focused on species with other sensitive classifications (such as ferruginaus hawk, a federal candidate species) and species of interest to NDW (such as prairie falcon). The focused effort approach was developed following consultation with NDW.

Based on literature review, personal communications, and a reconnaissance field survey, 26 sensitive wildlife species are known or have the potential to occur in the project area. Reference sources include those described in Section 8.1.1. Information on these species is provided in Table 8-2. Known locations in the project area are shown in Figure 8-2.

Of the 26 species, four are federal-listed species (desert tortoise, brown pelican, bald eagle, and American peregrine falcon). The latter two species are also state-listed endangered species. A Biological Assessment for the desert tortoise was prepared for BLM and submitted to USFWS as part of the Section 7 consultation as required by the Endangered Species Act. A "no-jeopardy" federal Biological Opinion was issued by USF&WS on 28 August, 1990. The opinion included USF&WS required mitigation measures and habitat compensation developed from information regarding impacts and mitigation contained within the Biological Assessment. Two additional state-listed (rare) and BLM sensitive species are known to occur in the project area: Gila monster and spotted bat. Seven birds and two mammals are federal candidates and/or state-protected species, including white-faced ibis, Swainson's hawk, ferruginous hawk, prairie falcon, western snowy plover, long-billed curlew, western yellow-billed cuckoo, greater mastiff bat, and Palmer's chipmunk. Among those species, the prairie falcon is a state-protected bird, but has no other sensitivity status. It is included with other sensitive species due to the known occurrence of several traditional nesting areas (eyries) within the project area (Figure 8-2). Some other species of raptors, also state-protected, are not included in Table 8-2.

Game species of the project area are chukar, Gambel's quail, desert cottontail, mule deer, and bighorn sheep. An additional game species, elk, could potentially occur in the northwestern corner of the project area. The cottontail is quite widespread, occurring throughout the project area. The four species of furbearers include muskrat, kit fox, gray fox, and bobcat. One species of bird, the phainopepla (Phainopepla nitens), currently has no sensitive status, but is under consideration by NDW for future state listing. One taxon each of fish (desert dace) and amphibian (Vegas Valley leopard frog) formerly occurred in the project area, but now are extinct. Both are described in Section 8.1.1.2.

Desert Tortoise Surveys

Desert tortoise occurrence in the project area is addressed in a Biological Assessment prepared by Dames & Moore for BLM and subsequently submitted to USFWS during a formal Section 7 consultation. Information for the Biological Assessment was developed from previous BLM data, literature sources, and intensive walk-over and triangular strip-transect surveys conducted during September and October 1989. Results of Dames & Moore 1989 surveys were in general agreement with previously developed information. Generally, estimated tortoise densities were highest in the southwestern subarea and relatively low in the other four subareas. General ranges of estimated tortoise densities based on categories developed by BLM are indicated in Table 8-3.

Survey methodology for desert tortoise was developed in consultation with BLM and USFWS. The locations of ten-year plan facilities outside or along the margins of urbanized areas were surveyed for desert tortoise from 22 September to 24 October 1989. Surveys included areas of potential permanent disturbance, as well as areas that will be temporarily disturbed during construction. Facilities surveyed, dates of surveys, and weather conditions during those surveys, are described in Table 8-5. The facility locations were identified in the field using air-photo based maps and USGS 7.5-minute quads. Field biologists placed identifying stakes at the location of each facility surveyed. Orientation was accomplished using compasses and maps.

The Angel Park outflow channel (Facility C2-47) was marked with survey stakes and resurveyed during the week of 5 March 1990 by the Environmental Research Center (ERC) of the University of Nevada, Las Vegas. Staking and resurveying of this facility was necessary due to refinements and changes during the final design phase. The terminal 750-foot portion of C2-47 in Section 29 was moved 950 to 1100 feet northwest. Results reported for that facility will be from the more recent ERC survey.

At each individual facility location, one to six biologists with experience censusing desert tortoise walked parallel transects across the areas of temporary and permanent disturbance. The number of transects varied depending on the size and configuration of the individual facilities.

During the surveys, habitat conditions were noted, including vegetation type and density, substrate, and amount of existing human-caused disturbance (Table 8-6). All observations of tortoise and their sign (such as burrows, tracks, scat, carcasses, and shell fragments) were documented using standardized data sheets. All burrows were examined to determine if tortoises were present. No tortoises were handled or marked. The survey methodology was designed to accurately estimate the number of burrows and individual tortoises in the potential impact zones.

Based on discussions with USFWS and BLM biologists, it was agreed to use a maximum transect width of 10 meters. It was also agreed that the accuracy of using this transect width to detect tortoise sign would be evaluated. This was accomplished by surveying debris basin and detention basin sites using 10-meter-wide transects, then conducting an intensive survey in a portion of each site. The "validation" or intensive surveys were conducted using two- to three-meter-wide transects. The size of the validation plots varied from 11 to 20 acres in size. Dates and weather conditions during validation surveys are described in Table 8-5. A total of 18 detention/debris basins was evaluated using standard and validation surveys.

During the surveys of the facility sites, all sign, "total sign" (Berry and Nicholson, 1984) was recorded. Total tortoise sign was adjusted to "corrected sign" and population density estimates were calculated using Berry & Nicholson's (1984) regression model, as well as modifications to the model developed by BLM districts in California and Nevada. Results were compared on a corrected sign per acre basis with general results from previous BLM surveys.

The evaluation of the 10-meter-wide transect was accomplished by comparing results (total sign) from standard and validation surveys in basin sites. The comparison was focused on burrows because they represent the most consistently observable sign.

In addition to conducting surveys in areas specifically proposed for development, special field sampling for tortoise was conducted in areas of potential indirect and cumulative impacts. This consisted of triangular strip-transect surveys, which were conducted from 11-19 October 1989 in accordance to BLM standards (Berry & Nicholson, 1984) by biologists familiar with the biological resources of the Las Vegas Valley. Each transect consisted of an equilateral triangle, 0.5 mile on each side. Distances of the triangle sides were measured by tallying paces and orientation was accomplished by using a hand-held compass and topographic maps. End points of the triangles, burrows, and other tortoise sign were mapped. Active and potentially active burrows were staked or flagged in the field.

Biologists from BLM and USFWS requested that a minimum of three repetitions of these triangular surveys be conducted at each location to derive an average value for tortoise sign observed. This was done at five triangular survey sites. At the other two sites, six repetitions were conducted. The same biologist conducted each replicate survey in a section; however, the location of the triangular survey route was rotated with each repetition to encompass a new portion of the section.

The seven triangular transects were located in the study area as follows: three in the Southwestern Las Vegas subarea (#4, 18, 26), two in the North Las Vegas subarea (#20, 25N), and one each in the Central Las Vegas (#25S) and Henderson (#21) subareas.

8.1.2.3 Wetlands and Aquatic Habitats

Wetland habitats are sensitive resources of the project area. Four types are present, including two in each of two categories (Table 8-1). Herbaceous wetlands and riparian areas comprise the wetlands category. Riparian scrub in the project area consist of desert riparian and saltbush/mixed shrub vegetation types. Important wetland areas include the Las Vegas Wash, Flamingo Wash, Tropicana Wash, Duck Creek, and Las Vegas Creek.

8.2 SUMMARY OF SPECIFIC ENVIRONMENTAL CONDITIONS BY SUBAREA

The occurrence of sensitive biological resources in the project area varies among the subareas (see Figures 8-1 and 8-2). Nineteen taxa of sensitive plants are known to or could potentially occur in both the northern Las Vegas Valley and southwestern Las Vegas Valley, while 13 taxa occur in the central portion of the valley (see Table 8-4). In contrast, only four and two taxa have been reported in, or have potential distributions that include, Henderson and Boulder City, respectively.

The distribution of wetlands, particularly herbaceous wetland and riparian habitats, influences the abundance and diversity of sensitive wildlife species. Because most of the lower Las Vegas Wash is in the Northern Las Vegas Valley subarea, along with a small portion in the Henderson subarea, those two subareas have the greatest potential for occurrence of sensitive wildlife species (Table 8-3). Twenty-three species of sensitive wildlife have been reported on at least a rare basis in the Northern Las Vegas Valley and Henderson subareas compared to 15 for the Central Las Vegas Valley, 17 for the Southwestern Las Vegas Valley, and 17 for Boulder City.

Based on results of the walk-over surveys conducted during September and October 1989, desert tortoise densities apparently vary substantially in the project area by subarea and facility type. Although substantial variation occurred in survey results, there were very general trends among subarea. Survey results were converted to a corrected sign per acre basis to facilitate comparisons among potential sites, as well as to results from previously conducted BLM triangular surveys. Table 8-8 lists estimated density ranges of desert tortoise from surveys conducted at the facility sites.

8.2.1 Northern Las Vegas Valley

This subarea contains the most sensitive biological resources in the project area. It includes extensive undeveloped areas (Figures 8-1 and 8-2). Eight taxa of sensitive plants are known to occur in the Northern Las Vegas Valley, as well as 11 plant taxa that could potentially occur there. Of the 19 taxa, six are state-listed, including the golden bear poppy, which occurs in relatively large areas (Figure 8-1).

Wetland resources in this subarea are extensive primarily due to the presence of the upper and lower portions of the Las Vegas Wash, as well as Kyle Canyon Wash and the easternmost portion of Duck Creek. The 19 species of sensitive wildlife reported from this subarea include 15 observed on a regular basis and four that are present only rarely or accidently.

The occurrence of several species in the project area is completely or mostly restricted to the Las Vegas Wash, including the federal- and state-listed bald eagle and American peregrine falcon; federal candidate species white-faced ibis, western snowy plover, and long-billed curlew; and one furbearer species (muskrat). The desert tortoise and Gila monster are present throughout much of the undeveloped portions of this subarea.

Proposed facilities surveyed for desert tortoise in this subarea included five detention basins, five channels, five dikes, one floodway, and seven other structures (Table 8-5). Validation surveys were conducted on all five detention basins. This subarea also included two triangular surveys.

Overall estimated tortoise densities in the North Las Vegas subarea (N-series facilities) were mostly low (10-45 tortoises/square mile) to moderate (45-90 tortoises/square mile) (Table 8-8). See Table 8-3 for general estimated tortoise densities expressed as tortoises per square mile and corrected sign/acre. This general trend included substantial variation between proposed basins and channels. For example, corrected sign per acre in the proposed basins ranged from 0.00 at N12-9 to 0.35 at N3-8 (very low to low tortoise density categories). In contrast, three of five proposed channels contained high to very high densities, including 2.39 corrected sign per acre at N5-5. Substantial portions of those channels were in existing drainages with caliche crevices used as burrows. Results from Dames & Moore surveys in the north subarea were in general agreement with BLM data. Triangular strip-transect surveys conducted previously in this subarea by BLM resulted primarily in estimates of low to moderate tortoise densities. The quality of habitat in this subarea varied. Relatively higher quality habitat occurred in the western and northwestern portions of this subarea.

Additional tortoise burrows observed during intensive validation plots conducted in this subarea represented 0 to 44 percent of the total found during the initial walk-over surveys (Table 8-8).

A recent, unverified observation of Yuma clapper rail (Rallus longirostris yumanensis) was reported from the Las Vegas Wash (Marlow, 1988; Turner, 1988). If confirmed, this sighting would represent a substantial range extension for this taxon. The northernmost, previously confirmed occurrences of Yuma clapper rail are the Topock Marsh near Needles, California, and a smaller marsh area near Bullhead City, Arizona (Hanebury, 1988; Semonsen, 1988). Suitable habitat no longer exists at Topock; the current northernmost regular occurrence of this taxon is now in the vicinity of Lake Havasu (Semonsen, 1988). Although apparently suitable habitat is present, the occurrence of the Yuma clapper rail in the Las Vegas Wash on more than a rare basis is unlikely (Hanebury, 1988; Semonsen, 1988).

One additional sensitive wildlife species has been reported near this subarea. The wood stork (Mycteria americana), a federal endangered species, has been observed at Corn Creek in the Desert National Wildlife Range (Mowbray, 1979). The occurrence of this species in the project area would be accidental and very rare.

8.2.2 Central Las Vegas Valley

The Central Las Vegas Valley includes extensive urbanized areas (Figure 8-1), however it also contains suitable habitat for 13 taxa of sensitive plants, including five that have been reported and eight that could potentially occur in the subareas (Table 8-4). Golden bear poppy (Arctomecon californica) and bicolored penstemon (Penstemon bicolor ssp. bicolor) have been reported from several locations in the northern and western portions of the subarea (Figure 8-1).

Wetlands of this subarea consist primarily of small scattered riparian and herbaceous wetland areas along Las Vegas Wash in mostly urbanized areas. In addition, riparian scrub occur in relatively small dry washes. Fourteen sensitive species of wildlife are regularly reported from portions of the Central Las Vegas Valley, as well as the Palmer's chipmunk, which could potentially occur at the western edge of this subarea (Table 8-4). Bighorn sheep and mule deer are known to occur in the higher elevations. The desert tortoise and Gila monster are present in relatively moderate densities in lower elevational areas outside the developed and urbanized areas (Figure 8-2).

Facilities in this subarea surveyed for desert tortoise included one detention basin, four channels, and three other structures (Table 8-5). An intensive validation survey was conducted on the detention basin site. In addition, one triangular survey was conducted in this subarea.

Most of the facility sites in the Central Las Vegas subarea (C-series facilities) either contained or were near existing disturbance. Despite the presence of human-caused disturbance, two of three proposed channels (C2-47, C2-49) contained moderate and very high estimated densities of tortoises, respectively, based on the walk-over surveys (Table 8-8). The numbers of corrected sign per acre for those two facilities were 0.74 and 2.22, respectively. In both cases, tortoises had used banks of dry washes for burrow sites. Results for C2-47 were taken from a survey conducted by ERC. Overall, the quality of habitat in this subarea for tortoises is quite low. Many areas have been isolated by previous developments.

During the intensive validation survey on Facility C-55, no additional active or potentially active tortoise burrows were located (Table 8-9). It should be noted that no active or potentially active burrows were observed during the initial walk-over survey.

Results from the only triangular transect survey conducted in this subarea (Transect 25S) yielded estimated tortoise densities in the low range (10-45/square mile) (Table 8-10).

8.2.3 Southwestern Las Vegas Valley

This subarea contains extensive undeveloped low desert habitats as well as mountainous areas (Figure 8-1). Approximately one-third of this subarea is urbanized. Nineteen taxa of sensitive plants are known to or could potentially occur in this subarea; five of these species are state-listed and 12 are federal candidate/BLM sensitive species (Table 8-4). Golden bear poppy (Arctomecon californica), bicolored penstemon (Penstemon bicolor ssp. bicolor), and Spring Mountain milk-vetch (Astragalus remotus) have been reported from several locations in the southwestern Las Vegas Valley (Figure 8-1).

Herbaceous wetland and riparian habitats are present primarily in Duck Creek, Tropicana Wash, and Flamingo Wash. Riparian scrub types, including desert riparian and saltbush/mixed shrub, are scattered in this subarea in low-lying areas and dry washes. The 17 species of sensitive wildlife include three state-listed, five federal candidate, and eight game and furbearer species (Table 8-3). Compared to other subareas, the Southwestern Las Vegas Valley contains moderate to high densities of desert tortoise. Gila monsters also occur in areas occupied by desert tortoises. The southwestern corner of this subarea contains good quality habitat for Gambel's quail, chukar, bighorn sheep, and mule deer (Figure 8-2).

Facilities in the Southwestern Las Vegas Valley surveyed for desert tortoise included 10 detention basins, 4 channels, 7 dikes, 1 floodway, and 1 additional structure (Table 8-5). Intensive validation surveys were conducted on each of the detention basins. Three triangular transect surveys were also conducted in this subarea.

The Southwestern Las Vegas subarea (S-series facility sites) contained the highest estimated densities of tortoises as indicated by results from Dames & Moore surveys (Table 8-8). Although basin sites in that subarea ranged in corrected sign per acre from 0.00 to 1.53, estimated densities overall were generally moderate to high. Estimated densities at other types of facility sites were substantially lower. Differences among proposed facility sites in the southwestern subarea could generally appeared to be associated with the level of existing human caused disturbance (Table 8-6). Most lightly to moderately disturbed facility sites in the S-series contained moderate or greater estimated densities. The results of these surveys are consistent with results from previously completed BLM triangular strip-transect surveys. Of those conducted in the Las Vegas Valley, the highest proportion of BLM triangular surveys resulting in high density estimates occurred in the southwestern portion of the valley.

Factors influencing these relatively high densities of tortoises appear to be habitat quality, level of existing disturbance and proximity to nearby high-quality habitat. Based on observations made during the surveys, the southwestern subarea appears to contain high quality habitat, including creosote bush scrub with relatively high plant species richness and substantial cover provided by shrubs. A comparative lack of residential and commercial development in the outer (western) portions of this subarea is accompanied by less human-caused disturbance and, thus, high-quality habitat that is contiguous with large blocks of suitable habitat to the west.

In contrast, S-series facility sites to the east are adjacent to existing disturbances, including residential and commercial developments, railroad tracks and facilities, Interstate Highway 15, and other heavily travelled roads, such as Las Vegas Boulevard. Those facilities, such as proposed basins S17-4 and S18-14 and proposed channel S10-60, contained no sign of current tortoise use. As such, they appeared to have either no tortoises or very low densities of this species.

Results from 10 intensive validation surveys in this subarea indicated that initial surveys conducted at 10-meter-wide intervals were effective in locating sign. An average of only six percent additional active or potentially active burrows were found during the intensive surveys (Table 8-6).

Results from the three triangular transect surveys in the Southwestern Las Vegas subarea differed somewhat from results of the walk-over surveys. Surveys along Transects 4, 10, and 26 yielded estimated tortoise population densities in the low (10-45/square mile) to moderate (45-90/square mile) range (Table 8-10).

8.2.4 Boulder City

Few reports of sensitive plants exist for this very small subarea which includes an urbanized area in the central portion, as well as varied topography in the outlying undeveloped areas (Figure 8-1). The southern half contains relatively level terrain. The northern half of this subarea is characterized by broken terrain, including the River Mountains. Only two taxa are likely to occur, including the relatively widespread federal candidate bicolored penstemon (<u>Penstemon</u> <u>bicolor</u> ssp. <u>bicolor</u>) (Table 8-4).

Wetlands in the Boulder City subarea consist primarily of riparian scrub types (desert riparian and saltbush/mixed shrub) in washes and low-lying areas, respectively. Thirteen species of sensitive wildlife regularly occur in this subarea, and four others have been recorded on a rare basis (Table 8-4). Eight game and furbearer species have been reported including observations within residential areas.

Facilities in the Boulder City subarea surveyed for desert tortoise included one debris basin, six channels, two dikes, three floodways, and four other structures (Table 8-5). An intensive validation plot was established and surveyed on the debris basin. No triangular transect surveys were conducted in this subarea.

Nearly all of the Boulder City facility sites in the Boulder City subarea (B- and 4000-series facilities) occurred primarily on low-quality tortoise habitat. The highest quality habitat in this subarea occurs south of Boulder City, away from much of the existing disturbance, in the vicinity of floodway sites 4108-26 and 4109-28. The numbers of corrected sign per acre observed at those two proposed sites were 0.34 (low density) and 0.87 (moderate density), respectively (Table 8-8). As in other proposed floodway sites, tortoises utilized portions of the dry washes, including banks and natural caliche crevices for burrows. Desert wash scrub species, such as catclaw and mesquite provided above-ground cover and shade sites.

Because the debris basin site (4114-13) in Boulder City was relatively small (11 acres of proposed disturbance, including 10 permanent and 1 temporary), the entire site was resurveyed during the intensive validation survey. No tortoise sign was located during either the initial walk-over or subsequent validation survey.

8.2.5 Henderson

Much of this small subarea contains relatively level terrain as well as the city of Henderson in the northern two-thirds, and hilly to mountainous terrain in the southern one-third, including the River and McCullough mountains (Figure 8-1). In addition, a small portion of the lower Las Vegas Wash occurs in this subarea. Similar to Boulder City, few sensitive plants have been reported. Two state-listed taxa (including golden bear poppy, Arctomecon californica) could potentially occur, as well as one federal candidate (bicolored penstemon, Penstemon bicolor ssp. bicolor) and one plant listed by the NNNPS (Knapp's brickellia, Brickellia knappiana) (Table 8-4).

Wetlands are mostly of the riparian scrub type, in addition to a small portion of the Las Vegas Wash (which contains riparian and herbaceous wetland). Of the 23 species of sensitive wildlife that have been reported, several are associated with riparian and marsh areas of the Las Vegas Wash, including white-faced ibis, western snowy plover, and long-billed curlew (Table 8-4). Bighorn sheep occupy portions of the River and McCullough mountains in this subarea (Figure 8-2). Railroad Pass is an important bighorn sheep travel corridor between those two mountain ranges.

Facilities in the Henderson subarea surveyed for desert tortoise included one detention basin, six channels, and five other structures. No dikes or floodways are proposed for this subarea. (Table 8-5). A validation plot was established and intensively surveyed in the detention basin. In addition, one triangular transect was surveyed in this subarea.

All proposed facility sites in the Henderson subarea (H-series facilities) occurred in or near relatively high levels of human-caused disturbance. Little sign of tortoise activity (only one burrow at all H-series facility sites combined) was observed during the walk-over surveys (Table 8-8). All Henderson subarea facility sites contained densities of tortoises estimated to be low or very low; tortoise sign was observed only at H1-14. Habitat quality throughout was low, with several sites containing no suitable tortoise habitat. No active or potentially active burrows were located at site H1-14 during either the initial walk-over or intensive validation survey (Table 8-9).

The triangular transect established in Section 21, located near the interface between the Henderson and Southwestern Las Vegas subareas, was surveyed three times. Results from those surveys indicated estimated tortoise population densities in the vicinity were in the very low (0-10 tortoises/square mile) to low (10-45 tortoises/square mile) range (Table 8-10).

8.3 GENERAL ENVIRONMENTAL EFFECTS

Impacts due to the construction and operation of the proposed facilities are categorized and described in general terms below without reference to any site-specific resources. Potential impacts on specific biological resources are identified in the following subsections for each alternative and subarea. The proposed facilities are described in detail in Section 2.0 and include: 1) hard-lined channels, 2) unlined channels, 3) diversion dikes, 4) detention basins, 5) bridges and culverts, 6) pipelines and box conduits, and 7) floodways. Potential effects to desert tortoise will be described seperately by facility type in Section 8.3.1.4.

The hard-lined channels will consist primarily of concrete. Unlined channels will have earthen bottoms. Most channels will be lined. Diversion dikes will be either unlined, lined, or only partially lined;

most will be unlined. Detention basins will consist of excavated sites with associated dikes and flow regulating structures and will only retain flood waters for a short time (24 hours or less). Floodways will consist of modifications to existing natural water courses where low dikes will be constructed to contain flows within a broad, low-gradient water course. It is assumed that minor grading will occur within the floodways to maintain the correct grade and remove natural obstacles. The modular system of diversion dikes and channels proposed for the floodway in the lower Las Vegas Wash is designed to encourage wetland growth throughout the width of the floodway.

8.3.1 Construction Impacts

8.3.1.1 Botanical Resources--Vegetation

Direct impacts to the botanical resources of the project area associated with construction activities include direct effects on the natural vegetation and sensitive plants. Construction activities would include earth-moving at the facility sites and access roads to these facilities. Construction of the facilities would cause a variety of potential temporary and permanent impacts to botanical resources, including: 1) removal of upland vegetation at facility sites, 2) removal of wetland vegetation at facility sites, 3) removal of sensitive plants at facility sites, and 4) establishment of undesirable weedy vegetation in disturbance areas

Flood Channels

Construction of flood channels would primarily affect wetland vegetation types (mostly riparian scrub such as desert wash) due to earth-moving activities and concrete lining. Because most of the proposed channels will be lined, this loss of vegetation would be long-term. Areas adjacent to proposed structures would experience temporary disturbance associated with equipment access, materials, stockpile locations, and work space requirements. Although temporarily disturbed areas are expected to eventually recover, recovery in the desert is very slow. As such, these disturbances should be viewed as a long-term impact.

Some beneficial wetland types would reestablish naturally in new unlined channels; however, undesirable weedy vegetation such as smotherweed (Bassia hyssopifolia), Russian thistle (Salsola australis), and salt-cedar (Tamarix spp.) could also become established in the channels.

The long-term loss of wetland vegetation and establishment of undesirable weedy vegetation due to the construction of flood channels will represent a potentially significant impact.

Diversion Dikes

Upland vegetation would be adversely affected due to the construction of diversion dikes which will mostly be located off-channel. Only the unlined dikes are expected to naturally revegetate with upland plant species. Construction of lined dikes would result in long-term loss of upland vegetation.

The disturbance of upland vegetation due to construction of diversion dikes is not considered significant due to the large amount of similar habitat in the study area.

Floodways

Establishment of floodways will result in the temporary loss and disturbance of wetlands due to construction of containment dikes and grade structures within the floodway. Construction activities will include earth-moving in existing natural channels and drainages, thus removing some wetlands vegetation. These impacts are expected to be limited to specific areas within the floodway and not represent wholesale clearing. Floodway establishment will likely occur within existing natural drainages, and will include creation of a 50-foot-wide pilot channel. Earthen berms would be constructed on either side of the pilot channel. Floodways will be unlined. As such, vegetation will recover within the floodway. The recovery will include both native wetlands and undesirable weedy species. These impacts are considered nonsignificant because 1) the loss of wetland vegetation in the floodway is restricted to localized areas associated with pilot channels and berms and is temporary; and 2) the invasion of undesirable species would likely be limited to small areas.

Overall, floodways are expected to have minimal adverse to potentially beneficial impacts, if the area disturbed represents a minor portion of the existing wetlands and the potential introduction of undesirable weedy vegetation is monitored and eradicated if necessary. Control of such vegetation may be accomplished with a revegetation program using native species.

Detention Basins

Although most detention basins will be located off channel, some will be within channel routes. Establishment of the basins will result in the removal of native upland vegetation. The detention basins may allow undesirable weedy vegetation to become established, depending upon the duration and frequency of inundation and the nature of maintenance procedures.

Disturbance of upland vegetation due to construction of detention basins is generally not considered significant due to the large amount of similar habitat in the study area. Establishment of undesirable weedy vegetation is a potentially significant impact, depending on the eventual range of this vegetation type in detention basins, throughout the study area.

Other Structures

Construction of other structures, including bridges, culverts, box conduits, and pipelines, would involve varying amounts of earth moving. Pipelines and box conduits would result in the permanent removal of small amounts of vegetation at the structure location. In addition, relatively small areas of vegetation would be temporarily disturbed due to access during construction. Due to the locations of pipelines and box culverts, most of the natural vegetation to be disturbed would be upland. Impacts caused by construction of pipelines and box conduits are not considered significant because: 1) a relatively large amount of upland vegetation occurs in the study area and 2) a substantial portion of the total pipeline/conduit system would traverse urban areas that have been previously disturbed.

The construction of bridges and culverts would result in removal of small areas of upland and wetland vegetation. The latter would consist mostly of riparian scrub types. Impacts to upland vegetation are not considered to be significant due to the relatively large amount of similar habitat occurring in the study area. Impacts to wetland vegetation caused by construction of bridges and culverts are expected to be adverse, but minimal due to the limited amount of this habitat type to be disturbed.

In summary, the loss of upland vegetation types by construction of the above facilities would create adverse, but nonsignificant impacts. The loss of wetland vegetation types by construction of flood control facilities would create adverse and potentially significant impacts. The impacts to wetland vegetation could be reduced by: 1) the compensating effects of newly created wetlands in detention basins and enhanced wetland quality in engineered floodways; and 2) implementation of project-specific mitigation measures, as described in Section 8.5. The resulting significance of impacts to wetlands depends on the overall flood control program characteristics and specific mitigation measures applied.

8.3.1.2 Botanical Resources--Sensitive Species

All of the above construction-related impacts could potentially affect sensitive plant species in both upland and wetland habitats by direct removal during construction. Individual species would be affected in the same manner as described for the vegetation types in which they occur. Establishment of weedy vegetation may result in indirect adverse effects on sensitive species by increased competition for limited soil moisture.

Potential direct impacts to sensitive plant species due to construction activities include removal of individual plants during grading and earth-moving, as well as crushing of plants by construction and access vehicles. These impacts could potentially occur during construction of the facilities described in Section 8.3.1.1. A wide variety of plant species could be adversely affected, as listed on Table 8-1. The rarity and protection status of these plants vary greatly. No federally-listed plant species would be affected. Most are associated with upland habitats. As such, construction of diversion dikes, detention basins, flood channel banks, and access roads are expected to have a greater impact on sensitive plant species than construction of floodways and bridges.

Loss of large populations of sensitive plants, particularly state-listed plants, such as golden bear poppy (Arctomecon californica) and Las Vegas cryptantha (Cryptantha insolita) would be a potentially significant adverse impact due to rarity and protected status of such plants. The significance of the impact would depend on the size and areal extent of populations potentially affected and the availability of compensation mitigation. Implementation of appropriate mitigation measures would minimize the loss of most sensitive species, and could reduce the significance of impacts. Mitigation measures are described in Section 8.5.

8.3.1.3 Wildlife Resources--General Wildlife

Construction of the facilities would result in direct and indirect impacts to wildlife resources. These impacts would consist of temporary and permanent disturbance to wildlife habitats and the regional fauna, including sensitive species, that would be caused by construction activities such as earth-moving at facility sites and access roads. Types of impacts (direct and indirect, beneficial and adverse) to wildlife resources would generally include: 1) direct loss or displacement of individual animals, 2) direct disturbance or loss of wildlife habitats at facility sites, 3) direct loss of important habitat features, such as dens, 4) creation of beneficial wetlands in floodways and unlined channels, 5) creation of undesirable, weedy habitats in disturbance zones, and 6) potential habitat fragmentation associated with the construction of linear features, especially lined channels.

Flood Channels

Construction of flood channels would include earth-moving activities, and thus, adversely affect wildlife species primarily in wetland habitats. Some animals, especially those with burrowing habits such as reptiles, small mammals, and some carnivores, would be lost or displaced during construction activities. Displaced animals would return to temporarily disturbed areas following construction activities. However, habitat disturbance would primarily be permanent because most channels will be lined. Important habitat features, such as dens and burrows would be lost. Some of those lost in temporarily disturbed areas would be re-established following construction activities. While some of the wetlands would revegetate to beneficial habitat types, others would become undesirable, weedy habitats that would be of lower quality to wildlife. For nonsensitive wildlife species, these construction impacts are not considered significant due to the small amount of habitat and number of individuals potentially affected compared to the study area as a whole.

In addition to these direct effects, some species (such as the desert tortoise and Gila monster) may be sensitive to the potential fragmentation of habitat associated with the installation of linear facilities such as flood channels that may act as a barrier to the movement of these animals. Dry washes are known to be an important habitat for these two sensitive species. Habitat fragmentation is a potentially significant impact for sensitive species as discussed in Section 8.3.1.4.

Diversion Dikes

Construction of dikes would result in adverse impacts to wildlife resources similar to those caused by construction of flood channels although the habitat loss would primarily be restricted to upland habitats. Direct impacts would be caused primarily by earth-moving activities, including loss and displacement of wildlife species, and disturbance to upland and wetland habitats, as well as to important habitat features. Following construction activities, temporarily disturbed areas would be expected to revegetate. As such, these impacts are not considered significant.

Floodways

The installation of engineered floodways generally requires the construction of a containment dike, and sometimes includes the clearing and excavation of an unlined pilot channel and grade control structures. This construction activity may result in impacts similar to those described for diversion dikes and unlined channel construction although a small or amount of wildlife habitat would be affected by construction activities compared to lined channels. In addition, native vegetation in floodways will be allowed to recover; as such, they will not represent an impediment to wildlife movement. As described in Section 8.3.1.1, floodway establishment would likely result in clearing of a 50-foot-wide pilot channel and construction of berms on both sides. These structures would represent an adverse but nonsignificant impact. Although not yet designed on a facility-specific basis, the berms are not likely to be a substantial barrier to wildlife movement.

Detention Basins

Construction of detention basins would have adverse impacts on wildlife resources, albeit in a highly localized area. Excavation and earth-moving activities would result in the displacement of wildlife species and the loss of wildlife habitat, including habitat for sensitive species and important habitat features such as dens and burrows. As previously discussed, some displaced animals would return and wildlife habitats would reestablish following construction activities if no other uses are planned for the basins. The rate at which desert habitats recover is very slow, however, and facility maintenance activities could prevent the reestablishment of natural vegetation in detention basins. In general, the impact associated with detention basin construction is considered a long-term effect. However, the impacts are considered nonsignificant because only upland habitats would be affected, the basins will be allowed to revegetate, and the impacts will be highly localized.

Other Structures

Construction of other structures, including bridges, culverts, box conduits, and pipelines, would involve varying amounts of short- and/or long-term losses of wildlife habitat due to grading and earth-moving. Pipelines and box conduits would result in the permanent removal of small amounts of habitat at the structure location. Relatively small areas of habitat would be temporarily disturbed due to access during construction. Because desert habitats recover very slowly, this would result in the long-term loss of small areas of habitat. The permanent and temporary (but long-term) loss of small amounts of wildlife habitat associated with these structures would not be considered a significant impact.

The construction of bridges and culverts would result in removal of small areas of upland and wetland habitat due to grading and earth-moving. Impacts to upland habitat are not considered to be significant due to relatively large amounts of similar habitat occurring in the study area. Impacts to wetland habitat are expected to be adverse, but minimal due to the limited amount of this habitat to be removed.

8.3.1.4 Wildlife Resources--Sensitive Species

Sensitive species most likely to be adversely affected by construction activities associated with the installation of the proposed facilities include desert tortoise, Gila monster, kit fox, and game birds. Other sensitive species in the study area (Table 8-2) such as bighorn sheep and raptors are not expected to be significantly affected by construction activities. Impacts to desert tortoise will be described in greater detail below.

Potential direct impacts to sensitive wildlife species include removal of suitable habitat and loss of individuals. Suitable habitat would be removed due to excavation and earth-moving during the construction of facilities described in Section 8.3.1.3. The construction of linear lined flood channels could result in fragmentation of habitat utilized by sensitive species such as the desert tortoise and Gila monster because lined channels would represent obstacles to movement.

Losses of individuals of sensitive wildlife species could potentially occur due to collisions or crushing by vehicles and equipment during construction. Species with potential to lose individuals due to collision and crushing include desert tortoise and kit fox.

The loss and fragmentation of suitable habitat for sensitive wildlife species would have potentially significant adverse impacts. Similarly, the loss of individuals to sensitive species due to collision with vehicles would be a potentially significant impact. However, implementation of appropriate mitigation measures would minimize the loss of these species and reduce the impacts. Examples would be the construction of wildlife passages across flood channels, utilization of floodways rather than lined flood channels in high density tortoise habitat, habitat compensation for unavoidable loss of habitat for sensitive species, and species avoidance and/or relocation activities immediately prior to construction activities.

Potential impacts to the desert tortoise due to construction of the proposed facilities would include direct impacts to individuals, as well as impacts to tortoise habitat and habitat features, primarily burrows. As a result of the implementation of the 10-year plan facilities within the Flood Control Master Plan, an estimated 1,620 acres of desert tortoise habitat are likely to be disturbed, including 1,292 acres of permanent disturbance and 328 acres of long-term, temporary disturbance. Acreages of potential disturbance due to construction are included in Table 8-11 through 8-15. Acreages are shown by facility type and density range for each subarea.

The greatest amount of relatively higher quality tortoise habitat (moderate, high and very high estimated densities) potentially disturbed by construction of flood control facilities would be in the Southwestern Las Vegas Valley subarea (Table 8-1). Totals of 194, 116 and 220 acres of disturbance to moderate, high, and very high densities, respectively, would potentially be disturbed. Totals for potential disturbance to higher quality tortoise habitats in other subareas were much lower, including 71.0 for the northern subarea, 13.2 for the central subarea, 21.8 for Boulder City, and 0 for Henderson (Tables 8-11, 8-12, 8-14, 8-15).

The most disturbance to tortoise habitat in general, as well as to moderate, high, and very high density habitat would be caused by construction of debris and detention basins (Table 8-16). Construction of these facilities would potentially result in disturbance to 1160.0 acres of tortoise habitat, including 462.0 acres of relatively higher quality habitat. The total numbers of tortoise habitat acres potentially disturbed by dikes (172.2) and floodways (176.8) are similar, but construction of the former would potentially result in more disturbance to higher quality habitat (77.8) acres of moderate density and 11.6 acres of high density compared to 59.8 acres of moderate and 0 acres of high density).

Removal of desert tortoise habitat due to construction of proposed facilities would represent a significant impact that would be reduced to a nonsignificant impact through the implementation of appropriate mitigation measures. These measures are described in Section 8.5.

Direct impacts to tortoises could potentially include loss of individuals to crushing by equipment and displacement of individuals due to loss of habitat. The estimated maximum number of tortoises potentially impacted by construction is 173, including 142 due to permanent impacts and 31 due to temporary impacts. These estimates were based on data collected during the Dames & Moore surveys of September and October 1989. These surveys are described in Section 8.1.2.2 and Tables 8-5 through 8-7. Results are presented, by subarea, in Section 8.2, as well as in Tables 8-8 through 8-10.

Similar to potential impacts to tortoise habitat, construction of proposed facilities would potentially affect the highest number of tortoises in the Southwestern Las Vegas Valley (Table 8-13). Based on estimated tortoise population densities at proposed facilities, the maximum number of tortoises that would be impacted in this subarea is 111. Estimates for other subareas range from 2 in Central Las Vegas Valley to 49 in Northern Las Vegas Valley (Tables 8-11, 8-12, 8-14, 8-15).

Primarily due to large areas affected, the highest number of tortoises potentially impacted would be due to construction of proposed debris and detention basins (Table 8-16). An estimated total of 134 tortoises could potentially be impacted by basin construction, compared to much lower totals for dikes (17), floodways (16), channels (6), and other facilities, such as bridges and box conduits (0).

The maximum number of tortoises potentially affected by facility construction (173) was adjusted. As noted in the Biological Assessment, adjustments to estimated numbers of tortoises at Facilities N5-3 and S21-29 (due to results from validation surveys at those facility sites) increased the maximum number potentially impacted to 183. To obtain a more realistic total of tortoises potentially displaced, the numbers that could potentially be relocated locally were subtracted from the overall total of 183. Those with potential to be relocated locally (rather than moved to a holding facility) would include tortoises in areas of temporary disturbance (32) and those in channels, dikes, and other facilities (21). Thus, the adjusted number of tortoises probably requiring relocation to a holding facility, based on estimated population densities at the proposed flood control facilities, is 150.

The loss or displacement of 150-183 tortoises due to construction of all facilities would be a significant impact. Development and implementation of appropriate mitigation measures (see Section 8.5) is considered to reduce the construction impact of the loss or displacement of tortoises.

Indirect impacts to desert tortoises due to construction of facilities include primarily habitat fragmentation and the effects of increased human presence. It is assumed that some of the proposed channels and dikes, especially those greater than 0.5 mile in length, would potentially act as barriers to tortoise movement in suitable habitat. As such, those facilities would potentially cause habitat fragmentation. Nineteen linear facilities (channels and dikes) greater than 0.5 mile in length are proposed for construction in suitable tortoise habitat. These proposed facilities are listed in Table 8-17, along with the length of each facility, and estimated tortoise density in the vicinity, as well as the relative total density.

The effects of habitat fragmentation on species such as the desert tortoise are not clearly understood. Little information has been previously developed regarding this effect. As such, attempts to quantify the indirect impacts due to fragmentation would be difficult at best.

In addition, although it is acknowledged that some fragmentation of tortoise habitat will occur, it would also be difficult to predict that quantity and quality of habitat remaining at the time of facility construction. The proposed flood control facilities will be constructed primarily to accommodate growth, rather than in anticipation of growth. As such, many of these linear facilities will be constructed in, and adjacent to, habitat that has already been extensively disturbed by residential and commercial development. In such cases, construction of linear facilities will not result in fragmentation of suitable tortoise habitat. It is anticipated that impacts to the tortoise due to development of those areas of previously suitable habitat will have been mitigated by measures developed and implemented in association with those residential and commercial developments.

Of 19 proposed linear facilities greater than 0.5 mile in length, 13 (68 percent) will be constructed on low or very low density tortoise habitat (Table 8-17). Only three (N5-4, N5-5, and C2-47) occur within tortoise habitat evaluated as containing moderate or greater densities of tortoises. Potential measures to mitigate the impacts (such as tortoise crossings) in those areas still containing suitable tortoise habitat will be examined.

Additional indirect impacts could be caused by increased human presence. These impacts, potentially caused by uninformed construction employees and off-road vehicle operators using access roads, include illegal collecting, shooting, and vandalism, as well as habitat disturbance and loss of tortoises due to off-road vehicles. Increased access to tortoise habitat and accompanying increased human presence could also result in trash dumping, which in turn, could attract common ravens. Ravens are known to be very efficient predators of young tortoises (BLM et al., 1989).

Mitigation measures, including off-site compensation, have been developed to reduce the above potential impacts to tortoises to non-significant levels. These measures are described in Section 8.5.

8.3.1.5 Aquatic Resources

Aquatic resources would be affected by construction of flood channels, floodways, dikes, and detention basins. Adverse impacts would include modification of existing aquatic vegetation due to earth-moving and excavation activities.

Construction activities in existing wetland areas would adversely affect aquatic resources associated with these habitats, including a relatively diverse amphibian fauna that occurs in the Las Vegas Valley (Marlow, 1988). Implementation of appropriate mitigation measures (such as those in Section 8.5) would be necessary to reduce these impacts to a level of nonsignificance.

8.3.2 Operation and Maintenance Impacts

Both direct and indirect effects of operation and maintenance of the proposed facilities on biological resources are described below.

8.3.2.1 Botanical Resources--Vegetation

The operation and maintenance of the proposed facilities after construction could result in direct and indirect impacts, including: 1) degradation of wetland vegetation due to upstream diversion of flood waters, 2) disturbance of wetland vegetation in downstream areas associated with increased flood flow rates caused by channelization of streams and washes, 3) creation of new, or expansion of existing, wetlands in some areas, 4) establishment of undesirable weedy vegetation, 5) routine maintenance disturbance associated with vegetation clearing, sediment removal, and herbicide application, and 6) loss of sensitive plants due to upstream diversion of flood waters, increased flood flow rates, and/or routine maintenance disturbance

Indirect impacts on wetland vegetation could potentially occur due to diversion of runoff into flood channels above natural watercourses with wetlands. Some wetlands downstream of major diversions could become degraded over time due to reduced water supplies. The magnitude of this impact is expected to range from no effect to potentially significant over a long period of time, such as decades.

Indirect impacts due to maintenance and operation activities would also include potential decreases in habitat quality downstream of dikes due to diversion of runoff. Proposed dikes that could potentially affect habitat quality are listed in Table 8-18. Similar to the impacts on wildlife due to habitat fragmentation, the potential effects on habitat (as well as to species of plants and wildlife) due to diversion of runoff water by dikes has received relatively little study. Results from a limited number of studies have provided a few general insights. Schlesinger and Jones (1984) found that creosote bush and white bursage decreased in biomass and plant density in areas downgradient from dikes in Riverside County, California. In addition, mortality in creosote bush was concentrated among larger plants. The areas studied were up to 1,800 feet downgradient from the dikes. Effects were generally noticeable for at least 1,000 feet. Measurements were taken and comparisons made to adjacent undisturbed areas 45 years after the construction of the dikes.

While studying the same study area, Schlesinger et al. (1989) reported greater availability of soil moisture in those areas downgradient from the dikes. The results reported in these two publications suggest that over a long period of time, the presence of dikes could have mixed effects on tortoise habitat due to diversion of runoff. The decrease in biomass and density of dominant shrubs could result in a partial loss of shade and shelter components of the habitat. However, the increase in soil moisture availability could potentially benefit some of the annual plants that comprise tortoises' diet, especially during spring and summer months. For this study it was assumed that effects to vegetation will likely occur for at least 1,000 feet downgradient of the dikes.

Similar to potential habitat fragmentation, it would be difficult to predict the quantity and quality of habitat remaining at the time of dike construction. It is anticipated that facility construction will generally follow, not precede, residential and commercial development. As such, many of the proposed dikes will be constructed near habitat that has been severely altered by developments.

Changes in flood flow rates could represent another indirect impact associated with the operation of flood control facilities. Installation of lined channels and removal of obstacles such as debris and vegetation within new unlined channels would allow flood water to flow with greater velocity compared to natural watercourses with wetland vegetation. These increased velocities could prohibit the reestablishment of new wetlands in unlined channels and could potentially increase scour in floodways. The loss of wetlands and the lack of reestablishment of wetlands would be a potentially significant impact. Conversely, the reduction in velocities of floodwaters associated with the use of detention basins, floodways, and grade-control structures could have a beneficial effect on wetland vegetation by reducing scour associated with major flood flows.

The reduction of flow velocities and retention of water caused by flood-control facilities could potentially create new, or expand existing, desirable wetland vegetation. For example, the reduction of flow rate in the lower Las Vegas Wash could potentially result in temporary retention of water over a greater area, and thus, expand the existing wetland. Creation or expansion of desirable wetlands would be a beneficial impact.

In contrast to the potential creation of new wetlands is the possible establishment of undesirable wetlands during the recovery period after construction. This is possible in detention basins when non-native species such as smotherweed (Bassia hyssopifolia) may become established in nearly monotypic stands. In some unlined channels and floodways, tamarsik (Tamarix spp.) may also become established. The establishment of undesirable weedy vegetation types could be a potentially significant impact, depending on the extent of such establishment.

Maintenance of the flood channels would entail periodic clearing of vegetation by either mechanical or chemical means (including such herbicides as Karmex 80w, Aatrex 90, Oust, Rodeo, X-77 Spreader). Dredging or removal of silt from the detention basins, if required, would adversely affect any reestablished vegetation. Regular maintenance could prevent beneficial native vegetation from becoming reestablished, and would likely allow and enhance the establishment of undesirable weedy vegetation such as described in the Section 8.3.1.1. Substantial clearing of wetland vegetation in floodways is not expected to be required, but some pilot channel maintenance may be necessary. Hence, routine maintenance activities could result in significant impacts to wetlands within flood control facilities.

The operation and maintenance of other structures, including bridges, culverts, pipelines, and box conduits, are likely to have only a limited effect on nearby vegetation. Access roads adjacent to pipelines and box conduits would disturb a relatively small amount of vegetation on a long-term basis. This would be primarily upland vegetation or ruderal vegetation in urban areas. Due to the occurrence of large amounts of similar vegetation in the study area, this is not considered a significant impact.

Periodic dredging of sedimentation may be necessary at some bridges and culverts. This may result in the removal of small areas of native wetland vegetation. Subsequent maintenance activities may prohibit the reestablishment of similar vegetation. The magnitude of this potentially significant impact is expected to be small due to the limited size of areas involved.

8.3.2.2 Botanical Resources--Sensitive Species

The operation and maintenance of flood control facilities could cause direct and indirect impacts on sensitive plant species. Because most of these plants occur in upland areas, impacts to wetlands associated with upstream diversion of flood waters, as well as increased velocities of flood flows will have little impact on sensitive species. Plants that sometimes occur within natural watercourses, such as California bear poppy (Arctomecon californica) and bicolored penstemon (Penstemon bicolor ssp. bicolor) may be affected on a limited basis. Overall, impacts to sensitive plant species due to upstream diversion of water and increased velocities of flood flows are not expected to be significant.

The establishment of weedy vegetation in floodways, unlined channels, and detention basins would adversely affect sensitive plant species only by precluding the natural, unaided revegetation of these areas by sensitive plant species. This is not considered a significant impact.

Routine clearing of vegetation in some facilities and access to all structures for maintenance activities could have a direct impact on sensitive species. Because clearing of vegetation and removal of sedimentation would occur mostly in flood channels, floodways, and detention basins, sensitive species that may occur in natural watercourses are most likely to be affected, including Arctomecon californica and Cryptantha insolita. Maintenance at other structures, including bridges, culverts, pipelines, and box conduits could potentially result in the removal of a limited number of sensitive plants, mostly along access routes. Species that could potentially be affected include Calochortus striatus, Penstemon bicolor ssp. bicolor, and Agave utahensis var. eborispina. Overall, impacts to sensitive plant species due to operation and maintenance of the other structures is not expected to be significant.

8.3.2.3 Wildlife Resources--General Wildlife

The operation and maintenance of proposed facilities after construction could result in direct and indirect impacts to wildlife, including: 1) disturbance of wetland habitats (which are high-quality wildlife habitats) due to upstream diversion of flood waters, 2) disturbance of wetland habitats in downstream areas associated with increased flood flow rates caused by channelization of streams and washes, 3) creation of new, or expansion of existing, wetlands in some areas, 4) establishment of undesirable weedy vegetation types within wetlands areas, 5) routine disturbance to habitats associated with vegetation clearing, sediment removal, and herbicide application, and 6) direct loss of sensitive wildlife due to maintenance activities, such as periodic clearing of vegetation and removal of sediment

Indirect impacts on wildlife could potentially occur due to diversion of runoff water above natural watercourses that contain wetlands habitats. Some of the wetlands downstream of major diversions could become degraded over time due to reduced water supplies. As such, habitat for a diverse and regionally significant fauna could be altered. Faunal groups that could be affected by decreases in quantity or quality of these habitats include the herpetofauna of the study area, as well as shorebirds, waterfowl, and some species of wetlands dependent mammals such as muskrat and beaver. A decrease in the area or quality of wetland habitats for wildlife would be a potentially significant impact.

Disturbance to wetland habitats associated with increased flood flow rates caused by channelization of streams and washes could also result in indirect impacts to wildlife. Installation of lined channels and removal of obstacles such as debris and vegetation within new unlined channels would allow flood water to flow with greater velocity. The increased velocity could potentially prohibit the reestablishment of wetlands or creation of wetlands in unlined channels and could potentially increase scour in floodways. The loss of wetlands habitats due to the increased velocity of flood waters would be a potentially significant impact on the faunal groups associated with the wetlands. Conversely, the reduction in velocity of flood waters associated with the use of detention basins, floodways, and grade-control structures could have a beneficial effect on wetland habitat by reducing scour associated with major flood flows. As such, the decreased velocity of flood flows would have a beneficial, indirect impact on wildlife utilizing those habitats.

The reduction in flow velocities and retention of water caused by flood-control facilities could potentially enhance, or expand existing, desirable wetland habitats in engineered floodways as described in Section 8.3.2.1. Expansion or enhancement of wetland habitats would have a beneficial impact on wildlife of the study area.

In contrast to the potential creation of new desirable wetlands is the possible establishment of weedy vegetation comprising undesirable wetlands as described in Section 8.3.2.1. Because these non-native habitat types are of lower value to wildlife compared to native habitats, their establishment would be a potentially significant impact.

Some disturbances to upland and wetland habitats of wildlife would potentially occur due to maintenance activities, including vegetation clearing and sediment removal. In addition, individuals of some species could potentially be lost due to collisions with maintenance vehicles. Maintenance activities within dry washes could potentially result in direct impacts such as losses of desert tortoise, Gila monster, kit fox, and other species known to utilize those areas. Overall, the magnitude of direct and indirect impacts on wildlife due to operation and maintenance of facilities is expected to vary from minimally adverse to potentially significant, depending on the location, as well as the amount and type of habitat involved.

8.3.2.4 Wildlife Resources--Sensitive Species

The operation and maintenance of flood control facilities could result in direct and indirect impacts on sensitive wildlife species. Disturbance of habitats utilized by sensitive species could occur, including wetlands and dry washes. Sedimentation removal and vegetation clearance in floodways and unlined flood channels could potentially alter wetlands and thus affect sensitive wildlife species. For example, disturbance to wetland habitat in the lower Las Vegas Wash could have indirect effects on several sensitive species, including the bald eagle, white-faced ibis, and western snowy plover. Disturbance to washes could potentially affect sensitive species known to occur in that habitat type, particularly the Gila monster and kit fox.

In addition to general habitat disturbance, habitat removal of key habitat features such kit fox burrows could occur during maintenance operations. Disturbance to habitats and habitat features of sensitive species due to operation and maintenance activities is a potentially significant impact.

Operation and periodic maintenance of flood-control facilities could have direct impacts to sensitive wildlife species. Collisions with maintenance vehicles would result in losses of individuals. Examples of species that could potentially be affected are kit fox and bighorn sheep. Losses of individuals of sensitive species would be a potentially significant impact.

Impacts to the desert tortoise due to maintenance and operation activities would be similar to those described for construction, but on a lesser scale. Individuals could potentially be lost or displaced due to collisions with vehicles, crushing of tortoises within burrows, and loss of habitat and habitat features, primarily burrows. These potential impacts are not expected to be significant due to: 1) the likely infrequent nature of periodic maintenance and operation activities; and 2) implementation of specific mitigation measures, such as avoidance of burrows and a restricted speed limit on vehicles. These mitigation measures are described in Section 8.5.

One specific indirect impact to tortoises potentially resulting from operation and maintenance activities is diversion of water from downgradient habitat, as described in Section 8.3.2.1. Based on results of the walk-over surveys, none of the 12 proposed dikes that will divert runoff occurs in habitat with high or very high tortoise densities (Table 8-18). Most (eight) occur in habitat containing very low or low tortoise densities. Considering the relatively low tortoise densities involved, the likelihood of habitat disturbance prior to dike construction, and the apparently limited effects observed elsewhere

(Schlesinger and Jones, 1984; Schlesinger et al., 1989), the diversion of runoff due to construction of CCRFCD dikes is not likely to result in significant impacts to the desert tortoise.

8.3.2.5 Aquatic Resources

Operations of the proposed facilities would result in adverse impacts to aquatic resources. Wetland (=aquatic) vegetation would be modified primarily by periodic clearing, herbicide application, and/or dredging (if required) and by the establishment of new species, most of which would be nonnative and undesirable. These effects would, in turn, impact the fauna associated with aquatic habitats by decreasing the value of the habitats. Both sensitive and common aquatic species would be adversely affected. These impacts are also described in Sections 8.4.2.1. Implementation of appropriate mitigation measures would be necessary to reduce these impacts to a nonsignificant level.

8.4 ENVIRONMENTAL EFFECTS BY ALTERNATIVE

The environmental effects of the Detention/Conveyance, All Conveyance, and No Project alternatives are discussed below. Because the Detention/Conveyance alternative was identified as the recommended alternative from a cost and engineering standpoint (Montgomery Engineers, 1986), that alternative is presented below in Section 8.4.1 followed by a comparison with the All Conveyance alternative in Section 8.4.2. As discussed later, the Detention/Conveyance and All Conveyance alternatives are quite similar, with the exception of the number and size of the detention and debris basins. As such, the impact assessment for the All Conveyance alternative (Section 8.4.2) will focus on the differences between it and the Detention/Conveyance alternative.

8.4.1 Detention/Conveyance Alternative

A summary of the potential impacts due to the Detention/Conveyance alternatives is provided in Table 8-19. These impacts are organized by impact type, resource affected, and location of impact by subarea. The Detention/Conveyance alternative would result in approximately 2155 acres of temporary and permanent habitat disturbance from the construction of 53 detention basins and 16 debris basins. About 48 linear miles of dikes and 186 and 11 miles of lined and unlined channels, respectively, are also proposed under this alternative. Approximately 105 miles of pipeline/conduit are planned as well; however, most of it will be constructed within developed areas and would not have significant effects on sensitive biological resources. This alternative could potentially result in disturbance to, or removal of, 1620 acres of tortoise habitat, including 1292 acres of permanent disturbance and 328 acres of temporary disturbance. The following represents a summary of impacts by each subarea.

8.4.1.1 Northern Las Vegas Valley

Because the Northern Las Vegas Valley contains nearly all of the Las Vegas Wash (Figure 8-1), it has more sensitive species subject to impacts than any other subarea. Overall, 19 taxa each of sensitive plants and wildlife could potentially occur in this subarea (Table 8-3) including golden bear poppy (Arctomecon californica), desert tortoise, and Gila monster. Among the species that utilize this subarea, but occur only rarely throughout the remainder of the project area, are three-cornered pod Geyer milk-vetch (Astragalus geyeri var. triquetrus), Ripley gilia (Gilia ripleyi), brown pelican, bald eagle, and muskrat. The upper Las Vegas Wash, and in particular, the lower Las Vegas Wash are highly sensitive habitats due to the presence of wetlands and various sensitive wildlife species. Establishment of floodways along the wash, particularly the lower wash, could result in the stabilization and expansion of existing wetlands, and thereby result in a major beneficial regional impact. Full implementation of the detention/conveyance alternative in this subarea would potentially result in disturbance to, or loss of, 717.5 acres of tortoise habitat. Acres of potential disturbance by estimated density are listed in Table 8-11.

8.4.1.2 Central Las Vegas Valley

Fewer taxa of sensitive biological resources potentially occur in the Central Las Vegas Valley (13 plants, 14 wildlife; Table 8-3). There are no taxa of sensitive biological resources unique to this subarea. Among the species most likely to be affected by earth-moving and excavation activities are golden bear poppy (Arctomecon californica), bicolored penstemon (Penstemon bicolor ssp. bicolor), desert tortoise, Gila monster, and kit fox. Wetland resources are quite limited in this subarea and consist primarily of desert riparian and saltbush/mixed shrub types. Construction and operation of proposed facilities in the Central Las Vegas Valley would potentially result in nonsignificant impacts to sensitive biological resources. Full implementation of this alternative in the Central Las Vegas Valley subarea would potentially result in disturbance to, or loss of, only 15.3 acres of tortoise habitat. Acres of potential disturbance by estimated density are listed in Table 8-12.

8.4.1.3 Southwest Las Vegas Valley

The Southwest Las Vegas Valley potentially contains the second highest number of sensitive biological resources, including 19 taxa of plants and 17 taxa of wildlife (Table 8-3). In addition to several widespread sensitive species that occur in nearly all of the subareas, the Southwest Las Vegas Valley is also occupied by sensitive taxa with more restricted distributions, such as Spring Mountain milk-vetch (Astragalus remotus), white-margined beardtongue (Penstemon albomarginatus), Clark Mountain agave (Agave utahensis var. nevadensis), Palmer's chipmunk, and chukar. Desert tortoise densities are mostly moderate to high in this subarea compared to other subareas. High densities are found generally below 4,000 feet in the north-central and northwestern portions of this subarea, particularly in the vicinities of Blue Diamond and Red Rock washes. Wetland habitats are scattered within Duck Creek, Tropicana Wash, and Flamingo Wash. Construction and operation of proposed facilities, particularly in areas containing wetlands or high densities of desert tortoise would require appropriate mitigation measures to reduce adverse impacts to a nonsignificant level. Full implementation of the detention/conveyance alternative in the Southwest Las Vegas Valley subarea would potentially result in disturbance to, or loss of, 689.6 acres of tortoise habitat. Acres of potential disturbance by estimated density are listed in Table 8-13.

8.4.1.4 Boulder City

The Boulder City subarea potentially contains the fewest number of sensitive biological resources. Only two sensitive plants and 13 sensitive wildlife taxa have been reported on a regular basis (Table 8-3). Wetland habitats are primarily riparian scrub types. Construction and operation of proposed facilities in this subarea would result in mostly adverse, but nonsignificant impacts. Exceptions include any facilities constructed near Boulder City that could potentially detain water, and therefore, attract bighorn sheep. Appropriate mitigation measures would be necessary to reduce the potential for adverse impacts due to bighorn sheep-human interactions. Examples include vehicle-bighorn sheep collisions and predation on bighorn lambs by domestic and feral dogs. Full implementation of this alternative in the Boulder City subarea would potentially result in disturbance to, or loss of, 100.8 acres of tortoise habitat. Acres of potential disturbance by estimated density are listed in Table 8-14.

8.4.1.5 Henderson

Similar to Boulder City, the Henderson subarea contains few sensitive plants; four taxa potentially occur in the subarea (Table 8-3). Because a small portion of the Las Vegas Wash is in Henderson (Figure 8-1), as many as 23 taxa of sensitive wildlife potentially occur in this subarea. Sensitive resources likely to be adversely impacted by construction and operation of the proposed facilities include golden bear poppy (Arctomecon californica), Knapp's brickellia (Brickellia knappiana), white-faced ibis, western snowy plover, and bighorn sheep. Construction and operation of proposed facilities could potentially result in significant adverse impacts to biological resources, particularly if situated in or near the Las Vegas Wash or crucial bighorn sheep range. Implementation of appropriate mitigation measures could potentially reduce those impacts to a nonsignificant level. Full implementation of the detention/conveyance alternative in this subarea would potentially result in disturbance to, or loss of, 96.7 acres of very low and low-density tortoise habitat. Acres of potential disturbance by estimated density are listed in Table 8-15.

8.4.2 All Conveyance Alternative

The All Conveyance and Detention/Conveyance alternatives have two primary differences: 1) the Detention/Conveyance alternative utilizes detention basins of varying size in the upper reaches of the watercourses to regulate peak flows in downstream urbanized areas and 2) as a result, the Detention/Conveyance alternative requires narrower flood channels, box conduits, pipelines, and bridges to carry flood flows. In all other respects, the two alternatives are very similar. That is, the locations of dikes, channels, floodways, and other facilities are mostly the same; however, the size and capacity of these facilities differ between the two alternatives.

As a result, both alternatives are expected to affect the same biological resources due to construction and operation of the facilities as summarized in Table 8-4 and described above for each subarea (Sections 8.4.1.1. through 8.4.1.5). However, the magnitude of the impact (such as the areal extent of disturbance) will differ as noted below.

The All Conveyance alternative (238 miles) would result in 21 percent more linear disturbance than the Detention/Conveyance alternative (197 miles) due to more extensive flood channels in the former. The difference in total area disturbed would also be greater because the proposed channels for the All Conveyance alternative will be wider.

There is also a major difference between the alternatives in the area of natural habitat to be disturbed due to construction of detention basins. The Detention/Conveyance alternative would result in approximately 2155 acres of temporary and permanent habitat disturbance compared to 1057 acres for the All Conveyance alternative. This would result in over twice the amount of areal disturbance for the Detention/Conveyance alternative.

In contrast, there would be little difference in area of natural habitat disturbed due to the construction of dikes between the Detention/Conveyance (48 linear miles) and All Conveyance (44 linear miles) alternatives.

Despite less disturbance (fewer acres of basins, fewer miles of channels and dikes) due to this alternative, potential impacts to tortoises could be greater. For example, implementation of the All Conveyance alternative in and near the Southwest Las Vegas Valley subarea would result in more habitat disturbance overall. Although less tortoise habitat would be removed for detention basins, there would be a substantial increase in habitat disturbance due to channels, dikes, and floodways. This increase in disturbance would be significant due to the location and type of facilities. These would be linear facilities located in the Southwest Las Vegas Valley subarea which contains primarily high estimated densities of tortoises. As such, not only would increased acreage of high quality tortoise habitat be lost or disturbed, but more potential barriers to tortoise movement would also be constructed.

Differences between the two alternatives would probably not result in relative differences in the magnitude and scale of impacts to tortoises for the North Las Vegas Valley, Central Las Vegas Valley and Henderson subareas. The All Conveyance alternative could potentially represent an increase in habitat disturbance to tortoises in the Boulder City area. Relative to the Detention/Conveyance alternative in Boulder City, the All Conveyance alternative includes more floodways south of the city. Although estimated tortoise densities, based on field survey results, were generally very low for Boulder City, relatively higher densities were noted in Floodway Sites 4108-26 and 4109-28. As such, an increase in area to be used as floodways south of Boulder City could potentially result in greater disturbance to tortoise habitat.

8.4.3 No Project

Without the proposed project, flood control facilities would be installed with each new development in the region in a much less coordinated and programmatic manner. As such, there will be a wide variation in the nature, size, and efficiency of the flood control facilities. More importantly, the level of environmental protection would be much less and would not be based on an understanding of the regional impacts. Hence, many of the biological mitigation measures recommended in Section 8.5 would not be implemented. As such, there is a strong likelihood that the No Project alternative would ultimately result in more significant biological impacts than the other two alternatives.

The No Project alternative could also result in major adverse impacts to the Las Vegas Wash, a highly sensitive regional biological resource. Nearly 80 percent of the wetlands in the Las Vegas Wash have been lost due to unchecked erosion since the early to mid-1970s (Bostick, 1988). Most of the erosion occurred during floods caused by summer rains in 1975 and 1984. This erosion is expected to continue unless flood control structures are installed to alter the existing hydrologic regime. Continued loss of wetlands would represent a decrease in habitat for aquatic and wetlands-associated plants and wildlife. Many of the sensitive species described in Table 8-2 utilize the wetlands of the Las Vegas Wash for at least a portion of the year.

8.5 PROGRAMMATIC MITIGATION MEASURES

Programmatic mitigation measures were developed for the Master Plan to avoid or reduce potential significant impacts to biological resources. As such, the measures are broadly defined and applicable for relatively large groups of sensitive resources (such as, all federal candidate/BLM sensitive plants) over the entire project area. With some exceptions, the measures were not designed for a single species, facility, or location. Instead, these measures mostly represent approaches for mitigation for certain types of impacts and resources that must be further refined for each site-specific condition. Exceptions include specific measures for the removal of cactuses and yuccas as specified by NDF, and some well defined measures recommended for avoidance of desert tortoise, Gila monster, kit fox, and bighorn sheep. More specific mitigation measures developed for the desert tortoise are described in the Biological Assessment prepared for BLM and subsequently submitted to USFWS. These measures are summarized in Section 8.5.2. Other mitigation measures were developed using available literature, agency reports (such as BLM, 1983), and personal communications from personnel of NDW (Marlow, 1988; Padilla, 1988; Turner, 1988), BLM (Cole, 1988; Hardenbrook, 1988; Maley, 1988; Slone, 1988), and UNLV (Baepler, 1988; Pratt, 1988).

8.5.1 Procedures to Implement Mitigation

The following represents a step-wise procedure that should be utilized by the District during the planning and implementation of individual flood control facilities. The objectives of the procedure is to determine if significant impacts to sensitive biological resources could occur due to the construction and operation of each individual facility, and what (if any) mitigation measures are deemed necessary. The procedure should be utilized as a routine aspect of project planning and construction. The mitigation measures that are identified during the procedure are likely to become more refined over time as various measures are implemented and tested for effectiveness.

Mitigation measures for desert tortoise were developed for the Biological Assessment and are included in Section 8.5.4 and Table 8-21. These measures address potential impacts at the 10-year plan facilities only (those facilities were included in the Section 7 consultation). Facilities with suitable tortoise habitat that are not in the 10-year plan will require additional Section 7 consultation or compliance with procedures in the Clark County Habitat Conservation Plan.

General steps to be followed include:

1) Determine the location of the proposed facility on Figures 8-1 and 8-2.

2) Assess the potential occurrence of sensitive biological resources at the proposed facility site using these figures.

3) If sensitive resources could potentially occur at the site, conduct a reconnaissance survey to determine if undisturbed native habitat is present which is potentially suitable for sensitive species (e.g., tortoise or rare plants) or which represents a sensitive resource itself (e.g., wetlands). This survey can be accomplished by a trained biologist acceptable to BLM, USFWS, and Nevada Department of Wildlife (NDW).

4) If the sensitive resources is present or suitable habitat of sensitive plants and animal is apparently present, then a biologist should assess what (if any) biological surveys need to be conducted to more accurately determine the nature and extent of sensitive resources. This determination will be based on the protection and legal status of the species in question, as well as any seasonal constraints on observing the species.

5) Conduct field investigations as needed at appropriate time of year to assess the presence or absence of the sensitive resources.

6) Assess the potential impacts to the sensitive resources due to construction, operation, and maintenance of the facility. Include an assessment of all indirect impacts to these and any other sensitive biological resources. Indirect impacts may occur both on and off-site. For example, access roads and downstream effects may result in off-site impacts.

7) Identify the programmatic mitigation measure that applies to the impacts of the proposed facility. These programmatic mitigation measures (A-M) are listed in Table 8-20. They have been developed for each major category of sensitive resources.

8) Select and implement the specific measures listed under the programmatic mitigations (A-M, Table 8-20) as necessary. Implementation will usually involve documentation of the occurrence of the resource and avoidance when feasible. In addition, species listed by the state or federal government will require coordination with USFWS, BLM, and/or NDOW.

To assist in this procedure, a current database on sensitive biological resources should be consulted. Data reviewed should be project-specific and may be obtained from a region-wide consolidated database maintained and periodically updated by CCRFCD, or from a review of currently available data for the vicinity of the proposed project.

8.5.2 Mitigation Measures

Thirteen mitigation measures (A-M) are described in Table 8-20, including four for sensitive plants, four for addressing wetlands, and five for sensitive wildlife. The measures are categorized primarily by degree of legal protection of plant and wildlife species, or by severity of potential impact to wetlands.

The need for these measures will be determined based on a site-specific field survey at the locations of the facilities as they are proposed. If certain sensitive resources are present and could be adversely affected, the specific measures listed in Table 8-20 should be implemented to reduce the potential impacts to nonsignificant levels. Potential impacts are summarized in Table 8-19.

An additional mitigation measure is recommended to reduce impacts to vegetation downgradient of dikes. As noted earlier in Section 8.3.2.1, effects on vegetation due to diversion of water are likely to occur for at least 1,000 feet downgradient of the dikes. The effects would likely include decreases in biomass and plant density of dominant shrubs and an increase in annuals. To reduce these effects, small low-flow drains would be installed in the dikes where these dikes intercept small natural drainages. The low-flow drains would allow passage of runoff during smaller-scale rainstorms. However, during large-scale storms accompanied by relatively larger amounts of runoff, the drains would naturally become plugged by debris. As such, water from small-scale storms would be available to downgradient vegetation, but high-velocity flow water would be directed to flood control facilities. Water in high-velocity runoff flows generally is not available to downgradient vegetation even if not directed away by dikes. These drains would be checked after larger-scale storms to remove debris.

8.5.3 Mitigation for Use of Herbicides

Herbicide use by local governments may adversely impact sensitive biological resources of the area. To lessen these potential impacts, the District should evaluate their current and future herbicide use program. Herbicides may impact sensitive vegetation, aquatic organisms, and wildlife, both onsite and downstream of the treatment area.

To mitigate these potential impacts, the District should evaluate the potential adverse effects of each herbicide it may use. These include residual effects onsite and downstream. For example, removal of vegetation from the flood control channels results in a loss of sensitive wetland vegetation which has direct and indirect impacts on aquatic organisms and wildlife species that utilize it. Herbicide residue may drift off-site (airborne or waterborne) and impact biological resources not intended to be treated.

Other methods, such as mechanical or engineered, should be considered to control unwanted vegetation. If some vegetation removal is required, then low-impact mechanical means should be utilized instead of herbicides. While mechanical removal of vegetation from facilities such as channels will be locally significant, the potential for downstream contamination from herbicides would be eliminated.

8.5.4 Mitigation for Desert Tortoise

The following mitigation measures for desert tortoise have two objectives: 1) minimize loss of tortoise habitat and 2) reduce loss and displacement of this threatened species. These mitigation measures are normally applicable to situations where observations of tortoises and/or tortoise sign indicate population densities are in excess of the very low density levels (0-10 tortoises/square mile). Because estimated densities for many of the proposed flood control structures and immediately adjacent habitat are in the very low category, it is anticipated that some of the proposed mitigation measures may not be applicable for all proposed facilities. For example, tortoise fencing would not be appropriate for areas where observed densities are very low in both the construction area and adjoining parcels. However, pre-construction surveys would normally be appropriate and prudent in all cases where land is to be disturbed. These measures are summarized in Table 8-21.

8.5.4.1 Pre-Construction Measures

Prior to any work done using vehicles, including surveying, pre-construction tortoise surveys would be conducted at facility sites within suitable tortoise habitat. Areas with suitable habitat scheduled for development would be surveyed by biologists, within 90 days of construction, walking 10-meter-wide transects. These areas would be searched in a two-fold manner (surveyed in a north-south direction and in an east-west direction).

Locations of currently and recently active tortoise burrows found would be marked. All tortoises, including those within burrows, would be relocated offsite. Before any tortoises are handled, appropriate permits would be obtained from the USFWS.

Appropriate personnel of BLM, USFWS, and NDOW would be consulted to develop handling and monitoring procedures for tortoises found within construction zones. This would involve development of protocol for eventual disposition of all desert tortoises displaced due to construction, including relocation to a holding facility. Protocols would differ between the active (March through October) and inactive (November through February) tortoise seasons. All burrows in non-linear facility sites, once determined to be unoccupied, would be collapsed to prevent future occupation. Burrows in linear facility sites would be evaluated for possible avoidance, which would be accomplished by reroute or redesign of these facilities, where feasible.

8.5.4.2 Construction and Post-Construction Measures

The size of any temporary disturbance area would be limited to the greatest extent possible. The area of allowable disturbance would be clearly marked with temporary construction fencing, and contractor specifications would include a requirement that no disturbance is to occur outside the fenced area. Where practical, disturbance in construction staging areas should be limited to crushing, rather than clearing of vegetation. This will allow temporarily disturbed habitat to recover more quickly.

The number of construction roads should be limited to reduce: 1) impacts to tortoise habitat; and 2) access to previously undisturbed habitat. The latter will minimize impacts caused by unauthorized recreational off-road vehicles.

In addition vehicles should be restricted to access roads and construction staging areas. Cross-country travel should be minimized. This measure would be in effect during construction and maintenance activities.

To avoid tortoises moving above ground, especially during the active season, vehicle speed would be limited to 25 miles per hour on unpaved access roads traversing low to very high-density (more than 10 tortoises/square mile) tortoise habitat.

To further reduce impacts to the desert tortoise, a worker education program would be developed and implemented. All CCRFCD employees, contractors, and sub-contractors would be informed of the protected and sensitive status of this species. Protocols would be developed for reporting any accidental injury to, or loss of, tortoises that might occur during construction, as well as during pre- and post-construction activity. The above information would be described in a brochure, which would be distributed to all workers. A signed acknowledgement form would be returned by all workers stating that they understand the procedures designed to reduce impacts to desert tortoises.

With some exceptions, monitoring would occur at all appropriate facility sites during any activity that results in surface disturbance, including pre-construction grading and removal of vegetation, actual construction of facilities, and post-construction clean-up activities. Appropriate sites are all proposed sites surveyed, except those: 1) completely fenced after intensive pre-construction surveys; and 2) considered to not represent suitable tortoise habitat based on observations and results from the 1989 Dames & Moore field surveys.

During tortoise monitoring, there would be an adequate number of biological monitors to cover all areas of construction activity. It is anticipated that a minimum of one monitor would be necessary for each area of activity located more than one mile from other construction areas. Open ditch areas would be monitored prior to the start of work in the mornings, at least every four hours during the day, and just prior to backfilling. All monitors would have prior experience and/or training in tortoise handling procedures and construction monitoring. Applicable USFWS and NDW handling permits would be obtained prior to handling any tortoises. The objectives of monitoring would be to prevent inadvertent tortoise mortality; reduce habitat loss, where possible; and provide continued worker education and environmental awareness during construction and post-construction activities.

Tortoises found on large facility sites (primarily detention basins) during pre-construction surveys, as well as during monitoring of construction and post-construction activities would be moved to an established holding facility designated by the appropriate agencies. Handling procedures would follow suggestions and recommendations made by those agencies.

In addition to the above mitigation measures, a trash abatement program would be initiated during pre-construction phases of the project and would continue through post-construction clean-up, as well as during maintenance and operations activities. This program would be included in construction contract specifications. As such, it would be the responsibility of the contractors to remove all trash and debris from the facility site upon completion of construction. Contractors would also be responsible for controlling and limiting litter, trash, and garbage by using dumpsters and receptacles with sealable lids. This trash could otherwise contribute to increasing the raven population with a detrimental effect on nearby tortoise populations.

8.5.4.3 Habitat Compensation

The objective of habitat compensation is to ensure that there is no net loss of habitat quality for the desert tortoise. The ultimate objective of such compensation is to ensure that the number and viability of regional tortoise populations are not diminished due to construction and operation of the CCRFCD proposed facilities. Compensation for the loss of habitat for threatened and endangered species, such as the desert tortoise, is required by applicable endangered species laws, regulations, and agency policies.

The unmitigated losses for which compensation will be evaluated would occur over a long period of time (at least 10 years). Other facilities would be developed over a long time frame, such that land disturbed due to their construction may no longer represent suitable desert tortoise habitat (due to the development of adjacent lands in the interim), and compensation for potential losses associated with these facilities is not addressed in this assessment.

Different methodologies and formulae have been utilized to assess tortoise habitat loss and necessary compensation. CCRFCD proposes that compensation be evaluated on a "per acre disturbed" basis similar to the assessment currently in effect in the Las Vegas Valley. Such compensation would include different per-acre values for permanent and temporary construction, and would be developed in consultation with USFWS and BLM.

Following determination of compensation, implementation could be accomplished by one or more of several options. It is proposed that one-half of the compensation funds would be contributed prior to initiation of construction of any facilities. The remaining would be contributed over 10 years. The number of facilities constructed and acres of suitable tortoise habitat disturbed by CCRFCD would be reviewed yearly. Adjustments to the annual acreage total would be made during the following year's review. This proposed system would result in a relatively large initial compensation contribution, with subsequent contributions related to the rate of facility construction. This system would also ensure that compensation would not occur for proposed facilities that may not be constructed.

Compensation funds from the initial contribution, as well as subsequent annual increments would be used as deemed necessary by USFWS in consultation with BLM and NDW. It is proposed that primary emphasis be placed on expansion of, and improvements to, a tortoise conservation/holding facility that will be established on BLM-managed land. The expanded holding facility will accommodate tortoises that must be relocated from CCRFCD facilities. Funds contributed in subsequent annual increments would be designated for holding facility maintenance.

Additional potential uses of compensation funds would include: 1) off-site habitat acquisition (including outright purchase from private landowners and the purchase of grazing privileges), perhaps in conjunction with suggested tortoise preserve sites, such as the Piute Valley or Mormon Mesa; 2) tortoise-related research; and 3) purchase of support equipment. Under this proposal, CCRFCD would contribute to funds established: 1) for the holding facility; and 2) for habitat acquisition and other uses, such as research (to be managed by The Nature Conservancy). As such, CCRFCD would not be responsible for the actual acquisition of land, grazing privileges, or mineral rights.

TABLE 8-1

SENSITIVE PLANT SPECIES AND AQUATIC HABITATS (WETLANDS) KNOWN OR LIKELY TO OCCUR IN THE PROJECT AREA

COMMON NAME[1]	SCIENTIFIC NAME[2]	PROTECTION STATUS[3] FED/STATE/NNNPS	HABIT[4]	REGIONAL DISTRIBUTION AND ECOLOGICAL NOTES[5]
SENSITIVE PLANTS				
Federal-Listed Species				
None				Nearest location of federally listed species is at Ash Meadows in w. Nye County.
State-Listed Species				
1. Golden Bear Poppy	Arctomecon californica	C2/CE/RFT	PH	AZ, Mohave Co. (near Lake Mead); NV, Clark Co. (Las Vegas Valley, and Muddy Mtns.). Habitat: Barren, gravelly desert flats, hummocks, and slopes, often found in soil heavily impregnated with gypsum. Flowering Period: April-May Vegetation Type: Creosote Bush Scrub Type Locality: Las Vegas (Wash?), Clark Co. (1845) Elevation: 1310-2760 ft.
2. Three-cornered Pod Geyer Milk-vetch	Astragalus geyeri var. triquetrus [A.triquetrus; Phara triquetra]	C2/CE/RFT	AH	AZ, Mohave Co.; NV, ne. Clark Co. (Dry Lake Valley area and Muddy River; California Wash). Habitat: Sand or sandy soil, on flats, dunes, washes, and gullies. Flowering Period: April Vegetation Type: Creosote Bush Scrub Type Locality: confluence of Muddy & Virgin Rivers, Clark Co. Elevation: 1500-2500 ft.
3. Cactuses & Yuccas	Cactaceae and Yucca spp.	-/CY/-	PH/S	All cactus and yucca species are protected under the Nevada Cactus & Yucca Law. These taxa occur throughout the region.
4. Clokey Pincushion Cactus	Coryphantha vivipara var. rosea [C. rosea]	3C/CY/-	PH	AZ, Mohave Co.; CA, Inyo and San Bernardino Cos.; NV, Clark, Eureka, Lincoln, Nye, and White Pine Cos. Habitat: Gravelly limestone or volcanic slopes and brushy hillsides. Flowering Period: June-July Vegetation Type: Desert Calcicolous Scrub Type Locality: Charleston (Spring) Mtns., Clark Co. Elevation: 3800-9000 ft.

TABLE 8-1 (continued)

COMMON NAME[1]	SCIENTIFIC NAME[2]	PROTECTION STATUS[3] FED/STATE/NNNPS	HABIT[4]	REGIONAL DISTRIBUTION AND ECOLOGICAL NOTES[5]
5. Las Vegas Cryptantha	Cryptantha insolita	C2*/CE/PE	AH	NV, Clark Co. (Las Vegas area). Presumed extinct; last known sighting in 1942 at the type locality (North Las Vegas). Habitat: Possible in saline clay soil with gypsum outcrops. Flowering Period: April-June Vegetation Type: Alkali Flats Type Locality: Las Vegas, Clark Co. (4 May 1905) Elevation: 1000-2000 ft.
6. LeContes' Barrel Cactus	Ferocactus acanthodes var. lecontei [Echinocactus l.]	-/CE/W	S	AZ, Mohave Co.; CA, San Bernardino Co. (e. Mojave Desert ranges); NV, Clark Co. (Blue Diamond Ridge, Desert Nat'l. Wildlife Range); UT; Baja, CA. Habitat: Dry rocky desert slopes and hillsides Flowering Period: April-June Vegetation Type: Cresote Bush Scrub and Desert Calcicolous Scrub Type Locality: ? Elevation: below 5000 ft.
7. Blue Diamond Cholla or Many Jointed Whipple Cholla	Opuntia whipplei var. multigeniculata [O. multigeniculata]	C2/CE/RFT	S	AZ, Mohave Co; NV, Clark Co. (e. of Wilson's Ranch on Blue Diamond Ridge and at Blue Diamond Gypsum Mine). Restricted to Blue Diamond Ridge in NV; more abundant in AZ. Habitat: Open rocky or sandy ridges. Flowering Period: May (fruiting in July) Vegetation Type: Desert Calicolous Scrub Type Locality: e. of Wilson's Ranch, Charleston (Spring) Mtns., Clark Co. Elevation: 4600-4675 ft.
Federal Candidate and BLM Sensitive Species				
8. Charleston Angelica or Rough Angelica	Angelica scabrida	C1/-/RFT	PH	NV; Clark Co. (Spring Mtns.; Red Rock Canyon area; Kyle Cyn.; La Madre Mtn. (Wilson Springs)). Habitat: In gravelly washes and hillsides. Flowering Period: July-August Vegetation Type: Yellow Pine Forest/Riparian Woodland Type Locality: Charleston Park (Kyle Cyn.), Charleston (Spring) Mtns., Clark Co. Elevation: 4320-8400 ft.
9. Spring Mountain Milk-vetch	Astragalus remotus [A. arrectus var. remotus]	C2/-/RFT	AH	NV, Clark Co. (e. foot of Spring Mtns., La Madre Mtn. s. to Goodsprings; Cottonwood Springs, Excelsior Cyn., Mountain Springs, Rocky Gap Springs, Wilson's Ranch). Habitat: Sandstone and limestone rocks. Flowering Period: April - May Vegetation Type: Desert Calcicolous Scrub Type Locality: Goodsprings, Clark Co. Elevation: 3300-4400 ft.

TABLE 8-1 (continued)

COMMON NAME[1]	SCIENTIFIC NAME[2]	PROTECTION STATUS[3] FED/STATE/NNNPS	HABIT[4]	REGIONAL DISTRIBUTION AND ECOLOGICAL NOTES[5]
10. Streaked Mariposa Lily or Alkali Mariposa Lily	Calochortus striatus	C2/-/W	PH	CA, San Bernardino Co. (Rabbit Spring); NV, Nye Co. (Ash Meadows); Clark Co. (Las Vegas Range, Red Rock Cyn., Spring Mtns). Habitat: In alkaline meadows or near seep areas. Flowering Period: April-June Vegetation Type: alkali meadows in shadscale Type Locality: Rabbit Springs, Mojave Desert, San Bernardino Co. (1882) Elevation: 985-4500 ft.
11. Pahrump Valley Buckwheat or Forked Buckwheat	Eriogonum bifurcatum	C2/-/RFT	AH	CA, Inyo Co. (Mesquite Valley) (along NV border); NV, Nye Co. (Pahrump Valley); Clark Co. (Goodsprings area), to be looked for in other areas. Habitat: Rolling hills, saline flats Flowering Period: May-June Vegetation Type: Shadscale; sagebrush scrub Type Locality: Stewart Valley, Nye Co. (1970) Elevation: 2500-2550 ft.
12. Low Grease-bush	Forsellesia pungens var. glabra [Glossopetalon pungens]	C2/-/W	S	CA, San Bernardino Co. (Clark Mtns. at head of Forsellesia Cyn.); NV, Clark Co. (Spring Mtns.) Habitat: N-facing slope; limestone cliffs Flowering Period: May-June Vegetation Type: Desert Calcicolous Scrub Type Locality: Forsellesia Cyn., Clark Mtns., San Bernardino Co. Elevation: 4000-6500 ft.
13. White-margined Beardtongue	Penstemon albomarginatus	BLM/-/-	PH	CA, San Bernardino Co. (near Lavic in s. Mojave Desert); Clark Co. (Goodsprings/Jean area); Nye Co. (below W. Spector Range (n. Amargosa Valley)). Habitat: Sandy open disturbed areas, washes, road-sides, in deep sand. Flowering Period: late April - early May Vegetation: Creosote Bush Scrub Type Locality: Goodsprings, Clark Co. Elevation: 1800-3000 ft.
14. Bicolored Penstemon	Penstemon bicolor ssp. bicolor [P. palmeri var. bicolor; P. pseudospectabilis ssp. bicolor]	C2/-/W	BH	AZ, Mohave Co.; NV, scattered locations throughout Clark Co. Habitat: On slight elevations, in shallow gravelly washes, roadsides. Flowering Period: May-June Vegetation Type: Creosote Bush Scrub/Joshua Tree Woodland Type Locality: Goodsprings, Clark Co. (1916) Elevation: 1970-5480 ft.

TABLE 8-1 (continued)

COMMON NAME[1]	SCIENTIFIC NAME[2]	PROTECTION STATUS[3] FED/STATE/NNNPS	HABIT[4]	REGIONAL DISTRIBUTION AND ECOLOGICAL NOTES[5]
NNNPS "Watch List" Species				
15. Ivory Spined Utah Agave or Century Plant	Agave utahensis var. eborispina [A. eborispina]	3C/-/W	PH	CA, Inyo; NV, Clark, Lincoln, and Nye Cos. Habitat: Exposed outcrops or ridges of limestone mtn. ranges; occasionally on quartzite. Flowering Period: May-June Vegetation Type: Desert Calcicolous Scrub Type Locality: Sheep Range, Clark Co. Elevation: 3800-8500 ft.
16. Clark Mountain Agave or Century Plant	Agave utahensis var. nevadensis	3C/-/W	PH	CA, San Bernardino Co. (Clark Mtns., Mescal Range, Ivanpah Mtns., Kingston Range); NV, Clark Co. (Spring Mtns.) Habitat: Dry limestone slopes Flowering Period: May-June (July) Vegetation Type: Desert Calcicolous Scrub Joshua Tree Woodland Type Locality: ? Elevation: 3000-5000 ft.
17. Merriam's Bear Poppy	Arctomecon merriamii	3C/-/W	PH	CA, San Bernardino Co. (Clark Mtns.), Inyo Co.; NV, Nye Co. (Ash Meadows), Clark Co. (Las Vegas Valley, Sheep Range, Desert Nat'l. Wildlife Range), Lincoln Co. Habitat: Shallow gravelly soil, limestone outcrops, or flats or old lake beds. Flowering Period: April-June Vegetation Type: Shadscale Scrub, Creosote Bush Scrub, Desert Calcicolous Scrub Type Locality: a few miles w. of Vegas Ranch, Clark Co. (1891) Elevtion: 2200-4800 ft.
18. Knapp's Brickellia	Brickellia knappiana	3C/-/W	S	CA, Inyo Co. (Panamint Mtns., Funeral Range), San Bernardino Co.; NV, Clark Co. (McCullough Range) Habitat: In streams, rocky slopes, and canyon walls. Flowering Period: Autumn Vegetation Type: Shadscale; Creosote Bush Scrub Type Locality: near the Mojave River, San Bernardino Co. Elevation: 2500-4400 ft.

TABLE 8-1 (continued)

COMMON NAME[1]	SCIENTIFIC NAME[2]	PROTECTION STATUS[3] FED/STATE/NNNPS	HABIT[4]	REGIONAL DISTRIBUTION AND ECOLOGICAL NOTES[5]
19. Mojave Cryptantha or New York Mtns. Cryptantha	Cryptantha tumulosa	3C/-/W	AH	CA, San Bernardino Co. (Providence Mtns., New York Mtns.); NV, Clark Co. (Spring Mtns., Desert Nat'l Wildlife Range). Habitat: Gravelly clay soils, on limestone hills and in washes. Flowering Period: April-June Vegetation Type: Desert Calcicolous Scrub, Pinyon-Juniper Woodland Type Locality: Providence Mtns., San Bernardino Co. (1902) Elevation: 4500-7100 ft.
NNNPS "Other Rare" Species				
20. Shockley Rock-cress	Arabis shockleyi	3C/-/OR	B/PH	CA, Inyo and San Bernardino Cos. (San Bernardino Mtns.), Riverside Co.; NV, Clark, Esmeralda and Nye Cos. (Desert Nat'l Wildlife Range, Eleana Range within Nevada Test Site); UT. Habitat: Limestone hillsides Flowering Period: March-May Vegetation Type: Desert Calcicolous Scrub Pinyon-Juniper Woodland Type Locality: ? Elevation: 6000-6400 ft.
21. Ackerman's Milk-vetch	Astragalus ackermanii	3C/-/OR	PH	NV, Clark Co. (Sheep Range, Desert Nat'l. Wildlife Range), Lincoln Co. (Nevada Test Site (Pintwater Range, Sheep Range)). Habitat: Cliff faces in limestone, ledges and crevices Flowering Period: May-early June Vegetation Type: Desert Calcicolous Scrub Type Locality: at head of box canyon overlooking Yucca Forest at southeastern edge of Sheep Range, Clark Co. (1979). Elevation: 4000-6000 ft.
22. Nye Milk-vetch	Astragalus nyensis	3C/-/OR	AH	NV, Clark, Lincoln, and Nye Cos. Habitat: Outwash fans and gravelly flats; sometimes in sandy soil on calcareous gravel knolls Flowering Period: April-May Vegetation Type: Creosote Bush Scrub, Desert Calcicolous Scrub Type Locality: Spotted Range, Nye Co. (1941) Elevation: 1700-5600 ft.

TABLE 8-1 (continued)

COMMON NAME[1]	SCIENTIFIC NAME[2]	PROTECTION STATUS[3] FED/STATE/NNNPS	HABIT[4]	REGIONAL DISTRIBUTION AND ECOLOGICAL NOTES[5]
23. Ripley Gilia	Gilia ripleyi [G. gilmanii]	3C/-/OR	PH	CA, Inyo Co. (Kingston Range); NV, Clark, Lincoln, and Nye Cos. Habitat: Dolomite, exposed crevices of steep south-facing limestone cliffs, occasionally in loose talus Flowering Period: May-October Vegetation Type: Desert Calcicolous Scrub Type Locality: s. end Specter Range, Nye Co. (1941) Elevation: 3000-5000 ft.
24. Intricate Large-headed Rock-daisy	Perityle megalocephala var. intricata [Laphamia intricata; P. intricata]	3C/-/OR	S	CA, NV; desert ranges of w. Nye and Clark Cos., w. to Inyo Mtns. and ranges surrounding Death Valley; W. Spotted Range, Spector Range, n. of Pahrump Valley. Habitat: Rock crevices and canyon walls. Flowering Period: July-September Vegetation: Desert Calcicolous Scrub Type Locality: Pahrump and on Sheep Mtn., NV Elevation: 2600-4800 ft.
25. A. Nelson Phacelia	Phacelia anelsonii	3C/-/OR	AH	CA, San Bernardino Co. (Clark Mtns.); NV, Clark and Lincoln Cos.; UT Habitat: Shaded places in rich soil at base of sandstone or limestone cliffs or among rocks or in sandy and gravelly washes. Flowering Period: April-May Vegetation Type: Desert Calciculous Scrub Type Locality: Meadow Valley Wash, Lincoln Co. (1902) Elevation: 2500-5000 ft.
AQUATIC HABITATS (WETLANDS)				
Wetlands				
26. Herbaceous Wetland				Similar to distribution of riparian. Most extensive in Las Vegas Wash, but also occurs in other, relatively large washes.
27. Riparian				Occurs primarily in the southern half of the project area. Extensive in Las Vegas Wash and scattered in Tropicana Wash, Flamingo Wash, Duck Creek, Paradise Valley, and Cottonwood Valley.

TABLE 8-1 (concluded)

COMMON NAME[1]	SCIENTIFIC NAME[2]	PROTECTION STATUS[3] FED/STATE/NNNPS	HABIT[4]	REGIONAL DISTRIBUTION AND ECOLOGICAL NOTES[5]
Riparian Scrub				
28. Desert Riparian (Desert Wash)				Occurs throughout the project area, mostly within small washes, drainages, and gullies as discontinuous habitat. Large areas of this habitat are in the upper Las Vegas Wash and Red Rock Canyon Wash.
29. Saltbush/Mixed Shrub				Similar to distribution of desert riparian. Occurs throughout the study area, including within the upper Las Vegas Wash, Red Rock Canyon Wash, and numerous smaller washes and gullies.

1 Common names follow: Abrams and Ferris, 1940-1960; Mozingo and Williams, 1980; Smith and Berg, 1988; Thorne et al., 1981.
2 Scientific nomenclature follows: NNNPS, 1987; Smith and Berg, 1988.
3 Protection Status
Federal: C1 = Category 1 candidate for federal listing;
C2 = Category 2 candidate for federal listing;
C2* = Category 2 candidate which is presumed to be extinct;
3C = Category 3 candidate for listing which is considered too common (USFWS, 1990);
BLM = Species not included in above categories which the BLM consider as sensitive.
State: CE = Critically Endangered (NDF, 1987a);
CY = cactus and yucca law.
NNNPS (Northern Nevada Native Plant Society, 1987);
Sensitivity categories listed in decreasing order of rarity and vulnerability:
RFT = recommended for federal listing as threatened;
PE = presumed extinct;
W = watch list;
OR = other rare.
4 Habit: AH = annual herb;
PH = perennial herb;
S = shrub.
5 Regional Distribution and Ecological Notes: data gathered from Abrams and Ferris, 1940-1960; Clokey, 1951; McDougall, 1973; Munz, 1974; Beatley, 1976; Mozingo and Williams, 1980; Thorne et al., 1981; Nevada State Museum, 1986; Nevada Natural Heritage Program, 1987; Smith and Berg, 1988; UNLV Herbarium Specimens, 1988; Knight, 1988. Known distributions in the project area are shown on Figure 8-1.

TABLE 8-2 (continued)

COMMON NAME[1]	SCIENTIFIC NAME[1]	PROTECTION STATUS[2]	REGIONAL DISTRIBUTION[3]
FEDERAL CANDIDATE, BLM SENSITIVE, AND/OR STATE-PROTECTED SPECIES (continued)			
41. Long-billed curlew	Numenius americanus	/ /C2/	Rare to uncommon transient, primarily during spring and fall. Documented occurrence in wetlands of Las Vegas Wash and nearby Lake Mead.
42. Western yellow-billed cuckoo	Coccyzus americanus occidentalis	/ /3C/B	Rare migrant in riparian areas of the region. The few reports since 1950 are primarily from Boulder City and areas north of Las Vegas. Also reported from LMNRA and DNWR.
43. Greater (=western) mastiff bat	Eumops perotis californicus	/ /C2/	Occurs primarily in the southwestern United States. Little known about occurrence in the region, however reported distribution includes the study area. One specimen collected in 1966 from Las Vegas.
44. Palmer's chipmunk	Tamias palmeri	/ /C2/	Reported to be restricted to the Charleston (Spring) Mountains. Based on museum specimens, potential to occur in the extreme western portion of the study area, in the Spring and La Madre mountains.
GAME, FURBEARER, AND OTHER SENSITIVE SPECIES			
45. Chukar	Alectoris chukar	/ / /G	Introduced year-round resident native to Asia. First released in Nevada in 1935. Frequents open, rocky, primarily arid habitats where it prefers to feed on cheatgrass (Bromus tectorum). Occurs in the southwestern corner of the study area in the Bird Spring Range and RRCRL. Also reported from LMNRA.
46. Gambel's quail	Callipepla gambelii	/ / /G	Year-round resident that is quite widespread in the study area. Common to abundant in and near the Bird Spring, McCullough, and River mountains, generally at relatively lower elevations. Less abundant at higher elevations. Frequents areas that provide shrub cover, particularly washes in the eastern Las Vegas Valley. Reported from LMNRA, DNWR, and RRCRL.

TABLE 8-2 (continued)

COMMON NAME[1]	SCIENTIFIC NAME[1]	PROTECTION STATUS[2]	REGIONAL DISTRIBUTION[3]
GAME, FURBEARER, AND OTHER SENSITIVE SPECIES (continued)			
47. Desert cottontail	Sylvilagus audubonii	/ / /G	Year-round resident that commonly occurs in a vareity of habitats. Abundant in areas of dense cover such as wetland, riparian, and wash vegetation.
48. Muskrat	Ondatra zibethicus	/ / /F	Rare year-round resident of aquatic habitat in Las Vegas Wash and LMNRA.
49. Kit fox	Vulpes macrotis	/ / /F	Occurs throughout the study area at lower elevations, particularly west of Las Vegas. Regional reports also include Boulder City, Las Vegas Wash, LMNRA, DNWR, and RRCRL. Often occupies dens in the banks of washes, as well as in human-made earthen structures, such as berms and levees. Will utilize areas in close proximity to residential/commercial development.
50. Gray fox	Urocyon cinereoargenteus	/ / /F	Year-round resident throughout much of the study area, particularly in wooded and shrubby areas of mountains along western and northern edges, and in the southeastern corner. At lower elevations, uses shrub cover of washes. Reported from Las Vegas Wash, LMNRA, DNWR, RRCRL, and Boulder City.
51. Bobcat	Felis rufus	/ / /F	Year-round resident in riparian habitats and rough, broken terrain within canyons and foothills. Reported from Las Vegas Wash, DNWR, RRCRL, and Boulder City. Rare in limited areas within LMNRA.
52. Elk	Cervus elaphus	/ / /G	Possible year-round resident of mountains in the northwestern corner of the study area. Frequents somewhat open forest and mountain meadows. Introduced to the region in 1934.
53. Mule deer	Odocoileus hemionus	/ / /G	Year-round resident of mountain ranges on western edge and in southwestern corner of study area (such as Bird Spring Range, Spring Mountains, and La Madre Mountain). Occupies a variety of habitats, including shrubby areas and woodlands. Reported from LMNRA, RRCRL, and the Sheep Range in DNWR.

TABLE 8-2 (continued)

COMMON NAME[1]	SCIENTIFIC NAME[1]	PROTECTION STATUS[2]	REGIONAL DISTRIBUTION[3]
GAME, AND FURBEARER, AND OTHER SENSITIVE SPECIES (continued)			
54. Bighorn sheep	Ovis canadensis	/ / /G	Year-round resident of several mountain ranges along the western and northern boundaries of the study area, as well as in the southeastern corner. Ranges occupied include the Las Vegas Range, Sheep Range, Spring Mountains, Bird Spring Range, La Madre Mountain, McCullough Mountains, and River Mountains. Railroad Pass, west of Boulder City and southeast of Henderson, is an important travel corridor.
55. Phainopepla	Phainopepla nitens	/ / /SC	Year-round resident and breeding species in mesquite habitat in the Upper Las Vegas wash of the North Las Vegas Valley subasin.

1 Nomenclature follows Collins et al. (1982) for reptiles, American Ornithologists' Union (AOU) (1983) for birds and Jones et al. (1982) for mammals.

2 Protection status:
- FE = federal-listed endangered (USFWS, 1989a);
- FT = federal-listed threatened (USFWS, 1989a);
- SE = state-listed endangered (Nevada Department of Wildlife [NDW], 1984);
- SR = state-listed rare (NDW, 1984);
- C2 = Category 2 federal candidate (sufficient data are on file for possible listing as threatened or endangered, but additional data are needed on vulnerability and threats; USFWS, 1985b);
- 3C = Category 3c federal candidate (considered too common for listing) (USFWS, 1989b);
- BLM = classified as a sensitive species by BLM;
- B = included on the National Audubon Society's Blue List of birds suffering significant decline in numbers throughout much of their ranges (Tate, 1986);
- F = included on the State of Nevada's list of furbearer species (NDW, 1984);
- G = included on the State of Nevada's list of game species (NDW, 1984);
- P = included on the State of Nevada's list of fully protected species (NDW, 1984).
- SC = Species of special concern. Under consideration for state listing.

3 Information on regional distribution from several sources, including:
1) personal communications;
2) 1988 database information from the Nevada Natural Heritage Program;
3) collections records from the southern division of the Nevada State Museum;
4) previous environmental reports; and
5) various publications and unpublished reports and checklists. These reference sources are described in Section 8.1.1. Distributions and/or sightings of most sensitive wildlife species shown on Figure 8-2.

* These species are also federal candidates.

TABLE 8-3

GENERAL RANGES OF DESERT TORTOISE DENSITIES ESTIMATED FROM WALK-OVER SURVEYS

Corrected Sign per Acre Observed During Surveys	General Density Estimates[1] Range (No. per Square Mile)	Relative Density
0	0-10	Very Low
0.1-0.4	10-45	Low
0.5-0.9	45-90	Moderate
1.0-1.4	90-140	High
1.4+	140+	Very High

1 Categories developed by BLM from information on file in the Las Vegas District.

TABLE 8-4

SUMMARY OF DISTRIBUTION OF SENSITIVE SPECIES AND HABITATS BY SUBAREA[1]

RESOURCE	NORTH LAS VEGAS VALLEY	CENTRAL LAS VEGAS VALLEY	SOUTH-WEST VEGAS VALLEY	BOULDER CITY	HENDER-SON
BOTANICAL RESOURCES					
Listed Plants					
1. Golden Bear Poppy (*Arctomecon californica*)	X	X	X		(X)
2. Three-cornered Pod Geyer Milk-vetch (*Astragalus geyeri* var. *triquetrus*)	(X)				
3. Cactus and yuccas	X	X	X	X	X
4. Clokey Pincushion Cactus (*Coryphantha vivipara* var. *rosea*)	(X)	(X)	(X)		
5. Las Vegas Cryptantha (*Cryptantha insolita*)	X	(X)			
6. LeConte's Barrel Cactus (*Ferocactus acanthodes* var. *lecontei*)	X	(X)	X		
7. Blue Diamond Cholla (*Opuntia whipplei* var. *multigeniculata*)	(X)		X		
Federal Candidate and BLM Sensitive Species					
8. Charleston Angelica (*Angelica scabrida*)	(X)	(X)	X		
9. Spring Mountain Milk-vetch (*Astragalus remotus*)			X		
10. Streaked Mariposa Lily (*Calochortus striatus*)	X	(X)	X		
11. Pahrump Valley Buckwheat (*Eriogonum bifurcatum*)	(X)	(X)	(X)		
12. Low Grease-bush (*Forsellesia pungens* var. *glabra*)		(X)	X		
13. White-margined Beardtongue (*Penstemon albomarginatus*)			(X)		
14. Bicolored Penstemon (*Penstemon bicolor* ssp. *bicolor*)	X	X	X	(X)	(X)

TABLE 8-4 (continued)

RESOURCE	NORTH LAS VEGAS VALLEY	CENTRAL LAS VEGAS VALLEY	SOUTH-WEST VEGAS VALLEY	BOULDER CITY	HENDER-SON
High Priority NNNPS Species					
15. Ivory Spined Utah Agave (*Agave utahensis* var. *eborispina*)	X		(X)		
16. Clark Mountain Agave (*Agave utahensis* var. *nevadensis*)			X		
17. Merriam's Bear Poppy (*Arctomecon merriamii*)	(X)	X	X		
18. Knapp's Brickellia (*Brickellia knappiana*)			(X)		(X)
19. Mojave Cryptantha (*Cryptantha tumulosa*)	(X)		X		
Other NNNPS Species					
20. Shockley Rock-cress (*Arabis shockleyi*)	(X)				
21. Ackerman's Milk-vetch (*Astragalus ackermanii*)	(X)				
22. Nye Milk-vetch (*Astragalus nyensis*)	X	(X)	(X)		
23. Ripley Gilia (*Gilia ripleyi*)	(X)				
24. Intricate Large-headed Rock-daisy (*Perityle megalocephala* var. *intricata*)	(X)				
25. A. Nelson Phacelia (*Phacelia anelsonii*)		X	(X)		
	19	13	19	2	4
WETLANDS					
26, 27. Wetlands	X	X	X	(X)	(X)
28, 29. Transitional Wetlands	X	X	X	X	X
WILDLIFE RESOURCES					
Federal-listed Species					
30. Brown pelican (*Pelecanus occidentalis*)	X				X
31. Bald eagle (*Haliaeetus leucocephalus*)	X			(X)	X
32. American peregrine falcon (*Falco peregrinus anatum*)	X		(X)		X
33. Desert tortoise (*Xerobates agassizii*)	X	X	X	X	X

TABLE 8-4 (concluded)

RESOURCE	NORTH LAS VEGAS VALLEY	CENTRAL LAS VEGAS VALLEY	SOUTH-WEST VEGAS VALLEY	BOULDER CITY	HENDER-SON
Federal Candidate, BLM Sensitive, and/or State-Protected Species					
34. Gila monster (Heloderma suspectum)	X	X	X	X	X
35. Spotted bat (Euderma maculatum)	X	X	X	X	X
36. White-faced ibis (Plegadis chihi)	X				X
37. Swainson's hawk (Buteo swainsoni)	X	X	X	X	X
38. Ferruginous hawk (Buteo regalis)	X	X	X	X	X
39. Prairie falcon (Falco mexicanus)	X	X	X	X	X
40. Western snowy plover (Charadrius alexandrinus nivosus)	X				X
41. Long-billed curlew (Numenius americanus)	X				X
42. Western yellow-billed cuckoo (Coccyzus americanus occidentalis)	(X)			(X)	(X)
43. Greater (=western) mastiff bat (Eumops perotis californicus)	X	X	X	X	X
44. Palmer's chipmunk (Tamias palmeri)		(X)	(X)		
Game, Furbearer, and Other Sensitive Species					
45. Chukar (Alectoris chukar)			X	(X)	(X)
46. Gambel's quail (Callipepla gambelii)	X	X	X	X	X
47. Desert cottontail (Sylvilagus audubonii)	X	X	X	X	X
48. Muskrat (Ondatra zibethicus)	X				X
49. Kit fox (Vulpes macrotis)	X	X	X	X	X
50. Gray fox (Urocyon cinereoargenteus)	X	X	X	X	X
51. Bobcat (Felis rufus)	X	X	X	X	X
52. Elk (Cervus elaphus)	(X)				
53. Mule deer (Odocoileus hemionus)	X	X	X	(X)	(X)
54. Bighorn sheep (Ovis canadensis)	X	X	X	X	X
Species Under Consideration for State Listing					
55. Phainopepla (Phainopepla nitens)	X				
	24	13	17	17	23

1 Occurrence in subareas: X = known occurrence; (X) = potential occurrence or known, but very rare occurrence.

TABLE 8-5

FACILITIES SURVEYED FOR DESERT TORTOISE

FACILITY	ID NO.	TYPE	DATE(S) SURVEYED[1]	DATE VALIDATION PLOT SURVEYED	GENERAL WEATHER CONDITIONS	MAXIMUM TEMPERATURE (°F) DURING SURVEY
N1	2	Box Conduit	Oct 17	--	Clear	81
N1	3	Box Conduit	Oct 17	--	Clear	81
N1	4	Channel	Oct 17	--	Clear	81
N3	1	Floodway	Oct 16	--	Clear	74
N3	8	Detention Basin	Oct 20, 23, 24	Oct 24	Clear/Windy	82
N4	8	Detention Basin	Sep 22	Oct 13	Clear	87
N4	23	Box Culvert	Oct 23	--	Clear	79
N5	1	Dike	Oct 16	--	Clear	82
N5	2	Dike	Oct 14	--	Rainy	75
N5	3	Detention Basin	Oct 20	Oct 20	Clear	83
N5	4	Channel	Oct 14	--	Intermittent Showers	93
N5	5	Channel	Oct 14	--	Intermittent Showers	93
N5	6	Box Culvert	Oct 14	--	Intermittent Showers	93
N5	7	Channel	Oct 14	--	Intermittent Showers	93
N7	4	Box Bridge	Oct 23	--	Clear/Windy	81
N10	9	Dike	Oct 15	--	Clear	82
N10	10	Dike	Oct 28	--	Clear	68
N10	11	Detention Basin	Sep 21	Sep 21	Clear	88
N10	13	Box Culvert	Oct 23	--	Clear	80
N12	9	Detention Basin	Sep 25	Oct 13	Overcast	97
N12	10	Dike	Oct 4	--	Clear	87
N12	11	Channel	Oct 4	--	Clear	87
C2	46	Bridge	Oct 7	--	Clear	95
*C2	47	Channel	Oct 7	--	Clear	95
C2	48	Bridge	Oct 7	--	Clear	95
C2	49	Channel	Oct 7	--	Clear	80
C2	51	Channel	Oct 7	--	Clear	80
C2	52	Bridge	Oct 7	--	Clear	95
C2	53	Channel	Oct 7	--	Clear	95
C3	55	2 Detention Basins	Sep 22	Oct 13	Clear/Overcast	97
S1	59	Detention Basin	Sep 25, 26	Sep 27	Intermittent Showers	94
S2	61	Channel	Oct 6	--	Clear	80
S4	23	Dike	Oct 8	--	Clear	75
S4	24	Detention Basin	Sep 29, Oct 2	Oct 9	Clear	93
S6	48	Box Conduit	Oct 6	--	Clear	87
S10	60	Channel	Oct 6	--	Clear	87
S11	2	Dike	Oct 16	--	Clear	81
S11	3	Detention Basin	Sep 27, 28, 29	Oct 10	Clear	93
S17	4	Detention Basin	Sep 22, 23	Oct 6	Clear	93
S18	14	Detention Basin	Oct 2	Oct 5	Clear/Windy	82
S19	24	Detention Basin	Oct 2	Oct 9	Clear	82
S20	17	Dike	Oct 4	--	Clear	85
S20	18	Detention Basin	Oct 3	Oct 5	Clear	80
S21	28	Dike	Oct 11	--	Clear	88

TABLE 8-5 (concluded)

FACILITY	ID NO.	TYPE	DATE(S) SURVEYED[1]	DATE VALIDATION PLOT SURVEYED	GENERAL WEATHER CONDITIONS	MAXIMUM TEMPERATURE (°F) DURING SURVEY
S21	29	Detention Basin	Oct 10, 11	Oct 11	Clear	88
S22	25	Floodway	Oct 4	--	Clear	84
S26	66	Dike	Oct 9	--	Clear	92
S26	67	Detention Basin	Sep 22	Oct 9	Clear	92
S26	85	Dike	Oct 9	--	Clear	92
S29	37	Dike	Oct 4	--	Clear	81
S29	38	Detention Basin	Oct 12	Oct 12	Clear	91
S29	39	Channel	Oct 4	--	Clear	81
S30	45	Channel	Oct 4	--	Clear	82
H1	10	Channel	Sep 23	--	Clear	95
H1	11	Channel	Sep 23	--	Clear	95
H1	12	Box Culvert	Sep 23	--	Clear	95
H1	13	Channel	Sep 23	--	Clear	95
H1	14	Detention Basin	Oct 3	Oct 12	Clear	90
H3	12	Box Culvert	Oct 4	--	Clear	95
H3	13	Channel	Oct 4	--	Clear	77
H3	14	Box Culvert	Oct 4	--	Clear	77
H3	17	Bridge	Oct 4	--	Clear	77
H3	31	Bridge	Oct 4	--	Clear	77
H3	56	Channel	Sep 23	--	Clear	91
2618	57	Channel	Sep 23	--	Clear	91
B1	4	Dike	Sep 26	--	Overcast	93
B1	5	Dike	Sep 26	--	Overcast	93
B2	35	Box Culvert	Sep 26	--	Overcast	79
B3	39	Channel	Sep 25	--	Overcast	95
B4	36	Channel	Sep 25	--	Overcast	95
B4	41	Channel	Sep 26	--	Overcast	81
B4	44	Channel	Sep 26	--	Overcast	88
4108	23	Channel	Sep 25	--	Overcast	90
4108	24	Channel	Sep 25	--	Overcast	90
4108	26	Floodway	Sep 22	--	Clear	90
4108	45	Bridge	Sep 25	--	Clear	81
4109	28	Floodway	Sep 27	--	Overcast	95
4110	30	Floodway	Sep 25	--	Overcast	93
4110	40	Culvert	Sep 26	--	Overcast	81
4110	43	Culvert	Sep 26	--	Overcast	88
4114	31	Debris Basin	Sep 27	Oct 12	Overcast	88

[1] All surveys conducted between 21 September and 24 October 1989.
* Resurveyed by ERC following relocation of a portion of this facility.

TABLE 8-6

CONDITIONS AT PROPOSED FACILITY SITES
DURING DESERT TORTOISE SURVEYS

FACILITY	ID NO.	TYPE	PRINCIPAL GEOMORPHOLOGICAL TYPE	VEGETATION TYPE[1]	RELATIVE AMOUNT OF DISTURBANCE
N1	2	Box Conduit	Alluvial Fan	CBS	High
N1	3	Box Conduit	Alluvial Fan	CBS	High
N1	4	Channel	Alluvial Fan	CBS	High
N3	1	Floodway	Desert Wash	DWS/CBS	Low-High
N3	8	Detention Basin	Alluvial Fan	CBS	Low
N4	8	Detention Basin	Lower Alluvial Fan	CBS	High
N4	23	Box Culvert	Desert Wash	DWS/CBS	Low
N5	1	Dike	Lower Alluvial Fan	CBS	Low
N5	2	Dike	Alluvial Fan	CBS	Low
N5	3	Detention Basin	Lower Alluvial Fan	CBS	Low
N5	4	Channel	Lower Alluvial Fan	CBS	Low
N5	5	Channel	Lower Alluvial Fan	CBS	Low
N5	6	Box Culvert	Lower Alluvial Fan	CBS	Low
N5	7	Channel	Lower Alluvial Fan	CBS	Low
N7	4	Box Bridge	Desert Wash	DM	Low
N10	9	Dike	Alluvial Fan	CBS	Low
N10	10	Dike	Lower Alluvial Fan	CBS	Low-Moderate
N10	11	Detention Basin	Alluvial Fan	CBS	Low
N10	13	Box Culvert	Desert Wash	DWS/RUD	High
N12	9	Detention Basin	Alluvial Fan	CBS/BBS	Moderate-High
N12	10	Dike	Lower Alluvial Fan	CBS	Moderate-High
N12	11	Channel	Lower Alluvial Fan	CBS	Moderate-High
C2	46	Bridge	Desert Wash	CBS	Moderate-High
C2	47	Channel	Desert Wash	CBS	Moderate-High
C2	48	Bridge	Desert Wash	CBS	Moderate-High
C2	49	Channel	Desert Wash	CBS	Moderate-High
C2	51	Channel	Desert Wash	CBS	Moderate-High
C2	52	Bridge	Desert Wash	CBS	Moderate
C2	53	Channel	Desert Wash	CBS	Moderate-High
C3	55	2 Detention Basins	Alluvial Fan	CBS	High

TABLE 8-6 (continued)

FACILITY	ID NO.	TYPE	PRINCIPAL GEOMORPHOLOGICAL TYPE	VEGETATION TYPE[1]	RELATIVE AMOUNT OF DISTURBANCE
S1	59	Detention Basin	Lower Alluvial Fan	CBS	Low-Moderate
S2	61	Channel	Desert Wash	CBS/DWS	Moderate-High
S4	23	Dike	Desert Wash	CBS	Moderate
S4	24	Detention Basin	Lower Alluvial Fan	CBS	Low
S6	48	Box Conduit	Channel	CBS	High
S10	60	Channel	Desert Wash	CBS/DWS	High
S11	2	Dike	Desert Wash	DWS	Low
S11	3	Detention Basin	Lower Alluvial Fan	CBS	Low
S17	4	Detention Basin	Lower Alluvial Fan	BBS	High
S18	14	Detention Basin	Valley Floor	CBS	High
S19	24	Detention Basin	Lower Alluvial Fan	CBS	Low-Moderate
S20	17	Dike	Desert Wash	DWS/CBS	Low
S20	18	Detention Basin	Lower Alluvial Fan	CBS	Low-Moderate
S21	28	Dike	Lower Alluvial Fan	CBS	Low
S21	29	Detention Basin	Lower Alluvial Fan	CBS	Low
S22	25	Floodway	Desert Wash	CBS	Low
S26	66	Dike	Desert Wash	CBS/DWS	High
S26	67	Detention Basin	Valley Floor	CBS/DWS	High
S26	85	Dike	Desert Wash	CBS/DWS	High
S29	37	Dike	Lower Alluvial Fan	CBS	Low
S29	38	Detention Basin	Lower Alluvial Fan	CBS	Low
S29	39	Channel	Lower Alluvial Fan	CBS/DWS	Low
S30	45	Channel	Lower Alluvial Fan/ Desert Wash	CBS	Low-Moderate
H1	10	Channel	Lower Alluvial Fan	CBS	High
H1	11	Channel	Lower Alluvial Fan	CBS	High
H1	12	Box Culvert	Lower Alluvial Fan	CBS	High
H1	13	Channel	Lower Alluvial Fan	CBS	High
H1	14	Detention Basin	Lower Alluvial Fan	CBS	High
H3	12	Box Culvert	Basin	CBS/DM	High
H3	13	Channel	Basin	DM	High
H3	14	Box Culvert	Basin	DM	High

TABLE 8-6 (concluded)

FACILITY	ID NO.	TYPE	PRINCIPAL GEOMORPHOLOGICAL TYPE	VEGETATION TYPE[1]	RELATIVE AMOUNT OF DISTURBANCE
H3	17	Bridge	Basin	DM	High
H3	31	Bridge	Basin	DM	High
H3	56	Channel	Desert Wash	CBS/DWS	High
2618	57	Channel	Desert Wash	CBS/DWS	High
B1	4	Dike	Alluvial Fan	CBS	Low
B1	5	Dike	Alluvial Fan	CBS	Low
B2	35	Box Culvert	Desert Wash	DWS	Low-Moderate
B3	39	Channel	Desert Wash	CBS	Low
B4	36	Channel	Desert Wash	DWS	Low-Moderate
B4	41	Channel	Desert Wash	DWS	Low
B4	44	Channel	Desert Wash	CBS/DWS	Low
4108	23	Channel	Desert Wash	CBS	Low-Moderate
4108	24	Channel	Desert Wash	CBS	Low-Moderate
4108	26	Floodway	Desert Wash	CBS	Low
4108	45	Bridge	Desert Wash	CBS	Low
4109	28	Floodway	Lower Alluvial Fan	CBS	High
4110	30	Floodway	Desert Wash	CBS	High
4110	40	Culvert	Desert Wash	DWS	Low
4110	43	Culvert	Desert Wash	CBS/DWS	Low
4114	31	Debris Basin	Alluvial Fan	CBS	Moderate

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1 Vegetation types: BBS = burro-bush scrub; CBS = creosote bush scrub; DM = desert marsh; DWS = desert wash scrub; RUD = ruderal.

TABLE 8-7

TRIANGULAR STRIP TRANSECT SURVEYS CONDUCTED

TRANSECT NO.	USGS 7.5' QUAD	TOWNSHIP	RANGE	SECTION	SURVEY NO.	DATES[1]	WEATHER CONDITIONS	MAXIMUM TEMPERATURE (°F)	VEGETATION TYPE[2]	RELATIVE AMOUNT OF DISTURBANCE
4	Blue Diamond SE	22S	60E	4	A	Oct 13	Overcast	85	CBS	low-moderate
					B	Oct 13	Overcast	85		
					C	Oct 17	Clear	85		
					D	Oct 17	Clear	85		
					E	Oct 18	Clear	73		
					F	Oct 19	Clear	79		
20	Tule Springs Park	19S	60E	20	A	Oct 12	Overcast	88	CBS	moderate
					B	Oct 12	Overcast	88		
					C	Oct 12	Overcast	78		
					D	Oct 13	Overcast	84		
					E	Oct 13	Overcast	88		
					F	Oct 13	Overcast	84		
18	Blue Diamond SE	21S	60E	18	A	Oct 12	Clear	77	CBS	moderate
					B	Oct 12	Clear	83		
					C	Oct 12	Partly Cloudy	83		
21	Las Vegas SE	22S	62E	21	A	Oct 11	Clear	81	CBS	high
					B	Oct 11	Clear	83		
					C	Oct 11	Clear	91		
25N	Valley	19S	61E	25	A	Oct 13	Overcast	76	CBS/BBS	moderate-high
					B	Oct 13	Overcast	80		
					C	Oct 13	Overcast	86		
25S	Blue Diamond NE	20S	59E	25	A	Oct 12	Overcast	91	CBS	low
					B	Oct 12	Overcast	91		
					C	Oct 12	Overcast	88		
26	Las Vegas SW	22S	61E	26	A	Oct 19	Partly cloudy	85	CBS	low-moderate
					B	Oct 19	Partly cloudy	83		
					C	Oct 19	Overcast	81		

[1] All triangular strip transect surveys conducted between 13 and 19 October 1989.
[2] Vegetation type: CBS = creosote bush scrub; BBS = burro-bush scrub.

TABLE 8-8

TORTOISE SIGN OBSERVED AT PROPOSED FACILITY SITES

FACILITY	ID NO.	ACRES TO BE DISTURBED			Tortoises	TORTOISE BURROWS Currently Or Recently Active	TORTOISE BURROWS Other Potentially Useable	Scat	Other Sign	Total Sign	Corrected Sign	Corrected Sign/Acre	Relative Total Density
DETENTION AND DEBRIS BASINS													
		Total	Perm.	Temp.									
N3	8	220.0	200.0	20.0	1	20	53	10	7	91	78	0.35	Low
N4	8	60.0	55.0	5.0	-	0	1	-	1	2	2	0.03	Very Low
N5	3	110.0	100.0	10.0	2	12	9	6	4	33	29	0.26	Low
N10	11	115.5	105.0	10.5	1	3	8	-	-	12	11	0.10	Low
*N12	9	170.5	155.0	15.5	-	-	-	-	-	0	0	0.00	Very Low
*C3	55	242.0	220.0	22.0	-	-	-	-	-	0	0	0.00	Very Low
S1	59	77.0	70.0	7.0	4	32	60	49	4	149	118	1.53	Very High
S4	24	137.5	125.0	12.5	3	30	7	18	5	95	82	0.60	Moderate
S11	3	143.0	130.0	13.0	4	60	89	70	18	241	215	1.50	Very High
*S17	4	71.5	65.0	6.5	-	-	-	-	-	0	0	0.00	Very Low
*S18	14	33.0	30.0	3.0	-	-	-	-	-	0	0	0.00	Very Low
S19	24	38.5	35.0	3.5	-	-	-	-	-	0	0	0.00	Very Low
S20	18	22.0	20.0	2.0	-	8	15	3	1	27	24	1.09	High
S21	29	82.5	75.0	7.5	9	39	80	18	7	153	125	1.33	High
*S26	67	11.0	10.0	1.0	-	-	-	-	-	0	0	0.00	Very Low
S29	38	60.5	55.0	5.5	-	5	16	-	3	24	21	0.35	Low
H1	14	82.5	75.0	7.5	-	1	-	4	-	4	3	0.04	Low
4114	31	11.0	10.0	1.0	-	-	-	-	-	0	0	0.00	Very Low
CHANNELS													
*N1	4	1.6	0.8	0.8	-	-	-	-	-	0	0	0.00	Very Low
N5	4	6.6	3.3	3.3	-	5	2	3	2	12	10	1.52	Very High
N5	5	4.6	2.3	2.3	-	7	1	4	1	13	11	2.39	Very High
N5	7	10.0	5.0	5.0	-	2	-	-	2	4	4	0.40	Low
N12	11	0.8	0.4	0.4	-	-	1	-	-	1	1	1.25	High
**C2	47	6.8	3.4	3.4	-	1	4	-	-	5	5	0.74	Moderate
C2	49	1.8	0.9	0.9	-	4	-	-	-	4	4	2.22	Very High
C2	51	1.8	0.9	0.9	-	-	-	-	-	0	0	0.00	Very Low
C2	53	4.6	2.3	2.3	1	4	-	-	-	5	4	0.87	Moderate
S2	61	4.6	2.3	2.3	-	-	-	-	-	0	0	0.00	Very Low
*S10	60	2.8	1.4	1.4	-	-	-	-	-	0	0	0.00	Very Low
S29	39	5.8	2.9	2.9	-	-	-	-	-	0	0	0.00	Very Low
S30	45	3.4	1.7	1.7	-	-	-	-	-	0	0	0.00	Very Low
H1	10	1.8	0.9	0.9	-	-	-	-	-	0	0	0.00	Very Low
*H1	11	0.8	0.4	0.4	-	-	-	-	-	0	0	0.00	Very Low
*H1	13	0.8	0.4	0.4	-	-	-	-	-	0	0	0.00	Very Low
*H3	13	13.6	6.8	6.8	-	-	-	-	-	0	0	0.00	Very Low
H3	56	10.4	5.2	5.2	-	-	-	-	-	0	0	0.00	Very Low
*2618	57	2.6	1.3	1.3	-	-	-	-	-	0	0	0.00	Very Low
B3	39	1.2	0.6	0.6	-	-	-	-	-	0	0	0.00	Very Low

TABLE 8-8 (continued)

FACILITY	ID NO.	ACRES TO BE DISTURBED			Tortoises	TORTOISE BURROWS Currently Or Recently Active	Other Potentially Useable	Scat	Other Sign	Total Sign	Corrected Sign	Corrected Sign/Acre	Relative Total Density
CHANNELS (Cont'd)		Total	Perm.	Temp.									
B4	36	2.2	1.1	1.1	-	-	-	-	-	0	0	0.00	Very Low
B4	41	6.8	3.4	3.4	-	-	-	-	-	0	0	0.00	Very Low
B4	44	14.6	7.3	7.3	-	-	-	-	-	0	0	0.00	Very Low
4108	23	1.0	0.5	0.5	-	-	-	-	-	0	0	0.00	Very Low
4108	24	10.4	5.2	5.2	-	-	-	-	-	0	0	0.00	Very Low
DIKES													
N5	1	5.8	2.9	2.9	-	1	-	-	-	1	1	0.17	Low
N5	2	30.0	15.0	15.0	-	2	14	6	1	23	21	0.70	Moderate
N10	9	29.0	14.5	14.5	-	1	8	3	2	14	13	0.45	Moderate
N10	10	27.0	13.5	13.5	-	3	5	1	2	11	10	0.37	Low
N12	10	5.0	2.5	2.5	-	-	-	-	-	0	0	0.00	Very Low
S4	23	29.8	14.9	14.9	-	1	-	2	2	8	7	0.23	Low
S11	2	6.6	3.3	3.3	-	-	-	-	-	0	0	0.00	Very Low
S20	17	16.6	8.3	8.3	-	1	9	2	-	12	12	0.72	Moderate
S21	28	11.6	5.8	5.8	-	-	4	4	1	10	10	0.86	High
*S26	66	6.6	3.3	3.3	-	-	-	-	-	0	0	0.00	Very Low
*S26	85	6.6	3.3	3.3	-	-	-	-	-	0	0	0.00	Very Low
S29	37	6.6	3.3	3.3	-	-	-	-	-	0	0	0.00	Very Low
B1	4	2.2	1.1	1.1	-	1	-	-	-	1	1	0.45	Moderate
B1	5	2.0	1.0	1.0	-	-	-	-	-	0	0	0.00	Very Low
FLOODWAYS													
N3	1	87.2	43.6	43.6	-	3	3	1	1	8	7	0.08	Low
S22	25	40.2	20.1	20.1	1	10	9	15	1	36	27	0.67	Moderate
4108	26	11.4	5.7	5.7	-	2	2	-	-	4	4	0.34	Low
4109	28	19.6	17.8	1.8	3	4	11	1	1	20	17	0.87	Moderate
4110	30	18.4	9.2	9.2	-	-	-	-	-	0	0	0.00	Very Low
OTHER STRUCTURES													
N1	2	1.2	0.6	0.6	-	-	-	-	-	0	0	0.00	Very Low
N1	3	3.2	1.6	1.6	-	-	-	-	-	0	0	0.00	Very Low
N1	4	1.6	0.8	0.8	-	-	-	-	-	0	0	0.00	Very Low
*N4	23	<0.2	<0.1	<0.1	-	-	-	-	-	0	0	0.00	Very Low
*N5	6	<0.2	<0.1	<0.1	-	-	-	-	-	0	0	0.00	Very Low
*N7	4	<0.2	<0.1	<0.1	-	-	-	-	-	0	0	0.00	Very Low
*N10	13	<0.2	<0.1	<0.1	-	-	-	-	-	0	0	0.00	Very Low
*C2	46	<0.2	<0.1	0.1	-	-	-	-	-	0	0	0.00	Very Low
*C2	48	<0.3	<0.1	0.2	-	-	-	-	-	0	0	0.00	Very Low

TABLE 8-8 (concluded)

FACILITY	ID NO.	ACRES TO BE DISTURBED			Tortoises	TORTOISE BURROWS: Currently Or Recently Active	TORTOISE BURROWS: Other Potentially Useable	Scat	Other Sign	Total Sign	Corrected Sign	Corrected Sign/Acre	Relative Total Density
OTHER STRUCTURES (Cont'd)		Total	Perm.	Temp.									
C2	52	0.3	0.1	0.2	-	-	-	-	-	0	0	0.00	Very Low
S6	48	3.4	1.1	2.3	-	-	-	-	-	0	0	0.00	Very Low
*H1	12	<0.2	<0.1	<0.1	-	-	-	-	-	0	0	0.00	Very Low
*H3	12	0.4	<0.1	0.3	-	-	-	-	-	0	0	0.00	Very Low
*H3	14	<0.2	<0.1	<0.1	-	-	-	-	-	0	0	0.00	Very Low
*H3	17	<0.3	<0.1	0.2	-	-	-	-	-	0	0	0.00	Very Low
H3	31	2.0	0.7	1.3	-	-	-	-	-	0	0	0.00	Very Low
*B2	35	<0.3	<0.1	0.2	-	-	-	-	-	0	0	0.00	Very Low
*4108	45	0.3	0.1	0.2	-	-	-	-	-	0	0	0.00	Very Low
*4110	40	<0.1	<0.1	<0.1	-	-	-	-	-	0	0	0.00	Very Low
*4110	43	<0.2	<0.1	<0.1	-	-	-	-	-	0	0	0.00	Very Low

[1] Assumes the establishment of a 50-foot-wide pilot channel (permanent disturbance) and an additional 50 feet of temporary disturbance.
* Proposed facility site does not contain suitable tortoise habitat.
** Proposed facility site resurveyed by ERC following relocation of a portion of this facility.

TABLE 8-9

RESULTS OF INTENSIVE VALIDATION SURVEYS AT PROPOSED DETENTION/DEBRIS BASIN SITES[1]

FACILITY NO.	VEGETATION TYPE/ EXISTING DISTURBANCE[2]	KNOWN OR POTENTIALLY ACTIVE BURROWS OBSERVED IN VALIDATION PLOT: DURING INITIAL WALK-OVER SURVEY	KNOWN OR POTENTIALLY ACTIVE BURROWS OBSERVED IN VALIDATION PLOT: DURING VALIDATION SURVEY[3]	PERCENT LOCATED DURING INITIAL SURVEY	ADDITIONAL PERCENT LOCATED DURING VALIDATION SURVEY
N3-8	CBS/low	7	8	88	12
N4-8	CBS/high	1	1	100	0
N5-3	CBS/low	10	18	56	44
N10-11	CBS/low	4	4	100	0
N12-9	CBS;BBS/moderate-high	0	0	-	0
C3-55 North	CBS/high	0	0	-	0
C3-55 South	CBS/high	0	0	-	0
S1-59	CBS/low-moderate	17	20	85	15
S4-24	CBS/low	6	7	85	15
S11-3	CBS/low	15	17	88	12
S17-4	BBS/high	0	0	-	0
S18-14	CBS/high	0	0	-	0
S19-24	CBS/low-moderate	0	0	-	0
S20-18	CBS/low-moderate	6	7	85	15
S21-29	CBS/low	12	17	70	30
S26-67	CBS;DWS/high	0	0	-	0
S29-38	CBS/low	5	5	100	0
H1-14	CBS/high	0	0	-	0
4114-31	CBS/moderate	0	0	-	0
Average of facility site results4				86	8

1 Locations of facilities shown on Figures 2-1 through 2-16.
2 Surveys conducted between 22 September and 28 October 1989.
3 Vegetation types: BBS = burro-bush scrub; CBS = creosote bush scrub;
Includes those burrows found during initial walk-over survey.
4 This figure represents the mean of all values calculated individually for facilities.

157.2/16-T8-9

TABLE 8-10

RESULTS OF TRIANGULAR STRIP-TRANSECT SURVEYS

TRANSECT	TORTOISE BURROWS: INACTIVE/ UNUSABLE	TORTOISE BURROWS: KNOWN OR POTENTIALLY ACTIVE	TORTOISES	SCAT	CARCASSES	TRACKS	EGGS/EGGSHELL FRAGMENTS	CORRECTED SIGN	DENSITY ESTIMATES: REGRESSION ANALYSIS	DENSITY ESTIMATES: DENSITY RANGE NV	DENSITY ESTIMATES: DENSITY RANGE CA	MEAN CORRECTED SIGN	STANDARD ERROR OF MEAN
SECTION 4													
A	-	1	-	2	-	-	-	3	-8 to 15	10-45	20-50		
B	1	3	1	-	-	-	-	5	26 to 81	45-90	50-100		
C	1	4	1	1	1	-	-	6	26 to 81	45-90	50-100		
D	1	2	-	-	-	1	1	3	-8 to 15	10-45	20-50		
E	-	-	-	-	-	-	-	0	0	0-10	0-20		
F	-	1	-	-	-	-	-	1	-8 to 15	10-45	20-50		
												3.0	0.9
SECTION 20													
A	-	4	-	-	-	-	-	4	26 to 81	10-45	50-100		
B	1	2	2	1	1	1	-	5	26 to 81	10-45	50-100		
C	2	5	-	3	-	-	-	8	26 to 81	90-140	50-100		
D	-	1	-	1	-	-	-	1	-8 to 15	10-45	20-50		
E	4	4	-	4	-	1	-	10	81 to 148	90-140	100-250		
F	-	6	2	1	-	-	-	7	26 to 81	45-90	50-100		
												5.8	1.3
SECTION 18													
A	2	3	-	-	-	-	-	5	26 to 81	45-90	50-100		
B	2	1	-	-	-	1	-	3	-8 to 15	10-45	20-50		
C	-	1	-	3	-	-	-	2	-8 to 15	10-45	20-50		
												3.3	0.9
SECTION 21													
A	-	-	-	-	-	-	-	0	0	0-10	0-20		
B	-	1	-	1	-	-	-	2	-8 to 15	10-45	20-50		
C	-	-	-	-	-	-	-	0	0	0-10	0-20		
												0.7	0.7
SECTION 25N													
A	-	-	-	-	-	-	-	0	0	0-10	0-20		
B	1	-	-	-	-	-	-	1	-8 to 15	10-45	20-50		
C	-	-	-	-	1	-	-	1	-8 to 15	10-45	20-50		
												0.7	0.3
SECTION 25S													
A	-	1	-	-	-	-	-	1	-8 to 15	10-45	20-50		
B	-	1	-	-	-	-	-	1	-8 to 15	10-45	20-50		
C	-	-	-	2	-	-	-	2	-8 to 15	10-45	20-50		
												1.3	0.3

TABLE 8-11

POTENTIAL IMPACTS TO DESERT TORTOISE, NORTHERN LAS VEGAS VALLEY SUBAREA, BY FACILITY

Facility	ID No.	Total Acres of Desert Tortoise Habitat Potentially Disturbed1 Very Low	Low	Moderate	High	Very High	Estimated Maximum Number of Tortoises Potentially Impacted[2]
DETENTION BASINS							
N3	8		220.0 (20.0)				17
N4	8	60.0 (5.0)					2
N5	3		110.0 (10.0)				3
N10	11		115.5 (10.5)				8
*N12	9	170.5 (15.5)					--
Subtotal by Facility Type (excluding apparently unsuitable habitat)		60.0 (5.0)	445.5 (40.5)				
CHANNELS							
*N1	4	1.6 (0.8)					--
N5	4					6.6 (3.3)	1
N5	5					4.6 (2.3)	1
N5	7		10.0 (5.0)				1
N12	11				0.8 (0.4)		<1
Subtotal by Facility Type (excluding apparently unsuitable habitat)			10.0 (5.0)		0.8 (0.4)	11.2 (5.6)	3
DIKES							
N5	1		5.8 (2.9)				<1
N5	2			30.0 (15.0)			4
N10	9			29.0 (14.5)			4
N10	10		27.0 (13.5)				2
N12	10	5.0 (2.5)					<1
Subtotal by Facility Type		5.0 (2.5)	32.8 (16.4)	59.0 (29.5)			10

TABLE 8-11 (concluded)

Facility	ID No.	Total Acres of Desert Tortoise Habitat Potentially Disturbed1 Very Low	Low	Moderate	High	Very High	Estimated Maximum Number of Tortoises Potentially Impacted2
FLOODWAYS							
N3	1		87.2 (43.6)				6
Subtotal by Facility Type			87.2 (43.6)				6
OTHER STRUCTURES							
N1	2	1.2 (0.6)					<1
N1	3	3.2 (1.6)					<1
N1	4	1.6 (0.8)					<1
*N4	23	<0.2 (<0.1)					--
*N5	6	<0.2 (<0.1)					--
*N7	4	<0.2 (<0.1)					--
*N10	13	<0.2 (<0.1)					--
Subtotal by Facility Type (excluding apparently unsuitable habitat)		6.0 (3.0)	--	--	--	--	<1
Total for Subarea (all facility types)		71.0 (10.5)	575.5 (105.5)	59.0 (29.5)	0.8 (0.4)	11.2 (5.6)	49

1 By estimated tortoise population densities, based on results of walk-over surveys. Acres of temporary disturbance in parenthesis.
2 Based on the upper end of estimated density ranges derived from survey results.
* Proposed facility site does not appear to contain suitable tortoise habitat.

TABLE 8-12

POTENTIAL IMPACTS TO DESERT TORTOISE, CENTRAL LAS VEGAS VALLEY SUBAREA, BY FACILITY

Facility	ID No.	Total Acres of Desert Tortoise Habitat Potentially Disturbed[1]					Estimated Maximum Number of Tortoises Potentially Impacted[2]
		Very Low	Low	Moderate	High	Very High	
DETENTION BASINS							
*C3	55	242.0 (22.0)					--
Subtotal by Facility Type (excluding apparently unsuitable habitat)		--					
CHANNELS							
C2	47			6.8 (3.4)			1
C2	49					1.8 (0.9)	<1
C2	51	1.8 (0.9)					<1
C2	53			4.6 (2.3)			1
Subtotal by Facility Type (excluding apparently unsuitable habitat)		1.8 (0.9)		11.4 (5.7)		1.8 (0.9)	2
DIKES							
None							
FLOODWAYS							
None							
OTHER STRUCTURES							
*C2	46	<0.2 (0.1)					
*C2	48	<0.3 (0.2)					
C2	52	0.3 (0.2)					<1
Subtotal by Facility Type (excluding apparently unsuitable habitat)		0.3 (0.2)					<1
Total for Subarea (all facility types)		2.1 (1.1)		11.4 (5.7)		1.8 (0.9)	2

1 By estimated tortoise population densities, based on results of walk-over surveys. Acres of temporary disturbance in parenthesis.

2 Based on the upper end of estimated density ranges derived from survey results.

* Proposed facility site does not appear to contain suitable habitat.

TABLE 8-13

POTENTIAL IMPACTS TO DESERT TORTOISE, SOUTHWESTERN LAS VEGAS VALLEY SUBAREA, BY FACILITY

Facility	ID No.	Total Acres of Desert Tortoise Habitat Potentially Disturbed[1]					Estimated Maximum Number of Tortoises Potentially Impacted[2]
		Very Low	Low	Moderate	High	Very High	
DETENTION BASINS							
S1	59					77.0 (7.0)	18
S4	24			137.5 (12.5)			20
S11	3					143.0 (13.0)	32
*S17	4	71.5 (6.5)					--
*S18	14	33.0 (3.0)					--
S19	24	38.5 (3.5)					1
S20	18				22.0 (2.0)		5
S21	29				82.5 (7.5)		18
*S26	67	11.0 (1.0)					--
S29	38		60.5 (5.5)				4
Subtotal by Facility Type (excluding apparently unsuitable habitat)		38.5 (3.5)	60.5 (5.5)	137.5 (12.5)	104.5 (9.5)	220.0 (20.0)	98
CHANNELS							
S2	61	4.6 (2.3)					<1
*S10	60	2.8 (1.4)					--
S29	39	5.8 (2.9)					<1
S30	45	3.4 (1.7)					<1
Subtotal by Facility Type (excluding apparently unsuitable habitat)		13.8 (6.9)					<1

TABLE 8-13 (concluded)

Facility	ID No.	Total Acres of Desert Tortoise Habitat Potentially Disturbed1 Very Low	Low	Moderate	High	Very High	Estimated Maximum Number of Tortoises Potentially Impacted[2]
DIKES							
S4	23		29.8 (14.9)				2
S11	2	6.6 (3.3)					<1
S20	17			16.6 (8.3)			2
S21	28				11.6 (5.8)		3
*S26	66	6.6 (3.3)					--
*S26	85	6.6 (3.3)					--
S29	37	6.6 (3.3)					<1
Subtotal by Facility Type (excluding apparently unsuitable habitat)		13.2 (6.6)	29.8 (14.9)	16.6 (8.3)	11.6 (5.8)		7
FLOODWAYS							
S22	25			40.2 (20.1)			6
Subtotal by Facility Type (excluding apparently unsuitable habitat)				40.2 (20.1)			6
OTHER STRUCTURES							
S6	48	3.4 (2.3)					<1
Subtotal by Facility Type (excluding apparently unsuitable habitat)		3.4 (2.3)					<1
Total for Subarea (all facility types)		68.9 (19.3)	90.3 (20.4)	194.3 (40.9)	116.1 (15.3)	220.0 (20.0)	111

1 By estimated tortoise population densities, based on results of walk-over surveys. Acres of temporary disturbance in parenthesis.
2 Based on the upper end of estimated density ranges derived from survey results.
* Proposed facility site does not appear to contain suitable tortoise habitat.

TABLE 8-14

POTENTIAL IMPACTS TO DESERT TORTOISE, BOULDER CITY SUBAREA, BY FACILITY

Facility	ID No.	Total Acres of Desert Tortoise Habitat Potentially Disturbed[1]					Estimated Maximum Number of Tortoises Potentially Impacted[2]
		Very Low	Low	Moderate	High	Very High	
DEBRIS BASIN							
4114	31	11.0 (1.0)					<1
Subtotal by Facility Type (excluding apparently unsuitable habitat)		11.0 (1.0)					<1
CHANNELS							
B3	39	1.2 (0.6)					<1
B4	36	2.2 (1.1)					<1
B4	41	6.8 (3.4)					<1
B4	44	14.6 (7.3)					<1
4108	23	1.0 (0.5)					<1
4108	24	10.4 (5.2)					<1
Subtotal by Facility Type (excluding apparently unsuitable habitat)		36.2 (18.1)					1
DIKES							
B1	4		2.2 (1.1)				<1
B1	5	2.0 (1.0)					<1
Subtotal by Facility Type (excluding apparently unsuitable habitat)		2.0 (1.0)	2.2 (1.1)				<1

TABLE 8-14 (concluded)

Facility	ID No.	Total Acres of Desert Tortoise Habitat Potentially Disturbed1					Estimated Maximum Number of Tortoises Potentially Impacted[2]
		Very Low	Low	Moderate	High	Very High	
FLOODWAYS							
4108	26		11.4 (5.7)				1
4109	28			19.6 (1.8)			3
4110	30	18.4 (9.2)					<1
Subtotal by Facility Type (excluding apparently unsuitable habitat)		18.4 (9.2)	11.4 (5.7)	19.6 (1.8)			4
OTHER STRUCTURES							
*B2	35	<0.3 (0.2)					--
*4108	45	0.3 (0.2)					--
*4110	40	<0.1 (<0.1)					--
*4110	43	<0.2 (<0.1)					--
Subtotal by Facility Type (excluding apparently unsuitable habitat)		--					--
Total for Subarea (all facility types)		67.6 (29.3)	11.4 (5.7)	21.8 (2.9)			5

1 By estimated tortoise population densities, based on results of walk-over surveys. Acres of temporary disturbance in parenthesis.
2 Based on the upper end of estimated density ranges derived from survey results.
* Proposed facility site does not appear to contain suitable tortoise habitat.

TABLE 8-15

POTENTIAL IMPACTS TO DESERT TORTOISE, HENDERSON SUBAREA, BY FACILITY

Facility	ID No.	Total Acres of Desert Tortoise Habitat Potentially Disturbed1					Estimated Maximum Number of Tortoises Potentially Impacted[2]
		Very Low	Low	Moderate	High	Very High	
DETENTION BASIN							
H1	14	82.5 (7.5)					6
Subtotal by Facility Type (excluding apparently unsuitable habitat)		82.5 (7.5)					6
CHANNELS							
H1	10	1.8 (0.9)					<1
*H1	11	0.8 (0.4)					--
*H1	13	0.8 (0.4)					--
*H3	13	13.6 (6.8)					--
H3	56	10.4 (5.2)					<1
*2618	57	2.6 (1.3)					--
Subtotal by Facility Type (excluding apparently unsuitable habitat)		12.2 (6.1)					<1
DIKES							
None							
FLOODWAYS							
None							

TABLE 8-15 (concluded)

Facility	ID No.	Total Acres of Desert Tortoise Habitat Potentially Disturbed[1] Very Low	Low	Moderate	High	Very High	Estimated Maximum Number of Tortoises Potentially Impacted[2]
OTHER STRUCTURES							
*H1	12	<0.2 (<0.1)					--
*H3	12	0.4 (0.3)					--
*H3	14	<0.2 (<0.1)					--
*H3	17	<0.3 (0.2)					--
H3	31	2.0 (1.3)					<1
Subtotal by Facility Type (excluding apparently unsuitable habitat)		2.0 (1.3)					<1
Total for Subarea (all facility types)		14.2 (7.4)	82.5 (7.5)				6

1 By estimated tortoise population densities, based on results of walk-over surveys. Acres of temporary disturbance in parenthesis.
2 Based on the upper end of estimated density ranges derived from survey results.
* Proposed facility site does not appear to contain suitable tortoise habitat.

TABLE 8-16

POTENTIAL IMPACTS TO DESERT TORTOISE IN THE STUDY AREA, BY FACILITY

Facility Type	Total Areas of Desert Tortoise Habitat Potentially Disturbed[1]					Total Acres Potentially Disturbed	Estimated Maximum Number of Tortoises Potentially Impacted[2]
	Very Low	Low	Moderate	High	Very High		
Debris and Detention Basins	109.5	588.5	137.5	104.5	220.0	1160.0	134
Channels	64.0	10.0	11.4	0.8	13.0	99.2	6
Dikes	20.2	62.6	77.8	11.6	0.0	172.2	17
Floodways	18.4	98.6	59.8	0.0	0.0	176.8	16
Other Structures	11.8	0.0	0.0	0.0	0.0	11.8	0

1 By estimated tortoise population densities, based on results of walk-over surveys.
2 Based on upper end of estimated density ranges derived from survey results.

TABLE 8-17

PROPOSED FACILITY SITES THAT COULD POTENTIALLY CAUSE FRAGMENTATION OF TORTOISE HABITAT

Facility Number	Length (feet)	Estimated Density (tortoises/acre)	Relative Total Density
N5-1	3,000	0.03	Low
N5-2	15,600	0.10	Moderate
N5-4	9,600	0.22	Very High
N5-5	5,000	0.34	Very High
N5-7	11,000	0.07	Moderate
N10-9	15,000	0.07	Moderate
N10-10	14,000	0.06	Low
C2-47	7,300	0.11	Moderate
N1-2	3,200	0.03	Very Low
N1-3	8,800	0.02	Very Low
N1-4	7,200	0.02	Very Low
S2-61	3,400	0.02	Very Low
S4-23	9,000	0.04	Low
S20-17	6,000	0.11	Moderate
S21-28	3,500	0.13	High
S29-39	4,200	0.06	Very Low
H3-56	9,000	0.02	Very Low
4108-24	9,000	0.02	Very Low
B3-39	2,800	0.02	Very Low

[1] Includes linear facilities greater than 0.5 mile in length in suitable tortoise habitat.

TABLE 8-18

PROPOSED DIKES THAT WILL DIVERT RUNOFF FROM DOWN-GRADIENT HABITAT

Facility Number	Estimated Density of Tortoises at Facility Site (tortoises/acre)	Relative Total Density
N5-1	0.03	Low
N5-2	0.10	Moderate
N10-9	0.07	Moderate
N10-10	0.06	Low
N12-10	0.02	Very Low
S4-23	0.04	Low
S11-2	0.02	Very Low
S20-17	0.11	Moderate
S21-28	0.13	High
S29-37	0.06	Moderate
B1-4	0.07	Moderate
B1-5	0.02	Very Low

TABLE 8-19

SUMMARY OF POTENTIAL IMPACTS BY SUBAREA FOR THE DETENTION/CONVEYANCE ALTERNATIVE

POTENTIAL IMPACTS	NORTHERN LAS VEGAS VALLEY Resource Affected	NORTHERN LAS VEGAS VALLEY Mitigation Measures	CENTRAL LAS VEGAS VALLEY Resource Affected	CENTRAL LAS VEGAS VALLEY Mitigation Measures	SOUTHWESTERN LAS VEGAS VALLEY Resource Affected	SOUTHWESTERN LAS VEGAS VALLEY Mitigation Measures	BOULDER CITY Resource Affected	BOULDER CITY Mitigation Measures	HENDERSON Resource Affected	HENDERSON Mitigation Measures
BOTANICAL RESOURCES										
Disturb or remove state-listed species	1,2,4, 5,6,7	A	1,4,5,6	A	1,4,6,7	A	--	--	1	A
Disturb or remove Federal candidate/BLM sensitive species	8,10,11, 14	B	8,10,11, 12,14	B	8,9,10, 11,12,13, 14	B	14	B	14	B
Disturb or remove other sensitive plant species (not included above)	15,17,19, 20,21,22, 23,24	C	17,22,25	C	15,16,17, 18,19,22, 25	C	--	--	18	C
Disturb or remove cactuses or yuccas	3	D	3	D	3	D	3	D	3	D
WETLANDS										
Disturbance to wetlands due to channelization	26,27,28, 29	E,F,G	26,27,28, 29	E,F,G	26,27,28, 29	E,F,G	--	G	28,29	E,F,G
Creation of desire-able wetlands vegetation	26,27,28, 29	G	26,27,28, 29	G	26,27,28, 29	G	26,27,28, 29	G	26,27,28, 29	G
Creation of un-desireable vegeta-tion	--	G	--	G	--	G	--	G	--	G
Disturbance to wetlands due to stream diversion	26,27,28, 29	H	26,27,28, 29	H	26,27,28, 29	H	--	--	26,27,28, 29	H

TABLE 8-20

SUMMARY OF PROGRAMMATIC BIOLOGICAL MITIGATION MEASURES

MITIGATION DESIGNATION	RESOURCE OF CONCERN	DESCRIPTION OF MEASURE
A	State-listed Plants (Figures A2-1 through A2-14)	° Conduct seasonal preconstruction survey to determine presence/extent of listed plant species; consult with Nevada Division of Forestry (NDF) if plants found; recommend consultation with USFWS. ° If found, avoid to maximum extent possible. ° If listed plants cannot be avoided: 1) where practical salvage, transplant, and revegetate on or off site; 2) protect existing populations offsite; and/or 3) develop further info on habitat requirements of affected plant species as well as potential methods of reclamation.
B	Federal Candidates/ BLM Sensitive Plants (Figures A2-1, A2-2, A2-9 through A2-11, A2-13)	° Conduct seasonal preconstruction survey to determine presence/extent of sensitive plant species; consult with BLM if plants found; recommend consultation with USFWS. ° Avoid to extent possible. ° If sensitive plants cannot be avoided: 1) where practical salvage, transplant, and revegetate on or off-site; 2) protect existing populations offsite; and/or 3) develop further info on habitat requirements of affected plant species as well as potential methods of reclamation.
C	NNNPS Sensitive Species (not included above) (Figures A2-1 through A2-14)	° Conduct seasonal site survey to determine presence/extent of sensitive plant species. ° Avoid to extent possible. ° If sensitive plants cannot be avoided, minimize disturbance to the extent feasible.
D	Cactuses and Yuccas (Figures A2-1 through A2-14)	° Conduct preconstruction survey to determine presence/extent of cactus and yucca species; consult with NDF if plants found. ° Avoid to extent possible. ° If individual plants cannot be avoided: 1) obtain permit from NDF to take; 2) purchase tags ($1/tag) and place one on each plant to be removed; 3) transplant individual plants to similar, but undisturbed habitat; or 4) disseminate plants to research organizations or nurseries as directed by NDF.
E	"Wetlands" directly removed or disturbed (Figures A2-5, A2-8 through A2-11)	° Avoid disturbance to wetland vegetation to the extent feasible. ° If disturbance is unavoidable, then implement some or all of the following in order to reduce level of impact to wetlands: 1) obtain 404 permit from Army Corps of Engineers if required; 2) minimize the area of disturbance; 3) replace affected vegetation in kind onsite if possible; 4) construct channels with natural materials or gabbions or crib walls and revegetate in kind on banks and channel bed; 5) leave streambed vegetation intact; 6) restrict construction zone to the extent possible; 7) utilize floodways rather than flood channels in areas with well-developed wetlands such as the lower Las Vegas Wash, as well as portions of Flamingo Wash, Tropicana Wash, and Duck Creek; in floodways, restrict disturbance to necessary pilot channels.

TABLE 8-20(continued)

MITIGATION DESIGNATION	RESOURCE OF CONCERN	DESCRIPTION OF MEASURE
F	"Transitional wetlands" directly removed or destroyed (Figures A2-1 through A2-14)	° Avoid disturbance to transitional wetlands vegetation to the extent feasible. ° If disturbance is unavoidable, then implement some of the following as feasible: 1) evaluate site for 404 permit jurisdiction (if applicable, obtain 404 permit); 2) minimize area of disturbance; 3) replace affected vegetation in kind onsite if possible; 4) construct facility with natural material if possible, or minimize amount of man-made material; 5) leave streambed vegetation intact; 6) restrict construction zone to the extent possible.
G	Undesirable vegetation (Figures A2-1 through A2-14)	° Implement monitoring program to assess the level of intrusion of undesirable plant species (such as Bassia, Salsola, Tamarix) into facility sites. ° If undesirable vegetation is becoming established, implement eradication program. Revegetation with desirable native species may discourage weedy invasions.
H	Wetlands potentially disturbed due to diversion of water (Figures A2-1 through A2-14)	° Redesign facility structures to maintain some level of downstream surface/subsurface flow to highly sensitive wetlands, if feasible. ° Implement monitoring program in areas potentially affected to assess level of impact; if vegetation is adversely affected, take corrective or compensatory action.
I	Federal-listed Wildlife (Figure A2-9)	° Conduct seasonal preconstruction survey within suitable habitat to determine the extent of occurrence; consult with USFWS and BLM. ° Avoid suitable habitats for these species to the maximum extent possible. ° If suitable habitats are unavoidable: 1) restrict construction to seasons of the year in which these species are least likely to be encountered; 2) minimize disturbance to the extent possible; 3) construction activities should be monitored if conducted in suitable habitat during seasonal occurrence of federal-listed species; 4) revegetate suitable habitats disturbed by construction; 5) provide for protection of wetlands habitats offsite as compensation for onsite habitat loss. See Table 8-21 for mitigation measures for desert tortoise.

MITIGATION DESIGNATION	RESOURCE OF CONCERN	DESCRIPTION OF MEASURE
J	State-listed and BLM Sensitive Wildlife (Figures A2-1 through A2-14)	° Conduct seasonal preconstruction survey within suitable habitat to determine extent of occurrence; consult with BLM and Nevada Department of Wildlife. ° Avoid suitable habitats for these species to the maximum extent possible. ° If suitable habitats are unavoidable: 1) restrict construction to seasons of the year in which these species are least likely to be encountered (low activity level seasons); 2) minimize disturbance to the extent possible; 3) conduct onsite surveys immediately prior to the extent possible; 4) revegetate wetlands habitats disturbed by construction. ° See Table 8-21 for mitigation measures for desert tortoise.
K	Federal Candidate and State Protected Wildlife (Figures A2-3, A2-5, A2-6, A2-9, A2-13)	° Conduct seasonal survey within suitable habitats to determine the extent of occurrence; consult with BLM and NDW; recommend consultation with USFWS. ° Avoid suitable habitats for these species to the maximum extent possible. ° If suitable habitats are unavoidable: 1) avoid construction in sensitive areas (vicinity of Las Vegas Wash and known prairie falcon nesting places) during periods of high activity for these species; 2) minimize disturbance to the extent possible; 3) if construction occurs during seasons of high activity, monitor for presence of these species in sensitive areas; 4) trap and relocate any Palmer's chipmunks that could potentially be affected by construction; 5) revegetate suitable habitats disturbed by construction. ° Measures described above in "J" that are appropriate for desert tortoise and gila monster will also be implemented with "K" measures.
L	Game and Furbearer Species and Species Under Consideration for State Listing (Figures A2-1 through A2-14)	° Conduct onsite surveys and consult with NDW personnel to identify important habitat components (such as kit fox dens and bighorn sheep migration corridors, crucial summer range, and lambing habitat) that may be affected. Avoid construction near those habitat components during critical times of the year (kit fox breeding season, bighorn sheep migration season). ° If construction occurs near those components during critical times of the year, monitor for the presence of kit fox and/or bighorn sheep. ° Avoid destruction of kit fox dens. ° If unavoidable, exclude kit fox from dens prior to construction, monitor dens during construction to ensure nonoccupation by kit fox. ° Minimize disturbance throughout suitable habitats.

TABLE 8-20 (concluded)

MITIGATION DESIGNATION	RESOURCE OF CONCERN	DESCRIPTION OF MEASURE
M	Desert Tortoise Cumulative Impact (Figures A2-1 through A2-14)	° Participate in a regional-scale tortoise mitigation program established in coordination with the BLM, USFWS, Nevada Department of of Wildlife, and Clark County Department of Comprehensive Planning.

TABLE 8-21

PROGRAMMATIC MITIGATION MEASURES FOR DESERT TORTOISE

PHASE	DESCRIPTION OF MEASURE
Pre-Construction	o Pre-construction surveys at facility sites within suitable tortoise habitat to be conducted within 90 days of construction. o Remove tortoises from burrows, handle tortoises as directed by agencies.
Construction	o Worker education program. o Minimize size of temporary disturbance areas to the extent feasible. o Where practical, in temporary disturbance areas, crush vegetation, rather than remove completely. o Limit the number of construction access roads. o Vehicles and equipment restricted to access roads and construction staging areas. o Vehicle speed limited to 25 miles per hour on unpaved access roads. o Monitoring for tortoises and potentially active burrows during construction activities. o Tortoises encountered during monitoring to be handled as directed by agencies. o Trash abatement program.
Post-Construction	o Continue to limit size of temporary disturbance areas to the extent feasible. o Vehicle and equipment speed limit to continue at 25 miles per hour. o Continue monitoring where heavy equipment is in use. o Tortoises encountered to be handled as directed by agencies. o Continue trash abatement program. o Habitat compensation in agreement with BLM and USFWS.
Operation and Maintenance	o Continue worker education program. o Restrict vehicles and equipment to designated access routes. o Limit vehicle speed to 25 miles per hour on unpaved access roads that traverse suitable tortoise habitats. o Pre-construction surveys in adjacent tortoise habitat that could potentially be disturbed. o Monitor only when large equipment could potentially disturb adjacent tortoise habitat. o Tortoises encountered to be handled as directed by agencies. o Continue trash abatement program.

FIGURE 8-1

KNOWN DISTRIBUTION OF SENSITIVE PLANTS & WETLANDS

(SEE VOLUME II, OVERSIZE MAPS)

FIGURE 8-2

KNOWN DISTRIBUTION OF SENSITIVE WILDLIFE

(SEE VOLUME II, OVERSIZE MAPS)

The intent of the land use study is to identify impacts on existing and future land use, including parks, recreation and open space, and also to recommend mitigation measures to reduce or eliminate the impacts.

The approach to the programmatic portion of the study includes a general description of land use conditions in each of the five subareas, a discussion of types of impact relative to the proposed flood control facilities according to land use categories, and recommendations for mitigation measures. The comparative effects of the Detention/Conveyance and All Conveyance alternatives are also discussed.

Data for the land use and recreation study were obtained from the Clark County Comprehensive Planning Department, Boulder City, and the cities of Las Vegas, North Las Vegas, and Henderson. Meetings with representatives of each of the jurisdictions were held to elicit background data and other information on potential impacts of proposed facilities. Black-and-white aerial photography at a scale of 1 inch=1200 feet, provided by Landis Aerial Surveys (1988) was used for the existing land use inventory (Figure 9-1). Where available, comprehensive plans for the respective jurisdictions were used to identify future land use. This information was supplemented by zoning classifications according to zoning classifications in "Landis Air Photo, Las Vegas, 1988" (Landis, 1988) and respective city zoning maps (e.g., City of North Las Vegas, 1988).

9.1 OVERALL ENVIRONMENTAL CONDITION

Clark County contains over five million acres of land, located in the southeastern corner of the state. Included is the Las Vegas Valley, surrounded by the Spring and Sheep Mountains and the Las Vegas Range. The desert floor occupies approximately 350,000 acres of land. Incorporated is a growing 60,000 acres of development, including such uses as residential, commercial, industrial, public, military, and parks. This is a relatively small proportion compared to the amount of open vacant land present in the valley. However, the development activity is occurring at a very rapid pace.

The study area encompasses the entire Las Vegas Valley, including Henderson and Boulder City. Recreation and Wilderness Study Areas (WSAs) are the predominant land uses found within undeveloped lands of the study area. Development is concentrated toward the intersection of the two major highway corridors, Interstate-15 (I-15) and US Highway 93/95. The convergence has created a collection of urban development primarily made up of commercial and industrial uses. Public facilities are also present in the downtown area and generally include government agency buildings.

Industrial uses spread south along the I-15 corridor, with the major commercial development located adjacent to the main urban thoroughfares. The hotel/casino establishments are included in these uses and are also found throughout the outlying commercial areas. However, the main concentration of the larger developments are found along the Las Vegas strip and in the downtown urban core.

The urban development sprawls outward from the downtown core and transforms to residential communities with public facilities interspersed. Residential communities occupy over 60 percent of the developed land in the Las Vegas Valley. They range in densities from multi-family apartments to rural desert homesteads. Residential areas represent the dominant land use of the study area, excluding the open vacant land surrounding the city. The highest proportion is 25 percent for public facilities. Among these are the main Clark County airport, various schools, hospitals, and other public uses. Park and recreation facilities are also found throughout the neighborhood communities, generally in close proximity to schools and other public facilities.

The planned land uses continue to be primarily residential communities with mixed uses of commercial, light industrial and hotel/casino resort. The major planned communities are located in the west and southern portions of the valley, with some smaller developments planned north of the downtown area.

9.2 SUMMARY OF SPECIFIC ENVIRONMENTAL CONDITIONS

Table 9-1 represents a summary of the existing conditions of the study area. Each land use is listed and marked according to the amount of area occupied. The symbols also illustrate the comparison of each land use classification to its presence in other subareas. This is to demonstrate the dominant land uses in each subarea and their general location. In addition, the table shows where the highest concentration of each general land use type can be found. The discussion below presents information concerning the overall layout of the existing and planned land uses within each subarea.

9.2.1 Northern Las Vegas Valley

Northern Las Vegas is the largest of the five subareas characterized best by its vast open space expanses of flat desert valley. The primary developed land uses in the subarea are the military facilities at Nellis Air Force Base. The largest proportion of land is currently vacant and open land. Land uses in these open land areas include recreation, wilderness and livestock grazing. Recreational areas include the Las Vegas Dunes Recreation Area, located north of the air force base, the Sunrise Mountain Natural Area, located to the south, and a portion of the Red Rock Canyon National Recreation Lands, located on the eastern slopes of the Spring Mountains. Within the subarea there are four BLM WSAs, including Quail Springs (NV-050-411), La Madre Mountain and the Summa exchange lands (NV-050-412), Nellis ABC (NV-050-4R-15A, 15B, and 15C), and Fish and Wildlife No. 3 (NV-050-217). Five grazing allotments are located within the subarea, including Lucky Strike, Dry Lake, Kyle Canyon, Spring Mountain, and Las Vegas. Only the Lucky Strike allotment is currently grazed and is a M category allotment. The rest have been designated category C or I by BLM.

In addition to the military land uses, development mainly consists of residential areas which form the suburban fringe of northeastern Las Vegas and the City of North Las Vegas. Industrial uses cluster around the edges of the residential areas and along the Union Pacific Railroad, with scattered open parcels among the developed land uses. Public facilities are grouped along the US Highway 93 corridor as it approaches Nellis Air Force Base.

Two major transportation corridors traverse across the Northern Las Vegas Valley. I-15 extends northeast and US Highway 95 stretches toward the northwest. Both are highly traveled and will be connected by the proposed beltway located north of downtown. The proposed beltway is planned to be constructed east to west, between the existing travel routes, and then turning south into the Central Las Vegas Valley (Regional Transportation Commission of Clark County, 1987).

Future land use in the City of North Las Vegas is directed by the "Master Plan, City of North Las Vegas, Nevada" (City of North Las Vegas, 1987) for the area south of the proposed beltway. The plan provides for a balance of residential densities surrounding a mixed-use commercial area northeast of the North Las Vegas Air Terminal. Land along the I- 15 corridor, fanning out at its intersection with the proposed beltway, would be used for 3420 acres of industrial land, according to the plan. Several ongoing or proposed development projects are located within this area; the largest of these is the Pardee, 1080-acre master planned community. Lands north of the proposed beltway, up to the northern city limit at Moccasin Road, are defined as "future growth areas" in the Master Plan; specific uses are not identified in this area.

The Northern Las Vegas Valley subarea also includes a portion of primarily undeveloped land within the City of Las Vegas, located adjacent to the western boundary of North Las Vegas. In the "Community Profiles: A Component of the Short Range Plan Phase of the General Plan" (City of Las Vegas, 1985), this area is identified as rural residential (0-3 du per acre).

Future land use in the unincorporated Clark County lands within the undeveloped remainder of this subarea is controlled through the use of zoning and the zone-change process. According to the "Comprehensive Plan, Clark County, Nevada" (CCDCP, 1987) the majority of zone change approvals between 1974 and 1979 did not conform to the adopted plan. Therefore, until a new general or comprehensive plan is completed and implementation has begun, future land use will be determined largely by individual zone-change processing; a general land use development pattern cannot be foreseen at this time.

9.2.2 Central Las Vegas Valley

Central Las Vegas Valley is the urban core of Las Vegas with the largest percentages of urban downtown development. The east half of the subarea contains the majority of the commercial land uses, comparable to the other subareas. In addition, it also includes a larger proportion of residential communities than any other subarea. Additionally, the subarea includes a portion of BLM LaMadre Mountain WSA and Summa exchange lands (NV-050-412). The Los Vegas Allotment is the only livestock grazing area within the subarea boundaries. The allotment is currently ungrazed and designated category C by BLM.

Dense residential communities surround the industrial and commercial developments and span between the urban highway corridors. The urban housing developments have rapidly spread to create small neighborhood communities. In suburban areas, residential uses are more dispersed and mixed with scattered parks and public uses.

The largest of the public park and recreation facilities is located in the Central Las Vegas Valley. Angel Park is a dual use facility, functioning as both a public park and golf course, and as a flood control facility. The development is currently under construction, nearing completion. This subarea also include a small portion of the Red Rock Canyon National Recreation Lands.

Industrial uses line the I-15 highway corridor, while commercial and public facilities are located adjacent to US Highways 93 and 95. Other commercial uses are found at major road intersections and are interspersed throughout residential portions of the subarea.

The western half of the subarea is dominated by the Summerlin Project, the largest area of master planned communities. This planned development extends into the northwestern section of the Southwestern Las Vegas Valley. The project includes retirement communities, residential developments, commercial retail facilities, public facilities, and light industrial parks. The planned developments include Del Web's Sun City Summerlin, Desert Shores, Peccole Ranch, The Lakes, and Summa Red Rock Development. The overall project site is bisected by the proposed beltway traveling north to south through the subarea. The west boundary of the planned community is shared by the LaMadre Mountain Range WSA.

The City of Las Vegas General Plan guides the future land use for the major part of the Central Las Vegas subarea (City of Las Vegas, 1986). The general plan prescribes land uses in each of sixteen Community Profile Districts for the "Short-Range Plan", which is defined within the period through the year 1990. The Community Profile Districts are further subdivided into Residential Planning Districts (RPDs), which are defined as "basic planning and measuring unit(s) to determine the impact of planning projects and development proposals in conformance to the long-range and mid-range goals adopted by the City Council." For example, the Summerlin (Husite) project area is in Profile District #16, designated as "Suburban" RPD, while the land in Profile District #15 (between Rancho Drive and Decatur Boulevard, south of Ann Road) is designated as "Suburban and Rural" RPD.

As discussed in Section 9.2.1 for the Northern Las Vegas Valley subarea, the identification of future land use in the unincorporated portions of the Central Las Vegas Valley subarea is difficult. Until the new Comprehensive Plan is completed, future land use will depend on case-by-case processing of individual zone-change requests. Many of the zone-change approvals between 1974 and 1979 did not conform to the adopted plan and a future land use development pattern cannot be accurately predicted.

9.2.3 Southwest Las Vegas Valley

The north subarea boundary divides the downtown urban core of Las Vegas, therefore establishing the Southwest Las Vegas Valley as the second most urbanized subarea. The major southwest portion of the area consists of the largest proportion of desert open space relative to the other land use classifications. This subarea also includes portions of BLM Pine Creek Wilderness Study Area (NV-050-414). Additionally, this area encompasses portions of the Hidden Valley, McCullough Mountain, Spring Mountain and Las Vegas grazing allotments. BLM designation for the former two areas is currently category I, while the latter two allotments are considered category C. The valley is bound by the foothills of the Bird Springs Range and the Sandstone Bluffs.

The northeastern section of the subarea is comprised of a major part of the urban development of the city. In this area it has a similar distribution of land uses as the Central Las Vegas Valley subarea. There is a large mixed industrial and commercial core along the I-15 corridor extending from McCarran International Airport. The airport represent the largest public facility in the subarea and the entire city. Other commercial uses and public developments are located along US Highway 93/95 in the northeast portion of the subarea. There are also similar developments scattered throughout the two major residential communities.

Unlike the Central Valley subarea, residential uses are divided by the industrial/commercial core and concentrate in the northeastern section of the subarea. Other smaller residential communities are in the north central and southern portions of the area, located near the airport and south of I-15.

The Summerlin Planned Community occupies the upper northwest section of the subarea. Also included are the Green Valley Master Planned Communities, located southeast of the downtown core. The project site is separated by the meandering eastern boundary of the subarea. The developments include planned communities such as, The Fountains, Silver Springs, and Whitney Ranch, some of which also spread into the City of Henderson subarea. The proposed beltway bisects the subarea in a north to south direction and is planned to connect with I-15 at the US Highway 146 interchange.

Five major parks are clustered near the urban core, while several smaller parks are distributed throughout the residential areas. The other recreational uses are at the Red Rock Canyon National Recreational Lands along the east and southwest boundary of the subarea.

As in the Central Las Vegas Valley subarea, future land use in the Southwestern Valley subarea is governed by the City of Las Vegas General Plan and re-zoning in the unincorporated lands of Clark County. Only a minor portion of the subarea is located within the City of Las Vegas limits. The situation for identifying future land use in the unincorporated portions of this subarea is similar to that of the Northern Las Vegas Valley and Central Las Vegas Valley subareas; refer to section 9.2.1 for further discussion.

9.2.4 City of Boulder City

Boulder City is the smallest of the five subareas, although it consists of the most balanced proportions of existing land uses, compared to the other areas. The city core is surrounded by vacant open land with limited or no development. The River Mountains are located to the northwest separating the subarea from the City of Henderson, while providing diverse terrain adjacent to the flat desert valley. Hoover Dam is located northeast of the downtown area along US Highway 93. Grazing allotments within the subarea include Ireteba Peaks, Las Vegas, and the River Mountains. The latter two are currently ungrazed or unallotted and designated category C by BLM, while the former is designated category I.

Most of the commercial, industrial and public uses are clustered along the west side of US Highway 93, while some commercial developments are located adjacent to the highway corridor north of downtown.

Residential communities are primarily found south of the highway, with smaller neighborhoods north of the commercial and industrial sites. Three parks and recreation facilities are located on the perimeter of the residential developments, encompassed by open desert. Two small military facilities are east of the city and also adjacent to the residential areas.

Planned developments are interspersed throughout the city and generally consist of small commercial uses with moderate sized housing projects.

Future land use is guided by "A Comprehensive Plan for Boulder City, Nevada" (Boulder City, 1981). The "Future Land Use" map delineates types of land use described as "the basis for all future land development decisions and controls." The majority of the planned uses are low and medium density residential categories, projected to include an increase of 2,887 dwelling units on 2,711 acres by the year 2000. This would represent an increase of nearly 70 percent over the number of units in the 1980s. Moreover, 729 acres of commercial and industrial land would be available, mainly along US Highway 93, to supplement the existing 64 acres of developed commercial and industrial land.

9.2.5 City of Henderson

The City of Henderson is the second smallest of the subareas and can be best characterized as the largest industrialized city in the Las Vegas Valley. The overall land use pattern of the subarea is more widely dispersed than typical in the other subareas. The Basic Manufacturing Incorporated industrial complex is located in the center of the city and occupies approximately 4000 acres. Other industrial facilities are found in the north central part of the subarea and encompass large parcels of developed land.

The Sky Harbor Airport, a private facility, occupies a major portion of two square miles in the southwest part of the city. Light industrial uses are planned around the airport to support the growth of the facility which has already been proposed for expansion.

Residential communities are generally located in the central and southern portions of the subarea. The residential areas are mostly lower densities with some limited, higher density developments. Both Pittman and Sierra Vista City communities include various types of housing densities and mobile home parks. Public parks and recreation facilities are limited and are usually found within residential areas.

Two major thoroughfares traverse the city, Lake Mead Drive and the Boulder Highway (US Highway 93/95). Both of these major streets are flanked by large areas of commercial strip development. The frontage along Lake Mead Drive is developed only in the vicinity of the downtown area. There is also a cluster of commercial uses around the intersection at Lake Mead Drive and the Boulder Highway. The development then becomes sparse again eastward out of town.

Planned developments in this subarea are parts of those extending from the Southwest Las Vegas Valley subarea. Open flat desert separates these developments from the industrial uses in the northern section of the subarea. The land is also vacant open desert from the central core of the city development southeast to the River Mountains and southwest to the McCullough Range. A portion of the Hidden Valley and Las Vegas grazing allotments are found within these undeveloped lands. BLM designations for these allotments include category I and C, respectively.

The "Comprehensive Plan, City of Henderson, Nevada" (1986) includes a Land Use Policy Plan which designates on a map the specific types of land use "for the most desirable utilization of land." The majority of proposed land use in the City of Henderson is planned for residential use, 34,166 acres (67.8 percent), located primarily northwest of State US Highway 146 and adjacent to existing residential areas. The plan also includes "Limited Service Areas" which are identified as beyond the city's capability of providing utilities.

9.3 SIGNIFICANT RESOURCES

The following section defines the significant resources of the land use classifications for the study area. The section includes a discussion of the potential sensitivities related to each resource and how they may be impacted by the proposed facilities. The discussions address the issues conceptually, not including the specific effects of each of the proposed facilities. Significant land use resources consist of residential, commercial, industrial, public facilities, parks and recreation, wilderness, agricultural and livestock grazing uses, and vacant land. Each land use classification is defined as follows in terms of what types of land uses are included and its sensitivity. Table 9-2 summarizes the potential sensitivity of each land use classification to specific impact categories. Impact categories are described in detail in Section 9.4.

9.3.1 Residential

9.3.1.1 Characteristics

Residential land uses primarily consist of inhabited areas with various levels of density and types of housing structures. Each of the residential types is represented by a typical site layout and set of design characteristics.

The highest of densities is multi-family, which includes attached residences, apartments, and condominiums. They may be either high or low rise developments. Within this classification there are many different types of densities included. These range from duplexes with six to ten units per gross acre, to high rise apartments with 18 units per gross acre. Generally there are parking lots associated with these types of developments, as well as typical urban facilities, such as paved streets and utilities. They may also include small open space areas, such as courtyards, plazas, and small parks.

Single family residences are perhaps the most typical components of urban areas and consist of a single home occupying each lot. These lots can range in size, although generally do not exceed one-half an acre. This determines the density of these developments to range from two to six units per gross acre and to be classified as low and high density single family. The low density areas are those with less than one unit per one-half acre and those with more are considered high density.

The densities which begin to involve more acres than units are described as rural residential with one unit per acre or less. These include ranches, farmsteads, vacation homes, desert homesteads, isolated mobile homes, and residences in areas with rural standard services. Large open spaces surround the developments and are sometimes incorporated within the communities. The residences may include horse pastures and stable facilities, as well as large greenbelts and parks in master planned communities.

9.3.1.2 Sensitivities

Residential land uses are particularly sensitive to actions which may displace or eliminate individual or multiple residences. Although homeowners would be compensated for displacement by purchase of right-of-way, remaining residents adjacent to the project would also be affected. The resource is also sensitive to actions which may result in barriers within residential neighborhoods, or between residential neighborhoods and services. For example, a channel which separates a residential area from a neighborhood school or local commercial services will potentially effect the convenience of residents, and the quality of life in general for the neighborhood. In general, medium to high density residential areas would be more likely than low (rural) density areas to be impacted by severance because they are often more unified, while low density areas tend to be less dependent on the neighborhood unit. The most severe effect would be to reduce the level of access between police, fire, or ambulance services, and a residential area.

Land use impacts may result from limited access, as well as actual or perceived physical separation of the neighborhood unit, even if existing access is preserved or alternate access is provided. Health and safety concerns are also a factor in the perception of quality of life. If one or more homes are removed to clear land for additional flood control right-of-way, the overall effects may be detrimental to a much larger portion of the neighborhood.

Project-specific review of facilities sited in existing residential areas should be conducted to identify the local impacts of facilities on residential neighborhoods. The analysis should focus on the linkages between all component parts of the neighborhood unit; that is, the residence, schools, commercial services, emergency response facilities, and access to the community transportation network. Vehicular as well as pedestrian access should be considered.

9.3.2 Commercial

9.3.2.1 Characteristics

Commercial land uses are broad-ranging in size and intensity. They vary from single-lot convenience grocery stores or gas stations, to regional shopping malls, office buildings and resort-hotel complexes. The building orientation and site layout of commercial uses varies from single or strip buildings, located along streets with street-side parking, to master-planned building complexes which include parking and open space within the interior of the building lot.

9.3.2.2 Sensitivities

The sensitivity of a commercial land use resource is highly dependent on the individual building and site configuration. It is assumed that where parking areas are displaced for flood control facility rights-of-way, alternate land area for parking would be provided as compensation to the commercial owner and tenants, in order to comply with minimum parking standards specified in the local zoning ordinance. However, in such cases where adjacent land area is not available for parking, the business operator may not be able to continue in his current location and additional compensation may be required to allow that business to relocate. In some cases, individual businesses may be affected by limitation of access from certain market areas, resulting in a loss of potential business.

Project-specific environmental review of facilities sited in commercial land use areas should include a detailed evaluation of the site constraints emphasizing parking, circulation, and access. If adverse effects are anticipated, close coordination with individual commercial owners and business operators is to develop a specific mitigation or compensation plan addressing site-specific impacts.

9.3.3 Industrial and Mineral Extraction

9.3.3.1 Characteristics

Industrial land uses include light industrial, heavy industrial, extractive areas, and wholesale or warehouse facilities. Wide variation in the scale and intensity of use for industrial uses makes it difficult to generalize about the effects of flood control facilities.

9.3.3.2 Sensitivities

The description of sensitivities for commercial land uses applies in many cases to industrial uses, particularly for light industry. In addition, the introduction of a flood control facility on certain industrial sites may potentially conflict with uses where specialized manufacturing and mineral extractive uses are constrained by the site layout and location of facilities.

Project-specific environmental review of facilities sited on industrial land use areas should focus on individual site constraints and location. Areas of mineral extraction or major manufacturing should be avoided if possible, or facilities designed to reduce or prevent direct conflict with the continued operation of the facility. Mining claims within flood control facilities must be either of a mineral extraction nature or previously disposed of; extraction of sand or gravel is prohibited within such areas.

9.3.4 Public Facilities

9.3.4.1 Characteristics

This is a broad category which includes all transportation (airports, railroads, highways), communications, utilities (including flood control), government offices, health care, educational (both public and private), religious, emergency response (police, fire, ambulance), and military facilities. Recreational uses and open space such as ballfields are included in this category if used in conjunction with schools; they are otherwise included in the Open Space and Recreation category (see 9.3.5).

Transportation, communications, and utilities structures are often compatible with flood control facilities and may be constructed in adjacent rights-of-way. (Some structures, such as bridges, are in fact needed where facilities intersect.)

9.3.4.2 Sensitivities

Educational and religious institutions are particularly sensitive to health and safety concerns, particularly where young children are present. As stated above in the discussion of effects on other uses (9.3.1.2), barriers to access between public facilities and other uses are of concern, but may be effectively mitigated. While direct compensation for right-of-way on lands in public use rarely takes place, alternative lands may be offered for exchange between the county and the respective government agencies affected by the use of their lands for flood control facilities. Lands reserved for future expansion of public facilities are also sensitive to displacement.

Project-specific environmental review of facilities sited on or near public facilities should evaluate the effects on the separation of public facilities from residential areas, as well as the direct effects of displaced facilities or lands set aside for future public use. This analysis should focus on public lands already developed as public facilities, or lands currently planned for such use.

9.3.5 Open Space and Recreation

9.3.5.1 Characteristics

Included here are all golf courses, parks, campgrounds, cemeteries, wildlife preserves, botanical gardens, beaches, auto race tracks, and other public and private recreational facilities. BLM Wilderness or WSAs are also included, as well as other federal, state, or locally operated recreation areas.

9.3.5.2 Sensitivities

Flood control facilities may be compatible with these uses in certain cases. For example, channels or pipeline rights-of-way or easements provide linear corridors suitable for jogging, hiking, or bicycling. Detention facilities could potentially be used as shooting ranges; such activities would be managed by BLM, and should be planned and regulated in accordance with future county plans for recreational activities at flood control facilities. Detention/retention basins are suitable for use as playing fields if the operating agency accepts responsibility for maintenance and operations control. The Clark County School District will not use detention/retention basins for playing fields because they are not available during or after rains. Basins are also useful as open space buffer areas.

Project-specific environmental review of facilities sited in open space and recreation areas should evaluate the effects of loss of recreation facilities or open space, resulting from the proposed flood control facilities. The importance of the resource in the neighborhood, community, or region should be considered in this evaluation. If a particular facility bisects or severs a recreation or open space parcel, the quality of the remainder should also be evaluated. Included in this evaluation should be the Red Rock Canyon National Recreation Lands. This area, jointly managed by BLM and the Nevada State Park System, is a principal recreation facility of the Las Vegas area and contains portions of the LaMadre Mountain and Pine Creek WSAs.

As discussed in Section 9.2, the proposed facilities would potentially impact five BLM WSAs including LaMadre Mountain, Pine Creek, Fish and Wildlife No. 3, Quail Springs, and Nellis ABC. Among these areas selected portions of La Madre Mountain and Pine Creek have been recommended as suitable for wilderness designation ("Partial Wilderness"), while Fish and Wildlife No. 3, Quail Springs and Nellis ABC have been recommended as nonsuitable for wilderness designation.

Recommendations for designation of wilderness were submitted to the Secretary of the Interior by the State BLM director of Nevada in March, 1990. The Secretary will recommend wilderness or non-wilderness designation of these WSAs to the President of the United States by October, 1990. The President will then have one year to make his recommendations to Congress. Subsequently, Congress will determine which WSAs to include in the Wilderness Preservation System. Until Congress determines the designation or release of these WSAs they will be managed under the Interim Management Policy and Guidelines for Lands Under Wilderness Review (IMP). All development within WSAs must meet the nonimpairment criteria mandated by the IMP; if the IMP cannot be met, the proposed action must be denied.

9.3.6 Agriculture

9.3.6.1 Characteristics

This category includes both irrigated and non-irrigated field crops, orchards and vineyards, pasture and grazing allotments, dairies and other livestock feeding facilities, poultry operations, nurseries, truck farms, and other agricultural related uses.

9.3.6.2 Sensitivities

Aside from actual loss of agricultural or grazing lands, interference with cultivation patterns and irrigation systems is the most direct impact. Severance of farm areas can lead to disruption of plowing and fertilizing patterns. Irrigation systems are usually designed to make maximum efficient use of a field based on its size and geometry. If a portion of the field is severed, irrigation systems may have to be re-configured to continue effective operations.

Project-specific environmental review of facilities sited on agricultural lands and grazing allotments should consider the effects of a proposed flood control facility on the specific type(s) of agricultural operation(s) of each affected parcel. Mitigation measures requiring the relocation of facilities to maintain the functional viability of these affected parcels should reduce potential impacts to insignificant levels.

9.3.7 Vacant Land

9.3.7.1 Characteristics

Vacant land can be described as undeveloped, vacant with improvements, or in transition. Transition refers to land in any stage of development prior to completion.

9.3.7.2 Sensitivities

Vacant land is sensitive to proposed flood control facilities to the degree that improvements may have been completed for the various land uses described above (see Sections 9.3.1 through 9.3.6). Undeveloped land may also be sensitive due to the owner/developer's investment in planning and design, even prior to any on-site improvements.

Project-specific environmental review of facilities located on vacant land should take into consideration proposed development plans by identifying site plans that are on record with the respective planning jurisdiction. Early coordination between planners and developers should effectively reduce the impact of proposed flood control facilities where such plans exist.

9.4 GENERAL ENVIRONMENTAL EFFECTS

The following section describes the potential impact types that could occur related to the existing and planned land uses. A list of impact types was compiled through contacts with city and county agencies and the District. The initial assumptions made by the study team were reviewed and incorporated into a final list of potential impact types. These were used to establish criteria to assess the land use impacts. The combination of material was then cross-referenced with the land use classifications to form a matrix for further developing the criteria to assess the impacts, and finally to recommend mitigation methods.

The following is a list of the projected impact types. Table 9-3 indicates which flood control facilities are most commonly associated with these impacts. Data in this matrix are based on discussions with the city and county agencies as well as currently available published data. The impact categories identified are:

1) ELIMINATE - Displace, remove or relocate existing structures or uses causing a substantial change in the land use pattern.

2) BARRIER - Create a barrier adjacent to the development causing inaccessibility or effecting the expansion of future development.

3) DIVIDE - Separate or break the existing land use pattern by locating the proposed facility within established land uses/developments thereby disrupting the integrity of a neighborhood unit or other land use complex. May reduce the viability of land uses requiring large areas such as mineral extraction and agriculture.

4) INCONVENIENCE - Create a nuisance during or after construction by generating noise, dust, traffic detours; inhibit normal operating procedures.

5) SAFETY - Create an unsafe environment for the public with facilities.

6) HEALTH - Create health hazards to the public by operational procedures.

7) ATTRACT ACTIVITIES - Attract undesirable recreational activities to the proposed facilities (i.e., ATC/off-road vehicles).

8) BENEFICIAL RECREATION OPPORTUNITIES - Proposed facilities offer opportunities for recreational development or passive recreational activities (such as parks in detention basins and nature trails or bikeways in floodways).

Types 1 through 3 are considered direct impacts, while types 4 through 8 are indirect operations impacts. Impact types 4 through 6 may also occur as impacts of short duration during the construction stage.

9.4.1 Construction Impacts

During construction of any of the ten types of flood control facilities, impacts described as inconvenience and safety (Types 4,5) may result. Resources of greatest concern relative to these impacts are residential and educational facilities. To a lesser extent commercial, recreational, or other land uses would also be affected by construction impacts. Impact types 1 through 3 could result during the construction phase as well as during operation.

Some impacts resulting from construction of facilities are mitigable. The amount of dust emitted can be controlled by spraying water during earthwork construction. Noise levels can be limited by requiring the use of mufflers on heavy equipment and prohibiting construction during nighttime hours. Safety concerns may be mitigated by requiring appropriate fencing or other barriers where potential hazards exist. Nuisances caused by temporary construction detours or interruptions in normal utility services cannot be effectively mitigated.

9.4.2 Direct Operational Impacts

Direct operational impacts include the following: eliminate, barrier, and divide (Types 1-3). Major effects would occur for existing residential, commercial, educational, emergency response facilities, and perhaps recreational, agricultural, and livestock grazing uses. Impacts upon these resources are potentially significant because their normal use and operations could be significantly disrupted by development and operation of the proposed facilities. Programmatic mitigation measures are proposed in Section 9.6 that may effectively reduce the level of these impacts. Beneficial impacts to all land use categories would also be associated with improved flood protection. These effects would be most significant in residential, commercial, industrial, and public facilities land use areas.

The following is a discussion of resource effects and compatibility according to each type of facility. Also refer to Table 9-2.

9.4.2.1 Channels, Floodways

Channels are natural, unlined, or concrete-lined open linear structures. In developed areas, channels would potentially eliminate or divide areas of existing or potential uses. The routing of channels on existing washes will minimize new adverse effects to some extent. Where channels must be rerouted, channels are most compatible with other linear facilities, such as roads, railroads, electrical transmission lines, communication lines, or pipelines. The location of new channels within existing linear corridors is desirable in that the amount of land used for these facilities would be reduced through consolidation, and areas may be held in common for maintenance of parallel facilities. Channels are also compatible with vacant lands, where future land use planning can be achieved in accordance with the location and geometry of the channel structures.

Channels and floodways may create barriers between portions of residential neighborhoods, between residences and schools, or between neighborhoods and emergency response facilities (e.g., police, fire stations). Depending on the size and appearance of the structure, division of an otherwise unified residential neighborhood could affect its integrity and viability, particularly if a small portion of a neighborhood unit is severed from the whole by the channel. However, in some instances such structures may help to define neighborhood communities, and/or serve as a buffer to adjacent land uses, thereby creating a beneficial impact. Agricultural areas, particularly where field crops or orchards are planted, would also be sensitive to channel crossings because irrigation systems and cultivation patterns could be disrupted. Livestock grazing could potentially be affected by channels if such crossings significantly separated portions of a continuous allotment. However, given the size, current designation and livestock distribution of these allotments, such impacts would be considered minimal.

If located adjacent to existing residential neighborhoods, channels will impact those areas directly if the right-of-way would require portions of land presently used for other purposes, or proposed for other purposes. If properly mitigated, channels adjacent to residential areas would not affect existing use.

Floodway areas may be suitable for some forms of recreation, such as bird watching and bicycle trails. These recreation uses may be particularly popular in areas of perennial flow where riparian and wetland vegetation is allowed to establish in the floodway.

Beneficial impacts may result in some circumstances from channel placement by the addition of linear buffer spaces which separate non-compatible land uses. For example, providing a natural channel which separates a residential area from an industrial area may achieve a positive neighborhood change. Consideration for health and safety concerns would also be necessary and these or other adverse effects may, in some cases, override any potentially beneficial impacts.

9.4.2.2 Culvert/Box Culvert, Pipeline, Bridge

In general, these three types of facilities would cause the least degree of direct, permanent impacts since they would be constructed either underground or in conjunction with streets, railroads, or other structures. These structures would usually be located within existing street or highway rights-of-way. In certain areas the development of new bridges, or the expansion of existing bridges could benefit the surrounding community. An exception would be where bridge or culvert structure design requires additional land area, encroaching on other uses in sensitive areas, or a pipeline that traverses a property supporting a conflicting land use. In general, the land use impacts of these facilities would be minimal.

9.4.2.3 Dike/Levees

The effects of these facilities are similar to those of the channels; such as dividing or eliminating existing uses, or causing a barrier between areas of common use. However, these structures would be located along drainages often unsuitable for residential or other uses. Therefore, dike and levee structures will result in generally low or moderate levels of impact.

9.4.2.4 Detention/Retention Basin, Debris Basin

Of all types of facilities, the basins will occupy the greatest concentrated amounts of land area. The most severe direct impacts may result from the elimination or division of existing uses (Types 1, 2) if basins cannot be located to avoid land use conflicts. The joint use of detention/retention basins for recreation purposes was considered and rejected by representatives of the Clark County School District on the basis that the availability of recreation facilities would be reduced during or after rains. Joint use of such facilities by other jurisdictions or private recreation users is potentially feasible.

9.4.3 Indirect Operational Impacts

Indirect impacts may occur as a result of the operation of flood control facilities. An example of a safety concern is the potential for persons to be injured or drown by falling into open water, such as a channel or detention basin. Examples of adverse health effects include the possibility of persons or animals becoming ill from ingestion of untreated water, or the transmission of disease carried by insects drawn to standing water in detention basins.

Another adverse indirect impact is the attraction of undesirable activities to the facility. Noise from all-terrain vehicles and other unauthorized recreation use would be an indirect, adverse impact on nearby residences or other noise-sensitive areas. This impact is of greatest concern with respect to detention basins, debris basins, and floodways, but may also occur in lined and unlined channels.

Flood control facilities also offer opportunities for potential beneficial indirect impacts associated with enhanced recreational opportunities. Detention basins may be developed as park facilities and could provide substantial recreation opportunities in outlying areas that would not otherwise be available. Debris basins may provide similar opportunities Floodways provide opportunities for other recreational interests, such as nature trails and bikeways. These areas may offer a significant local amenity in areas of perennial flow if riparian and wetland vegetation is allowed to establish within the floodway.

9.4.4 Summary of Potential Impact Significance

Information in Sections 9.3 and 9.4 have been combined to develop a matrix of potential impact significance of different flood control facilities in each land use category (Table 9-4). This information, along with information in Tables 9-2 and 9-3 should be consulted in a preliminary review of specific facilities proposals.

9.5 COMPARISON OF ENVIRONMENTAL EFFECTS OF FLOOD CONTROL ALTERNATIVES

The All Conveyance and Detention/Conveyance alternatives differ as follows: The Detention/Conveyance alternative includes varying sizes of detention basins in the upstream reaches of the watercourses to regulate peak flows in downstream urbanized areas. As a result, the Detention/Conveyance alternative requires narrower flood channels, box culverts, pipelines, and bridges to carry flood flows.

With respect to land use and recreation resources, the Detention/Conveyance alternative would have generally greater levels of impact than the All Conveyance alternative due to the areal extent of the basins, where the basins are located in areas of land use impact. Because the major detention basins are located in currently undeveloped area, adverse impacts associated with these structures is not considered significant. Potential beneficial impacts associated with the possible use of detention facilities as a recreational resource would be substantial in the case of the Detention/Conveyance alternative. The relative impacts of conveyance structures would be lower for the Detention/Conveyance alternative as a result of the narrower rights-of-way required for these facilities in this alternative. The Detention/Conveyance alternative also offers greater opportunities for the use of floodways as a recreational resource than that associated with the All Conveyance alternative, but the greater land area required for floodways would preclude other land development in those areas. Overall, the total amount of developable land appears to be greater with the All Conveyance alternative, but the major land requirements of the Detention/Conveyance alternative are associated with detention basins in undeveloped outlying areas and floodways associated with major drainages presently prone to flood events. Land requirements within the existing developed portions of the study area would be less with the Detention/Conveyance alternative.

The No Project alternative would not affect current land use patterns or opportunities. It also does not provide any additional flood protection, which is considered a significant beneficial effect of both of the other flood control alternatives.

9.6 PROGRAMMATIC MITIGATION MEASURES

Programmatic mitigation measures were developed with respect to land use and recreation resources to avoid or reduce the level of potential impacts resulting from the proposed flood control facilities. These measures are designated A through F, and are summarized in Table 9-5. The mitigation measures refer specifically to the primary land use and recreation resources of concern which are listed in the second column of the table, but may also apply to other resources in special cases. These mitigation measures were developed through consultation with District representatives and local planning professional staff.

TABLE 9-1

SUMMARY OF EXISTING LAND USE BY SUBAREA

RESOURCE	NORTH LAS VEGAS VALLEY	CENTRAL LAS VEGAS VALLEY	SOUTHWEST LAS VEGAS VALLEY	BOULDER CITY	HENDERSON
Residential	I	V	I	III	I
Commercial	II	IV	I	I	II
Industrial	I	I	I	I	V
Public Facilities	I	IV	I	I	I
Military	V	--	--	I	II
Parks & Recreation	II	I	I	I	II
Agriculture	I	--	IV	--	--
Vacant/Open	III	II	III	I	I
Wilderness Study Area (BLM)	IV	I	II	--	--
Planned Community	I	IV	I	--	I
Active Grazing Allotments	II	II	II	II	II

Legend:

Classifications are based on the percentage of area occupied by each land use within each subarea and their comparison to other subareas.

-- = not present
I = present - average percentage comparable to other land uses
II = limited - low percentage of area comparable to the size of the subarea and the other land uses
III = major - high percentage of the subarea occupied
IV = largest - largest percentage of area comparable to other subareas
V = combo - both the major land use of the subarea and the largest percentage comparable to other subareas

TABLE 9-2

IMPACT SENSITIVITY BY LAND USE CATEGORY[1]

LAND USE	ELIMINATE	BARRIER	DIVIDE	INCONVENIENCE	SAFETY	HEALTH	ATTRACT	BENEFICIAL RECREATION
Residential	O	O	O	C/O	C/O	O	O	--
Commercial	O	O	O	C/O	C/O	O	O	--
Industrial and Extractive	O	--	O	C	C	--	--	--
Public Facilities/Military	O	O	O	C/O	C/O	O	O	--
Open Space and Recreation	O	--	--	C	C/O	O	--	O
Agriculture	--	--	O	C	C	--	--	--
Vacant Land	--	--	--	--	--	--	--	O

[1] Impact types are described in Section 9.4. Entries in this table refer to the principal types of effects that could be associated with potentially significant impacts in each land use category.

C = Construction Related Impact

O = Operation Related Impact

TABLE 9-3

FLOOD CONTROL FACILITIES PRINCIPAL IMPACTS[1]

FLOOD CONTROL FACILITIES	ELIMINATE	BARRIER	DIVIDE	INCONVENIENCE	SAFETY	HEALTH	ATTRACT	BENEFICIAL RECREATION
Natural Channel	--	YES	--	--	YES	YES	YES	--
Unlined Channel	--	YES	YES	YES	YES	YES	YES	--
Lined Channel	--	YES	YES	YES	YES	YES	YES	--
Culvert/Box Culvert	--	--	--	YES	--	--	--	--
Pipeline	--	--	--	YES	--	--	--	--
Bridge	--	--	--	YES	--	--	--	--
Floodways and Dike/Levee	--	YES	YES	YES	--	--	YES	YES
Detention Basin	YES	YES	YES	YES	YES	YES	YES	YES
Debris Basin	YES	YES	YES	YES	YES	YES	YES	YES

[1] Impact types are described in Section 9.4

TABLE 9-4

SUMMARY OF FACILITIES IMPACT LEVELS
BY LAND USE CATEGORY

LAND USE CLASSIFICATIONS	NATURAL CHANNELS	UNLINED CHANNELS	LINED CHANNELS	CULVERT	PIPELINE	BRIDGE	FLOODWAY	DETENTION BASINS	DEBRIS BASIN	DROP STRUCTURE
Residential	L-N[1]	L-M	H	L	L	L	M-H	H	L-M	L-M
Commercial	L-N	L-M	M-H	L	L	L	M	M-H	L-M	L-M
Industrial/Extractive	L-N	L-M	M-H	L	L	L	M	M-H	L-M	L
Public Facilities/Military	L-N	L	H	L	L	L	M	H	L-M	L
Open Space and Recreation	L-N	L	M-H	L	L	L	L-M	L-M	L	L
Agriculture	L-N	L-M	L-M	L	L	L	L-M	M	L-M	L
Vacant Land	N	N	N	N	N	N	N	N	N	N

[1] KEY:

H - High Impact Potential - Nearly Always Significant
M-H - Moderate to High Impact - Likely Significant Unless Mitigated
M - Moderate Impact - Significant Under Many Circumstances, Mitigation Appropriate in Most Cases
L-M - Low to Moderate Impact - Generally Not Significant, But May Be Under Special Circumstances
L - Low Impact - Not Significant
N - No Identifiable Impact - Not Significant

TABLE 9-5

SUMMARY OF PROGRAMMATIC MITIGATION MEASURES
FOR LAND USE AND RECREATION RESOURCES

MITIGATION DESIGNATION	RESOURCE OF CONCERN	IMPACT TYPES[1]	DESCRIPTION OF MEASURE
A	All except vacant and agriculture	Eliminate	o Identify buildings potentially displaced by proposed facilities o If found, relocate facilities to avoid displacement to the extent possible
B	All except public	Eliminate	o Identify locations where land uses must be removed or altered for construction of flood control facilities o Provide owners of property used for flood control facility rights-of-way or easements with monetary compensation equal to value of property displaced plus relocation costs
C	Residential, Public Facilities (Schools), Commercial, Recreation	Safety, Health	o Identify areas in potential conflict with proposed facilities for health and safety concerns for unrestricted access o If potential safety hazard is identified, require fencing or other barrier(s) to restrict access to open structures
D	Open Space, Parks, and Recreation Lands	Eliminate, Beneficial Recreation	o Where proposed facilities are located on designated open space or recreational land, consider and evaluate potential joint use of facilities for recreation and flood control purposes; also consider open space/buffer areas application o Develop facilities for joint recreation use where appropriate agreements with local jurisdictions prove feasible. Detention basins floodways offer recreational use potential
E	All	Inconvenience	o Identify areas where close proximity to proposed facilities may reduce the value, or otherwise impair, a given property o If this condition exists, add appropriate landscaped buffer areas of other screening to substantially reduce any undesirable visual, odor, or noise impacts from the flood control facility

[1] Impact types refer to numbered impact categories described in Section 9.4

TABLE 9-5 (concluded)

MITIGATION DESIGNATION	RESOURCE OF CONCERN	IMPACT TYPES	DESCRIPTION OF MEASURE
F	All	Barrier, Divide	o Locate channels along existing washes or other linear corridors to the extent feasible o Identify locations where pedestrian or vehicular access is potentially severed, limited, or impaired o Consult with transportation planning representatives of local jurisdictions to develop alternate access plan o Construct alternative access structures and crossings as determined necessary by local jurisdiction
G	All	Inconvenience	o Determine areas where temporary impacts would result from noise, dust, detours, or other nuisances during construction of flood control facilities o Provide dust and noise control measures to minimize impacts; consider construction scheduling where possible in very sensitive areas -- coordinate with schools and other local jurisdictions
H	All	Eliminate, Barrier, Divide	o Locate facilities to allow maximum amount of common public use areas (allow joint use of rights-of-way for roads, utilities, or other uses where possible)
I	Residential, Commerical, Public Facilities (Especially Schools)	Attract	o Install fencing or other barriers to prevent unauthorized entry to facilities o Establish civil penalties and enforcement mechanism to control unathorized entry to facilities

FIGURE 9-1

GENERAL LAND USE CLASSIFICATIONS

(SEE VOLUME II, OVERSIZE MAPS)

SECTION 10
VISUAL RESOURCES

The following section will discuss the potential impacts related to the aesthetics of the proposed flood control facilities. The intent is to identify how they will affect the visual environment associated with existing and planned developments, recreation areas, and natural settings.

The issue of the rapid development of the Las Vegas Valley was considered in this visual resource assessment. As future development transforms existing vacant land to an urban character, the remaining open space will function as a visual backdrop to the valley. The Master Plan assumes for flood control planning purposes that urbanization would extend to an "ultimate growth boundary" (Montgomery Engineers, 1986). The boundary is an area identified in the Master Plan as an area determined through input from respective jurisdictions. The methodology evolves around the visual resource implications of the proposed flood control facilities on the changing visual character of the valley.

The visual resource methodology follows a separate sequence of steps as shown on Figure 10-1. Based on this methodology, the programmatic assessment includes the following steps:

- assess visual character units and map at 1:100,000 scale
- assess visual sensitivity of visual character units
- analyze visual characteristics of planned flood control facilities
- identify potential impact types
- establish visual dominance levels
- assess potential visual impacts to visual character units
- recommend mitigation measures

The process consisted of first establishing appropriate visual character units present throughout the study area which are mapped on Figure 10-2. The characteristics of these units relate to the planning, design, and topographic characteristics which identify the key visual elements in each area and conform to the existing conditions in "Comprehensive Plan, Clark County, Nevada" (CCDCP, 1987). Also included are the visibility to the surrounding mountain ridges and viewer orientation. Visual character units are the unifying component of the study and are used to determine the range of visual resource values and experiences across the valley, both existing and future.

The sensitivity of the visual units was dependent on the visual character, amount of activity and public use, and the project descriptions of the proposed facilities. The units were rated high, moderate, or low based on the facilities' compatibility with the setting and the character units' ability to absorb the proposed flood control structures.

Once the character and sensitivity of the visual units were established, the specific project descriptions of the facilities were evaluated to determine the type of potential impacts that may occur through their implementation. Factors for establishing the potential visual dominance of the proposed facilities consist of their form, line, color, and texture. A derivative list of visual dominance levels was compiled to define how much the facility would dominate the existing views and their ability to be absorbed into the existing visual character of the unit. A matrix of the sensitivity and dominance levels was developed to cross evaluate these factors to determine the potential impact levels. These are based on comparing the sensitivity of visual resources within study units to the level of dominance that planned facilities would exhibit. After assessing the impacts, potential mitigation measures were developed to reduce the effects of the facilities. These consisted of such measures as coloring concrete structures and planting landscape vegetation to screen views of facilities.

The visual resource data are primarily dependent on the material provided in the land use section for both the existing and planned land uses. Field checking and the use of aerial and ground photos were also included in the data collection process.

10.1 OVERALL ENVIRONMENTAL CONDITIONS

The Las Vegas Valley is visually dominated by open desert which is surrounded by mountain ranges on all sides. Urban development occurs on the desert floor and is centralized within the valley. The vertical elements of the downtown and the Strip act as focal points for the surrounding urban and rural areas. The visibility is open due to the gently sloping terrain and relatively consistent building height.

The mountain ranges act as a constant backdrop for urban and rural viewers, thus providing scenic vistas of the desert landscape. The downtown is compact with primarily older architecture, while the Strip is more spread out with contemporary designs that extend southward down Las Vegas Boulevard. The homogeneous character of the urban development provides middleground views for the outlying areas. The rural development establishes the fringe of the urban core and filters out into the open undeveloped desert basin.

The emphasis on landscape treatment is minimal to none in the downtown and Strip areas due to the lack of open space. However, the urban development includes introduced landscape vegetation that contrast with the native character of the rural and natural areas. There are significant urban features and planned landscape areas which are visually apparent within the surrounding urban development. These elements are generally high activity areas such as urban malls, convention facilities, golf courses, and country clubs. The emphasis on design and landscape enhancement increases the visual character of these developments.

The Las Vegas Valley study area includes two major transportation corridors, which traverse the desert in north to south, and northwest to southeast directions. The linear features provide strong viewer orientation to distant scenic vistas and the downtown core. The elevated sections allow for more of the valley to be seen in panoramic views. The intersection of these highways is located in the central core of the urban development adjacent to the downtown.

The study area stretches southward along the Boulder Highway to include Henderson and Boulder City. The visual conditions of Las Vegas differ from that of these communities, due to their smaller scale and lower density. Henderson is visually dominated by a large industrial complex with older residential neighborhoods surrounding the development. The downtown includes some higher activity areas and is similar in character to urban Las Vegas.

Further south along the Boulder Highway is Boulder City, known as the "City of Hoover Dam." The city is oriented around an open green space which functions as the grounds of the city government facilities and local recreation activities. The small-town character is surrounded by well kept community neighborhoods and rural development with adjacent open land and a variety in topography. The architecture is older with more emphasis on landscape planting for public and private applications. Structures are less dominant; however, views are moderately contained due to vegetation and topography.

10.2 SUMMARY OF ENVIRONMENTAL CONDITIONS

Table 10-1 presents a summary of the existing visual conditions of the study area. The visual character units are listed and their occurrence in individual subareas is indicated. See Figure 10-2 for the configuration of each visual unit within the study area and subareas. The visual character of each subarea is described below.

10.2.1 Northern Las Vegas Valley

The North Las Vegas Valley is the largest of the subareas and is dominated by the natural desert basin of the study area. The open natural area is predominantly classified as a Wilderness Study Area, which has limited topographic changes. The subarea also includes the only designated recreation area and the upper section of the Las Vegas Wash.

The Las Vegas Dunes Recreation Area has a distinct visual character with variations in topography and soil color which combine to provide scenic interest and recreation opportunities. The Upper Las Vegas Wash is generally insignificant in visual character and basically represents the major wash in the study area. The wash consists of limited scrub vegetation which has limited visual interest to the general public.

There are two major transportation corridors located in the subarea, US Highway 95 extending northwest and Interstate-15 (I-15) to the Southwest. These linear features provide orientation for travelers and allow for more open views of adjacent rural development.

The development of the area primarily consist of rural residential communities with minimal urban or higher density neighborhoods. The Nellis Air Force Base is also located in the subarea representing one of the dominant developments in the section and a major part of the airfield and heavy industrial sites in the Las Vegas Valley. Comparable to the central and southwest subareas, there is minimal proposed development and a lack of significant urban features in the Northern Las Vegas Valley.

The planned landscaped areas are limited with few parks and open green space integrated into community developments. Those that are present are located northwest from the urban core. Overall, the landscape vegetation is sparse throughout the subarea and generally consists of desert scrub and low profile vegetation.

10.2.2 Central Las Vegas Valley

The Central Las Vegas Valley consists primarily of higher density urban development which surrounds the downtown core. The homogeneous character of the urban framework is accented by the downtown structures, which function as a focal point for the area and the valley.

In addition to the significance of the vertical elements in the downtown, there are other developments which contrast the monotony of the surrounding urban neighborhoods. The Meadows Mall and the Las Vegas Civic Center are visually distinguishable, based on the increase in public activity, concentration of users, and the emphasis on architectural design.

The subarea has limited open landscaped areas due to the dominating structures of the community environment. The Angel Park dual recreation and flood control facility is located on the fringe of the developing area. The facility represents a design emphasis for flood facilities and also provides open landscaped areas which contrast the surrounding desert setting. Overall, the landscape within the urban areas is visually insignificant. The perimeter of the urban development is sparse with rural communities. While the open natural areas is dominated by the Summerlin Planned Community, which will transform the natural character to urban neighborhood.

10.2.3 Southwest Las Vegas Valley

The Southwest Las Vegas Valley consists of the Strip development with the popular hotel casinos providing a highly visually active area. Urban development surrounds the Strip extending southwest toward the open basin of the valley.

The McCarran Airport, University of Nevada at Las Vegas and the Convention Center function as significant features within the urban framework of the subarea. These developments contrast the uniform setting outside the Strip, due to their design theme and increase in public activity.

The subarea is predominantly rural development located along the fringe of the urban core. The rural areas filter to the open basin which are surrounded by the mountain ranges on the southern edges of the subarea. Planned communities are included in the area and located in the western and the southern portions of the area. Both Summerlin and Green Valley communities will change the open natural character to urban development.

10.2.4 Boulder City

Boulder City is the smallest of the subareas. The family and pedestrian oriented atmosphere provides a clean small town environment with older architecture and street side development. The commercial areas are quaint with small shops and outside cafes where landscape treatment is emphasized. The older design theme creates visual continuity and interest to viewers.

The city is oriented around a landscaped park setting, which serves both as the local recreation site and the grounds for the city government facilities. The community neighborhoods surround the commercial core with an emphasis on street tree planting which provides shade and contrasting color to the desert landscape. The visibility is somewhat contained due to the vegetation and adjacent topography.

The surrounding rural development is more characteristic of the existing rural neighborhoods of the Las Vegas Valley, while the natural areas have limited plans for development.

10.2.5 Henderson

Henderson is primarily older residential neighborhoods, which are dominated by the heavy industrial complex north of the downtown area. The visual character of the industrial site is significant with no visible landscaping and open areas surrounding the development. The visibility to the industrial site is high with no screening.

The visual character of the downtown is similar to the urban areas which extend along the flat desert valley. The main street in Henderson does have increased public activity and a concentration of users, due to the town shops and civic center complex. The character is more pedestrian oriented with small setbacks, street parking, and some street planting.

Rural development forms the edges of the subarea communities with more open space incorporated and higher visibility to the adjacent natural areas. Upper elevations and changes in topography function as a visual backdrop for the inner city views.

10.3 SIGNIFICANT RESOURCES AND ENVIRONMENTAL SENSITIVITY

The following section defines the character and sensitivity of the visual units identified within the Las Vegas Valley and Boulder City areas relative to the "Comprehensive Plan, Clark County, Nevada" (CCDCP, 1987). The components for determining the visual character consists of the following: planned layout and density of development structure size, architectural design, landscaping, amount of surrounding open space, viewer orientation, views to surrounding amenities, and topography of natural settings. Visual units are described below as general categories which are identified on Figure 10-1. While there may be local variations, each unit type is generally consistent in the study area.

The visual sensitivity is dependent on the facilities compatibility with the setting and the character units ability to absorb the proposed structure. Absorption is related to the structure of the setting and how well the facility will fit within it. Compatibility considers the character of the visual unit and how much contrast is created by the facility. The levels consist of high, moderate, or low and are defined as the following:

High Visual Sensitivity--A high sensitivity rating is given to a unit which has a low compatibility level and a limited ability to absorb proposed facilities. This would be characteristic of a unit with high visibility, public activity, and minimal landscape disturbance.

Moderate Visual Sensitivity--A moderate sensitivity rating is given to the units which have some compatibility and absorption ability for proposed facilities. This would include areas with higher density development, lower visibility, landscape disturbance, and limited orientation.

Low Visual Sensitivity--A low sensitivity rating is given to a unit with a high compatibility level and a high ability to absorb proposed facilities. This is characteristic of a unit with limited public use, and similarities with the character of the proposed facilities.

The visual characterization of planned development included in current city and county comprehensive plans is based on the existing character of the adjacent development patterns. However, the visual analysis of properties presently approved and under development reflects the proposed character of the project. Assumptions were based on the available development plans.

10.3.1 Downtown

10.3.1.1 Visual Character

The downtown urban core displays a distinct visual character, with a more compact, dense, and pedestrian-oriented image than other areas. It primarily consists of multi-story buildings, which define an area dominated by vertical elements. The architecture is older with minimal design variety. The construction materials are generally composed of concrete and brick with limited steel and glass structures.

The surrounding open space and setbacks are minimal, with narrow sidewalks functioning as buffers between the streets and buildings. The landscaping within the downtown is generally sparse, although some developments have incorporated minor landscape treatment. The planned layout is predominantly on a narrow street grid which creates strong view corridors and orientation. The outside visibility is limited from street level; however, there are distant views of surrounding mountains from upper story buildings.

10.3.1.2 Sensitivity

The visual sensitivity of the downtown area is moderate based on the units' ability to absorb the proposed facilities. This is dependent on the dense structure of the unit and concentration of viewers. Due to visual enclosure within the downtown core, local project facilities would only be evident to immediate on street or lower level building views. Distant flood control facilities would only be seen on a limited basis from the upper stories of the high-rise developments. The facilities would be moderately compatible with the visual character of the unit based on the limited open space and lack of existing landscaping.

10.3.2 The Strip

10.3.2.1 Visual Character

The Strip character is composed of a series of large glamorous architectural monuments located along Las Vegas Boulevard extending southward from downtown. The area is visually noted for the high-rise hotels and casinos with contemporary architectural design and neon signs, which equal or surpass the building heights. The overall building setbacks are larger than the downtown area, although the massive signage visually dominates the views adjacent to the boulevard. The nighttime atmosphere creates a highly active environment with the flashing lights and pedestrian traffic.

The open space consists primarily of large parking lots, with wide sidewalks and arterial streets. The landscaping is minimal and dominated by the designed hardscaped areas incorporated into the resort developments. Landscaping is not an important visual element and only is occasionally used to enhance walkways and entries.

The scale and visual sequences of the Strip define strong focal points which are perceived when traveling on the road. The views beyond the Strip are very limited due to the orientation and visual activity present along Las Vegas Boulevard. Distant vistas of the surrounding mountains may act as a backdrop, but most likely will not be influenced by the proposed flood control facilities.

10.3.2.2 Sensitivity

The visual sensitivity of the Strip is rated as moderate due to the compatibility of the area and the ability to absorb the proposed facilities. This is based on the high level of visual activity and constant changing focal points. The proposed facility would be moderately compatible with an existing hardscaped environment and potentially be absorbed into an area with present vertical elements. This is consistent with the downtown area; therefore, the issue of distant views from the upper stories of the hotels also applies. Depending on the location and description of the proposed flood control facility, the distant views may be an issue for large-scale dikes and detention basins along the valley perimeter.

10.3.3 Urban

10.3.3.1 Visual Character

The visual character of Las Vegas in an urban area is classified by the relatively uniform one- and two-story developments surrounding the downtown and Strip areas. The city appearance is unvarying and primarily consists of high density multi- and single-family communities.

The urban structure is generally compact with established single-family residences which are constructed along grid-patterned streets. The multi-family apartments and commercial developments are common along major thoroughfares. The newer developments have incorporated curvilinear street layouts; however, the densities are primarily consistent with older urban development.

The architectural variety of the urban character unit is limited and primarily tends to blend with no visual dominance. The materials are very consistent and generally reflect either the desert or selected mission styles. Based on the majority of high density and condensed developments, open space is limited. The landscaping is definitely more apparent than downtown or along the Strip; however, the structures continue to be the overall dominant elements.

Along with the development patterns, transportation corridors, utility lines, and smaller signage are all descriptive factors for the urban area. The major highways are part of the visual character and sometimes create visual barriers to distant views from the adjacent land uses. Even though they may obstruct views, they also provide elevated view corridors both east-west and north-south. They add further perspective and drama with a strong emphasis on the distant views and mountain backdrops. Due to the topography of the valley and the relatively uniform heights of the dominant structures, it is difficult to view much of the city at one time. The exceptions may be the downtown and the Strip. The primary orientation is internal with intermittent views of the distant mountains.

10.3.3.2 Sensitivity

The visual sensitivity of the urban area is rated as moderate, based on the compatibility of the visual character. There could be potential visual effects, due to the obstruction or partial obstruction of adjacent and or distant views of dikes or detention basin facilities. Outward views from perimeter development are vulnerable toward distant vistas, because the duration is longer and the view may be more direct. Local planned facilities such as channels and detention basins within urban settings may result in more significant visual effects, depending on their design and location. However, the units' ability to absorb the proposed facilities is generally higher than that of a rural area due to the dominance of structures, lack of open space, and visibility.

10.3.4 Significant Urban Features

10.3.4.1 Visual Character

There are specific features that are not always visually prominent from a distance but are important elements in the visual structure of the urban areas. These primarily provide contrast in scale and intensity of use to the surrounding homogeneous urban character units.

Although the strip and downtown dominate the visual character of Las Vegas, there are developments which consist of similar traits at a smaller scale, which are present within the urban character units. These have been identified due to the high activity and concentration of public usage. These include: 1) The University of Nevada at Las Vegas, 2) McCarran Airport, 3) North Las Vegas Civic Center, 4) Henderson Downtown, 5) Las Vegas Convention Center, and 6) Meadows Mall (Figure 10-1).

These features are prominent due to level of attention paid to design and city planning, and justify an increase in mitigation considerations.

10.3.4.2 Sensitivity

The level of visual sensitivity is considered high based on the lower ability to absorb the proposed facilities and the associated use of these developments. The compatibility of the above features is limited due to the character and increase in pedestrian activity.

Construction of proposed facilities would affect the existing setting and change the visual character of the developments. The emphasis on public attraction for specific activities is accommodated by the upgraded character of the developments. Disturbing the landscape environment could also potentially affect the existing activities.

10.3.5 Rural

10.3.5.1 Visual Character

The rural character units predominantly encompass the development on the outer perimeters of the urban areas. However, there are rural developments interspersed throughout the urban core, although these are generally surrounded by higher density developments and are potentially due for zone changes.

The existing rural developments are primarily older homesteads, desert ranches, and larger custom homes. Due to the availability of local building materials, concrete block and stucco are dominant, both in old and new developments. The earth tones and simple lines provide indigenous architecture, with some mission style developments being introduced.

The open space within the rural character units is generally more evident, with larger setbacks and more open area surrounding existing developments. Landscaping is more prevalent, although primarily consists of native vegetation and some introduced species. Areas which are not natively landscaped provide a strong color contrast with the uniform nature of the desert backdrop.

The streets in rural areas are predominantly narrower and planned in a loose grid pattern with minimal utilities located throughout the units. The developments are more spread out providing random visibility. Based on the topography and density of the areas, the views to distant vistas and mountain ridges are more apparent and frequent. The backdrop for adjacent views generally consists of the downtown and Strip areas and the surrounding mountain ranges.

10.3.5.2 Sensitivity

The visual sensitivity of the rural character units is rated as high based on the low ability to absorb the proposed facilities. Considering the potential for direct views of the surrounding structures due to the lower densities and additional internal open space the compatibility level is low. In addition, the larger and more visually obtrusive flood control facilities are generally located on the perimeter of the urban core, therefore having greater potential of dominating rural viewsheds. Dikes and levees extending for long linear distance could potentially effect distance views to surrounding vistas. The smaller unlined channels and bridges have more opportunities to be compatible with the existing setting.

10.3.6 Airfield/Heavy Industrial

10.3.6.1 Visual Character

The visual character units described as airfield and heavy industrial include such developments as airports, military bases, chemical plants, and all major industrial uses.

The specific developments within these areas primarily consist of the major facilities involved in airport and military properties. The airstrip and buildings incorporated are components of these visual character units. Other determinants are the large industrial developments with major facilities including storage tanks, refineries, utilities, and disposal areas.

The open space surrounding and incorporated in the units create large setbacks and sufficient clearing areas. The characteristics of the structures included in these developments somewhat require large open spaces surrounding them to provide buffers to adjacent land uses. The landscaping is basically non-existent and definitely not a factor for the visual character. Views are attained in all directions, with some limited screening due to on-site buildings.

10.3.6.2 Sensitivity

Based on the units' compatibility with the proposed structures and their ability to absorb them into the existing character, the sensitivity is very low. The disturbance caused by the proposed flood control facilities would be minimal due to the character of the setting and the type of public or private uses. The location of the facilities may increase the effects on the visual character; however, considering the airstrip and industrial uses the sensitivity would still remain low.

10.3.7 Landscaped

10.3.7.1 Visual Character

The visual character units classified as landscaped primarily include open areas with a strong emphasis on planned landscaping. These consist of such developments as golf courses, parks, and country clubs. The landscaped areas are generally located within urban and rural areas. They are also found in neighborhood communities and incorporated into hotel/casino developments.

The character of these units includes both formal and random planting designs. The landscaped units predominantly consist of introduced plant species, which are not indigenous to the environment. This generally creates high contrast to surrounding areas caused by the scale and color of the vegetation. The large shade trees and open green areas assist in designating the units' distinct visual character.

The orientation is random with visibility partially screened by vegetative planting. Views may be obstructed depending on the density of the landscaping; however, the overall conditions of the visual unit allows for views beyond the boundaries of the sites. Primary uses generally tend to be recreational and determine the level of public usage. Golf courses, parks, and country clubs are landscaped to enhance the existing conditions of the environment.

10.3.7.2 Sensitivity

The visual sensitivity of the landscaped areas is high, based on the low ability to absorb the proposed facilities. The compatibility of the unit is also low, due to the character and intended recreational uses of the landscaped areas. The construction of the flood control facilities such as dikes, lined channels, detention and debris basins, would create potential visual disturbance due to the structure design and size. The facilities which are smaller and less significant have higher potential to fit into the setting. However, if a facility is located adjacent to or in direct visibility of a landscaped unit, the potential for effecting the visual character is considered higher.

10.3.8 Natural

Visual character units classified as natural are primarily undeveloped land with limited to no disturbance. These surround the urban and rural developments and spread outward from the central core of development.

The natural areas can be classified into five separate units, based on the amount of landscape disturbance and public usage. Different views may be obtained in certain units due to the terrain and adjacent development. The significance and species of existing landscape vegetation are also factored to determine the visual character of the natural units. The sensitivities of the natural units vary and are dependent on the type of views, land disturbance, and compatibility with the existing landscape. Constructing those flood control facilities which extend for long distances and variable heights above grade can effect the character of these areas. Disturbing the existing conditions of the natural areas could potentially effect the distant views from other units and change the character of the surrounding desert landscape. The following are descriptions of the various natural character units and how they differ from one another.

10.3.8.1 Wilderness Study Areas

Visual Character

The natural areas defined and managed under the wilderness interim guidelines are classified as Wilderness Study Areas (WSAs). These areas are specifically designated for preservation of the existing character and must remain undisturbed or the classification of the area will change. Issuance of rights-of-ways are not permitted.

Sensitivity

The visual sensitivity of this unit is the highest of all the natural areas, due to the incompatibility of the proposed structures. Areas under wilderness review are managed under VRM class II interim designation until Congress acts upon the recommendation. Once designated wilderness, the areas would be managed as VRM class I. Areas not designated wilderness will be managed as class II, III, or IV depending upon the visual resource classification.

10.3.8.2 Open Basin Areas

Visual Character

The open basin areas are those with minimal topographic change and various types of landscape disturbances such as random desert trails, dirt roads, uncontrolled dumping grounds, and gravel pits. Visibility is extremely open and primarily blocked by on-site activities and the surrounding mountain ranges. The flat nature of the areas allows for limited views of the visual unit itself. However, the gentle slope of the terrain provides views of the urban development and the contrasting vertical elements of the downtown and Strip areas. The orientation is generally back toward the city or to the mountains. The existing landscape vegetation is low profile native desert scrub, which is sparsely distributed. Due to the natural drainage channels, there are occasionally areas with more dense and taller vegetation. These visual units primarily surround existing areas of development or those that are currently under construction.

Sensitivity

The visual sensitivity of the open basin are is low, due to the units ability to absorb the facilities. The existing character is potentially compatible based on the present activity and limited views within the unit. Effects to the existing character are generally dependent on the construction of above grade facilities. Larger channels, detention basins, and dikes would be seen from more adjacent views, while bridges and unlined channels would have limited changes to existing views.

10.3.8.3 Open Range Area

Visual Character

The open range areas are those with significant topography and upper elevations. These consist of the surrounding ridges of the Spring, Sheep, and Las Vegas Valley Range mountains. The upper elevations provide panoramic views and orientation toward the valley development and surrounding basin areas. The topography allows for distant views and an increase in potential effects to views overlooking adjacent properties. The existing landscape conditions consist of no visible vegetation and limited variations in soil color and texture. The exposed geological surfaces create distinct textures and ridged landforms. The minimal landscape disturbance is due to the restrictive topography and limited area available for development.

Sensitivity

The visual sensitivity of the open range areas is rated as moderate. This is based on the moderate absorption capabilities and potential for more of the proposed facilities to be visible from higher elevations. The panoramic views would allow for system networks or multiple facilities to be viewed. Also, facilities located in the range areas would alter the terrain and create color contrast in the soil, due to the cut and fill requirements of the structure. These factors increase the potential for effects to the landscape character and create a higher sensitivity than basin areas.

10.3.8.4 Natural Recreation Areas

Visual Character

Visual character units classified as natural recreation areas include designated sites for regulated outdoor public use. The units remain undeveloped, although demonstrate visible activity due to the higher public usage. This increases the landscape disturbance and creates similar visual elements as in open natural areas. However, regulations only permit certain activities, which generally consist of hiking trails, off-road vehicle tracks, and open camping sites.

The landscape condition of these units is predominantly consistent with open basin areas, though it is potentially maintained in some locations due to the controlled activity of the sites. These areas are usually distinct in character and draw public interest, which leads to their designation as natural recreation areas. This may be due to a difference in landforms, soil patterns, or vegetation.

Sensitivity

The sensitivity of the recreation areas is rated as high. This is due to the visual incompatibility with the proposed structures. The ability to absorb the landscape disturbance is low and not consistent with the character of the areas. Construction of proposed facilities could potentially affect the character of the unit based on the increased public usage and designated recreational activities. Views of the distinct landscape setting of the units could also be disturbed dependent on the location and characteristics of the proposed facilities.

10.3.8.5 Las Vegas Wash
Visual Character

The Las Vegas Wash has a distinct visual character in the lower sections toward Lake Mead, with prominent vegetation from the perennial flow of the wash. Comparable to the landscape condition of the entire Las Vegas Valley, the lower wash is a major area of vegetation (Kennedy/Jenks/Chilton et al., 1988). The riparian habitat provides a strong visual contrast against the surrounding greys and browns, which dominate the landscape. In the lower areas of the wash potential development could completely change the character of the setting. Rainbow Gardens in the Lower Las Vegas Wash is an important visual feature. No flood control facilities will be built in this area.

However, in the upper stream sections on the Northern Las Vegas Wash, the character is different from the Lower Wash and similar to open basin areas. The area is a major drainage channel with collected debris along the edges of the wash. The vegetation is less apparent and not visually significant. The water flow is not consistent, therefore, the bottom of the wash and remaining deposits from the waste water are often visible.

Sensitivity

The visual sensitivity of the Las Vegas Wash is rated as a moderate, based on the areas ability to absorb the proposed facilities (Kennedy/Jenks/Chilton et al., 1988). The character of the major drainage channel is compatible with the flood control structures, although the landscape setting is still natural and can potentially be affected. Dikes, levees, and detention structures would disrupt the existing visual character, while unlined channels and smaller lined channels would be more compatible. Construction of facilities in the lower sections of the wash toward Lake Mead would be visually incompatible, and those proposed in the upper sections would potentially affect the existing character of the wash.

10.3.9 Proposed Development Areas

10.3.9.1 Visual Character

The areas which have been approved for development and in the process of changing from one visual character to another are designated as proposed units. The classification of the visual character for these areas is directly dependent on the nature of the proposed development.

10.3.9.2 Sensitivity

The visual sensitivity of the proposed areas is based on the anticipated character of the approved developments. Assumption may be made depending on the available plans for landscape treatment and structure density and size. This will assist in determining the potential visibility, orientation, and presumably the visual character of the developments. The units ability to absorb the facilities and compatibility levels would be improved by joint planning efforts to incorporate design details, mitigation measures, and planned dual uses to reduce visual effects.

10.4 GENERAL ENVIRONMENTAL EFFECTS

The following section discusses the potential impacts of the proposed flood control facilities. The section will define the impacts based on the visual sensitivity of the character units and the dominance level of the facilities. Together these will determine the potential impact levels which range from high to low.

Each project description was evaluated on the factors which can potentially create visual obtrusions. These relate to the form, line, color, and texture of the structures. A list of potential impacts was derived to better understand how the facilities could dominate the existing visual characters of the study area. Levels of visual dominance were established based on the same criteria as the visual sensitivity of the character units. The levels address the compatibility of the facility and the setting and how well the structure can be absorbed into the character of the area. A set of four levels was compiled and ranges from no compatibility and low absorption to high compatibility and high absorption. These reflect that a facility will either completely dominate the view or be absorbed into the setting. However, a facility can dominate the existing view and be compatible with the setting, although this is dependent on the visual sensitivity of the character unit.

The potential impacts determine the level of visual dominance which will apply to each of the facilities. The following are definitions of the factors for establishing potential visual impacts. The characteristics of each facility related to these factors are described in Table 10-2.

Form--Impacts due to the geometric design or shape of the facility in relation to the character of the existing structures.

Line--Impacts caused by horizontal linear features extending for long distances which are in contrast with the existing visual setting.

Color--Impacts based on the introduced color of the structure material or the disruption of existing soil conditions, therefore exposing new and contrasting soil color.

Texture--Impacts related to the disturbance of existing geologic conditions with introduced grading or fill sections, therefore creating contrast to the ground surface, landform, and soil condition of the area. Also the proposed facility may have a more smooth contrasting texture than the surrounding visual elements of the settings.

Levels of visual dominance of individual facilities were derived from Table 10-2. These were dependent on the facilities' compatibility with the setting and ability to be absorbed into the visual character. Based on the factors of potential impacts and the project descriptions, the following four levels of dominance were compiled:

Level 1--Facility completely dominates view due to the scale. There is no ability for visual character unit to absorb proposed facility and limited compatibility of the visual unit and the proposed facility.

Level 2--Facility attracts attention and changes orientation of view. There is limited ability for the character to absorb the facility and the facility is moderately compatible with the character of the unit.

Level 3--Facility is subordinate to surrounding character and is relatively moderate in dominance. There is moderate ability of absorption into existing visual character and the facility is higher in compatibility with visual unit.

Level 4--Facility causes minimal change and limited dominance. This level has the highest ability of absorption into existing visual character and the highest compatibility with the character of the unit.

10.4.1 Construction Impacts

The potential impacts which would occur during the construction of the proposed flood control facilities are primarily due to the initial disturbance of the existing landscape setting. The factors related to these impacts are the color and texture of the existing soil conditions.

The ground excavation during construction will expose different colors and textures of the soil, therefore causing impacts to the existing visual character of the setting. The excavation process would also create visual impacts based on the dust produced during the construction of the facilities. This would potentially impact the adjacent visual character of the proposed area and attract attention from the areas with distant views of the construction.

Some of the facilities were assumed to have no potential impacts to the visual character. This was based on the project descriptions (Section 2.0) and primarily due to the below-grade characteristics. These facilities include concrete pipes, precast boxes, floodways, drop structures, and natural channels. Even though these facilities would not cause impacts after installation, they would create initial visual impacts due to the landscape disturbance during construction.

Impacts related to the construction of the facilities generally apply to short-term situations and can potentially be mitigated. The disrupted soils may be replaced and appropriately graded after the completion of the facility. This will reduce the impacts and allow for the facility to be more compatible with the existing color and texture of the setting. The amount of dust emitted during the earthwork construction can be controlled through the application of water to the ground surface. These mitigation measures should be applied to all areas of temporary construction disturbance and resulting impacts are not considered significant.

10.4.2 Direct Operation

The potential direct operation impacts were determined by applying the proposed facilities to the existing visual character units of the study area. The combination of the visual sensitivity of these units and the visual dominance of the facility was cross evaluated to determine the visual impacts. This assessed the compatibility of structures and the visual character of the setting, while also determining how well the facilities can be absorbed after they are constructed.

The actual project descriptions and their potential impacts were applied to each visual character unit and evaluated against the visual sensitivity of areas. Table 10-3 illustrates the matrix used to define potential visual impact levels. Visual sensitivities of each visual character unit were derived from Section 10.3 and visual dominance levels of each facility were derived by evaluation of facility information in Table 10-2 in the context of visual character unit characteristics. This information was applied to the potential impact level matrix (Table 10-3) to derive the facility-type impact levels reported in Table 10-4.

10.4.3 Indirect Operation

The indirect operation effects are considered as the potential opportunities which are created by construction of the facilities. Overall, the indirect operation of the proposed facilities will accommodate the growth of the Las Vegas Valley. Therefore, the visual character of the environment will change from a dominant rural and natural setting to a more urbanized character. This will also provide opportunities to plan for dual uses and reduce the need for mitigation measures.

The construction of the proposed facilities could cause both positive and potentially negative indirect operation effects to the existing and proposed urban development, depending on the surrounding visual character. The linear flood control facilities, such as channels, provide corridors which can be utilized for other municipal uses. These are classified as siting opportunities by utility and transportation planners for transmission lines and travel routes which would extend parallel to the flood control facility. The positive concept of combining the proposed facilities is contradicted by the increase in potential visual impacts caused by the heights of the transmission towers or elevated overpasses. The specific design of the facilities would determine the actual impacts, although the concept of utilizing existing linear corridors is generally part of the planning process.

However, there are many positive opportunities for utilizing the right-of-way and site locations for the planning of park and recreation activities. The linear features provide prime locations for trail systems, buffering from adjacent contrasting visual character units (heavy industrial, commercial strip development). Also, detention basins and floodways are a positive focus for siting recreational facilities. Parks, golf courses, lakes, nature trails, and other recreational amenities can be positive indirect operation effects.

10.5 ENVIRONMENTAL EFFECT BY ALTERNATIVE

This section presents an overview comparison of the Detention Conveyance and the All Conveyance alternatives. The No Project alternative is also addressed. The section also discusses the cumulative visual impacts of the alternatives.

The major difference between the two regional flood control program alternatives is associated with detention basins included in the Detention/Conveyance design, which are located upstream to reduce peak flows through urbanized areas. This allows for narrower linear flood facilities, such as channels, pipelines, and box culverts to carry storm flow.

10.5.1 Detention/Conveyance

The Detention/Conveyance alternative incorporates the construction of detention basins and associated diversion dikes. The potential visual impacts discussed in Section 10.4 are generally related to more localized situations based on the forms of the structures. The above grade facilities may be viewed from distant areas and the principal impacts are associated with potential contrast with the adjacent visual character units.

Considering the higher level of dominance for the detention basins, the ability of these structures to be absorbed is relatively low. The size of the structures increase the potential for dominating the urban and natural characters for both adjacent and distant views. The above grade construction can potentially reach over 30 feet and create high impacts to the surrounding visual character.

Impacts would relate to the change in all the determining factors of form, line, color, texture, they primarily related to form and line. The harsh geometric shapes would be viewed more often and at closer distances in urban areas. Also, the lines of the existing character may be affected due to the heights of the structures. The color and texture of the proposed facilities would be more compatible and absorbed into the existing setting, due to the visual character of the urban areas and rapidly developing rural areas. Most of the major detention basins are located outside existing developed urban areas, which may help mitigate impacts to some degree.

Channels associated with this alternative are generally smaller than those associated with the All Conveyance alternative. Although these structures are still considered visually intrusive, the smaller scale of the Detention/Conveyance alternative channels may reduce their dominance and result in improved visual absorption of these facilities.

10.5.2 All Conveyance Alternative

The All Conveyance alternative requires larger channels and other linear facilities to accommodate the higher peak flow levels. Dikes and levees are incorporated to collect flow conveyance in upstream channels. The design of larger channels and dikes could potentially impact the lines of the surrounding natural setting.

Based on the potential visual impacts discussed in Section 10.4, the increase in the size of the linear facilities would primarily effect the distant views to the structures. These impacts relate to the disturbance of the existing landscape conditions. Constructing larger channels and extensive dikes and levees could increase the amount of soil excavation for long linear distances. This is based on the amount of excavation and extensive open concrete areas which would create contrast for color and texture associated with these larger facilities would represent greater potential for significant visual impact than the smaller channels associated with the Detention/Conveyance alternative.

The facilities included in the All Conveyance alternative could potentially be less compatible in urban areas due to the lack of open space and the increase in facility size. The potential for dominating views adjacent to the structures is dependent on the existing visual character, however, would be more likely in rural and natural areas.

10.5.3 No Project

The No Project alternative would not directly affect the short term impacts of the valley. No visual impacts would occur due to the lack of change to the initial visual character of the area. As major developments proceed in outlying areas, developers would likely be required to include flood control facilities in their project design. Because developers would not be likely to install regional-scale detention facilities, protection of major developments would likely emphasize facilities similar to those associated with the All Conveyance alternative. Local visual impacts would be similar to the impacts of the All Conveyance alternative, but regional-scale impacts would be somewhat less due to the discontinuous nature of these new facilities and lack of new flood control structures in areas outside of major new developments.

10.6 PROGRAMMATIC MITIGATION MEASURES

This section discusses the potential mitigation measures proposed to reduce visual impacts. These measures directly relate to the factors defined for determining potential impacts, the form, line, color, and texture of the facilities based on the BLM Visual Resource Management 8400 (BLM, 1984). Specific measures can be applied to potentially reduce the impacts due to these factors and can relate to all of the facilities (Wirth Associates, 1981; United States Department of Agriculture, 1978).

The most appropriate mitigation measure is the planning of dual uses which would incorporate proposed facilities with planned development such as parks, golf courses, schools, etc. This would greatly decrease the potential for visual impacts. However, those facilities that may not have the opportunity to plan for dual uses can potentially apply the following mitigation measures. Information presented in Tables 10-2 and 10-4 should be consulted to identify potential impacts of each facility type to determine the need for mitigation measures listed below.

Form

F1 -- Use curvilinear forms to reduce rigid shapes by rounding corners of structures, incorporating undulating walls, recessed and step designs which will decrease large flat open surfaces, and be more consistent with surrounding landforms.

F2 -- Use variations in wall heights to increase interest and homogeneous forms.

F3 -- Design facilities to include dual uses for park and recreational activities, landscaping, meandering trails and natural curvilinear forms will reduce impact and increase absorption abilities.

F4 -- Use berms to reduce vertical flat shapes by incorporating rounded landforms into facilities such as dikes/levees, and detention basins. Berms will also increase heights of landscaping.

Line

L1 -- Use landscape planting, community walls and fences to screen adjacent and distant views to linear elements.

L2 -- Incorporate curvilinear design with recreation trails and access roads to contrast and reduce emphasis on linear features.

L3 -- Use rip rap and landscape berms to break up angular lines by feathering edges and softening abrupt ends of facilities.

L4 -- Incorporate landscape elements, large boulders and vegetative planting to break up linear elements in urban setting and more localized views.

Color

C1 -- Use concrete varnishing or color mixing to tint and match existing soils or surrounding concrete colors.

C2 -- Accent concrete surfaces with artistic graphics to enhance the structures in urban and potentially natural settings.

Texture

T1 -- Incorporate rip rap into channels and exposed fill sections to reduce contrast in soil textures of graded surfaces and concrete.

T2 -- Replace top layer of graded surface with existing soil and limit finished grading.

T3 -- Landscape and revegetate berms and disturbed areas to replace soil texture and landscape patterns.

T4 -- Incorporate concrete texturing to open flat surfaces in natural and urban developed areas.

TABLE 10-1

VISUAL UNITS SUMMARY

VISUAL UNITS	SUBAREAS North Las Vegas Valley	Central Las Vegas Valley	Southwest Las Vegas Valley	Boulder City	Henderson
Downtown	--	IV	--	--	--
The Strip	--	--	IV	--	--
Urban	II	V	I	I	I
Significant Urban Features	II	II	I	--	I
Rural	I	I	V	I	I
Airfield/Heavy Industrial	IV	--	I	I	IV
Landscaped	II	II	I	I	II
Natural WSA	V	I	II	--	--
Natural Rec. Area	IV	--	--	--	--
Natural Basin Area	III	I	III	III	III
Natural Range Area	I	II	IV	I	I
Las Vegas Wash	IV	--	--	--	--
Proposed	II	V	I	--	II

KEY:

Classifications are based on the percentage of area occupied by each visual character unit within each subarea and their comparison to other subareas.

-- = not present

I = present - average percentage comparable to other visual units

II = limited - low percentage of area comparable to the size of the subarea and the other visual units

III = major - high percentage of the subarea occupied

IV = largest - largest percentage of area comparable to other subareas

V = combination-both the major visual units of the subarea and the largest percentage comparable to other subareas

TABLE 10-2

POTENTIAL VISUAL IMPACTS

PROPOSED FACILITY	FORM	LINE	COLOR	TEXTURE
Unlined Channel	- Generally inverted trape-zoidal forms which are below grade with 2:1 side slopes - Smaller in size compa-rable to lined channels - Less rigid designs with more flexibility in location - Shapes can impact more localized conditions rather than regional or broader areas	- Generally shorter in linear distances due to capacity levels - Locations generally in existing right-of-way or within current drainage areas - Lines would impact dense areas with limited open space and unavailable existing liner features	- Homogeneous areas with natural soils would be impacted due to the dis-turbance of the ground surface	- Generally smooth texture concrete with natural lining for base of channel - Locations in natural areas primarily with rigid land-forms create contrasting textures with smooth concrete Textures in urban development would be less contrasting due to existing hardscape areas
Lined Channels	- Forms are also trape-zoidal, but generally more extended in width and depth - Size and carry capacities create more rigid designs and limited curvilinear layouts - Shapes can impact more than adjacent views, size can dictate impacts to distant views	- Generally longer linear distances can be attained by larger structures - Size determines general location and may indicate widening of existing areas - Lines of structures would extend to distant hori-zontal views. Surrounding mountain forms contrast with the line of the channels	- Standard concrete color would create contrast to most areas with existing landscape treatment - Locations with dominant hardscaped areas would have less contrast in color	- Same as unlined channel

TABLE 10-2 (continued)

PROPOSED FACILITY	FORM	LINE	COLOR	TEXTURE
Bridge	- Generally forms will be a typical slab design with vertical pilings extending below grade for bridge support - Safety structures will be visible although they will be incorporated into design - Form can be somewhat tailored to surrounding character and will generally be subordinate	- Low profile horizontal lines will span the channel crossing, primarily at grade levels - Lines would have limited effect on views	- Standard concrete color would contrast natural settings, however limited change in character would occur in urban areas - Location of bridges is dependent on traffic flow, those requirements are generally within urban areas	- Finished concrete could impact surrounding character, depending on adjacent development - Urban areas generally have various textures previously introduced to the setting
Levee/Dike	- Forms are above grade trapezoids with 12-foot tops and 3:1 side slopes - Rigid form is dependent on amount of concrete for side slopes or natural berming with required five-foot cut off wall - Shapes can impact distant views depending on setting and size of structure - Full concrete structures have harsh above grade appearances and create obtrusive corners when structures turn - Unlined structures would appear more natural and not as rigid	- Long horizontal designs create linear visual elements which can impact the landscape settings - Impacts are related to adjacent and distant views - Lines of structure which extend along open areas will impact more than one character unit - Berms would create softer lines - Lines can also be considered vertical due to some extreme high structures therefore may potentially be more consistent with urban and other developed areas	- Color contrast are dependent on amount of concrete and design of the berm - Disrupted soils would create contrast and could be viewed from distant areas - Color of soils and structure would be more evident in upper elevations due to difference in soil and fill requirements - Color would effect urban areas less	- Depending on construction, concrete would have smooth texture and unlined berm would be graded and appear smooth from distant views - Textures would effect natural areas due to lack of development while in urban areas textures may have more variety

TABLE 10-2 (concluded)

PROPOSED FACILITY	FORM	LINE	COLOR	TEXTURE
Detention Basins	- Variety in form, generally oblong with a network of accompanying facilities - Embankments similar to concrete dikes at least 15 feet high - Forms are sometimes dictated by shape of site and surrounding landscape character and uses - Shapes generally impact localized areas and adjacent views, however depending on location and surrounding character, distant views can be impacted - Combination of multiple facilities creates various shapes and can increase impacts	- Lines are dependent on form of structure, however they generally are viewed as more vertical comparable to other facilities - Heights of embankments would block local internal views of urban areas and distant vistas - Based on part of structure viewed more than one line character can be attained due to many structures	- Due to the use of all concrete embankments, outlet structures and other facilities there is higher potential for color contrast - Facilities in open natural areas are highly susceptible to contrast in soil color - Large facilities could be visible from distant views and color contrast would intensify impact and draw viewer orientation	- Same as levee/dike
Debris Basins	- Similar to detention basin - Incorporated into system networks - Similar impacts	- Similar impact as detention basins	- Same as detention basin	- Same as detention basin and levee/dike

TABLE 10-3

POTENTIAL IMPACT LEVELS[1]

FACILITY VISUAL DOMINANCE LEVELS[3]	VISUAL SENSITIVITY LEVELS[2] High	Moderate	Low
Dominates view (1)	H	H-M	M
Attracts attention but is not dominant (2)	H-M	M	M-L
Subordinate to surrounding character (3)	M	M-L	L
Represents minimal visual change (4)	M-L	L	L

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1 Table entries refer to potential impact significance as follows:

H = Significant impacts that may be partially mitigated
H-M = Significant impacts that may be partially mitigated
M = Moderately significant impacts that can generally be mitigated to less than significant levels
M-L = Impacts may be significant under special circumstances, but can be mitigated to less than significant levels
L = Impacts generally not significant

2 Visual Sensitivity Levels are defined in Section 10.3

3 Visual Dominance Levels are defined in Section 10.4

TABLE 10-4

POTENTIAL LONG-TERM VISUAL RESOURCES IMPACTS

		FLOOD CONTROL FACILITIES											
		Unlined Channel		Lined Channel		Bridge		Levee/ Dike		Detention		Debris Basin	
VISUAL CHARACTER UNITS	Sensitivity[1]	DL[2]	VI[3]	DL[2]	VI[3]	DL[2]	VI[3]	DL[2]	VI[3]	DL[2]	VI[3]	DL[2]	VI[3]
Downtown	M	3	M-L	2	M	3	M-L	1	H-M	1-3	H-M	1-3	H-M
The Strip	M	3	M-L	2	M	3	M-L	1	H-M	1-3	H-M	1-3	H-M
Urban	M	2	M	1	H-M	3	M-L	1	H-M	1-3	H-M	1-3	H-M
Significant Urban Features	H	2	H-M	1	H	3	M	1	H	1-3	H-M	1-3	H-M
Rural	H	2	H-M	1	H	3	M	1	H	1-3	H-M	1-3	H-M
Airfield/Heavy Industrial	L	4	L	3	L	4	L	3	L	3	L	3	L
Landscaped	H	2	H-M	1	H	2	H-M	1	H	1-3	H-M	1-3	H-M
Natural WSA	Excluded												
Natural Rec. Area	H	2	H-M	1	H	2	H-M	1	H	1	H	1	H
Natural Basin Area	L	3	L	2	M-L	3	L	1	M	1	M	1	M
Natural Range Area	M	2	M	1	H-M	2	M	1	H-M	1	H-M	1	H-M
Las Vegas Wash	M	4	L	3	M-L	3	M-L	1	H-M	1	H-M	1	H-M

1 Visual Sensitivity Levels are defined in Section 10.3 and include:
H = High Sensitivity
M = Moderate Sensitivity
L = Low Sensitivity

2 Visual Dominance Levels (DL) are defined in Section 10.4 and include:
1 = Facility dominates view
2 = Facility attracts attention, but is not dominant
3 = Facility is subordinate to surrounding character
4 = Facility represents minimal visual change
The visual dominance level of detention and debris basis varies depending upon the height of the structure above ground surface.

3 Potential Visual Impact (VI) Levels:
H = high
H-M = high to moderate impact
M = moderate impact
M-L = moderate to low impact
L = low impact
The visual impact level of detention and debris basis varies depending upon the height of the structure above ground surface.

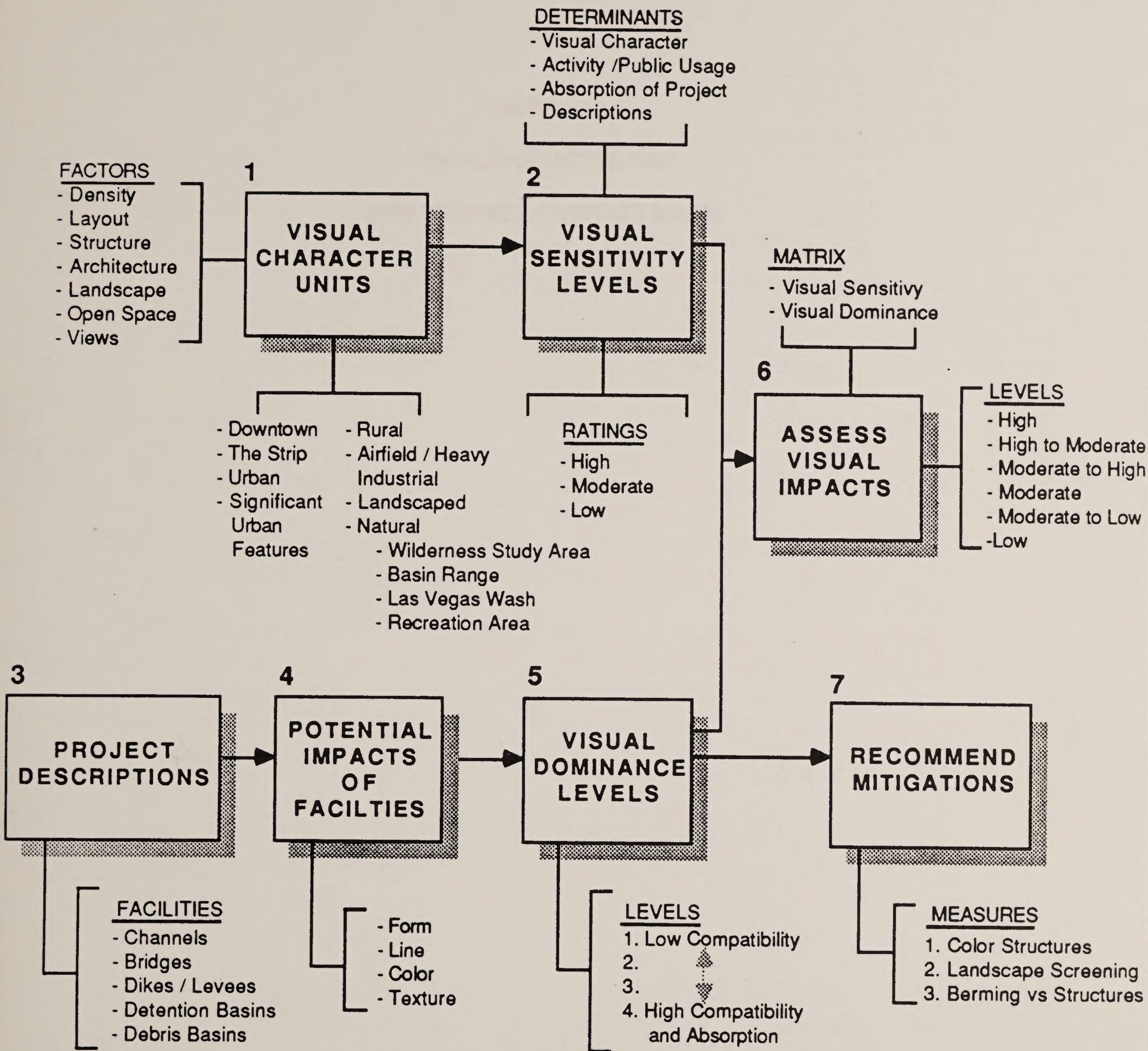


FIGURE 10-1

VISUAL RESOURCES METHODOLOGY

DAMES & MOORE

FIGURE 10-2

VISUAL CHARACTER MAP

(SEE VOLUME II, OVERSIZE MAPS)

11.1 OVERALL ENVIRONMENTAL CONDITIONS

Growth in the Las Vegas Valley area of Clark County, Nevada is occurring at phenomenal rates. Its location relative to other metropolitan centers such as Los Angeles, Phoenix, and Salt Lake City, its warm climate, and its relative affordability have made the area attractive to increasing numbers of residents.

Because of the rapid rates of growth in the area, current data and accurate projections are difficult to obtain. As such, information obtained during interviews with local planning officials and Realtors was used to supplement published sources of information on overall socioeconomic conditions. Major printed sources consulted included: 1) Clark County Department of Comprehensive Planning (CCDCP, 1987) and Las Vegas Perspective 1988 (Cooper et al., 1988). The latter publication provides the most up to date statistics on the valley since the Comprehensive Plan was last revised in 1982.

11.1.1 Population

The current population of Clark County is estimated to be approximately 681,000 persons (Table 11-1). Because the majority, about 95 percent, of the population of Clark County is concentrated in the urbanized metropolitan area of the Las Vegas Valley, Clark County figures will be used as an approximation of the population in the project study area (Cooper et al., 1988).

Following construction of Hoover Dam Clark County's population grew rapidly. The highest annual growth rates were experienced in the 1940s and 1950s, averaging 11.7 and 10.2 percent respectively. More recent growth rates have generally been lower. For example, the average annual growth rate between 1980 and 1987 was 4.9 percent; the annual growth rate between 1985 and 1987 was 6.5 percent.

The 1988 growth rate is probably higher than growth rates in the past several years as indicated by the increase in the numbers of Certificates of Occupancy (COs). COs are issued by planning departments and represent the number of structures built. The number of COs issued in the past few years had been in the range of 11,000 to 12,000. As of mid-December 1988, COs for the year totaled approximately 24,000 (Harris, 1988).

The median age of the Clark County population is approximately 33. The Las Vegas Valley is an attractive area to live for all age groups, including retired persons, who represent 19 percent of the total households in the Las Vegas Valley (Cooper et al., 1988). Table 11-2 presents the distribution of the population by age group based on a 1987 market survey.

Projections of future population in Clark County vary widely, ranging from 816,000 persons to 1,069,430 persons in the year 2000. Table 11-3 presents a comparison of various population projections. The sources and dates of the projections, when available, are cited. In cases where our data source had cited other data sources or a combination of other data sources, these are also indicated.

Discussions with planners did not indicate a preferred population projection for the year 2000. Planners, other local agency personnel, and Realtors all agreed that growth is currently occurring at a rapid rate and is expected to continue. All local governments are promoting growth in the Las Vegas Valley, with the exception of Boulder City, which has a moratorium on growth.

Table 11-4 presents estimates of the number of residents and households in Las Vegas Valley subareas as of 1987 (Cooper et al., 1988). Most of the valley's population resides on the north and west (Spring Valley) sides of the valley, while most commercial and industrial activity is in the central and southern parts of the valley. Residential development has been most rapid in the unincorporated county areas on the north and west sides of the valley, in central Las Vegas, and in Henderson (Cooper et al., 1988).

11.1.2 Employment

High rates of employment growth have been associated with the high population growth rates. In May 1987, the number of employed persons in Clark County averaged approximately 284,200 (Nevada Employment Security Department, 1987). Table 11-5 provides a breakdown of employment by industry in Clark County.

The Las Vegas area contains the majority of the County's population and workforce. The largest single employer is Nellis Air Force base, employing approximately 12,000 military and civilian personnel. It is located approximately eight miles northeast of Las Vegas. Hotel and Gaming is the largest industry, accounting for 88,100 jobs in 1987, or 31 percent of the total. Retail trade is also a strong component of the local economy, accounting for 49,800 jobs in 1987, or 18 percent of the total.

The annual unemployment rate in Clark County for 1988 is projected to be approximately 5.5 percent, one of the lowest in the nation (Murdock, 1988). Between 1980 and 1988 the unemployment rate varied from a high of 10.9 percent in 1982 to the current low of approximately 5.5 percent. The unemployment rate has decreased steadily since 1982.

11.1.3 Housing

Expansion of the housing stock has been driven by the area's population growth. Currently, several large subdivisions are under construction. The housing market is strong and is expected to remain so in the near future.

Approximately 48 percent of Las Vegas residents live in single-family dwellings and approximately 71 percent of Las Vegas residents own their homes (Cooper et al., 1988). The number of various types of housing in the Las Vegas area is presented on Table 11-6. Preference for the single-family dwelling is expected to continue.

The median home price in Las Vegas is in the range of $89,000 to $92,000 (K. Rubin, 1988; M. Rubin, 1988; Gerstler, 1988; Cooper et al., 1988). There is a broad range of prices varying from approximately $45,000 to over $1 million. The majority of the new homes are within large subdivisions and there is a large supply of affordable housing.

11.1.4 Retail Sales

The sales tax rate in Nevada is six percent and total taxable retail sales for 1987 in Clark County were approximately $5.67 billion, an increase of 11 percent over the 1986 total of approximately $5.1 billion. The steady increase in volume of sales is illustrated in Table 11-7.

11.1.5 Personal Income

Personal income in Clark County totaled approximately $8.84 billion in 1986 with a per capita personal income of $14,896 (Murdock, 1988). The median household income of Las Vegas Valley residents for 1988 is estimated to be $32,300, with 64 percent of these households having an income of $25,000 or more (Cooper et al., 1988).

11.1.6 Property Values

Land values, home prices, and commercial and industrial lease prices were obtained through interviews with Realtors in the Las Vegas Valley. They provided professional opinions and examples of experiences relating to the impact of flood protection facilities on property prices and development patterns.

Residential land prices in the valley range from approximately $30,000 to $40,000 per acre for parcels with utilities available and ready for development. Commercial land prices range from approximately $6.50 to $15.00 per square foot for parcels with utilities in established areas, while industrial land prices range from approximately $3.50 to $5.00 per square foot.

Most residential land in the valley is purchased in large parcels for subdivision development. Commercial properties are generally within "strip developments" along main streets and development of industrial lands generally is limited to industrial parks (K. Rubin, 1988; M. Rubin, 1988).

Development is occurring throughout the metropolitan portion of the valley. A large portion of the development is taking place in two areas: the northwest portion of the valley including lands along Highway 95 and the southeast portion of the valley including the Paradise, Green Valley, Enterprise, and Henderson areas. A large planned community, Summerlin, is currently under construction west of Las Vegas. Summerlin is expected to reach full capacity after approximately 50 years and will accommodate over 200,000 residents (Harris, 1988).

Flood protection or lack of flood protection affects the market value of property according to Realtors interviewed. Several reasons were given for the difference in market value: 1) the buyers' perception of the degree of safety, 2) physical building limitations, and 3) extra expense associated with the protection of flood-prone properties.

Realtors reported that properties adjacent to a wash or properties including a wash are more difficult to sell because buyers tend to avoid wash properties and are generally lower in price. A property adjacent to a wash could sell for approximately ten percent less than property further removed from a wash (K. Rubin, 1988; M. Rubin, 1988). The price of a wash property is dependent on the amount of usable land on the parcel since development of the wash portion of the parcel is extremely limited by drainage regulations. Therefore the wash portion of the parcel is not as valuable, lowering the total price of the parcel (Gerstler, 1988).

Because much of the valley is traversed by washes, parcels purchased for large residential subdivisions often include washes. Since local drainage regulations restrict development and require flood protection, this adds to the developer's costs and limits the layout of the subdivision. For example, a wash on a large parcel might be channelized by concrete lining; the lands immediately adjacent to a wash might be used for a golf course or not used at all; or a brick wall might be constructed between nearby houses and a wash.

Building restrictions also apply to alluvial fans, which cover much of the western and northern portions of the valley and are subject to sheet flooding. For example, structures are required to be at least 18 inches above the 100-year surface water elevation and channels could be required to carry water into culverts and washes in the event of a flood.

11.1.7 Public Services

11.1.7.1 Police Protection

Police protection for Clark County is provided by four police departments: Las Vegas Metropolitan (Metro), Boulder City, Henderson, and the City of North Las Vegas. Las Vegas Metro provides service to the City of Las Vegas and the unincorporated areas of Clark County. Unincorporated rural areas are policed by Metro officers who are assigned to and live in a specified rural area. Table 11-8 provides information on each of the police departments.

The current rapid population growth is exerting pressure on existing police protection capacities. All of the police departments listed above, with the exception of Boulder City, are planning to expand their police forces by hiring more officers. Boulder City is not growing as rapidly as other jurisdictions in the Las Vegas area due to a growth moratorium. Funding for the police force expansions will be provided by recently approved tax increases. Developers are not assessed impact fees to help provide police services (Botkin, 1988; Ginser, 1988; Kinnee, 1988).

11.1.7.2 Fire Protection

Fire protection is provided by Clark County, Nellis Air Force Base, and the cities of Las Vegas, North Las Vegas, Henderson, and Boulder City. The Clark County Fire Department serves the unincorporated urban and rural areas. Service in rural areas is provided by 16 stations operated by volunteer firefighters. Clark County Fire Department provides the stations and the equipment. The Clark County Fire Department has mutual aid agreements with Nellis Air Force Base and the cities of Las Vegas, North Las Vegas, and Henderson. When a fire occurs, the fire station nearest to the fire responds regardless of jurisdiction. Table 11-9 presents information on staff and equipment maintained by each fire department in the study area.

Ratings made by the Insurance Service Offices, a private organization which classifies urban areas for fire insurance purposes, rates fire departments on a scale of 1 to 10, with 1 being the best rating. The ratings of fire departments in the study are presented in Table 11-10. As this table indicates, fire department ratings in the Las Vegas Valley and Boulder City areas are generally very good.

Rapid population growth is exerting pressure on the departments' existing firefighting capabilities. Discussions with planners and fire department personnel indicate that sources of funding for expansion of capabilities, such as the construction of new fire stations near the new subdivisions, is now limited to tax increases and bond measures (Ginser, 1988; Kinnee, 1988; Mills, 1988; Price, 1988; Shoeburne, 1988). Currently, developers are not required to contribute to fire departments' expansions.

11.1.7.3 Water

The water sources for Clark County are Lake Mead and public and private wells. Water from Lake Mead is provided through the Southern Nevada Water System Project which is jointly owned by the State of Nevada and the federal government. The Bureau of Reclamation, in cooperation with the Colorado River Commission, designed and developed the Southern Nevada Water System to provide the ultimate delivery of 299,000 acre-feet per year to the Las Vegas Valley. In 1987, approximately 174,000 acre-feet per year or 58 percent of ultimate capacity are being used. The ultimate delivery amount of 299,000 acre-feet could be increased in the future based on return flow credits to the Southern Nevada Water System (Braybrook, 1988).

Contracting water users of the Southern Nevada Water Project are the Las Vegas Valley Water District, Nellis Air Force Base, and the cities of North Las Vegas, Henderson, and Boulder City. Basic Manufacturing Inc. has a separate contract for water from Lake Mead. A breakdown of water currently delivered to the Las Vegas Valley from the Southern Nevada Water Project is presented in Table 11-11.

Basic Manufacturing Inc. is an industrial park in Henderson; its water is used in the park's industrial facility and in the City of Henderson. The Las Vegas Valley Water District serves major portions of the City of Las Vegas and other unincorporated areas in the Las Vegas Valley. The City of North Las Vegas serves itself, a small part of the City of Las Vegas, and a portion of the unincorporated areas of Clark County.

The second source of water in the valley is a number of private wells which pumped approximately 67,000 acre-feet/year in 1987. The Las Vegas Valley Water District pumped approximately 37,154 acre-feet of this water in 1987. Other users are Nellis Air Force Base and the cities of North Las Vegas, Henderson, and Boulder City. Since 1945, groundwater withdrawals have exceeded recharge. This continued overdraft has resulted in a general lowering of the water table and surface settlement in some areas of the County.

The daily per capita use of water in the Las Vegas Valley area is approximately 318 gallons (Braybrook, 1988).

11.1.7.4 Sewer

Collection

The incorporated cities in the Las Vegas Valley, as well as Nellis Air Force Base collect wastewater within their jurisdictions. Clark County Sanitation District collects wastewater in the majority of the serviced unincorporated area which is generally south of Sahara Avenue and east of Pecos Road (CCDCP, 1987). The City of Las Vegas collects wastewater from portions of the unincorporated areas north of Sahara Avenue and west of Highway 95, in addition to the incorporated area of the city.

Treatment

Individual treatment facilities are operated by the Clark County Sanitation District, and the cities of Las Vegas, Henderson, and Boulder City. Clark County Sanitation District treats wastewater from Nellis Air Force Base and services unincorporated portions of Clark County.

Clark County Sanitation District maintains three plants: a 40 million gallon capacity secondary plant, an 18 million gallon capacity headworks facility, and a 90 million gallon capacity Advanced Water Treatment Facility. The headworks facility screens and degrits wastewater, mixes it with secondary effluent from the secondary plant, then sends it to the County's Advanced Water Treatment Facility. Clark County currently processes approximately 41 million gallons of wastewater per day. Treated effluent is discharged into the Las Vegas Wash which flows into Lake Mead (Faulkner, 1988).

The City of Las Vegas has a 40 million gallon capacity secondary plant which is currently operating at full capacity. The City of Las Vegas' facility treats wastewater from both the cities of Las Vegas and North Las Vegas. A 25 million gallon capacity expansion is currently under way. Treated effluent is discharged into the Las Vegas Wash (Faulkner, 1988).

The City of Henderson operates a closed treatment system. Treated effluent flows into infiltration basins and infiltration lagoons. There is no discharge to a surface water body (McCormick, 1988).

Boulder City operates a treatment system which includes oxidation ponds. Approximately two-thirds of the treated effluent is released onto desert land where it infiltrates into the ground. The other third of the treated effluent is recycled and used in a local sand and gravel operation.

In some rural areas, private wastewater treatment plants are in operation. In unsewered areas, wastewater treatment is handled by septic tank disposal systems (CCDCP, 1987).

11.1.7.5 Natural Gas

Supply of natural gas to all of southern Nevada is provided by Southwest Gas Corporation. The gas line enters Clark County at the Arizona border, passes through Boulder City and terminates in the Las Vegas Valley. In Boulder City, gas is distributed by C.P. National which buys its gas from Southwest Gas Corporation. In the remaining serviced portion of Clark County, natural gas is distributed directly by Southwest Gas Corporation. The outlying areas of Clark County are not served (Clement, 1988).

The current capacity of the existing system is 170 million cubic feet per day (MMCFD). Peak use is approximately 150 to 160 MMCFD and occurs in the winter. Average use is approximately 120 MMCFD per day. Southwest Gas Corporation is planning to expand its facilities in the Las Vegas Valley. The future expansion is expected to accommodate the expected growth in the valley (Clement, 1988).

11.1.7.6 Electricity

Electricity service to the entire Las Vegas Valley, with the exception of Boulder City, is provided by the Nevada Power Company (NPC). Boulder City contracts directly with federal power sources which include Hoover Dam Power (CCDCP, 1987).

The NPC operates two power plants in the Las Vegas Valley. One plant is located to the northeast of the City of Las Vegas; the second plant is located to the southeast.

Peak demand for electricity in 1987 was 1,740 megawatts and occurred during the summer months. The lowest demand occurs in the winter months and is approximately 60 percent of the summer peak demand, or 1,040 megawatts. The combined capacity of NPC in the valley, including both power plants owned by NPC and power plants in which NPC has an interest is approximately 1,876 megawatts (Galati, 1988).

NPC has two plans for expanding its existing system. The first expansion involves a transmission tie-in line which will connect the valley facilities to a power grid in Utah. The tie-in is expected to be completed by the spring of 1989. The second expansion involves the construction of a new power plant. This plant is scheduled for completion in the mid- or late-1990s (Galati, 1988). NPC works closely with planners and other government entities to insure an adequate power supply to the Las Vegas Valley (Galati, 1988).

11.1.7.7 Telephone Service

Local telephone service to Clark County is provided by the Central Telephone Company ("Centel"), a subsidiary of Centel Corporation. The recent high growth rates in the Las Vegas Valley have not affected the level of service significantly; Centel works closely with developers in order to provide service. The anticipated growth in the valley is not expected to result in inadequate service capacity (Goodell, 1988).

11.1.7.8 Medical Facilities

The Las Vegas area has eight hospitals, more than 150 local clinics, many convalescent centers, and the Nathan Adelson Hospice. A total of 803 licensed physicians, 2,701 registered nurses, 770 practical nurses, and 219 dentists, orthodontists, and oral surgeons staff these facilities (Cooper et al., 1988:14). There are 2,127 licensed beds, divided among the eight hospitals (Table 11-12).

11.1.7.9 Solid Waste

Collection and disposal of solid waste in the Las Vegas Valley is provided by Silver State Disposal Company. The county and the cities do not provide collection or disposal services (Jenner, 1988).

Collection services are mandatory for the incorporated cities of Henderson, Las Vegas, North Las Vegas, and Boulder City. Collection is also mandatory for the unincorporated areas within the metropolitan Las Vegas area (CCDCP, 1987). Solid waste is collected by Silver State Disposal Company and deposited at several transfer stations throughout the valley and then transferred to the Sunrise Landfill.

The Sunrise Landfill is located east of the City of Las Vegas and occupies 720 acres. Sufficient landfill capacity is available, as well as additional land for new landfills (Jenner, 1988). The land containing the Sunrise Landfill is owned by the BLM and leased to the City of Las Vegas (Jenner, 1988). The landfill is operated by Silver State Disposal Company.

11.1.7.10 Flood Protection

Flood protection in the Las Vegas Valley is provided by both public and private sources. Local governments are using bond funds to implement flood control improvements. The CCRFCD has recently completed and is currently building several flood control facilities. Recently completed projects include the Meadows Detention Basin and the Kings Charles Diversion Channel. The District's Master Plan outlines conceptual plans to significantly expand the area's flood control system in the future and is the focus of this EIS.

Private developers often are required to provide flood protection. The District has formulated uniform drainage regulations which have been adopted by the cities in the valley (Sutko, 1988). Flood protection provided by developers includes improvement of existing washes, construction of walls along channels, and elevation of building foundations.

11.1.8 Schools

The Clark County School District serves the Las Vegas Valley. The school district has a total of 137 schools as of August 1988. These include 80 elementary schools, eight sixth grade centers, 20 junior high schools, and 16 high schools. Thirteen other programs include adult education, juvenile court programs, and alternative programs (Clark County School District, 1988). The distribution of the 104,077 enrolled students by grade is listed in Table 11-13.

The schools are currently at or above full capacity (Nehl, 1988). Many of the schools have formulated programs to help relieve the capacity difficulties. For example, 15 of the elementary schools are operating on a year-round schedule instead of the regular nine-month schedule. Many schools have portable classrooms to accommodate the increasing student population and some schools are operating on a double session schedule. In a double session schedule, a portion of the students arrive and leave earlier or later than regular schedule students.

New school construction is financed through bond issues (Nehl, 1988). Developers are not required to provide land or funding for school construction.

11.1.9 Parks and Recreation

Recreational areas and facilities are available on both a local and a regional level in the Las Vegas Valley area. Locally the area contains 124 parks including 55 county parks, 10 parks in Boulder City, 34 parks in Las Vegas, and 25 parks in North Las Vegas. There are 15 golf courses, several miniature golf ranges, several public tennis courts, and 8 bowling centers (Cooper et al., 1988).

On a regional level, there are several larger parks within a one hour drive of the Las Vegas Strip. These parks include Hoover Dam and Lake Mead National Recreation Area, Spring Mountain Ranch State Park, Valley of Fire State Park, Toyable National Forest, Bonnie Springs/Old Nevada, and Red Rock Canyon.

To accommodate the growing population in the valley, Clark County, Las Vegas, and Boulder City levy park development fees on developers. The cities of North Las Vegas and Henderson do not collect these fees.

Clark County Parks and Recreation Department charges a per dwelling unit fee on all dwelling units built in the unincorporated county, including hotel and motel rooms. The fee is tied to the development's construction cost and the highest fee is $313 per dwelling unit (Trowbridge, 1988).

The Clark County Commission has established a standard of four acres of developed County parkland per 1,000 people, although current parks include only 2.7 acres of developed parkland per 1,000 people. During the past ten years this ratio has been decreasing (Trowbridge, 1988). Currently, the development fees do not cover the entire cost of acquisition and development of new County parkland or development of existing parkland and the County Parks and Recreation Department must secure funding from other sources.

Boulder City imposes a construction tax on residential developers. The developer pays one percent of the sales price of each house, up to a maximum per house charge of $1,000. Tax monies collected are used to construct new parks or improve existing neighborhood parks in the vicinity of the new development.

11.1.10 Government Revenues and Expenditures

The total assessed value of all real property in Clark County for fiscal year 1987/1988 was approximately $11.59 billion. Assessed value of all real property within the incorporated cities of Las Vegas, North Las Vegas, Henderson, and Boulder City totaled approximately $3.22 billion.

Property taxes levied for all districts and entities within Clark County during fiscal year 1987-1988 totaled approximately $198.3 million (Canez, 1989). Approximately $78.1 million of this total is returned to Clark County (Canez, 1989). The tax rate in fiscal year 1987-1988 was approximately 2.5 percent of assessed value. Assessed value is determined by taking 35 percent of appraised value (June, 1989).

Projected taxable sales totaled approximately $5.94 billion in fiscal year 1988 (MacDonald, 1988). The sales tax rate in Nevada is six percent.

11.2 SIGNIFICANT RESOURCES AND ENVIRONMENTAL ISSUES

Major infrastructure projects affect the lives of many people and can significantly affect the economic productivity and cultural structure of a region. Flood control projects are a special case because their geographical spheres of influence are highly localized, according to the local hydrology, rather than diffused like a power or water supply facility's. If the region is highly developed, the socioeconomic impacts of a flood control project are almost exclusively positive because: 1) developed properties rarely are permanently displaced or disturbed by the works, and 2) the local economy has ample manpower and material resources to execute the works without requiring the importation of transient labor. As a result, many of the socioeconomic impacts ordinarily associated with construction and operation of infrastructure projects do not occur with flood control projects.

Except in the few instances where construction of a flood channel or detention basin or other facility requires condemnation of private property or relocation of roads, utilities, or other structures, flood control projects do not generate adverse socioeconomic impacts or the need for mitigating measures. Should construction of the flood control facilities cause displacement of residences, businesses, schools, and other public services, potential impacts on population, housing, employment, education, and public health and safety could occur. Absent physical displacement, these resources would be benefited by the facility, which is an effect not requiring any mitigation. The approach for evaluating these resources in instances where a proposed flood control structure would have a direct impact on one or another of them is described in programmatic fashion in Section 11.5.

Apart from highly localized impacts on specific structures such as homes and businesses, the proposed flood control project would not significantly affect the overall levels and trends of economic and social activity in the Las Vegas Valley. Some concerns regarding local government expenditures and resulting tax rates warrant review, however. In addition to these potential adverse effects, the implementation of a regional flood control program could result in socioeconomic effects that are generally considered beneficial. These beneficial effects include improved construction employment, increased local expenditures for construction materials, and improved protection against flood-related losses. The following discussion addressed potential socioeconomic issues associated with each area of potential concern described in Section 11.1.

11.2.1 Population Growth and Related Development

The distribution and growth of population, industry, and public services is governed by the Comprehensive Plan, which treats the flood control program as a supportive element of the overall development process (CCDCP, 1987). The restraining forces on growth due to the addition of flood control facilities are a combination of institutional policies and procedures.

The primary institutional restraint on potential inducement of growth is the set of criteria used to prioritize facilities construction by the District. The relative priority of Master Plan projects will be assessed using these ten criteria. The criteria and their relative weights are listed in Table 11-14. Application of this prioritization scheme would tend to favor projects in developed or developing areas. For example, application of criterion "population affected" to a developed area would indicate a large number of people protected, yielding a high "score." Conversely, application of this same criterion to an undeveloped area is likely to indicate the reverse, that is, a small number of people protected, yielding a low "score."

A particular flood control project would be considered growth-inducing if its presence would cause unplanned development. Local and regional planning policies, procedures, and documents such as master plans and zoning ordinances determine allowable growth patterns. Limits are established on the areas that may be developed and the densities to which such areas may be developed. In areas where a comprehensive plan calls for no development, there would be no reasonable justification for construction of a flood control facility to accommodate growth in that area. Of course, plans, ordinances, and policies are periodically updated and amended. Subsequently, an undeveloped area could become a developing area due to an amendment to a general plan or a change in zoning designation. However, the amendment or rezoning would occur due to a request from a developer or a public entity for the development itself, and not to the potential of public supported flood control.

The availability of publicly supported flood control facilities is not a constraint on or an impetus to growth in the same way that the availability of other public services such as availability of water or a sewer system. This is apparent in the existing development patterns in the Las Vegas Valley in particular, which does not appear to have been constrained by the lack of adequate flood control facilities in many areas. Current development proposals commonly include project-specific flood protection, and would likely proceed in the absence of a regional flood control program. For this reason, and considering the institutional constraints mentioned above, no socioeconomic impacts associated with population growth and related development are attributed to the regional flood control program.

11.2.2 Employment

The overall cost of the proposed flood control program for the five subareas is approximately $1,260 million (All Conveyance alternative) or $763 million (Detention/Conveyance alternative). This translates into approximately 34,294 (All Conveyance) or 21,135 (Detention/Conveyance) jobs over the buildout period of the entire project. Depending on the duration of the construction periods and their scheduling relative to one another, several of the jobs created could likely provide employment for a single individual over time.

During construction of the 10-year plan facilities, a total of approximately $158 million would be spent as discussed in Section 3.2. This amount of capital expenditure translates into approximately 4,377 additional jobs for the region (United States Department of Commerce, 1986). This figure includes both direct and indirect employment. If these 4,377 jobs were equally distributed over the ten year period, approximately 438 new positions would be created each year. This represents an increase to the existing job base (283,700 in 1987) of about .0015 percent. The impact on employment is positive, but less than significant.

11.2.3 Local Sales

Spending related to increased personal income would result in a small increase in taxable sales throughout the construction phase of the project. Because the personal income increment is negligible the resulting sales amounts would also be negligible.

11.2.4 Income

The approximately $1,260 million (All Conveyance alternative) or $763 million (Detention/Conveyance alternative) spent over the buildout period of the entire flood control system would generate approximately $718 million or $435 million in additional personal income for each alternative respectively.

The approximately $158 million spent over the ten year period would add a total of approximately $90 million to personal income for residents of the Las Vegas Valley area. If this $90 million were equally distributed over the ten year period, approximately $9 million would be added to the existing total personal income of $8.84 billion in 1986 dollars. This represents an increase of less than one percent. The addition to personal income, though positive, is not a significant impact and therefore would not warrant further environmental analysis.

11.2.5 Property Values

Depending on the location of the flood control channels, detention basins, and dikes relative to developed and undeveloped lands, construction of the flood control facilities would affect the value of some properties. Property values are expected to increase in both developed and undeveloped areas. The increases, however, would be limited to properties immediately adjacent to the flood control facilities or properties whose flood insurance costs decrease as a result of reduced flooding risks once flood control facilities are in place. The relative magnitude of property value increases in undeveloped areas would be greater than increases in developed areas as discussed below.

11.2.5.1 Potential Value Increases

Undeveloped Areas

Values of undeveloped properties immediately adjacent to channels and properties immediately downstream of dikes and basins would likely increase.

The system of channels proposed in the flood control plan would formalize and contain the drainage courses on properties which currently have natural washes. Although the land within the channel would be taken into the public domain, the land remaining in private ownership would realize an increase in its per acre value.

Channel properties without flood control can be viewed as having three parts: the unusable wash, a usable area, and a "fringe area" between the unusable wash and the usable area, as illustrated in Figure 11-1.

The installation of a flood control channel would have three effects. First, the fringe area would become part of the usable area, making a larger portion of the parcel available for development. Second, potential buyers of channel properties would view the property as safer. Third, developers of channel properties would not have to pay for construction of private flood control measures. Any of these effects or a combination of them would cause the value of the property to increase.

In the case of detention basins and dikes, properties immediately downstream of the structure would have a reduced chance of flooding from storms originating in upstream locations. Because of the greater degree of flood protection, the value of these properties is likely to increase at a faster rate than those parcels located outside of the cone-shaped area below the detention basin or dike. This area of improved protection is illustrated schematically on Figure 11-2. Installation of a dike or basin would have effects on property values similar to the effects caused by channel construction. First, developers of properties protected by dikes and basins would avoid having to pay for the design and construction of private flood control facilities. Second, potential buyers of dike or basin-protected properties would view the property as safer. Either of these effects or a combination of the two would cause the value of the property to increase.

Developed Areas

Property values in developed areas would either remain the same or increase slightly. In cases where the addition of the flood control facility would cause an increase in the available upper limit of flood insurance coverage and/or a decrease in flood insurance premiums, property values could increase slightly. Homeowners would feel safer with the additional coverage and/or would pay less for coverage. Currently, less protected areas have lower insurance limits and higher premiums than do protected areas.

Insurance companies establish coverage limits and premiums based on Federal Emergency Management Agency (FEMA) maps which delineate flood potential such as frequency of floods and water depths. Amendment of FEMA maps is possible through submission of an application which includes a description of the facility and its maintenance program, as well as a hydrological (engineering) study identifying the area's changed flood potential as a result of the flood control facility. The extent and type of FEMA map amendments would determine the magnitude of property value increases resulting from the flood control insurance changes.

11.2.5.2 Potential Value Decreases

If structures or improvements were to be removed in order to construct a flood control facility, the value of the affected property could decrease due to the absence of the structure or improvement. However, due to District regulations governing facility planning and construction, it is very unlikely that structures and/or improvements would be taken. Were this to occur, the entire property would likely be purchased for the flood control facility, causing it to be removed from the assessment rolls. Some reduction in value could occur associated with the visual impact of flood control structures in scenic areas, but this reduction would likely be more than offset by increased value associated with improved flood protection.

11.2.6 Government Reserves and Expenditures

11.2.6.1 Property Tax Revenues

Property tax revenues are expected to be unaffected or to increase slightly as a result of the project. In some cases, proposed detention basins may be located on private property. These parcels would be removed from the assessed roll and transferred into public ownership. As a result, these parcels would generate no further property tax revenues to local jurisdictions. However, the parcels whose value increases due to the addition of flood control could potentially generate higher tax revenues, which are expected to more than offset the losses due to removal of private property. The net effect would be an slight increase in property tax revenues of minor significance.

11.2.6.2 Sales Tax Revenues

Spending related to increased personal income would result in a small increase in taxable sales throughout the construction phases of the project. This increase is expected to be less than significant.

Temporary increases in sales tax revenues would occur during the construction periods of the facilities. During construction of the 10-year facilities, approximately $62.6 million would be spent on construction materials, most of which are expected to be purchased locally. The sales tax rate in Nevada is six percent. The portion of sales tax revenues which flow directly to the county represent one percent of taxable sales. If the $62.6 million were to be spent in equivalent increments over the ten-year period, an annual increase of approximately $62,600 to the existing tax base would occur. This represents a minor increment to the existing tax base (almost $6 billion) of about .001 percent. This represents a positive, yet less than significant impact.

11.2.6.3 Local Government Expenditures

With respect to local government costs, operation of the flood control facilities proposed in the District's Master Plan would have minimal direct effects. Currently, local jurisdictions make expenditures for road repair and maintenance following flood damage. With the proposed area-wide flood control system, expenditures would be focused on maintenance of channels, detention basins, and dikes. Funds that were previously spent on repairing roads damaged during floods would now be spent on keeping channels and basins clear of debris. Thus, operation and maintenance costs of the flood control facilities would represent a shift of resources rather than a new expense for local governments (Sutko, 1988). No further environmental analysis of this issue would be necessary.

11.2.7 Housing, Public Services, School Capacity, Parks and Recreation

Significant impacts on housing, public services, and school capacities are not expected to occur due to the proposed flood control facilities. The construction and operation of the facilities are not expected to necessitate the import of workers from outside the county. Therefore, no impacts directly due to the flood control facilities are expected to occur to housing, public services, and schools. The proposed flood control system could have negative visual impacts on existing recreation areas, but may enhance parks and recreation opportunities by the multiple use of detention basins and floodways.

11.3 GENERAL ENVIRONMENTAL EFFECTS

In general, socioeconomic impacts would not represent a major criterion for choosing between the two flood control alternatives, nor would the cumulative effects of the projects in terms of adverse impacts be a criterion for selection of one or the other. The potentials for localized negative impacts are very low, given the criteria for prioritization of program elements, while the positive effects would be widely diffused. The nature of construction impacts and direct and indirect effects of operation are discussed below.

11.3.1 Construction Impacts

Construction of the proposed flood control facilities would have potentially significant impacts on socioeconomic resources located at the sites of facilities if the siting criteria require acquisition of developed property. Because it is the policy of the District to not displace structures if they can be avoided, these effects are likely to be minimal. Beyond these highly localized site-specific impacts, however, the impacts on the Las Vegas Valley region would be small and positive.

11.3.2 Direct Operational Impacts

Operation of the proposed facilities would have beneficial effects through the protection of lives and property. Operation of the facilities would have a minor effect on employment and maintenance costs. Resources previously devoted to repairing flood damaged assets would be shifted to activities associated with maintenance of the flood control facilities.

11.3.3 Indirect Operational Impacts

As discussed previously in Section 11.3, indirect effects of the proposed flood control system on tax revenues, employment, and income would be positive but not significant. These benefits would be dispersed throughout the Las Vegas Valley region.

11.4 ENVIRONMENTAL EFFECTS BY ALTERNATIVE

Section 11.3 discusses the socioeconomic effects of flood control facility construction and operation on the Las Vegas Valley area. This section provides a comparison of the socioeconomic effects of each flood control alternative.

11.4.1 All Conveyance Alternative

Potential adverse effects of this alternative include local government expenditures of approximately $1,260 million. Because the source of funds supporting this program is a sales tax which includes substantial reserves from non-resident expenditures, possible federal funding support, and expenditures primarily associated with local labor and construction materials, adverse impact associated with local government expenditures are not considered significant. These expenditures may result in positive, but generally not significant effects on local employment and sales.

Beneficial effects of the All Conveyance alternative are small and generally not significant when considered in the context of the economy of the entire Las Vegas Valley region. The magnitude of these positive effects is related to the cost of this alternative and would be proportionally greater than positive impacts associated with the less expensive Detention/Conveyance alternative.

Because the All Conveyance alternative would require wider channels to accommodate storm runoff, this alternative potentially may be more disruptive to existing land uses in the urban area. Thus, the socioeconomic implications of compensating or relocating dislocated businesses or residences may be greater for this alternative in comparison to the Detention/Conveyance alternative.

11.4.2 Detention/Conveyance Alternative

This alternative would involve local government expenditures of approximately $763 million. Effects of these expenditures are similar to those described for the All Conveyance alternative, and are small and generally not significant when considered in the context of the economy of the entire Las Vegas Valley region. The magnitude of potential effects is related to the cost of this alternative and would be proportionally smaller than effects associated with the more expensive All Conveyance alternative.

While the Detention/Conveyance alternative would require large areas of land for detention basins, the channels to convey storm runoff would be narrower than those required for the All Conveyance alternative. The narrower channels would cause less disruption to existing land uses in urban areas. Detention basin locations are proposed for land that is currently vacant or undeveloped. Hence, the socioeconomic implications of compensating or relocating displace businesses or residences would be smaller for this alternative relative to the All Conveyance alternative.

11.4.3 No Project

The No Project alternative would not commit local governments to a major capital program and would not directly generate the positive effects identified for the other two alternatives. Local government expenditures for facility repair following flood events would likely be higher, however, as well as costs for emergency services during these events. Because a sales tax surcharge and federal funds may not be available to finance these activities, overall fiscal impacts of the No Project alternative could represent a net negative, but unquantifiable impact.

Under the No Project alternative it is expected that local entities would continue to build flood control facilities similar to those provided by local developers. Greater emphasis on protection of existing housing and connection of existing facilities would likely be emphasized.

11.5 PROGRAMMATIC MITIGATIONS

This section outlines the programmatic approach to be applied to proposed flood control facilities to be developed either as a part of the 10-year plan or beyond the initial ten years. Significant socioeconomic resources and issues identified in Section 11.2 and identified as being subject to potential adverse effects would be evaluated under this approach. Other socioeconomic issues not included in the programmatic approach are also discussed. Finally, this section presents policy recommendations directed toward socioeconomic-related factors which should receive consideration during the implementation of the proposed program.

11.5.1 Evaluation Process

If the facilities construction prioritization process is adhered to, no significant socioeconomic impacts are expected to occur. This is because the site selection and design criteria seek to avoid dislocating or disrupting facilities and activities on developed property, and adequate funding sources are required before proceeding with a flood control project.

Modifications or additions to proposed flood control facilities could involve existing property improvements in the form of taking of residential, commercial or institutional land and structures, or intersecting vital public services and utilities. Conceivably, situations could arise where the general benefits of increased flood protection from a particular facility might be considered to outweigh the costs of condemning or relocating some existing structure. In such cases, a programmatic approach to determining necessary mitigating measures could be followed.

The basic concept for mitigations is analogous to the procedure for acquiring rights-of-way for a highway, railroad or public utility, either through negotiation of compensation for damages such as loss of use of property and costs of relocation or exercise of eminent domain. The measure of the impact is the cost of damages or other compensation, arrived at either by negotiation or via use of an appraiser under condemnation proceedings.

The procedure to assess potential impacts of a proposed structure would consist of locating the facility site on a detailed land use map and/or aerial photo of the general vicinity. If a residential, commercial or institutional structure or vital public service were intersected or displaced by the facility then an appraisal would have to be made of the costs of damages and relocation. Property acquisition would be covered by federal law under the Uniform Relocation Assistance Act of 1970, which calls for a third party appraisal process, full disclosure of findings, and negotiated settlements. Invocation of the right of eminent domain in instances where a property owner will not negotiate is usually a last resort.

11.5.2 Other Socioeconomic Issues Not Included in the Programmatic Approach

The effect of the proposed flood control facilities on growth, property values and fiscal matters in the Las Vegas Valley has been discussed in Section 11.2. These discussions indicate that the flood control facilities would not have significant adverse effects on these resources as summarized below:

11.5.2.1 Growth

The prioritization process employed by the District favors construction of facilities that would provide protection to the greatest number of residents and structures. Because development of the flood control system would closely parallel urban development, the Master Plan would accommodate, rather than induce, growth. Further, the protection afforded by the flood control system may encourage infill development as opposed to development of the outlying areas. Assuming the District consistently applies its prioritization criteria to each flood control proposal, the potential for growth inducement is minimal and does not require further review.

11.5.2.2 Property Values

Development of flood control facilities would have a net positive effect on the value of directly affected properties. Because no adverse property value effects are anticipated, project-specific review of mitigation would not be required.

11.5.2.3 Fiscal Resources

Once flood control facilities are in place, property tax and sales tax revenues to local jurisdictions would increase slightly while the costs of maintaining the facilities would not trigger an increase in local government expenditures, resulting in a net positive effect. Because no adverse fiscal effects are anticipated, no project-specific review or mitigation would be required.

11.5.3 Policy Recommendations

The preceding programmatic approach was based on the assumption that the implementation of the Master Plan will proceed according to the project prioritization procedures currently established by the District. If, however, the factors underlying this assumption were to change, the need to conduct further environmental analysis with respect to socioeconomic resources would be affected. This section presents recommendations that would preserve the validity of the programmatic approach presented in this document.

1) **Recommendation:** Ensure that the Flood Control District's prioritization procedures (refer to Table 11-14) are applied consistently and continuously to all individual flood control proposals.

   Discussion: Implementation of this recommendation would eliminate the potential for the flood control facilities to induce growth in the Las Vegas Valley beyond that which is currently planned.

2) **Recommendation:** Once a ranking of projects has been established after the prioritization process, ensure that projects receive funding allocations according to their position on the list.

   Discussion: Because local jurisdictions will be competing for limited funds, it will be necessary to direct available funds to those projects which have been given higher priority or have already initiated aspects of their project such as engineering design or property acquisition. This process would reduce the potential fiscal impacts of an unanticipated delay in the completion of the project on those jurisdictions.

3) **Recommendation:** Changes in the current flood control project prioritization criteria, or proposals to construct projects in a manner inconsistent with their identified priority, should be reviewed in detail with respect to potential socioeconomic impacts.

   Discussion: The priority level of each facility included in the flood control construction plan should be reviewed for consistency with District policies. Any facilities that are identified as potentially inconsistent should be subject to a project-specific review addressing all potential issues identified in Section 11.2. Proposed changes to the District's prioritization criteria should be subject to similar review considering the potential effect of the proposed change with respect to the entire flood control program.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

TABLE 11-1

RECENT POPULATION GROWTH IN CLARK COUNTY

YEAR	POPULATION
1980	463,087
1985	572,140
1987	648,900
1988[1]	681,000
1990[2]	715,377

1 Extrapolated using 1987 and 1990 figures
2 Projection

Source: Las Vegas Perspective 1988 (Cooper et al. 1988)

TABLE 11-2

POPULATION BY AGE GROUPS

AGE GROUP	NUMBER OF PERSONS	PERCENT
0-17	154,800	25
18-34	177,100	28
35-54	174,700	28
55+	122,700	19
	629,300	100

Source: Las Vegas Perspective 1988 (Cooper et al., 1988)

TABLE 11-3

COMPARISON OF CLARK COUNTY POPULATION PROJECTIONS

YEAR	PROJECTION1	PROJECTION2	PROJECTION3	PROJECTION4	PROJECTION5
1990	664,000	715,377	660,000	662,000	770,000
1995	766,000	879,878	757,000	739,000	885,000
2000	891,000	1,069,430	867,000	816,000	1,000,000

Projection 1--Clark County Popluation Data Book, 1988
Projection 2--State of Nevada, Cooper, et al., 1988
Progection 3--Office of Planning Coordinator, 1978[1]
Projection 4--State Water Plan, 1973[1,2]
Projection 5--State Water Plan, 1972[1,3]

[1]Modified from Table 1-4, CCDCP, 1987
[2]Estimated low
[3]Estimated high

TABLE 11-4

LAS VEGAS VALLEY SUBAREA POPULATION AND HOUSEHOLDS IN 1987

SUBAREA	POPULATION (THOUSANDS)	HOUSEHOLDS (THOUSANDS)
North Las Vegas[1]	301.1	103.3
Central Las Vegas[2]	232.8	94.0
South Las Vegas[3]	38.6	17.8
Boulder City[4]	12.0	4.6
Henderson[5]	44.8	14.8
	629.3	234.5

---

[1] Includes Survey Areas 1, 2, and 3
[2] Includes Survey Areas 4, 5, 6 and 7
[3] Includes Survey Area 8
[4] Survey Area 10
[5] Survey Area 9

Source: Las Vegas Perspective 1988 (Cooper et al., 1988)

TABLE 11-5

CLARK COUNTY EMPLOYMENT BY INDUSTRY IN 1987

INDUSTRY	AVERAGE 1987	PERCENT OF TOTAL
Mining	300	0.1
Construction	18,600	6.6
Manufacturing	8,600	3.0
Transportation/Public Utilities	15,900	5.6
Total Trade	57,800	20.3
Finance, Insurance, and Real Estate	14,500	5.1
Service Industries	135,900	47.8
Government	32,600	11.5
Total Employment	284,200	100.0

Source: Las Vegas Perspective (Cooper et al., 1988)

TABLE 11-6

HOUSING IN THE LAS VEGAS VALLEY IN 1987

DWELLING TYPE	NUMBER OF HOUSEHOLDS	PERCENT OF TOTAL
Single Family	111,500	48
Duplex	17,600	8
Mobile Home	22,900	10
Apartment	58,300	25
Townhouse	9,200	4
Condominium	15,000	6
Total	234,500	100

Source: Las Vegas Perspective (Cooper et al., 1988)

TABLE 11-7

CLARK COUNTY TAXABLE SALES BETWEEN 1982 AND 1988

YEAR	TOTAL TAXABLE SALES IN THOUSANDS OF DOLLARS
1982	3,596,900
1983	3,799,376
1984	4,119,296
1985	4,547,518
1986	5,096,700
1987	5,672,500
1988	5,937,165

1 Projected (MacDonald, 1988)

Source: Las Vegas Perspective 1988 (Cooper et al., 1988)

TABLE 11-8

POLICE DEPARTMENTS LAS VEGAS VALLEY

DEPARTMENT	NO. OF SWORN OFFICERS	DETENTION FACILITY	CAPACITY	DIFFICULTIES
Las Vegas Metro	850	yes	1,250	yes
North Las Vegas	116	yes	77	yes
Henderson	60	yes	40	no
Boulder City	19	no	--	--

1 Capacity difficulty exists, therefore inmates are released before their sentences are served in full in order to accommodate new inmates

Sources: Botkin, 1988; Brubaker, 1988; McKee, 1989; Zohner, 1988

TABLE 11-9

FIREFIGHTERS AND FIREFIGHTING EQUIPMENT
IN THE LAS VEGAS VALLEY

FIRE DEPARTMENT	NUMBER OF FIREFIGHTERS	NUMBER OF TRUCKS[1]
Clark County	347	19
North Las Vegas	45	5
Las Vegas	282	16
Henderson	53	6
Boulder City	12	4
Volunteer	16	-

[1] Trucks include pumpers, ladders, hose wagons, and snorkel trucks

Sources: Hulbert, 1988; Mills, 1988; Price, 1988; Shoeburne, 1988; Williams, 1988

TABLE 11-10

FIRE DEPARTMENT RATINGS

FIRE DEPARTMENT	INSURANCE SERVICE OFFICES RATING
Clark County	2[1]
North Las Vegas	3
Las Vegas	2
Henderson	4
Boulder City	3

[1] Metropolitan areas only

Sources: Hulbert, 1988; Mills, 1988; Price, 1988; Shoeburne, 1988; Williams, 1988

TABLE 11-11

WATER USE IN THE LAS VEGAS VALLEY

WATER USER	ACRE-FEET/YEAR
BASIC MANUFACTURING INC.	
Basic Manufacturing Inc.	8,877
Henderson	3,779
SOUTHERN NEVADA WATER SYSTEM	
Las Vegas Valley Water District	130,196
Nellis Air Force Base	1,340
North Las Vegas	13,217
Henderson	12,326
Boulder City	6,303

Source: Braybrook, 1988

TABLE 11-12

MEDICAL FACILITIES IN THE LAS VEGAS VALLEY

FACILITY	NUMBER OF LICENSED BEDS
Boulder City Hospital	35
Community Hospital of North Las Vegas	163
Desert Springs Hospital	369
Humana Hospital-Sunrise	679
St. Rose de Lima Hospital	74
University Medical Center of Southern Nevada	436
Valley Hospital Medical Center	310
Women's Hospital	61
	2,127

Source: Las Vegas Perspective 1988 (Cooper et al., 1988)

TABLE 11-13

STUDENTS BY GRADE
CLARK COUNTY SCHOOL DISTRICT

GRADE	TOTAL STUDENTS
Pre-K	18
K	8,824
1	9,620
2	9,023
3	8,893
4	8,337
5	7,868
6	7,763
7	7,679
8	7,461
9	7,190
10	7,241
11	6,748
12	6,748
13	588
	104,077

Source: Clark County School District, 1988

TABLE 11-14

FLOOD CONTROL PROJECT PRIORITIZATION

WEIGHT	CRITERION
5.0	Population Affected Refers to the existing population affected by the construction of the project considered. Impact includes reducing flood hazards.
4.5	Assessed Land Value Impacts Assessed land values for developed and undeveloped land affected by the project, including all structures (public, commercial, or residential) will be reviewed. Impact on land values related to a reduction of the floodplain area will be considered under this item.
4.0	Public Perception of Need The project will be evaluated in terms of satisfying the public desire to their money spent on "worthwhile" projects and the public's perception of need.
3.5	Emergency Access and Public Inconvenience The project will be evaluated to determine its impact on the access of emergency vehicles including police, ambulance, and fire vehicles to their respective substation, hospital or station. The evaluation will include an assessment of the project's contribution to the development of an all-weather transportation system and accessibility to flood isolated residences, businesses, and public facilities.
3.0	Cost Avoidance Cost avoidance includes projects which will reduce future costs, including potential damage, construction of oversized facilities, and the ability to construct. This item should also address other costs associated the lost opportunity and the risk associated with inadequate or undersized facilities.
2.5	Availability of Other Funding Sources This includes an evaluation of the potential for funds from grants, developers, the Corps of Engineers, and other public and private interests. Additional funding sources shall include but are not limited to land donated by private developers and the Bureau of Land Management.
2.0	Interrelationship to Other Projects Projects which score high on this criterion can function independently or are needed to complete or increase the effectiveness of the existing regional and local drainage system.
1.5	Timing and Implementation All aspects of timing and implementation should be considered under this item including availability of right-of-way, permit review if necessary, and ability to administer and begin a project in a reasonable time-frame.

TABLE 11-14 (concluded)

WEIGHT	CRITERION
1.0	Environmental Enhancement Evaluation of this criterion includes benefits derived from improving or mitigating the threat to public health resulting from stagnant water, erosion, raw sewage spills, and contamination of the domestic water supply, It also includes, if applicable, information on the project's enhancement of habitat, recreational opportunities, and water quality.
0.5	Annual Maintenance Costs Projects which will rank high on this criterion have a lower maintenance cost than those facilities now in existence or will reduce maintenance costs downstream.

Source: Clark County Regional Flood Control District Policies and Procedures Manual (Bax-Valentine, 1988)

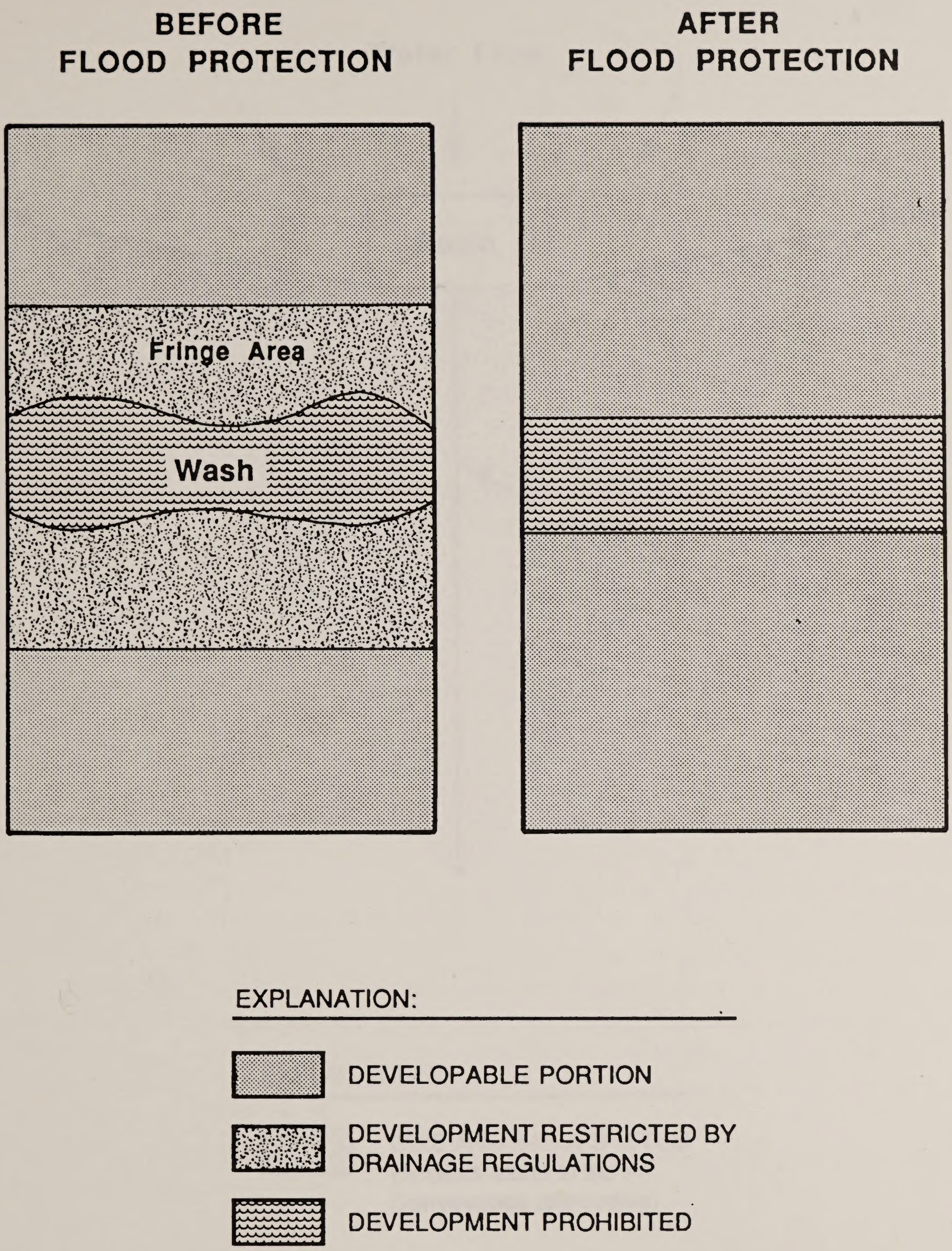
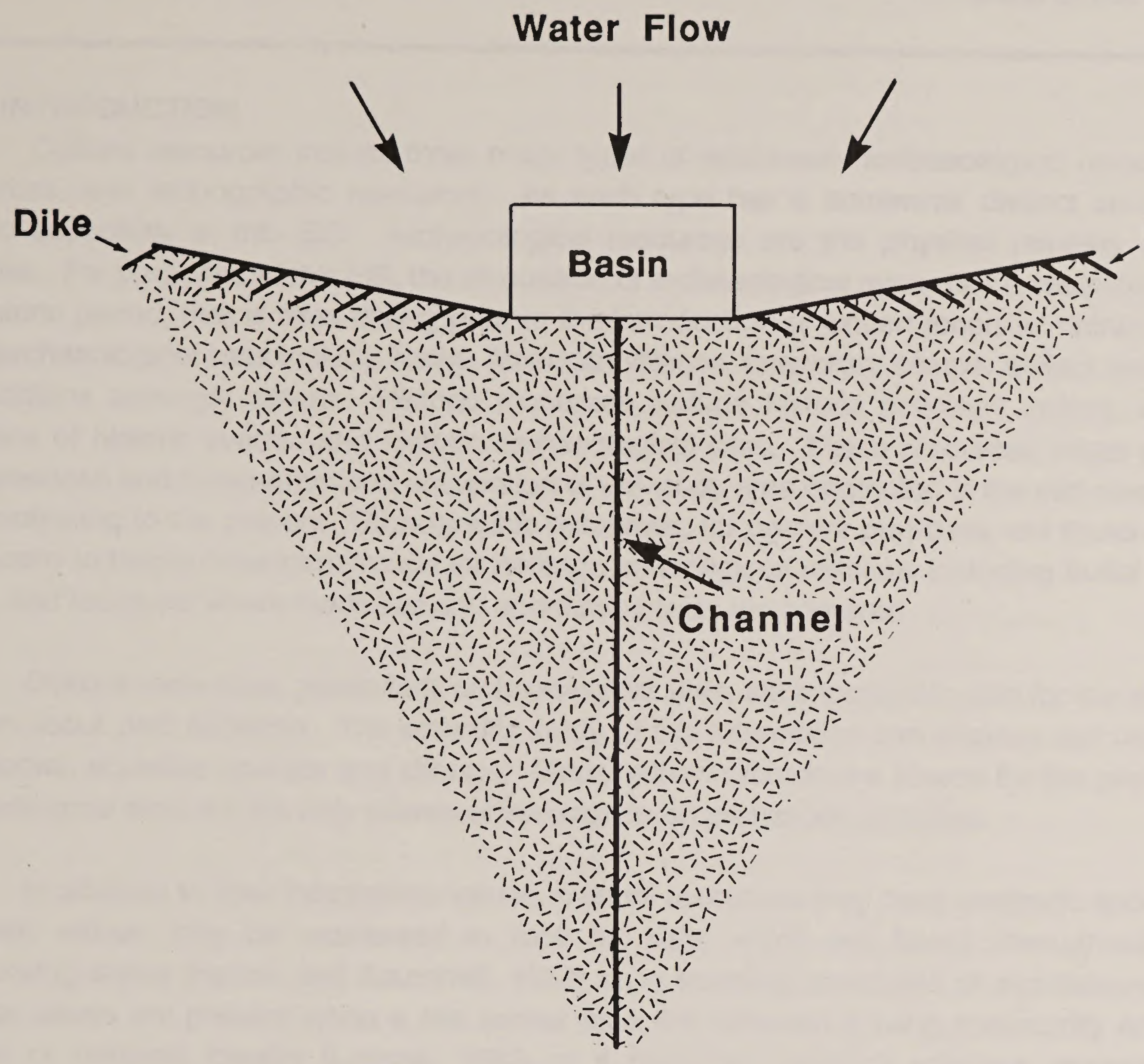


FIGURE 11-1

**ENHANCED FLOOD PROTECTION-
PROPERTIES LOCATED ALONG CHANNELS**



EXPLANATION:

DIKE AND BASIN SYSTEM
(or dikes alone in the All Conveyance alternative)

FIGURE 11-2

ENHANCED FLOOD PROTECTION-PROPERTIES LOCATED DOWNSTREAM OF DIKES AND BASINS

- Nevada Historic Preservation Plan -- Provides guidance for the identification and evaluation of cultural resources with particular emphasis on the historic resources.

- An Archaeological Element for the Historic Preservation Plan (Lyneis, 1982a) -- Provides guidance for the evaluation and treatment of archaeological sites of both the prehistoric and the historic period.

- American Indian Religious Freedom Act -- Instructs federal agencies to avoid actions that will adversely affect Native American rights to the free exercise of traditional religions.

Altogether these regulations and guidelines establish a comprehensive program for the identification, evaluation, and treatment of cultural resources. Cultural resources studies conducted for this EIS are designed to meet NEPA needs for the consideration of impacts. Mitigation measures presented herein address additional studies that will be necessary to comply with Section 106 of the NHPA.

12.2 OVERALL ENVIRONMENTAL CONDITIONS

The study area has been occupied by cultural groups for as long as 13,000 years. The following sections summarize the archaeological, ethnographic, and historic occupations, thus providing the context under which impacts to cultural resources can be assessed.

12.2.1 Archaeological Resources

The prehistoric archaeology of the study area has been summarized in a variety of major sources. These include the Clark County Comprehensive Plan (CCDCP, 1987), Lyneis (1982b and c), Rafferty (1984) and Warren and Crabtree (1986). Although there is general agreement on the broad patterns of regional prehistory, there remain many areas of controversy, and additional data are needed to answer a variety of research questions (Lyneis, 1982b). The following summary and definition of cultural periods largely follows Rafferty (1984) as this source is the most specific to the Las Vegas area.

12.2.1.1 Tule Springs Period

Earliest evidence of human occupation in the Las Vegas Valley was recovered from the Tule Springs site. A small number of artifacts were found in association with Pleistocene faunal forms which included camel, mastodon, and horse. Radiocarbon dates ranging from 13,000 years before present (B.P.) (the present is assumed to be A.D. 2000) to 10,000 B.P. were related to these artifacts (Lyneis, 1982c). However, no diagnostic artifacts were recovered from the site, making it impossible to relate the limited site assemblage to that of subsequent tool traditions. Rafferty (1984) proposes a Tule Springs period based upon the above findings and the suitability of the Pleistocene environments of the Las Vegas Valley for human occupation and exploitation. Others do not consider that there is sufficient evidence to support the idea of a separate cultural period. Warren and Crabtree (1986) and Lyneis (1982) note that much of the evidence for Paleoindian occupation of the Las Vegas Valley is problematical. Surface sites in the area are very limited in number, while dates relating to Paleoindian artifacts and sites are often considered questionable.

12.2.1.2 Lake Mojave Period

The Lake Mojave Period ranges from approximately 10,000 to 7,500 B.P. This cultural complex/tool tradition is more prevalent in the desert areas of southern California than in the Las Vegas Valley. Controversy exists concerning the lifeways of these people. Bedwell (1973) and Hester (1973) contend that peoples of the Lake Mojave period were hunters and gatherers especially adapted to exploitation of lacustrine environments. Warren (1967) hypothesizes a generalized hunting, gathering, and fishing culture adapted to the ecological zones of the north-south trending mountain ranges (Warren et al., 1980). Artifacts characteristic of this period include a fairly generalized tool kit which includes Lake Mojave and Silver Lake points. Suisa (1964) reports these points on terraces of the Las Vegas wash near the Tule Springs site. Ecological characteristics of the Duck Creek area during the Lake Mojave period was especially suited to the generalized hunting, fishing, and gathering adaptations of the Lake Mojave peoples (Rafferty, 1984).

12.2.1.3 Archaic or Pinto-Gypsum Period

The Archaic or Pinto-Gypsum Period ranges from approximately 7,500 to 2,000 B.P. Hauck et al., (1979) postulate a hiatus in human utilization of the Las Vegas Valley from circa 7,000-5,000 B.P. These dates are coincident with a period of extreme aridity in the area. Thus, the Archaic Period cultures would have not have existed until 5,500 B.P. It is probable that some population did exist during this arid period, however. Suisa (1964) and Warren and Crabtree (1986) place the beginnings of the Archaic as 6,000-7,000 B.P. Warren et al., (1980) define separate Pinto and Gypsum periods and note that the Pinto Period is poorly defined and is centered around the rather poorly defined Pinto Point tool type.

There is also much overlap in radiocarbon dates for projectile points characteristic of the Archaic. Humboldt points date from 5,900-3100 B.P.; Pinto points date from 5,350-2670 B.P.; while Gypsum points date from 3,790-2,450 B.P. (Heizer and Hester, 1978). Hauck et al., (1979) suggest a temporal but not spatial overlap of the Humboldt/Pinto and Gypsum complexes after about 5,000 B.P. Thus, it is possible that southern Nevada was inhabited by two different cultural groups although chronological and functional factors may account for the distribution. In the project area sites dating to the Archaic Period are found around Las Vegas Valley springs, in the Duck Creek region, mountain foothills, lower mountains and upper mountains. Milling stones are present in the Archaic tool assemblages. Peoples of that time exploited all available ecozones and types of food resource. Development of an economic pattern of seasonal transhumance is proposed by Bettinger and Baumhoff (1982).

Rafferty (1984) notes that dates for the appearance of the Elko point generally range around 4,000 B. P. and that the type disappears sometime between 920-650 B.P. Rafferty also cites ethnographic evidence that Elko "points" were knives in 1870 Utah. Citing the longevity of this tool type and the Paiute style settlement patterns noted by Aikens and Witherspoon (1982) in central Nevada he argues that the Numic speaking peoples may have been in Nevada for several thousand years. Thus, in Rafferty's view, the argument that Numic speaking peoples entered the Great Basin and displaced other peoples is not valid. Bettinger and Baumhoff (1982), utilizing linguistic evidence, assume the actuality of the Numic spread. They support their arguments by citing the differences in subsistence techniques between the pre-Numic and Numic populations as evidence that Numic speakers must have spread into the areas once inhabited by pre-Numic groups. It should be noted that the spread of neither languages nor cultural attributes require any movements of people.

Two areas within the overall project area contain sites or site complexes most representative of the Archaic Period. One is a small campsite near Duck Creek known as the Bleland Site. The site tool assemblage site contains Elko, Pinto, and Humboldt points. The Las Vegas Wash Archaeological Complex contains 42 sites ranging in age from Pinto to Protohistoric. Archaic Elko and Humboldt points are found at some of these sites (Rafferty, 1984).

12.2.1.4 Anasazi-Pueblo Period

The Anasazi-Pueblo Period ranges from approximately 2,000 to 800 B.P. This period is characterized by cultural continuity, cultural change, and interaction between different cultural groups. Shulter (1961) divided this period into four phases:

1) Moapa Phase (2000-1500 B.P.) Anasazi occupation of the Virgin and Muddy River valleys began. Primarily hunters and gatherers, they practiced small amounts of agriculture. No evidence of occupation of the Las Vegas Valley by the Virgin River Anasazi is known. During this time the project area was occupied by Archaic peoples.

2) Muddy River Phase (1500-1200 B.P.) At this time Anasazi sites began to occur in the Las Vegas Valley and agriculture became a more important component of Anasazi culture. Ceramics appeared during this phase. Lyneis (1982c) contends that the Corn Creek and Big Springs sites were examples of unsuccessful colonization attempts by the Anasazi. The Midby site in the Duck Creek area contained both Anasazi and Paiute cultural remains.

3) Lost City Phase (1300-900 B.P.) This is the high period of the Virgin Anasazi culture. Population numbers are greatest during this phase and there is a marked population increase in the project area . Beginning in 1100 B.P. an economy develops which is characterized by an elaborate trading system. Lost City phase ceramics and habitation sites are found in the Las Vegas Valley. Rafferty (1984) regards the Las Vegas Valley as the hub controlling turquoise trade with the Halloran Springs area, the turquoise mines at Crescent Peak and Sullivan, and the northern trade routes. The Big Springs and Midby sites are probably Lost City phase habitation and trade sites.

4) Mesa House Phase (900-850 B.P) This time period is characterized by the retraction and collapse of the Virgin Anasazi culture. Evidence of Anasazi presence in the project area during this time is found at the Midby site.

The Archaic populations were not pushed out of the Las Vegas Valley during this phase. The hunter-gatherers of the deserts developed use of the bow. Small projectile points (true arrowheads) began to appear by 1500 B.P. (Warren and Crabtree, 1986). In most of the Mojave desert little change in lifeways occurred. The Las Vegas Valley became the interface between the two cultures (CCDCP, 1987).

12.2.1.5 Paiute Period

The Paiute Period ranges from approximately 850 to 200 B.P. The farming communities of the Muddy and Virgin Rivers were abandoned by about 850 B.P. The southern Paiutes were nomadic hunter-gatherers who, at time of European contact, practiced a limited form of horticulture. The produce of this horticulture was supplemental, rather than central, to the food supply of the Paiute. The date of development of Paiute horticulture is not known. It is notable that if these peoples had lived coterminously with the Anasazi they would have had a ready example for development of their own agricultural techniques. Rafferty (1984) argues that the Paiute were there before the Anasazi came, formed a symbiotic relationship with them while the Anasazi were present and remained when the Anasazi departed. Rafferty notes that there are many sites with Paiute components and/or associations. Most notable of these are the Las Vegas Wash sites examined by Ferraro (1975, 1980). Paiute sites are marked by the presence of Desert Side-notched points and brown earthenware ceramics.

The Las Vegas Valley continued to be a cultural frontier. The Berger site along Duck Creek and the Las Vegas Wash sites examined by Ferraro contained both Paiute and Mojave ceramics. Rafferty indicates that Lower Colorado River pottery has been found on "a number of sites" in the Duck Creek-Paradise Valley area. Lyneis (1982b) and the Clark County Comprehensive Plan (CCDCP, 1987) indicate that the Numic Paiutes of the Las Vegas Valley were permanent residents of the area and that the Yuman speaking Lower Colorado River peoples were only visitors.

12.2.2 Ethnographic Resources

During the ethnohistoric period, the entire study area was inhabited by the Southern Paiute, who occupied a broader region extending across southern Utah and southern Nevada. The Southern Paiute belong to the Southern Numic branch of the Uto-Aztecan linguistic family. These hunter-gatherers' subsistence strategy provided a varied but sometimes precarious existence. Small game such as rabbits, wood rats, and gophers were taken, although plant material including pine nuts, grass seeds, and agave provided a more substantial portion of the diet. Shortly before the European contact, some Southern Paiute began practicing limited horticulture, adopting maize and squash from the Pueblo area, while borrowing other crops from the lower Colorado River. The Southern Paiute seasonal subsistence cycle was not greatly affected with the advent of horticulture. Groups of individual households moved together on hunting and gathering trips, leaving the elderly to tend the fields. The mobile groups would then return later in the year to the same spring or same agricultural site.

Disruption of this lifestyle began soon after early Mormon colonizing efforts in southern Nevada. By 1855, there were several Mormon communities in the area, including missions in Moapa and Las Vegas. Mormon settlements and farms displaced Southern Paiute from their best gathering and horticultural lands. Before long, traditional food supplies throughout the region were further depleted by livestock, timbering, and other activities. Although dissension among the Mormons led to the recall of missions in 1858, other Euroamerican settlers and miners began arriving by the turn of the century, preventing the Southern Paiute from returning to their traditional lifeways. In 1872, many of the Paiute in southern Nevada were settled on the Moapa Indian Reservation, established on the upper Muddy River. Other reservations followed, including the Las Vegas Colony near the city of Las Vegas in 1911.

12.2.3 Historical Resources

Prior to 1826, the vast arid regions of present-day Nevada remained largely unexplored. The Spanish explorations of Father Francisco Garces and the Dominquez-Escalante party approached Nevada in 1776, however, American fur trapper Jedediah Smith is credited with the first successful crossing of the southern Nevada desert in 1826. Smith's venture down the Virgin and Colorado rivers linked the Dominquez-Escalante route and the Graces route, and stimulated the development of trade between New Mexico and southern California (Wright, no date).

New Mexico merchant Antonio Armijo was the first to bring his trading caravan into the Las Vegas Valley in 1830. Following the Las Vegas Wash, Armijo entered the valley at Whitney Mesa in the present-day Paradise Valley region (Roske, 1986). Armijo's trace did not become the regular route of the Old Spanish Trail, however. Later that same year the Wolfskill Yount party pioneered a variant of the route through the Needles area, while a northern fork of the trail was developed through the Las Vegas Springs in the 1830s (Roske, 1986).

John C. Fremont reached Las Vegas Springs via the northern variant of the Old Spanish Trail in 1844. His notes and maps were published the following year, popularizing the northern route of the trail through Las Vegas (Myhrer, 1987; Roske, 1986). The trading era along the Old Spanish Trail ended in

1848. However, travel through Las Vegas continued as the Mormon Trail, linking Mormon headquarters in Salt Lake City with southern California, emerged from the route of the Old Spanish Trail (Pahrer, 1971).

In 1855, Las Vegas was selected by Mormon leader Brigham Young as a settlement site. A party of Mormon missionaries arrived in the Las Vegas Springs area on June 14, 1855 and proceeded to establish a settlement four miles to the east (Roske, 1986). Construction of an adobe brick fort was initiated at the site, but was never completed. The unsuccessful mission was terminated in 1857 and the site abandoned by 1858.

Mining activity in the Las Vegas Valley was regenerated in 1861 when silver was discovered in an old Mormon lead mine southwest of Las Vegas. The mine was reopened and a smelter and mining camp established nearby named Potosi (Wright, no date). During this time, ranching and farming activities also developed within the valley. The Las Vegas Springs area and the Old Las Vegas Mormon fort and adjoining lands were eventually acquired and developed into ranches by Octavius Decatur Gass in the 1860s and 1870s. Both ranches became the property of Archibald and Helen Stewart in 1881 (Roske, 1986). Mrs. Stewart continued ranch operations from 1884 to 1902 after her husband was murdered. In 1902 she sold the 1,800 acre Stewart Ranch to the San Pedro, Los Angeles, and Salt Lake Railroad. The Kiel (or Kyle) Ranch was established by Conrad Kiel in 1875, on land located north of the Old Mormon Fort which has once served as the Mormon Indian farm (Roske, 1986).

Las Vegas remained a quiet ranching region until 1905 when the San Pedro, Los Angles and Salt Lake Railroad was completed through the Old Las Vegas Ranch. The Las Vegas Land and Water Company, a subsidiary of the railroad, held a property auction on May 15, 1905, offering undeveloped lots for sale in "Clark's Las Vegas Townsite," (Wright, no date; Roske, 1986), an area which today is bounded by Stewart, Garces, Main and Fifth Streets.

In 1909, the new townsite experienced an additional spurt of growth when the railroad installed its main machine shops at the Las Vegas railroad facilities (Wright, no date; Charles Hall Page and Associates, 1978). On July 1, 1909, Las Vegas was named the county seat of the newly formed Clark County.

Las Vegas remained primarily a railroad community from its founding in 1905 until the early 1930s (Pahrer, 1971). Numerous farms and ranches sprang up throughout the valley, at this time, particularly in the Paradise Valley area south of town (Pahrer, 1971).

On December 21, 1928, Congress passed the Boulder Canyon Project Act, authorizing the construction of Boulder (Hoover) Dam. Six Companies, Inc. was awarded the contract for the construction of the dam (Roske, 1986). The government determined that a new city would be constructed near the site of the dam to house the company's new employees. The building of the dam and Boulder City was begun concurrently in 1931. Crude settlements emerged prior to the completion of Boulder City, including McKeeversville and Hell's Hole, or Ragtown. Both were located in Hemenway Wash, and consisted primarily of tents and shacks. These settlements were gradually abandoned as better housing became available in Boulder City. Shanties still remain on the McKeeversville site (Roske, 1986).

Legalized gambling was approved by the Nevada State Legislature in 1931, however, it did not immediately become a significant source of revenue in Las Vegas. A major economic boost was brought about with the coming of World War II. In 1941, the Las Vegas Army Air Field was opened at the present-day Nellis Air Force Base, to serve as an aerial gunnery school (Pahrer, 1971). The Basic Magnesium Plant was constructed twelve miles southeast of Las Vegas in order to process metallic magnesium for the war effort. A new townsite was constructed to house the workers from the plant, known only as Basic townsite until 1944, when the name was changed to Henderson (Roske, 1986).

During and after the war, gambling took on a greater significance to the local economy of Las Vegas. The first "Strip" hotels and casinos were built during the war. Gangster "Bugsy" Siegel opened his plush Flamingo Hotel on the Strip in 1946 and several other resort hotels and casinos were added in the 1950s.

Tourism and gambling continued to expand throughout the 1960s and 1970s, becoming the cornerstone of the local economy (Wright, no date).

12.3 SIGNIFICANT RESOURCES AND ENVIRONMENTAL SENSITIVITY ANALYSIS

An inventory of known cultural resources has been compiled for the regional study area using literature sources, records searches, contacts with knowledgeable individuals, and limited field reconnaissance. This inventory provides a comparative basis for the identification and evaluation of cultural resource sensitivity. The sensitivity analysis then provides the basis for the assessment of impacts.

The significance of cultural resources can be judged on the basis of the National Register criteria for eligibility:

> The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

b) that are associated with the lives of persons significant in our past; or

c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

d) that have yielded, or may be likely to yield, information important in prehistory or history (36 CFR 60.6).

Assessing whether individual resources meet these criteria generally requires detailed field investigations and analytic procedures. Prior to such investigations, all resources must be considered potentially significant, unless there is evidence that meeting at least one of the criteria is unlikely. The National Register criteria establishes a threshold of significance. Beyond this threshold, it is usually possible from existing data to assess the general level of resource sensitivity. Sensitivity takes into account resource quantity, resource quality, and the susceptibility of the resource to adverse impact from the project under consideration. The following sections describe the methods by which archaeological resources, ethnographic resources, and historical resources were inventoried and assessed and the results of the sensitivity assessment.

12.3.1 Archaeological Resources

Data utilized to assess the archaeological sensitivity of the study area were obtained from a variety of sources. A literature review was conducted, emphasizing information and ideas obtained from examination of authoritative sources. A record search of the project facilities and adjacent areas was conducted at the Environmental Research Center of the University of Nevada at Las Vegas. Locations of all recorded sites and surveys near project facilities were plotted. Site records of all project area sites were obtained, as were bibliographic references for all archaeological surveys conducted in the project area. Computer plots of locations for all recorded sites (current through August, 1986) in the entire regional study area were obtained by use of Intermountain Antiquities Computer System (IMACS) data. Data obtained by Dames & Moore during previous work in the project area was also used. Archaeologists knowledgeable of significant sites and locales in the Las Vegas Valley were consulted to facilitate identification of archaeologically significant areas.

Utilizing data from the above sources, areas of high, moderate, and low archaeological sensitivity were identified and are presented in Figure 12-1 and Table 12-1. The archaeological sensitivity analysis was conducted on an areal, rather than site-specific, basis because of the large number of resources involved (the IMACS data-base for the regional study area contains 387 sites) and because there are undoubtedly many unrecorded sites in the regional study area. The areal sensitivity analysis provides an objective basis for comparing the impacts of the alternative flood control programs and developing appropriate mitigation measures.

High sensitivity areas are characterized by high site densities. Locations with environmental conditions where the peoples of past cultures preferred to locate were designated as high sensitivity areas. These are locations such as springs, terraces above prehistoric water courses, and areas where resources were prehistorically abundant. Moderate significance areas are characterized by a moderate scattering of known sites. Areas of low archaeological sensitivity have no known sites despite previous surveys completed in the area and no environmental reason to predict the occurrence of sites.

12.3.1.1 Northern Las Vegas Valley

The sensitivity analysis of the Northern Las Vegas Valley resulted in the identification of five areas of high sensitivity and three areas of moderate sensitivity. The remainder of the Northern Las Vegas area is judged to be of low sensitivity. Areas of high sensitivity include: 1) N1, a grouping of sites located adjacent to or near Tule Springs, 2) N2, sites located on the Eglington escarpment and a major intermittent drainage, 3) N5, sites located along the upper Las Vegas Wash, 4) N7, sites located along the lower Las Vegas Wash, and 5) N8, the Tule Springs site (26-CK-4) and the adjacent drainage (Figure 12-1; Table 12-1).

12.3.1.2 Central Las Vegas Valley

The sensitivity analysis of the Central Las Vegas Valley resulted in the identification of two areas of high sensitivity and five areas of moderate sensitivity (Figure 12-1; Table 12-1). The remainder of the Northern Las Vegas area is judged to be of low sensitivity. Areas of high sensitivity include: 1) C1, located in the Brownstone Basin and La Madre Mountains, and 2) C7, the Las Vegas Springs National Register site.

12.3.1.3 Southwest Las Vegas Valley

The sensitivity analysis of the Southwest Las Vegas Valley resulted in the identification of three areas of high sensitivity and four areas of moderate sensitivity (Figure 12-1; Table 12-1). The remainder of the Southwest Las Vegas area is judged to be of low sensitivity. Areas of high sensitivity include: 1) S1, the Calico Basin, 2) S3, in the Red Rock Canyon area, and 3) S6, in the Sloan area.

12.3.1.4 Boulder City

No areas of high or moderate sensitivity were identified in the Boulder City subarea. This entire subarea is judged to be of low archaeological sensitivity.

12.3.1.5 Henderson

The sensitivity analysis of the Henderson area resulted in the identification of two areas of high sensitivity and one area of moderate sensitivity (Figure 12-1; Table 12-1). The remainder of the Henderson area is judged to be of low sensitivity. The two areas of high sensitivity include: 1) H1, located along a major drainage west of Henderson, and 2) H3, located at the foot of the River Mountains.

12.3.2 Ethnographic Resources

The inventory of ethnographic resources was compiled through a review of major ethnographic sources and a Native American contact program.

Three sensitive ethnographic sites (Figure 12-1; Table 12-2) were identified through the inventory of the following sources: Dobyns, 1974; Fowler and Liljeblad, 1986; Grosscup et al., 1974; James et al., 1981; Kelly and Fowler, 1986; Lyneis, 1982a; Malouf and Hultkrantz, 1974; Manners, 1974a, 1974b; Pendleton et al., 1982; Rafferty, 1984; Steward and Wheeler-Voegelin, 1974; Stoffle and Dobyns, 1982; Stoffle et al., 1983; Thomas et al., 1986; U.S. Department of Agriculture 1986a, 1986b, and 1986c, and Dames & Moore inhouse files.

The Native American contact program was initiated through the posting of a letter and map describing the project and soliciting Native American input. This letter was sent to Southern Paiute, including Chemehuevi groups and individuals in Utah, Nevada, and California on November 7, 1988 (Table 12-3). Additional letters were sent to two individuals referred as knowledgeable on November 18, 1988. Follow-up telephone calls were then conducted between November 16 and 30, 1988.

No specific sites or places were identified within the context of the contact program, although some general concerns for the area and cultural resources were documented. Las Vegas Wash was mentioned by several of those contacted as containing evidence of prehistoric activity and concerns were expressed for archaeological sites and artifacts. Several political leaders deferred to the Las Vegas and Moapa Paiute and another to the Southern Paiute Chairman's Association. The chairperson at Shivwits noted that the cultural resources studies should be conducted following established guidelines and, along with representatives of the Las Vegas and Moapa Paiute, expressed concerns for burials. Additionally, the Moapa Paiute expressed concerns for artifacts and medicinal plants which might be disturbed or destroyed during construction. Several groups requested copies of reports generated by the project and asked that they be kept informed of developments as the project progresses.

The most common referral was to Herbert Myers (Moapa), who is considered by many to be the most knowledgeable Southern Paiute for the Las Vegas region. One respondent to these contacts, Mr. Weldon Johnson, Sr., indicated that Myers had informed him of Native American concerns in the study area for native plants, archaeology sites, and places associated with songs, legends, and narratives. The Las Vegas Valley, Las Vegas Wash, and Cashman Field were mentioned although the concerns were generalized to the overall study area.

12.3.2.1 Northern Las Vegas Valley

Review of the database revealed three sites in the regional study area (Figure 12-1; Table 12-2). All are within the Northern Las Vegas subarea. These sites include: Las Vegas Colony (a Paiute reservation), Sunrise Mountain, and Frenchman Mountain. The latter two areas are of religious significance. Frenchman Mountain and Sunrise Mountain have been assigned "exclusion" sensitivity levels. The Las Vegas Colony has been given a sensitivity level of "moderate."

12.3.2.2 Central Las Vegas Valley

No ethnographic sites were located in this area.

12.3.2.3 Southwest Las Vegas Valley

No ethnographic sites were located in this area.

12.3.2.4 Boulder City

No ethnographic sites were located in this area.

12.3.2.5 Henderson

No ethnographic sites were located in this area.

12.3.3 Historical Resources

Data sources used to identify historic resources within the survey area include federal and state registers of historic properties, local inventories of historic sites and structures, archaeological site survey record forms designating historic sites, and various literature and cartographic sources. Literature sources include published primary and secondary sources on the history of the area. Cartographic sources include U.S. General Land Office (USGLO) survey plots and USGS topographic quadrangles. Individuals knowledgeable in the history of Clark County and the Las Vegas Valley were consulted, as was an existing database compiled by Dames & Moore.

The sensitivity of inventoried historical resources was rated on the basis of: 1) register status, 2) the quality of the physical remains that are known or likely to occur, and 3) the strength of the sites associations with persons and events important in local history. Those sites which appeared on the Nevada State Register and the National Register, or had been determined eligible for the National Register, were assigned a sensitivity level of "high." Roads/trails and railroad grades were assessed as having moderate to low sensitivity, as were sites whose existence is somewhat questionable. Structures, townsites, ranchsites, and known areas of habitation were generally accorded a sensitivity rating of "moderate." Seventy historic resources were inventoried in the regional study area (Figure 12-2; Table 12-4).

12.3.3.1 Northern Las Vegas Valley

The inventory of the Northern Las Vegas Valley included the Tule Springs Ranch, a National Register Historic District, as well as three previously recorded historic sites which, according to archaeological site records, have been determined eligible to the National Register. Portions of Las Vegas Wash which were traversed by Armijo in 1830 are also included in this subarea, along with historic roads, railroad grades and sidings, mines, and mining districts, ranching areas, and a quarry.

12.3.3.2 Central Las Vegas Valley

The Central Las Vegas Valley subarea contains numerous National Register properties, including the Kyle Ranch, Las Vegas Mormon Fort, and the Las Vegas Springs historic site. Three additional National Register eligible sites are also included in the inventory for this region. Additional historic properties include the Eglington ranch site, the Las Vegas Union Pacific Railroad Yards, a railroad underpass, and several historic roads.

12.3.3.3 Southwest Las Vegas Valley

Inventoried sites within Southwest Las Vegas Valley cover a variety of historic themes and include historic roads and railroad grades, ranch sites and railroad stops, mine sites, pipelines, and a historic airfield. A portion of Las Vegas Wash, which encompassed Armijo's trace, has been included. There is one National Register site within this subarea: Sandstone Ranch, also known as Spring Mountain Ranch, is a National Register Historic District consisting of ranch structures dating from late 1860s. It is currently being used by the Nevada State Park System for interpretive purposes and as a visitor's center.

12.3.3.4 Boulder City

The Boulder City subarea contains three National Register sites: the Old Boulder City Hospital, Boulder Dam Hotel, and the Boulder City Historic District. Additional historic sites include roads, McKeeversville site, and the abandoned grade of the U.S. Government Railroad, which was constructed in the early 1930s to haul equipment and supplies from Las Vegas over Railroad Pass to the site of Hoover Dam.

12.3.3.5 Henderson

Three historic sites have been inventoried within the Henderson subarea. Included among these sites are the Henderson dump site (26-CK-1279), a portion of the historic road from Las Vegas to El Dorado Canyon, and Railroad Pass, through which the Boulder City Branch of the Union Pacific was constructed in 1930-31 (Myrick, 1963). All three sites have been assigned moderate sensitivity levels.

12.4 GENERAL ENVIRONMENTAL EFFECTS

Cultural resources could be subject to a variety of impacts from the proposed project. The following types of impacts are potentially the most significant and are considered in the impact assessment.

12.4.1 Construction

Earth moving required for the construction of dikes, levees, lined channels, channel improvements, detention basins, debris basins, culverts, and other project facilities could cause the destruction or loss of cultural materials or the disruption of their integrity with respect to their archaeological context. In addition, construction of access roads, construction laydowns areas or other ancillary facilities could likewise damage cultural resources through ground disturbance.

Design and construction of project facilities may create aural and visual intrusions resulting in adverse impacts to the integrity of historic and cultural settings. This is normally a problem only for sites with architectural, aesthetic, or high cultural values and those with strong associations with important events or people.

12.4.2 Direct Operation

Periodic flooding and detention of water in detention basins not requiring subsurface excavation or behind dikes or levees would create an alternating wet-dry regime, highly destructive of organic materials and could result in increased erosion. Routine and emergency maintenance activities at project facilities could disturb cultural resources in the vicinity.

12.4.3 Indirect Operation

In remote areas, construction of new maintenance access roads can open previously inaccessible resources to increased impact from recreational activities and unauthorized artifact collection. Due to the study area's proximity to urban Las Vegas existing access is generally good and creation of new areas associated with flood control facilities is likely to have only a marginal additional increment. Another potential indirect impact of operation is the potential for artifact collection by maintenance crews.

These types of general environmental impacts to cultural resources apply equally to all subareas.

12.5 ENVIRONMENTAL EFFECTS BY ALTERNATIVE

Considering the general types of effects discussed in Section 12.4, potential impacts of the project alternatives have been assessed for each type of significant cultural resource. Each assessment takes into account the sensitivity of the resource and the severity of potential disturbance that might be caused by development and operation of the project. Additionally, impacts of the "No Project" alternative are considered.

It should be noted that the assessment of effects is predictive in nature. As complete cultural resources inventories have not been conducted and detailed project designs have not been developed, precise identification of effect as required by Section 106 of the National Historic Preservation Act has not been attempted. Such consultation on effect under this legislation should be conducted prior to construction of any project facility.

Effects on archaeological resources were assessed by examination of quantities and kinds of project facilities located within each archaeological sensitivity area. No attempt has been made to assess site-specific impacts. Rather, the assessment of effects predicts the relative severity of impacts based on the sensitivity analysis. For example, ground disturbance activities in areas of high sensitivity would be more likely to impact significant resources than would similar levels of ground disturbance in moderate sensitivity areas. The effects of two types of project facilities, lined channels and pipelines/box conduits, were assessed and measured as linear features which would impact a resource area over a given distance. Floodways, debris basins, and detention/retention basins were assessed and measured as areal facilities, and measurement of such impacts are presented as areal measurements.

Dike/levees were examined as volumetric facilities whose construction materials are often derived from the immediate locality of the facility. Thus, the impact could not be accurately gauged by either linear or area measurements. An index was developed for such impacts based on approximate volumetric measurements estimated using the following formula:

$$DII = \frac{(.5 \text{ base} \times \text{height} \times \text{length})}{10,000}$$

The derived values provide a more accurate method for judging the relative impacts of dike/levees of widely differing sizes.

The results of the assessment of effects on archaeological resources are presented in Table 12-5. These data indicate that the All Conveyance alternative would result greater impacts for the construction of lined channels, while the Detention/Conveyance alternative would result in greater impacts for the construction of dike/levees, pipeline/box conduits, and detention/retention basins. The slight differences between the two alternatives with regards to the potential impacts of debris basins and floodways are probably not significant.

Effects on historic resources were assessed on a site-by-site basis (Table 12-6). Historic resources were plotted on the regional base maps and compared with maps showing the location of the flood control facilities. Where a historic resource was found to be in or adjacent to a proposed facility, an impact level was assigned to assess the degree of effect. The greater the area of effect appeared to be, the higher the impact level. A majority of the historic resources affected were linear in nature, such as, historic roads and railroad grades. These resources were often impacted more than once by different facilities.

Facilities which impacted large segments of a resource were generally given a "high" impact rating, while those facilities which intersected a resource or impacted a smaller area were assigned an impact level of moderate to low. Table 12-6 presents the results of this study, listing each resource impacted and assigning a weighted score assessing the impact of each alternative on the resource.

Thirty-two historic resources would be affected by one alternative or the other. Table 12-7 summarizes these effects by the sensitivity level of the resource. Although each alternative is preferred in ten instances, the All Conveyance alternative generally minimizes impacts to historic resources of high and moderate sensitivity.

With regards to ethnographic resources, neither alternative would significantly effect the three inventoried resources. Native Americans do have concerns for archaeological resources, nonetheless, and should continue to be consulted regarding their treatment.

12.5.1 Detention/Conveyance

Potential effects of the Detention/Conveyance alternative are presented in Tables 12-5, 12-6, and 12-7. Areas of particular concern include:

- Eglington Escarpment (Archaeological Sensitivity N2). An area of high site density would be impacted by construction of 2.3 miles of lined channels and 2.1 miles of pipeline/box conduit.

- Upper Las Vegas Wash (Archaeology Sensitivity N5). Approximately 0.4 linear miles and 2,400 acres of an area of known high site density would be effected.

- Lower Las Vegas Wash (Archaeological Sensitivity N7). Approximately 27 miles of lined channels and dikes would be constructed in an area of known high site density.

- Brownstone Basin and La Madre Mountains (Archaeological Sensitivity C1). Approximately two miles of linear facilities and 42 acres of detention basins would be affected in an area of moderate to high site density.

- Las Vegas Springs National Register Site (Prehistoric Sensitivity C7). A detention basin measuring approximately 35 acres could impact the site.

- Las Vegas Springs National Register Site (Historical Inventory 1). A 35-acre detention basin could directly affect the resource area.

- Old Emigrant Road from Salt Lake to San Bernardino (Historical Inventory 34). A floodway would impact a 1000-foot segment of the resource.

- Las Vegas Wash/Paradise Valley/Duck Creek (Historical Inventory 28). A floodway and lined channel would bisect the resource area, potentially impacting several sites.

- Rock Alignment Features (Historical Inventory 43). A system of lined channels, dike/levees, and drop structures could impact the site.

12.5.2 All Conveyance

Potential effects of the All Conveyance alternative are presented in Tables 12-5, 12-6, and 12-7. Areas of particular concern are as follows:

- Eglington Escarpment (Archaeological Inventory N2). An area of known high site density would be impacted by 4.4 miles of lined channels.

- Upper Las Vegas Wash (Archaeological Inventory N5). Approximately 0.4 lined mile and 2,200 acres of an area of known high site density would be effected.

- Lower Las Vegas Wash (Archaeological Inventory N7). Approximately 27 miles of lined channels and dikes would be constructed in an area of known high site density.

- Brownstone Basin and La Madre Mountains (Archaeological Inventory C1). Approximately one mile of linear facilities would be in an area of moderate to high site density.

- Las Vegas Springs National Register Site (Prehistoric Inventory C7). A lined channel and box conduit measuring 0.4 mile would impact the area.

- Las Vegas Springs National Register Site (Historic Component 1). A lined channel and box conduit measuring 0.4 mile would impact the area.

- Old Emigrant Road from Salt Lake to San Bernardino (Historical Inventory 34). A floodway would impact a 1000-foot segment of the resource.

- Las Vegas Wash/Paradise Valley/Duck Creek (Historical Inventory 28). A lined channel would bisect the resource area in two places, potentially impacting several sites.

- Rock Alignment Features (Historical Inventory 43). A system of lined channels, dike/levees, and drop structures could impact the site.

12.5.3 No Project Alternative

The No Project alternative accounts for the fact that the Las Vegas area is developing rapidly. Even without the flood control project, many resources will be lost to private development or be impacted by increased recreational use of the surrounding open spaces. However, such impacts are difficult to gauge.

Cultural resources on federal land are afforded protection by the NHPA and Archaeological Resources Protection Act. Thus, it is reasonable to suggest that the No Project alternative would reduce impacts to sites on federal land, but that this would not necessarily be the case on private land, where development projects would not in all cases be preceded by mitigation of impacts to cultural resources.

Assuming that an adequate mitigation program is carried out on flood control projects on private as well as federal land, the No Project alternative would not necessarily reduce impacts overall. Rather, the extra protection afforded resources on private land by virtue of the projects NHPA compliance efforts could actually have a positive benefit to cultural resource preservation.

12.6 PROGRAMMATIC MITIGATIONS

Mitigation of impacts to cultural resources will be achieved through the NHPA Section 106 consultation process as described in 36 CFR 800. BLM in its role as lead federal agency will consult with the State Historic Preservation Officer (SHPO) to determine compliance requirements. The District and Corps of Engineers (COE) will also be consulted, the latter as a cooperating agency. These consultations have been initiated, but are not yet complete.

It is anticipated that a Programmatic Agreement (PA) will be reached with these agencies and the Advisory Council on Historic Preservation (ACHP) regarding requirements for District to: 1) inventory resources, 2) provide data for their evaluation for eligibility for the National Register of Historic Places, and 3) provide adequate treatment for significant sites. Concerned groups and individuals in the general public have the opportunity to provide input into the PA process under 36 CFR 800.13.

Until such time that a PA is completed, the District will consult with BLM concerning compliance with Section 106 on a site by site basis. The following subsections provide general guidelines regarding appropriate studies to be undertaken prior to the approval and construction of individual projects.

12.6.1 Archaeological Resources

Project-specific environmental studies should be prepared, containing a complete records search for all known sites that are within the Area of Potential Effect (APE). These data, along with the sensitivity analysis (revised as necessary based on new data), will be provided to BLM to consult with the SHPO and assess inventory requirements. Today's standards suggest that a complete archaeological survey of the APE in moderate and high sensitivity areas would be required. In low sensitivity areas spot-checks should be conducted to confirm the absence of significant resources. Archaeological survey need not be conducted for the environmental document, but would be completed well in advance of construction to allow adequate time for consultation on significance and effect.

Following completion of the inventory, the BLM would consult with the SHPO to determine whether any resources qualify as eligible for the National Register of Historic Places. Assessing the potential eligibility may require subsurface testing or other fieldwork; if so, the District should retain a qualified archaeologist and/or historian to conduct the work and make recommendations regarding significance. If resources are found to be eligible for the National Register, the District will develop a treatment plan for BLM which will be used during consultation with COE, SHPO, and ACHP. In developing treatment plans District will attempt to avoid impacts wherever feasible. If avoidance is not feasible, data recovery or other appropriate mitigation measures will be proposed. The treatment plan will also address measures to be taken should potentially significant resources be unexpectedly encountered during construction.

12.6.2 Ethnographic Resources

Although no impacts to specific ethnographic resources have been identified, Native American groups have expressed general concerns for cultural resources in the project area. Consequently, continued communication with appropriate Native American groups will be maintained throughout the environmental review process and Section 106 consultation process. Based on the contact program reported herein, it would be appropriate to address subsequent communication regarding the cultural resources component of the Master Plan to the Las Vegas and Moapa Paiute with copies to the Southern Paiute Chairman's Association. These three entities will also receive copies of the EIS.

During the cultural resources survey phase of the project, Paiute Elders will be notified of specific facility proposals. Involvement of Paiute representatives in the field reconnaissance surveys will be based upon their project-specific comments and direction from the SHPO.

12.6.3 Historic Resources

Project-specific environmental studies should contain an updated register search for facilities proposed for construction. Historic archaeological sites identified through the archaeological records search should be included in this inventory.

Prior to the archaeological survey, a search of primary historic documents, including, but not limited to early USGS quadrangle maps, USGLO survey maps, and county road maps will be conducted to assess the location of potential historic sites. These will be included in the updated inventory of historic resources.

Concurrent with the archaeological survey, potentially significant historic resources will be revisited in the field to assess their current condition. This work will be completed in accordance with requirements set forth during Section 106 consultation and provide information requested by SHPO to assess potential impacts and determine an appropriate treatment plan.

TABLE 12-1

ARCHAEOLOGICAL SENSITIVITY

SENSITIVITY[1] AREA	SENSITIVITY	JUSTIFICATION
NORTHERN LAS VEGAS VALLEY		
N1	High	High Site Density, Environment
N2	High	High Site Density, Environment
N3	High/Moderate	Moderate Site Density
N4	Moderate	Moderate Site Density
N5	High	High Site Density, Environment
N6	Moderate	Moderate Site Density
N7	High	High Site Density, Environment
N8	High	Tule Springs; National Register Site 26 CK 4
CENTRAL LAS VEGAS VALLEY		
C1	High	High to Moderate Site Density, Environment
C2	Moderate	Moderate Site Density
C3	Moderate	Moderate Site Density
C4	Moderate	Moderate Site Density
C5	Moderate	High to Moderate Site Density Downgraded from High due to Extensive Impacts and Development
C6	Moderate	Moderate Site Density
C7	High	Las Vegas Springs, National Register Site 26CK 948
SOUTHWEST LAS VEGAS VALLEY		
S1	High	High Site Density, Environment
S2	Moderate	Moderate Site Density
S3	High	High Site Density, Environment
S4	Moderate	Moderate Site Density
S5	Moderate	Moderate Site Density, Environment
S6	High	High Site Density
S7	Moderate	High Site Density, Environment Downgraded from High due to Extensive Impacts and Development

[1] Area designations refer to sensitivity areas mapped on Figure 12-1

TABLE 12-1 (concluded)

SENSITIVITY AREA	SENSITIVITY	JUSTIFICATION
BOULDER CITY		
No sensitive areas recorded		
HENDERSON		
H1	High	High Site Density
H2	Moderate	Low Site Density, Environment
H3	High	High Site Density, Environment

TABLE 12-2

ETHNOGRAPHIC RESOURCES[1]

SITE NAME	SITE TYPE	SENSITIVITY	REFERENCE
Las Vegas Colony	Reservation	Moderate	Kelly and Fowler, 1986
Sunrise Mountain	Sacred Area	Exclusion	Stoffle and Dobyns, 1982
Frenchman Mountain	Sacred Area	Exclusion	Stoffle and Dobyns, 1982

1 Locations are mapped on Figure 12-1

TABLE 12-3

CONTACT PROGRAM SUMMARY

NATIVE AMERICANS	DATE	MEDIUM
Mr. Richard Arnold, Chairman	11-07-88	Letter
Pahrump Paiute Indian Tribe	11-16-88	Message
Pahrump, Nevada	11-17-88	Message
	11-21-88	Telephone
Ms. Margaret Henry, Chairperson	11-07-88	Letter
Las Vegas Paiute Indian Tribe	11-16-88	Message
Las Vegas, Nevada	11-17-88	Message
	11-18-88	Message
	11-28-88	Telephone/Brenda Snow
Ms. Christine Walker, Chairperson	11-07-88	Letter
Chemehuevi Indian Tribe	11-16-88	Telephone/Pat Martis
Chemehuevi Valley, California		
Ms. Dolores Savala, Chairperson	11-07-88	Letter
Kaibab Paiute Indian Tribe	11-16-88	Telephone
Fredonia, Arizona		
Ms. Vivian Jake	11-07-88	Letter
Kaibab Paiute Indian Tribe	11-16-88	Telephone
Fredonia, Arizona	11-29-88	Message
Mr. Charlie Smith	11-07-88	Letter
Chemehuevi Indian Tribe	11-16-88	Telephone
Chemehuevi Valley, California		
Ms. Louella Tom	11-07-88	Letter
Moapa Paiute Indian Tribe	11-16-88	Telephone
Moapa, Nevada	11-21-88	Telephone

TABLE 12-3 (continued)

NATIVE AMERICANS	DATE	MEDIUM
Mr. Weldon B. Johnson, Sr.	11-07-88	Letter
Colorado River Indian Tribes Mus.	11-17-88	Message
Parker, Arizona	11-18-88	Telephone
	11-22-88	Telephone
	11-28-88	Telephone
Ms. Geneal Anderson, Chairperson	11-07-88	Letter
Paiute Indian Tribe of Utah and	11-17-88	Telephone
Southern Paiute Chairman's Assn.		
Cedar City, Utah		
Ms. Gloria Hernandez	11-07-88	Letter
Las Vegas Paiute Indian Colony	11-17-88	Message
Las Vegas, Nevada	11-22-88	Telephone
	11-29-88	Telephone
Mr. Eugene Tom, Chairman	11-07-88	Letter
Moapa Paiute Indian Tribe	11-17-88	Message
Moapa, Nevada	11-21-88	Telephone/Don Levi
	11-29-88	Telephone/Don Levi
	11-30-88	Telephone/Don Levi
Mr. Anthony Drennan, Sr., Chairman	11-07-88	Letter
Colorado River Indian Tribes		
Parker, Arizona		
Mr. Dan Bulletts, Sr.	11-07-88	Letter
Kaibab Paiute Indian Tribe	11-23-88	Telephone/Daughter
Fredonia, Arizona		
Mr. Mart Snot, Chairperson	11-07-88	Letter
Shivwits Paiute Indian Tribe	11-17-88	Message
Ivins, Utah	11-20-88	Message
	11-29-88	Telephone

TABLE 12-3 (concluded)

NATIVE AMERICANS	DATE	MEDIUM
Mr. Herbert Myers	11-18-88	Letter
Moapa Paiute Indian Tribe	11-28-88	Telephone/Weldon Johnson
Moapa, Nevada		
Mr. Tito Smith	11-18-88	Letter
Chemehuevi Indian Tribe		
Chemehuevi Valley, California		

AGENCY PERSONNEL AND OTHERS	DATE	MEDIUM
Mr. Keith Myhrer, Archaeologist	11-07-88	Letter
Bureau of Land Management	11-22-88	Message
Las Vegas, Nevada	11-23-88	Telephone
Ms. Alice Becker, Archaeologist	11-07-88	Letter
State Historic Preservation Office		
Division of Historic Preservation and Archaeology		
Carson City, Nevada		
Mr. Tim Sutko, Senior Hydrologist	11-07-88	Letter
Clark County Regional Flood Control District		
Las Vegas, Nevada		
Dr. Richard Stoffle	11-07-88	Letter
Institute for Social Research		
Survey Research Center		
University of Michigan		
Ann Arbor, Michigan		

TABLE 12-4

HISTORIC RESOURCES INVENTORY

IDENTIFICATION NUMBER	SITE NUMBER	SITE NAME	SITE TYPE	SENSITIVITY	COMMENTS
1	26-CK-948	Las Vegas Springs (aka Big Springs)	National Register Prehistoric and Historic Site	High	Surrounding area, while not included in N.R.nomination, is included here as a potentially sensitive historic site
2	26-CK-1527	Kyle Ranch	National Register Historic Site	High	T20S, R61E, Sec. 15 SE 1/4
3	26-CK-1214 26-CK-2607	Las Vegas Mormon Fort	National Register Building	High	Surrounding area (Cashman Field), while not included in NR nomination, is included here as a potentially sensitive historic site
4	26-CK-3918	Tule Springs Ranch (Flyod R. Lamb State Park)	National Register Historic District	High	T19S, R60E, Sec. 9 NE 1/4 NE 1/4 NE 1/4
5	26-CK-3913	Westside School	National Register Building	High	Washington and D Streets, Las Vegas
6	26-CK-3919	U.S. Post Office and Courthouse	National Register Building	High	301 E. Stewart Avenue, Las Vegas
7	26-CK-3920	Las Vegas High School Academic Building and Gymnasium	National Register Building	High	315 S. Seventh Street, Las Vegas
8	26-CK-3921	Jay Dayton Smith House	National Register Building	High	624 S. Sixth Street, Las Vegas
9	26-CK-3923	Stephen Whitehead House	National Register Building	High	333 N. Seventh Street, Las Vegas
10	26-CK-3924	Railroad Cottages	National Register Historic District	High	T20S, R61E, Sec. 34
11		Victory Hotel (Lincoln Hotel)	National Register Eligible	High	307 N. Main Street, Las Vegas
12		Fifth Street School/ Clark County Court-house Annex	National Register Eligible	High	400 S. Fourth Street, Las Vegas

TABLE 12-4 (continued)

IDENTIFICATION NUMBER	SITE NUMBER	SITE NAME	SITE TYPE	SENSITIVITY	COMMENTS
13		Railroad Storehouse Building (Hanson Hall)	National Register Eligible	High	700 Dividend Drive, Las Vegas
14		Las Vegas Art Museum/ Twin Lakes Resort	Historic Site	Moderate	3333 W. Washington in Lorenzi Park
15		Eglington Ranch Site	Historic Site	Moderate	Inventoried by Nevada Historical Society (Ritenour and Tipton, 1978)
16		Dike Railroad Siding	Historic Site	Low	Ritenour and Tipton, 1978
17		Dike Mining District	Historic Site	Moderate	Ritenour and Tipton, 1978
18		Valley Railroad Siding	Historic Site	Low	Ritenour and Tipton, 1978
19		Bracken	Ranch, Railroad Stop	Moderate	Ritenour and Tipton, 1978 Myrick, 1963
20		Blue Diamond Railroad Spur	Historic Railroad	Low	Ritenour and Tipton, 1978
21		Pierce	Railroad Stop	Moderate	Ritenour and Tipton, 1978
22		Arden	Railroad Stop	Moderate	Ritenour and Tipton, 1978 Myrick, 1963
23		Arden Plaster Narrow Gauge Railroad Grade	Railroad Grade	Low	Myrick, 1963
24		Knob Hill Gypsum Quarry	Quarry	Low	Ritenour and Tipton, 1978
25		Arden Railroad	Historic Railroad	Low	Ritenour and Tipton, 1978
26	26-CK-4039	Railroad Grade	Historic Railroad Grade	Low	Temporary railroad grade in use 1905-06
27		Willow Spring	Historic Site	Low	Ritenour and Tipton, 1978
28		Las Vegas Wash Paradise Valley Duck Creek	Historic Trail/ Historic Ranches, Farms, Springs	Moderate	Sites of several historic ranches, farms, and springs are located in this region. Carpenter, 1915; Ritenour and Tipton, 1978 Site of Armijo's trace; Roske, 1986

TABLE 12-4 (continued)

IDENTIFICATION NUMBER	SITE NUMBER	SITE NAME	SITE TYPE	SENSITIVITY	COMMENTS
29		Old Road Callville - St. Thomas	Historic Road	Low	USGLO 1883, 1933
30		Old Road	Historic Road	Low	USGLO 1933
31		Old Road from Las Vegas to El Dorado Canyon	Historic Road	Low	USGLO 1881, 1883
32		Old Road from Las Vegas to Ivanpah	Historic Road	Low	USGLO 1881
33a,b		Old Arrowhead Trail	Historic Road	Moderate	a) USGLO 1935 b) Ritenour and Tipton, 1978; Roske, 1986
34		Old Emigrant Road from Salt Lake to San Bernardino/Road to Ivanpah	Historic Road	Moderate	USGLO 1882, 1881
35		Old Road to El Dorado Canyon	Historic Road	Low	USGLO 1881
36		Road from Ash Meadows to El Dorado Canyon	Historic Road	Low	USGLO 1882
37		Old Road	Historic Road	Low	USGLO 1881
38		Old Road from Las Vegas to Resting Springs	Historic Road	Low	USGLO 1881
38a	26-CK-3848	Mormon Road Historic Trail Segment	Historic Road/ Trail Section	Moderate	Myhrer, 1987, IMACS Site Form Agency No. BLM 53-4969
39		Old Road	Historic Road	Low	USGLO 1881
40	26-CK-1277	Rock Structure	National Register Eligible	High	Site Survey Record, Ferraro,1975
41	26-CK-1278	Historic House Foundation	National Register Eligible	High	Site Survey Record, Ferraro,1975
42	26-CK-1279	Henderson Dump	Historic Dump Site	Moderate	Site Survey Record, Brooks and Ferraro 1975; Material in dump site dates from 1940s.

TABLE 12-4 (continued)

IDENTIFICATION NUMBER	SITE NUMBER	SITE NAME	SITE TYPE	SENSITIVITY	COMMENTS
43	26-CK-1303	Rock Alignment Features	Historic Site	Moderate	Site Survey Record, Bussard and Olson 1975
44	26-CK-4046	Railroad Grade	Historic RR Grade	Moderate	Site Record, Leavitt 1981; Abandoned grade of U.S. Government Railroad 1930s-1962
45	26-CK-503	Dump Site	Historic Dump Site	Low	Site Survey Record, Moen 1967
46		Old Road to Marble Quarry	Historic Road	Low	Carpenter, 1915
47		Pipeline from Cottonwood Springs	Pipeline	Low	Carpenter, 1915; USGS 15′ Quad, Las Vegas 1908
48		Bonanza Road Railroad Underpass	Historic Underpass	Moderate	Charles Hall Page and Assoc., 1978:74; Moderne Styling ca 1935
49		Las Vegas and Tonopah Railroad Grade	Historic Railroad Grade	Moderate	Carpenter, 1915; USGS 15′ Quad, Las Vegas 1908
50	26-CK-3915	Old Boulder City Hospital	National Register Building	High	701 Park Place, Boulder City
51	26-CK-3914	Boulder Dam Hotel	National Register Building	High	1305 Arizona Street, Boulder City
52	26-CK-3917	Boulder City Historic District	National Register Historic District	High	Roughly bounded by Nevada Highway, Avenue L, Date Street, and 5th Street
53		Las Vegas Union Pacific Railroad Yards	Railroad Yards	Moderate	Charles Hall Page and Assoc., Inc. 1978; see also Railroad Storehouse Building (#11)
54		Rockwell Field	Historic Airport	Moderate	Ritenour and Tipton, 1978; Roske 1986:69-70
55		Frenchman Mine South Nevada Gold Mining Co. Mine and Mill/Boarding Houses and Cottages	Historic Mine Site	Moderate	Ritenour and Tipton, 1978
56		Old Road	Historic Road	Low	USGS 15′ Quad, Las Vegas, 1908

TABLE 12-4 (continued)

IDENTIFICATION NUMBER	SITE NUMBER	SITE NAME	SITE TYPE	SENSITIVITY	COMMENTS
57		Railroad Pass	Historic Railroad Pass	Moderate	Ritenour and Tipton, 1978; Myrick, 1963
58		Marble Quarry	Historic Quarry	Low	Carpenter, 1915
59		McGiff Ranch	Historic Ranchsite	Moderate	Ritenour and Tipton, 1978
60		Gilcrease Ranch	Historic Ranchsite	Moderate	Ritenour and Tipton, 1978
61		Gilcrease Vineyard	Historic Vineyard	Moderate	Ritenour and Tipton, 1978
62		Dugout Ranch	Historic Ranchsite	Low	Ritenour and Tipton, 1978
63		Blue Diamond Adobe	Historic Site	Moderate	Ritenour and Tipton, 1978
64		Cottonwood Springs	Historic Site	Low	Ritenour and Tipton, 1978
65		Cottonwood Ranch	Historic Site	Moderate	Ritenour and Tipton, 1978
66		Blue Diamond Mine	Historic Site	Moderate	Ritenour and Tipton, 1978
67		Historic Mine Sites Valentine Mine Carnotite Prospect Pauline Mine Dawn Mine 99 Mine Double-Up Mine	Historic District	Moderate	Ritenour and Tipton, 1978
68		Sandstone Ranch (Spring Mountain Ranch)	National Register Historic District	High	Nevada State Park system uses ranch for interpretive purposes and as a visitors' center
69		McKeeversville (Government Camp Number 1)	Historic Settlement	Moderate	Roske, 1986:77
70		Old Road	Historic Road	Low	Carpenter, 1915

TABLE 12-5

ARCHAEOLOGICAL RESOURCES IMPACT ASSESSMENT

FACILITY TYPE	ALL CONVEYANCE	DETENTION/CONVEYANCE
DIKE/LEVEE		
Moderate	2.90 miles (DII=116.5)	2.60 miles (DII=99.8)
High	14.40 miles (DII=136.9)	15.50 miles (DII=179.0)
LINED CHANNEL		
Moderate	12.75 miles	9.05 miles
High	21.58 miles	19.98 miles
PIPELINE/BOX CONDUIT		
Moderate	0.45 mile	1.15 mile
High	0.30 mile	2.50 miles
DETENTION/RETENTION BASIN		
Moderate	95 acres	1423 acres
High	25 acres	402 acres
DEBRIS BASIN		
Moderate	53 acres	57 acres
High	0 acres	10 acres
FLOODWAY		
Moderate	130 acres	301 acres
High	2,254 acres	2,176 acres

TABLE 12-6

HISTORIC RESOURCES IMPACT ASSESSMENT

RESOURCE INVENTORY NUMBER	RESOURCE SENSITIVITY	WEIGHTED IMPACT SCORES ALL CONVEYANCE	DETENTION/CONVEYANCE	LOWEST IMPACT ALTERNATIVE
1	High	4	5	All Conveyance
2	High	1	1	Equal Impacts
3	High	1	3	All Conveyance
14	Moderate	0	2	All Conveyance
15	Moderate	1	3	All Conveyance
20	Low	2	0	Detention/Conveyance
21	Moderate	1	2	All Conveyance
23	Low	5	5	Equal Impacts
24	Low	2	2	Equal Impacts
25	Low	3	3	Equal Impacts
27	Low	2	1	Detention/Conveyance
28	Moderate	6	5	Detention/Conveyance
29	Low	4	4	Equal Impacts
30	Low	6	5	Detention/Conveyance
31	Low	12	14	All Conveyance
32	Low	12	9	Detention/Conveyance
34	Moderate	26	31	All Conveyance
35	Low	5	5	Equal Impacts
36	Low	11	10	Detention/Conveyance
37	Low	8	8	Equal Impacts
38	Low	2	4	All Conveyance
38a	Moderate	4	4	Equal Impacts
39	Low	2	1	Detention/Conveyance
43	Moderate	3	3	Equal Impacts
44	Moderate	5	5	Equal Impacts
45	Low	2	1	Detention/Conveyance
46	Low	4	5	All Conveyance
47	Low	2	2	Equal Impacts
49	Moderate	2	1	Detention/Conveyance
53	Moderate	2	2	Equal Impacts
56	Low	1	2	All Conveyance
70	Low	2	1	Detention/Conveyance

TABLE 12-7

HISTORIC RESOURCES IMPACT SUMMARY

RESOURCE SENSITIVITY	PREFERRRED ALTERNATIVE ALL CONVEYANCE	DETENTION/CONVEYANCE	EQUAL IMPACTS	TOTAL
High	2	0	1	3
Moderate	4	2	4	10
Low	4	8	7	19
TOTAL	10	10	12	32

FIGURE 12-1

ETHNOGRAPHIC AND PREHISTORIC
ARCHAEOLOGICAL SENSITIVITY AREAS

(SEE VOLUME II, OVERSIZE MAPS)

FIGURE 12-2

KNOWN HISTORIC RESOURCES

(SEE VOLUME II, OVERSIZE MAPS)

13.1 INTRODUCTION

Cumulative impacts refer to the environmental effects of the proposed project in combination with the anticipated impacts of past, current, and other reasonably foreseeable projects within the same vicinity. The intent of the discussion is to identify the collective impacts that are likely to occur from development within the Las Vegas Valley during the projected build-out time of the proposed project. The following sections review the design and need for the proposed project, discuss recent growth and development trends within the Valley area, and detail the cumulative impacts affecting each resource.

In 1986 the "Clark County Regional Flood Control District Flood Control Master Plan" proposed two flood control system alternatives for the Las Vegas Valley, a Detention/Conveyance system and an All Conveyance system. Both alternatives follow the same general configuration of interrelated facilities; however, the size, number, spatial extent, construction time and cost of the facilities comprising the two alternatives vary considerably.

The Detention/Conveyance alternative would consist of approximately 48 miles of dikes and 197 miles of lined and unlined channels for collecting flood flows and conveying them to any of 69 detention and debris basins for metered release. The majority of the detention and debris facilities would be located on undeveloped lands along the periphery of currently urbanized areas. Construction of this alternative would require an estimated 59 years to complete at a cost of $763,125,000.

The All Conveyance alternative would include a series of structures and facilities designed to catch flood flows and convey them out of the project area. The system would consist of 44 miles of dikes, 238 miles of lined and unlined channels, 34 miles of floodways, 99 miles of pipelines and conduits, 182 bridges and 34 detention and debris basins. The construction time of this alternative is estimated to be 97 years at a cost of $1,259,676,000.

In 1986, the District selected the Detention/Conveyance system as the preferred alternative. Construction of the facilities comprising this system is mandated by the 10-year plan of the Master Plan. Between the fiscal years 1988-89 and 1997-98, Phase 1, Phase 2, and amended facilities of the 10-year plan will be built. As detailed in Section 3.2, Phase 1 facilities include those facilities that should be constructed immediately in an effort to prevent life-threatening flood scenarios, while Phase 2 facilities are necessary for the proper functioning of the flood control system as a whole.

Large infrastructure projects can significantly affect the population growth, structure and stability of an area. The current population of Clark County is approximately 715,377 persons, with 95 percent of residents living within the Las Vegas Valley area (Cooper et al., 1988). Although projections for future growth within the region vary widely, it is anticipated that the area will continue to grow beyond the year 2020 (Planning Information Corporation et al., 1989). The distribution and rate of growth within the project area will be governed primarily by the county's Comprehensive Plan, which treats the flood control program as a supportive element of the overall development process (CCDCP, 1987). As such, impacts upon population growth due to the addition of flood control facilities would be controlled by institutional policies and procedures. Established limits, plans, and regulations, therefore, would prevent the proposed flood control project from inducing uncontrolled population growth or related development.

13.2 PROPOSED DEVELOPMENT IN THE LAS VEGAS VALLEY

Predictions of population growth and development are dependent upon a number of interrelated local, regional and national economic and demographic trends, as well as such physical limitations as water and land availability, air quality, and infrastructure conditions (Planning Information Corporation et al., 1989). Due to the number and complexity of the above parameters, there is typically: 1) substantial variation among independent population projections and, 2) greater confidence in the initial periods of a prediction than in it's latter portions. Consequently, it is difficult to forecast the long-term development of the Las Vegas Valley area.

Although build-out within the project area cannot be predicted with absolute confidence, review of existing population projections, compilation of major permitted and presumed-to-be-permitted residential projects, and interviews with local Las Vegas Valley planners suggest that: 1) construction of the proposed flood control facilities are necessary in order to protect development areas that have been recently constructed, or are currently under construction and 2) greater certainty can be affixed to flood control facilities proposed by the ten-year plan than to the long-term goals of the Master Plan.

13.2.1 Long Term Population Predictions

Population and development projections for Clark County and the Las Vegas Valley reviewed include forecasts for the Nevada Power Company, the State of Nevada, the Clark County 208 Water Quality Conservation Plan (Black & Veatch, 1989), the 1988 Yucca Mountain Socioeconomic Study, and the Las Vegas Perspective, 1988. Although there is substantial variation among the results of these projections, the following general conclusions can be made:

- Clark County has grown faster than either the region or the country as a whole, and the pattern of growth has been remarkably uniform for the past 80 years.

- Clark County and the Las Vegas Valley will continue to grow through the year 2020, but at progressively slower rates.

- The Las Vegas Valley will continue to hold the majority of the County and State's population.

- The distribution of growth within the Las Vegas Valley has been highly variable from one year to the next. Availability of undeveloped private land has and will continue to affect growth in the area for the foreseeable future.

- Population growth within the City of Las Vegas and unincorporated areas of the Las Vegas Valley has been greater in developed areas than undeveloped areas, principally as a function of the development of lands annexed by the city during the 1980's.

- Population growth within the cities of North Las Vegas and Henderson has primarily occurred on previously undeveloped lands.

- Trends towards master-planned residential communities are evident throughout the entire Las Vegas Valley area.

Modelling techniques represented by the forecasts in Clark County Subarea Population Projections (Planning Information Corporation, 1989) include: 1) employment by place of residence [1977 projections for Clark County's 208 Plan], 2) growth according to allocation of vacant land [1988 projections for the Nevada Power Company], 3) growth according to recent population trends and allocation of vacant land [1988 Nevada State Demographer], and 4) growth as a function of increased "capture" of regional and national population growth [1988 REMI/Clark model for Yucca Mountain Socioeconomic Study]. The fourth approach was considered to be the most consistent with patterns that are expected to prevail during the immediate future, and was therefore used as the basis of sub-county population projections for the 208 Plan.

13.2.2 Interviews with Local Planners

During the fall of 1989 and spring of 1990 interviews were held with local planners of the Las Vegas Valley in an effort to assess future development plans within the project area. Planners from Clark County, Nellis Air Force Base, and the cities of Las Vegas, North Las Vegas, Henderson and Boulder were contacted.

13.2.2.1 Clark County

Clark County covers 7,910 square miles of land, 85 percent of which is owned and managed by the Federal Government (CCDCP, 1987). Of the 62 percent of Clark County lands surveyed in 1979, approximately 85 percent were designated vacant, 8.7 percent residential, 2.2 percent commercial/industrial, 0.6 percent resort/highway frontage, and 3.1 percent public facilities.

Residential growth is concentrated in the Las Vegas Valley area, particularly in the areas west of I-15, the Green Valley area of Henderson and the northwest portion of the Valley adjacent to the new US Highway 95. Most of this development is occurring in the form of master planned communities and single family dwellings. Residential growth will continue in both the unincorporated and incorporated portions of the county, driven primarily by competitive market forces.

13.2.2.2 City of Las Vegas

The City of Las Vegas covers approximately 116 square miles of land which is divided into 16 Community Profile areas. The core of the metropolitan area is dominated by commercial land uses; however, the overall character of the City is suburban residential. Corridors of growth have predominantly occurred on the west and northwest corridors of the City (City of Las Vegas, 1986). Future planning guidelines will encourage both a balance of in-fill development within the City and new development along the periphery of the City to accommodate population growth, and development of master planning of large parcels of land under private ownership. Such developments are anticipated to be built out within the next ten years. The City is not planning to annex new areas in the future.

13.2.2.3 City of North Las Vegas

The City of North Las Vegas covers slightly less than 60 square miles of land, some of which is being developed for both light and heavy industrial purposes. An estimated 95 percent of the area is currently designated vacant land, and the community anticipates substantial growth within the next decade. A large portion of this projected growth is expected to occur as a result of the purchase of approximately 7,500 acres of BLM land located in the northern portion of the City. Residential developments are expected to be principally single family dwellings.

13.2.2.4 City of Henderson

The city of handerson covers approximately 81 square miles of land, 72 of which are incorporated. The area has become a regional center for industry and warehousing, and is currently experiencing extremely rapid residential and commercial growth. No more large planned communities can be developed in the area without annexation. Major projects currently under development include Cosmo World/Silver Springs, Green Valley, Lake at Las Vegas, McDonald Ranch, and Whitney Ranch.

13.2.2.5 Boulder City

Boulder City covers an estimated 35 miles of land, all of which is incorporated. Although host to numerous visitors en-route to Lake Mead, Hoover Dam and other local recreation areas; the City's land use is principally driven by it's right-of-way and easement agreements for Hoover Dam's power transmission lines. Local growth ordinances recently adopted by the City restrict residential growth to four percent a year. Only 132 residential building permits are issued annually.

13.2.2.6 Nellis Air Force Base

The total occupational range of the Nellis Air Force Base is 3,012,369 acres; the Base itself occupies 11,193 acres. With a work force of an estimated 12,298 persons, the Base contains approximately 5,810,640 square feet of permanent or semi-permanent buildings, including 1,364 residential units. The Nellis long-range Facility Improvement Plan (Nellis Air Force Base, 1989) includes numerous projects to construct, upgrade and repair facilities through the year 2,000; none of these projects include development of residential areas. There are no areas of the Base that cannot be developed due to flooding.

13.2.3 Permitted and Presumed-to-be-Permitted Projects

Clark County is experiencing unprecedented growth, particularly in the Las Vegas Valley area. The growth is driven by the current boom in construction for the hotel/gaming industry, resulting in over 4,000 new residents monthly.

Aggressive residential development is currently occurring in many areas of the Valley, much of which is associated with relatively large, privately owned master-planned communities. As a result, master planning on a valley-wide scale is virtually impossible, and the public services sector has been forced to operate largely in a reactive mode to accommodate both the rate and spread of these developments. One large constraint to valley-wide planning is the lack of large tracts of privately owned land within the area. Approximately 50 percent of the Las Vegas Valley is owned by the Federal Government, which exerts significant influence on the location, type and timing of future growth. (Dames & Moore, 1990)

More than 150 residential developments are known to be permitted and currently under construction in the Valley area; collectively they represent 144,700 dwelling units. Additionally, there are an estimated 155 residential developments which have been, proposed. A summary of permitted and presumed-to-be-permitted master residential plans greater than 160 acres are presented in Table 13-1 and illustrated on Figure 13-1.

13.3 Cumulative Impacts

Considering total development in the Valley in terms of both current and proposed projects, the primary affected resources include: air quality, biological resources, visual resources, and cultural resources.

It is clear from development information presented in Section 13.2 that significant growth will occur in the Valley area regardless of whether or not the proposed project is developed. This growth will substantially impact available water, air, transportation, and biological resources. Ultimately, however, the rate and level of this growth will be directly dependent upon these resources.

13.3.1 Air Quality

Indirect effects of the Detention/Conveyance alternative include the addition of CO and particulate matter emissions in an area currently designated non-attainment, and the potential influence of flood control facilities on regional growth patterns.

Since CO emissions from other sources are expected to increase as development proceeds, cumulative effects of maintenance-related emissions are of potential concern. Maintenance of flood control protection in existing developed areas would be required in the absence of a regional flood control program, however. As a result, it cannot be clearly concluded that the proposed Detention/Conveyance alternative would actually result in any net increase in CO associated with maintenance activities.

Cumulative effects of maintenance-related particulate matter emissions would result from the addition of these emissions to similar emissions from other sources in the study area. As development proceeds, wind-blown fugitive dust levels are likely to decrease, and the cumulative effects of this reduction combined with facility maintenance activities are not expected to represent a significant adverse impact.

The implementation of a regional flood control program could result in indirect cumulative air quality impacts by influencing the rate or pattern of regional growth. As discussed in Section 9.5, the Detention/Conveyance alternative involves the construction of upstream detention basins and associated diversion dikes early in the implementation of the program. As a result, it provides some degree of flood protection in outlying areas that could reduce constraints to development. Historical development patterns in the Las Vegas Valley do not indicate that such constraints have been particularly effective as a development control, however. For this reason, air quality impacts associated with urban expansion and related vehicle emissions are not considered a likely indirect cumulative effect of the Detention/Conveyance alternative.

Indirect and cumulative effects of the All Conveyance alternative include the addition of CO and particulate matter (PM) emissions in an area currently designated non-attainment, and the potential influence of flood control facilities on regional growth. The addition of maintenance-related CO and particulate matter emissions to other sources would be similar to that discussed in Section 4.5.1.3 associated with the Detention/Conveyance alternative, and is not expected to be significant.

The implementation of a regional flood control program could result in indirect cumulative air quality impacts by influencing the rate or pattern of regional growth. As discussed in Section 9.5, the All Conveyance alternative would require downstream improvements in proximity to existing developed areas to occur first. Scheduling of facilities construction can be accomplished in a manner that keeps pace with development, rather than removing a development constraint. For this reason, air quality impacts associated with urban expansion and related vehicle emissions are not considered a likely indirect cumulative effect of the All Conveyance alternative.

Of potential concern is the indirect cumulative effect of regional growth accommodated by the implementation of a regional flood control program. Because growth in the Las Vegas Valley has not been constrained by the lack of such a program in the recent past, this cumulative effect is not considered a significant impact of the flood control program itself. Continued growth does represent a potentially significant cumulative air quality issue in the study area, however. A consideration of the potential effect of different flood control alternatives on the pattern of regional growth is important as far as the comparison of different alternatives.

13.3.2 Geology

Potential cumulative impacts of the Detention/Conveyance alternative could result in the loss of potentially significant volumes of mineral resources (sand and gravel) due to the proposed use of several quarry areas for detention basins. However it is uncertain what overall effect this would have on the operations of other existing quarries or the future need for additional quarries.

The cumulative effect of the Detention/Conveyance alternative will be to decrease peak flows throughout much of the area. This would decrease the potential for erosion in unlined channels. In addition, the detention basins and lining of unlined channels will remove much of the sediment load which is currently transported and deposited downstream. This would increase the potential for erosion of unlined portions of channels and at discharge points to lower Las Vegas Wash. It is likely that the lower discharge rate would have a greater effect than the decreased sediment load on erosion potential.

Peak flows estimated in the Master Plan for the All Conveyance alternative are generally similar to or less than the existing flow conditions. However, at some locations, peak flows are increased by this alternative. Under existing conditions most channels are unlined. In as much as most channels will be lined under this alternative less sediments will be transported downstream. Because the erosive potential of clean water is higher than that of sediment laden water, unlined portions of channels and the Lower Las Vegas Wash would suffer increased erosion.

13.3.3 Ground Water

Potential cumulative effects on ground water associated with the future development of the Las Vegas Valley could include localized increases in shallow ground water associated with increased landscape watering and urban runoff. Because shallow ground water in the Las Vegas Valley is generally of poor quality, these increases could result in some degradation of water quality in deeper aquifers if the resulting head pressure causes an increased downward percolation to deeper aquifers used to supplement local water supplies. Both the Detention/Conveyance and the All Conveyance alternatives could contribute to potential cumulative effects on ground water quality of the principal aquifers. This effect could occur as a result of shallow ground water level increases associated with the widespread introduction of lined channels and pipelines in channels currently allowing ground water discharge into natural channels. This impact could be significant unless facility-specific mitigation described in Section 6.6.2 is implemented. With the application of these measures, residual impacts associated with flood control facilities are expected to be less than significant and would not contribute to this potential cumulative impact.

13.3.4 Surface Water

Urban growth within the study area would increase the area of impermeable surfaces and could increase surface water runoff conveyed by natural drainage systems and flood control structures. This flow increase, and the presence of increased urban populations would expose greater numbers of people to safety hazards and property losses associated with flood events. Increased flows could also result in increased erosion in wash channels, especially sensitive areas such as the Lower Las Vegas Wash. Increased sediment loads could degrade surface water quality, and may increase the volume of sediment transported to Lake Mead. The implementation of the Master Plan, including the proposed 10-year construction plan, is expected to reduce public safety hazard by efficiently conveying flows. Although flood control facilities could result in increased sediment loads and increased erosion in localized areas during facility construction and early stages of flood control system development, attention to controlling flow velocities, and establishing erosion control facilities in areas of identified erosion problems during facility design is expected to mitigate these effects. Although cumulative surface water impacts may be considered potentially significant, the proposed flood control facilities are not expected to contribute to these impacts and may partially mitigate potential adverse effects. The most significant effect of the proposed flood control facilities is the beneficial reduction of public safety hazards.

13.3.5 Biological Resources

Implementation of either the Detention/Conveyance or All Conveyance alternative would cause the loss or disturbance of wetland vegetation and various wildlife habitat throughout a 250-square-mile region. Although these impacts would occur in scattered, disjunct portions of the region, there will be a cumulative effect because the same biological resources will be affected throughout the region wetland habitats and sensitive wildlife species. One example of cumulative impacts to the latter resource is the potential fragmentation of desert tortoise habitat due to installation of large, linear flood control facilities that represent barriers to tortoise movement. Potentially significant cumulative impact can be mitigated by conducting a construction monitoring program to reduce direct impacts to tortoises, by the construction of tortoise-proof fencing around construction sites and facilities, by reducing the acreage of sensitive habitats to be removed or disturbed by the installation of tortoise walkways across flood control channels, and/or by compensation for habitat losses on a regional basis. These measures and others recommended by the US Fish and Wildlife Service (1990) in its biological opinion have been accepted by the District.

Overall, the type of cumulative impacts due to the Detention/Conveyance and All Conveyance alternatives would be quite similar. However, the Detention/Conveyance alternative would result in a greater net loss of habitat for sensitive biological resources. The Detention/Conveyance alternative flood control facilities included in the 10-year plan would result in the disturbance and permanent loss of 1292 acres of desert tortoise habitat, and the temporary disturbance of 327.9 acres of desert tortoise habitat based on onsite field surveys conducted at all 10-year plan facility locations (Dames & Moore, 1990). Based on observations of tortoise sign during these surveys, and other data concerning tortoise populations in the Las Vegas Valley, The US Fish and Wildlife Service (1990) estimated a direct tortoise mortality of 86 tortoises associated with construction, maintenance, and flood events associated with the proposed 10-year plan facilities. An additional 157 tortoises are expected to experience harassment associated with relocation during the construction process (US Fish and Wildlife Service, 1990)

Based on a review of information prepared by the Nevada State Board of Wildlife Commissioners, the Draft Environmental Assessment for Proposed Issuance of a Section 10(a) Permit (RECON, 1990) estimated a free living desert tortoise population in Nevada of 26,000 to 161,000 individuals. The RECON Draft Environmental Assessment also presents an estimate of 5400 wild tortoises within the Las Vegas Valley. The potential effect of the continuing development of the Las Vegas Valley on tortoise populations is addressed in the RECON (1990) study, with an estimated loss of 460 to 1150 Tortoises (and 15,000 acres of habitat) associated with a short term Habitat concervation Plan study area, or a loss of 1600 to 4000 tortoises (and 24,000 acres of habitat) associated with a BLM Programmatic Section 7 consultation alternative. The cumulative effect of future development in the Las Vegas Valley is likely to result in the removal of a large amount of acreage of desert tortoise habitat, and will cause a substantial reduction of the local desert tortoise population.

The further development of the Las Vegas Valley will require consultation with the US Fish and Wildlife Service under Section 7 of the Endangered Species Act for Federal Actions (including the issuance of a 10(a) permit in connection with a Habitat Conservation Plan). For this reason, the US Fish and Wildlife Service (1990) concluded that this further development of the Las Vegas Valley should not be considered reasonably certain to occur in connection with the approval of the Master Plan, and should not be considered cumulative to the action addressing flood control facilities. The US Fish and Wildlife Service (1990) concluded that the issuance of rights-of-way agreements for the 10-year plan flood control facilities is not likely to jeopardize the continued existence of the desert tortoise. No opinion has been issued concerning the potential cumulative effects of the long term development of the Las Vegas Valley. This topic will be an important component of the review of the Habitat Conservation Plan, which is currently in preparation.

Construction of Master Plan facilities is expected to be growth accommodating rather than growth inducing. Development pressures due to projected population growth in the Las Vegas region are likely to dictate the location and rate of flood control construction. Without the Master Plan, development in flood hazard areas of the Las Vegas Valley will require implementation of project-by-project flood control measures. Without a Master Plan for flood control that incorporates environmental mitigation on a regional basis, it is likely that significant, unmitigated impacts to sensitive biological resources will occur. Hence, implementation of either Master Plan alternative will have fewer regional cumulative impacts than the No Project alternative.

The rate and location at which flood control facilities are constructed in order to keep pace with projected development in the Las Vegas Valley will differ greatly between alternatives. Facilities associated with the All Conveyance alternative would be constructed starting from the center of the Las Vegas Valley and moving outward to undeveloped areas. Hence, disturbance to biological resources due to flood control will be paced by development rates. In contrast, for the Conveyance/Detention alternative to function properly, the upstream detention facilities must first be constructed. Hence, large areas of habitat would be disturbed in outlying undeveloped areas prior to the initiation of development that begins within the core of the Las Vegas Valley. As such, the nature and rate of the cumulative impacts differs greatly between alternatives.

13.3.6 Land Use

Of potential concern is the cumulative effect of regional growth induced or accommodated by the implementation of a regional flood control program. Because growth in the Las Vegas Valley has not been constrained by the lack of such a program in the recent past, this cumulative effect is not considered a significant impact due to the flood control program itself. The characteristics of a regional flood control program and initial project funding priorities can influence the pattern of regional growth, however. This factor is an important consideration in the comparison of different flood control program alternatives.

The characteristics of different flood control alternatives may also influence the pattern of regional growth. Cumulative effect on regional growth patterns would be greatest with the Detention/Conveyance alternative, since the implementation of this alternative would require the installation of upstream detention basins relatively early in the development of the flood control system. As a result, the Detention/Conveyance alternative could provide some degree of flood protection in outlying areas that could remove one constraint to development.

The All Conveyance alternative would more likely focus on improvements on major drainages in downstream reaches first, which happen to be in the existing developed areas. The removal of development constraints in these areas would tend to concentrate development, rather than allowing outward expansion as suggested by the Detention/Conveyance alternative. Development patterns in the Las Vegas Valley do not indicate that flood-related constraints have been particularly effective as a development control, however. For this reason, potential cumulative land use impacts associated with both the Detention/Conveyance and All Conveyance alternatives are not considered significant.

Cumulative impacts associated with growth would depend on individual developers' priorities under the No Project alternative, since project-specific flood protection would be installed in connection with individual projects. Because developers would not be likely to install regional-scale detention facilities, protection of major planned developments would likely emphasize facilities similar to those associated with the All Conveyance alternatives. Infill development in existing developed areas is less likely to occur since developments would be smaller and construction of flood control facilities would be greater in relationship to individual unit costs than major expansions on the urban fringe. It is not clear how the No Project alternative might affect the rate of regional growth as compared to the other two alternatives, but no information is available that suggests any significant differences.

13.3.7 Visual Resources

The cumulative impacts of the proposed Master Plan facilities would result in a potential for growth accommodation and setting the urban framework for future development. The initial visual character of the Valley will change based on the potential visual impacts previously described in Section 10.4. However, as the development continues to grow, the transition of rural areas to urban uses will increase the visual absorption capacity and change visual sensitivity in these areas from high to moderate. As a result, the impacts will reduce and the opportunities for mitigation and planning for dual uses will become more available.

13.3.8 Socioeconomics

With the exception of water supply impacts, the principal cumulative socioeconomic impacts involve minor incremental benefits described in Section 11.2 extending over 20 years or more. These effects are beneficial, but not significant.

The development of the Las Vegas Valley will increase local consumptive use of fresh water. In a study prepared for Clark County, Black & Veatch (1989) indicated that the Las Vegas Valley could reach its water supply limit by the year 2002 if current water use patterns continue and total Las Vegas Valley population reaches their projection of approximately one million residents. Black & Veatch (1989) concluded that current water supplies would be adequate to accommodate the cumulative growth of the Las Vegas Valley beyond the year 2010 (and would accommodate a population of 1.7 million residents) if water usage patterns are modified in a manner comparable to other southwestern cities.

Total consumptive use of water in the Las Vegas Valley in 1988 included 114,000 acre feet from Colorado River sources and 69,000 acre feet from ground water (Black & Veatch, 1989). Total water available to Southern Nevada from the Colorado River is 295,000 acre feet per year. Although the precise volume of water required for flood control facility construction (concrete make-up, soil cement, dust suppression, etc.), annual water demand associated with the proposed construction activities are expected to represent a very minor component of the cumulative local water consumption.

13.3.9 Cultural Resources

Although both project alternatives could result in significant impacts to cultural resources, these impacts are largely restricted to a few key areas rather than generalized throughout the entire project area. Moreover, these impacts are mitigable through standard cultural resource management procedures. Perhaps the single exception to this generalization is the Las Vegas Springs National Register Site, which would be impacted by both project alternatives as currently designed. This site is of unique significance and should be avoided, if possible. While a variety of other significant resources could be affected, the types identified herein are significant largely for their informational values. The informational potential of most or all affected resources could be effectively retrieved through data recovery mitigation, if avoidance is not feasible. Such a mitigation program could result in a Finding of No Adverse Effect under the consulting process implementing the requirements of NHPA. Conditional on appropriate mitigation at the Las Vegas Springs site, both project alternatives could be built without unacceptable impacts to cultural resources.

Cumulative impacts of the two project alternatives are very similar in overall effects. Both propose similar types of structures in generally the same areas of concern for cultural resources. Within this same general range, however, the analysis herein suggests that All Conveyance Alternative is somewhat preferable for reducing potential impacts to cultural resources. It reduces the amount of ground disturbance necessary in areas of high and moderate archaeological sensitivity (Table 12-5) and reduces the incidence of impacts to historic sites of high and moderate sensitivity. The All Conveyance Alternative proposes a lined channel through the Las Vegas Springs Site while the Detention/Conveyance alternative proposes construction of a detention basin. Neither project would have an impact on specific sites of ethnographic concern.

TABLE 13-1

RESIDENTIAL DEVELOPMENTS
LAS VEGAS VALLEY - OVER 160 ACRES (AS OF 1Q 1990)

CITY/DEVELOPMENT	ACRES	UNITS	ESTIMATED BUILDOUT YEAR	BUILDERS/DEVELOPERS
LAS VEGAS				
Angel Park	640.0	N/A	1990	County Park
Canyon Gate	352.0	575	1992	Torino Construction
Desert Shores	682.0	3,300	1992	RA Homes: 19 builders
The Lakes	1,304.0	7,570	1990	West Sahara Investments
Los Prados	433.0	1,400	1992	US Homes
Painted Desert	462.0	1,900	1993	Builders: Regal, Sunland, Medici, Andrews Group, CalPacific, Distinctive Homes, Schulman
Peccole Ranch[1]	1,700.0	12,497	2000	Triple Five Development
Rainbow Vista[2]	240.0	1,018	1991	Includes 10 acres commercial and 42.38 acres MFD with no buildout date or totals determined.
Rancho Alta Mira	327.0	1,824	1995	Dunmore Homes Builder
South Shores	303.0	1,650	1990	American West, Lewis, Signature. Buildout targeted to dovetail with opening of Summerlin village(s).
Summerlin[1]	24,960.0	80,000-85,000	2040	Summa Corp. 30 villages. First village scheduled for residents late 1990.
CLARK COUNTY				
Rancho Las Palmas	586.0	3,390	1990	Pardee: Marbella 1988; Castile 1990(?); Barcelona TBD
Spanish Trail	640.0	1,300	1992	Blasco Family
Spring Valley[2]	1,310.0	6,000-6,200	1990/3	Pardee-Buildout tentatively targeted for end of 1990. May extend if successful.
Stone Gate, (Windsong), Sunrise Valley, Nevada Savings	2,110.2	7,000	2,000	Rose Golf Course, Winterwood Park (8 acres), Lewis Homes The Orchards - 428 acres - 4,000 units - 1990 to 2000

TABLE 13-1 (concluded)

CITY/DEVELOPMENT	ACRES	UNITS	ESTIMATED BUILDOUT YEAR	BUILDERS/DEVELOPERS
NORTH LAS VEGAS				
BLM ("3400")	7,500.0	N/A	N/A	"Under Acquisition;" Multi-use; Multiple builders
Eldorado	1,000.0	8,500	2015	Pardee
Pecos Ranch	320.0	TBD	1993	Trinity Capital - begin construction 1/1/91
Rancho Del Norte	320.0	1,388	1992	CRIB, LTD
HENDERSON				
Green Valley[2]	8,400.0	55,000	2000	American Nevada Corp. 7 villages: Green Valley, Green Valley South, Warm Springs, Silver Springs Westwood, Valle Verde, Legacy
Lake Las Vegas[1]	2,445.0	3,000	1999	TransContinental Prop. Pacific Malibu Dev. Corp. (LA)
Silver Canyon/ Cosmo World	11,288.0	2,700	1997	Cosmo World Corp.; Spanish Trails Assoc. (Blasco Family)
Whitney Ranch[2]	510.0	798	1995	American West

1 Includes hotel/casino, commercial, residential

2 Includes commercial

FIGURE 13-1

CURRENT AND PROPOSED DEVELOPMENT

(SEE VOLUME II, OVERSIZE MAPS)

14.1 INTRODUCTION AND OVERALL APPROACH

The information presented in Sections 4.0 through 12.0 provides a suitable database to characterize the potential region-scale environmental impacts of different flood control program alternatives and identifies general mitigation measures that may be appropriate to reduce identified impacts. This section describes a procedure that may be applied to allow the consistent application of this information to the specific environmental evaluation of facilities proposed in the District's 10-year construction plan and subsequent facility proposals. The application of this procedure is intended to result in the determination of appropriate facility-specific mitigation measures, and identify the need to prepare supplemental "second-tier" EISs addressing individual projects.

The overall process of facility-specific analysis involves the comparison of potential impacts by facility type to the impact sensitivity of resources affected by the proposed facility. This comparison is first accomplished using data presented in Sections 4.0 through 12.0 to focus further investigation on issues of potential significance and is then supplemented by site-specific field investigations and additional data collection.

Project-specific and site-specific data are then used to determine the potential for significant impact. If potentially significant impacts are identified, mitigation measures described in Sections 4.0 through 12.0 are applied to the facility and expected residual impacts are identified. If residual impacts are still considered potentially significant, a second-tier project-specific EIS should be accomplished. The project-specific EIS should be focused on those issues of potential significance to allow the development of additional mitigation measures required to reduce impacts to less than significant levels, or allow the determination of an overriding public need for the proposed facility with full opportunity for public involvement in this decision. This overall process is summarized in Figure 14-1.

The following subsections present the specific procedures to be applied in each environmental issue area, with summary information necessary to apply the information in Sections 4.0 through 12.0. The results of each discipline-specific review include the determination of appropriate mitigation measures to apply to each individual project and identification of additional environmental investigations that may be required prior to rendering conclusions concerning each project's environmental acceptability.

14.2 AIR QUALITY

14.2.1 Background and Input Data

The analysis of potential air quality impacts of individual facilities should focus on pollutants of potential concern within the study subarea affected by the proposed facility. As indicated in Section 4.0, pollutants of current concern include TSP and CO. For this reason, this analysis procedure is focused on these pollutants. If future ambient concentrations of other pollutants result in potential air quality problems within the study area, similar analyses should be applied to address these pollutants.

To simplify the process of identifying potentially significant facility-specific impacts, this analysis procedure incorporates the use of composite emissions rates and threshold-level emissions increases. Composite emissions rates were determined by a review of typical facilities construction activities and characteristics described in Sections 2.0 and 3.0 of this EIS. This analysis is focused on construction activities because they have been assessed to result in the highest short-term particulate matter (PM) and CO emissions and were identified as the only project phase with the potential to result in significant adverse impact in Section 4.0 of this EIS.

Composite emission rates were utilized to determine short-term (e.g., 1-hour, 8-hour, 24-hour) and total project construction (referred to as annual) emissions for each type of facility included in the Master Plan. The composite emission rates were developed from equipment use typical for activities defined by the facility. The United States Environmental Protection Agency (USEPA) has established emission factors for individual equipment and facility-specific construction rates that allow calculation of composite emission rates. Table 14-1 presents facility construction rates and resultant composite emissions for pertinent project activities. Threshold emission levels were estimated by reviewing existing ambient air quality monitoring data, consideration of existing regional emission inventory, and application of atmospheric dispersion modeling.

Threshold short-term emission levels for PM were determined through a review of existing ambient TSP monitoring data on a subarea basis. An available TSP increment was determined by subtracting subarea-specific measurements from the Clark County ambient air quality standards. Atmospheric dispersion modeling was then applied to determine the facility PM emission rate which would yield a ground-level TSP concentration equal to the available TSP increment. A review of long-term (annual) TSP measurements in the Las Vegas Valley indicated that the Clark County annual standard has been consistently exceeded at several monitoring locations. Consequently, no TSP increment is available by new projects. As a result, the long-term threshold emission level for PM was determined by utilizing the significant emission criteria of 0.1 percent of the existing PM emission inventory in the Las Vegas Valley (41 tons/year). Ambient TSP data applicable to each subarea and assumed potentially significant ambient concentration increases used in this analysis are presented in Table 14-2. The resulting threshold emissions rates for each facility type by study subarea are listed in Table 14-3.

It is important to note that the USEPA has recently replaced the federal TSP standards with inhalable particulate (PM10) standards. At this time, Clark County continues to recognize the old TSP standards while transitioning to the new PM10 standards. In addition, few representative PM10 data have been collected in the Las Vegas Valley. Consequently, analysis of PM emissions in the study area must rely upon correlation of PM emissions with TSP levels in the ambient air. It is suggested that evaluation of PM emission thresholds be again addressed when sufficient PM10 data become available in the study area.

Because ambient CO data are not available for much of the study area and concentrations of this pollutant tend to be highly localized within urban areas, ambient threshold concentrations of one-half the one-hour and eight-hour standards were used to determine threshold emissions in areas over one-mile from the area of CO exceedences shown on Figure 4-1. Locations within one mile of the CO exceedence area are subject to a more stringent threshold determined as a de minimus level unlikely to result in a clearly measurable ambient CO increase. Threshold concentrations of CO, and resulting emissions increase thresholds are presented in Table 14-4.

14.2.2. Project-Specific Air Quality Analysis

14.2.2.1 Total Suspended Particulates

The analysis of project-specific TSP impacts due to facility PM emissions is illustrated in Figure 14-2. As indicated in this figure, the first step in the analysis is the characterization of facility emissions and the identification of facility locations for a given yearly construction period. Daily and total (annual) PM emissions of each facility are presented in Table 14-1. These emission were then utilized in conjunction with the daily and threshold concentrations presented in Table 14-2 to determine the need to apply mitigation measures.

Through use of the air quality constraints map (Figure 4-1), existing TSP levels by subarea were utilized to develop available TSP concentration increments. For this study, use of the existing TSP standards provided the strongest basis for planning. For short-term (24-hour) impacts, the difference between the TSP standard and the existing subarea maximum TSP concentration was used to represent the available TSP concentration increment (ranging from 52 ug/m^3 to 118 ug/m^3 as depicted in Table 14-2). The subarea increments exceeded the federal Prevention of Significant Deterioration (PSD) increment for 24-hour TSP impacts from new emission sources of 37 ug/m^3. The PSD increment was not applied for this study for the following reasons:

- the PSD new source review program was not intended for construction (temporary) emissions; and

- the PSD increment for TSP may be changed or eliminated in a similar manner as the federal standards in the near future.

Since existing long-term (annual) TSP concentrations in the study area exceed the annual TSP standard (thus resulting in the current non-attainment status in the Las Vegas Valley), no TSP concentration increment is available for the study area. Therefore, the annual TSP concentration shown in Table 14-2 is equal to the de minimus level of 1 ug/m^3.

PM emission threshold levels are presented in Table 14-3. The short-term (24-hour) emission threshold as established from the proposed facility within the subarea with the lowest individual emission threshold for those projects without a detention basin as part of planned project. For those projects with a detention basin, a higher threshold was established which considered the combined emissions of the lowest individual emission threshold facility and the detention basin facility emission threshold since the fugitive PM emissions from detention basin construction are significantly less per area of disturbed acreage than for other proposed facilities. As a result, the TSP concentrations due to detention basin emissions will be relatively smaller than for other facilities. Total (annual) project PM emission thresholds for each subarea were established on the basis of Clark County Air Pollution Control District criteria for de minimus emissions in non-attainment areas. This emission level of 41 tons per year was estimated as 0.1 percent of the existing fugitive dust component of the PM emission inventory.

In evaluating projects for PM emission impacts, facility emissions are compared to daily and annual emission thresholds (Table 14-3) to determine the need to apply first-phase (emissions reduction) mitigation. If this mitigation is required, project emissions are recalculated to account for emissions reductions and again compared to threshold levels. If thresholds are still exceeded, second-phase (construction management) mitigation would be considered.

If second-phase mitigation is applied, project activities are not expected to result in significant adverse impact. If construction management mitigation is impractical, detailed facility-specific emissions calculations should be prepared and potential impacts on TSP levels determined by application of air quality models. If these models identify the potential for significant adverse air quality impacts, a project-specific EIS should be prepared to identify appropriate facility modifications and/or additional mitigation required to reduce impacts to acceptable levels.

14.2.2.2 Carbon Monoxide

The analytical procedure applied to project-specific CO emissions is analogous to that described for short-term TSP emission thresholds in Section 14.2.2.1 above. The CO evaluation procedure is illustrated in Figure 14-3. In this case, emission thresholds were established for areas within one mile of known CO standard violations (referred to as the CO exceedence zone and depicted in Figure 4-1). CO threshold emissions within the exceedence zone were established on the basis of facility emission levels, which were expected to result in insignificant (not measurable) CO impacts. CO threshold emissions outside of the exceedence zone were determined on the basis of facility emission levels which were expected to result in ambient CO impacts of approximately one half of the 1-hour and 8-hour standards. Mitigation evaluation for CO emissions is to be implemented in the same two-phase approach presented for PM emissions.

14.3 GEOLOGY AND SOILS

The analysis of potential effects associated with geologic conditions includes an evaluation of geologic hazards and constraints that require special engineering design or construction practices, as well as an analysis of potential impacts of flood control facilities on geologic and soils resources. The procedure to be applied to each individual project involves the mapping of proposed facilities on the soils and geologic hazards maps (Figures 5-4 and 5-7) and identification of potential resource sensitivity and hazards by review of Tables 5-1, 5-2, and 5-3. This information is compared to information concerning facility-type hazards and impacts of concern prepare a composite listing of potential facility-specific hazards and constraints. Field investigations focused on identified concerns are then conducted to refine mapped resource information and allow the compilation of tabular listings of resources affected and impacts anticipated at each facility. This information is used as the basis for determination of special design requirements, appropriate mitigation, need for additional environmental studies if any, and final conclusions regarding the acceptability of geologic and soils impacts. Figure 14-4 illustrates the application of this project-specific review process.

14.4 GROUND WATER

The analysis of potential ground-water related impacts presented in Section 6.0 identified two concerns considered potentially significant. These concerns include: 1) construction difficulties associated with the presence of shallow ground water, and 2) facility impacts associated with the reduction of discharge to the shallow aquifer. The second concern is the only one which is considered an environmental impact and it is considered potentially significant with respect to any proposed lining of existing unlined channels in areas of shallow ground water.

The procedure to be applied to evaluate potential ground-water impacts and determine appropriate mitigation is summarized on Figure 14-5. In general, this process involves the application of identified mitigation to allow discharge to shallow ground water from lined channels, and to include special construction practices addressing the presence of shallow ground water. If identified mitigation addressing discharge to ground-water cannot be incorporated into proposed facility design, or additional information is needed to properly design drains, site-specific investigation and additional engineering studies would be conducted. If appropriate mitigation still cannot be identified, a facility-specific second-tier EIS would be required to accomplish an evaluation of the potential for significant impacts on discharge to ground water and related nearby and downstream effects.

14.5 SURFACE WATER

The analysis of potential project-specific surface water effects is illustrated on Figure 14-6. As indicated on that figure, this analysis is accomplished by locating proposed facilities on the surface water resources map (Figure 7-1) and determination of potential resources affected by review of mapped information and information in Table 7-1. This information is then used to evaluate potential facility-specific environmental concerns using Table 7-7 and to evaluate the potential source and significance of impacts using Table 7-8. A composite tabulation of facility-specific impacts can be prepared using this information to provide input to project engineers during project design. One-hundred-year flows predicted to be discharged from each facility should be determined and compared to no-project flows under the same development conditions. If no increase in flow is identified, the project may proceed through routine design. If increases are identified, the capacity of downstream conveyances should be evaluated to identify potential flood hazards. If downstream facilities are not adequate to accept discharges anticipated from the proposed facility, a project-specific EIS would be required to evaluate the increased flood hazard risk.

14.6 TERRESTRIAL AND AQUATIC BIOLOGY

The analysis of potential project-specific impacts to biological resources is illustrated on Figure 14-7. As indicated on that figure, this analysis begins with the listing of potentially affected resources at each facility location using Figures 8-1 and 8-2 and a review of Table 8-3. Background information concerning identified resources presented in Tables 8-1 and 8-2 is then consulted to develop an appropriate field reconnaissance investigation of the facility site by biologists familiar with the resources expected to be present. The results of the field reconnaissance are then used to refine the assessment of potential impacts associated with the proposed facility. If federal or state listed or candidate species may occur at the project site, the analysis procedure requires the direct involvement of responsible resource agencies, including the BLM, U.S. Fish and Wildlife Service, and Nevada Division of Wildlife. This review pathway includes additional species-specific surveys and formal resource agency determination of the project's potential to jeopardize the continued existence of a viable species population. If a jeopardy determination is rendered, the project would not be allowed to proceed as planned. The review procedure also addresses biological resources that are not officially listed, but nonetheless require special consideration. The review pathway addressing these species or habitats allows the review of potential impact significance, development of appropriate mitigation measures, and may require the preparation of a project-specific EIS if mitigation measures reducing potential impacts to less than significant levels are not incorporated into the proposed project. Mitigation measures presented in Table 8-5 are to be used as a guide for measures expected to effectively reduce impacts to less than significant levels and many include detailed biological investigations, facility modifications, and consultation with resource agencies.

14.7 LAND USE AND RECREATION

The analysis of potential land use impacts associated with specific flood control projects requires a consideration of both existing and proposed land uses at the facility site and the nature of impacts associated with the construction and operation of the facility proposed. The procedure illustrated on Figure 14-8 allows the initial screening of proposed projects using information presented in Section 9.0 of this EIS and readily available data sources to focus project-specific reviews on facilities with the potential to result in significant adverse effects.

By combining up-to-date land use information with impact sensitivity data and facility impact data presented on Tables 9-2 and 9-3, a preliminary assessment of the types of impacts that could be associated with the proposed facility is accomplished. This information is then applied to the impact significance level data presented on Table 9-4 to determine the need for mitigation measures. Table 9-5 is used to identify potential mitigation measures, and a process of project re-evaluation is accomplished. If project-specific mitigation resulting in less than significant project impacts cannot be determined, a second-tier project-specific EIS is required prior to approval of the proposed facility.

14.8 VISUAL RESOURCES

The assessment of potential visual impacts involves a highly subjective judgment concerning the degree of landscape modification allowable before a threshold of impact considered significant is reached. The analysis presented in Section 10.0 attempts to divide this topic into components that can be considered by different individuals with relatively consistent results. Figure 14-9 illustrates the application of information presented in Section 10.0 to individual facilities to identify appropriate mitigation measures and determine when additional project-specific environmental studies may be required.

As indicated on Figure 14-9, proposed facilities are located on the visual resource map (Figure 10-2) and the visual character and sensitivity of the area affected is determined by review of information in Section 10.3, supplemented by the reviewer's subjective analysis of the facility site. This information is combined with information concerning the nature of visual impacts associated with the type of facility proposed (presented in Tables 10-2 and 10-4) to develop a composite assessment of the potential visual impact of the specific proposal. Mitigation measures applicable to the proposed facility are then determined by review of information presented in Section 10.6, and results are tabulated. Proposed facility sites which may experience significant adverse effects are then evaluated in the field and a determination of likely visual impact significance is rendered. Additional, site-specific mitigation may be developed to reduce impacts further. Additional environmental study, such as a project-specific second-tier EIS, may be required to provide public involvement in the determination of additional mitigation, project alternatives, or overriding public need prior to the approval of some facilities.

14.9 SOCIOECONOMICS

As discussed in Section 11.4, the project prioritization process described in the Regional Flood Control District's Policy and Procedures Manual (Bax-Valentine, 1988) is expected to mitigate effectively the potential adverse socioeconomic effects. Proposed facilities in compliance with District priorities are not expected to result in significant adverse socioeconomic impacts and would not require detailed project-specific review. Should modifications to the District policies be proposed, they should be reviewed for potential socioeconomic effects. If significant effects could occur, an evaluation process to be applied to each facility considered under the revised policy should be developed and adopted as a component of the policy modification.

14.10 CULTURAL RESOURCES

The project-specific analysis procedure addressing cultural resources involves the consultation with other agencies, such as the State Historic Preservation Officer (SHPO) and Advisory Council on Historic Preservation (ACHP) before proceeding with projects that may adversely affect cultural resources. This process is legally mandated by Section 106 of the National Historic Preservation Act. Because this process is sometimes lengthy and final conclusions concerning impact significance would be premature prior to its completion, this project-specific analysis procedure is directed towards the efficient compilation of data necessary to implement the consultation process. The consultation process may be completed on a project-by-project basis or result in the preparation of a Programmatic Agreement (PA).

As indicated on Figure 14-10, the facility-specific procedure involves the use of cultural resources sensitivity maps (Figures 12-1 and 12-2), a site records search, and consultation with Native Americans to develop an inventory of potentially affected cultural resources. This information will be submitted to the SHPO to initiate Section 106 consultation with the ACHP. Depending upon the types of resources identified and eligibility for inclusion on the National Register of Historic Places preparation of site-specific treatment plans may be required. If the site is important primarily for its information content, adverse impacts may be reduced to acceptable levels by implementing archaeological excavation and analysis plans; or completing detailed architectural recording according to standards developed by the Department of Interior. If the site is significant for values other than its information content, a memorandum of agreement must be prepared for review by the ACHP. This will include a detailed analysis of potential project impacts and alternatives to be evaluated prior to the final determination concerning project acceptability.

TABLE 14-1

COMPOSITE EMISSION RATES
CONSTRUCTION ACTIVITIES
PARTICULATE MATTER AND CARBON MONOXIDE

		EMISSIONS RATES[1]			
FACILITY TYPE	CONSTRUCTION RATE	PM (lb/day)	PM (ton/yr)	CO (lb/hr)	CO (lb/8-hr)
Pipelines	300 ft./day	14.50	0.06	2.10	16.80
Concrete Box	150 ft./day	13.00	0.06	3.10	24.80
Unlined Channel	500 ft./day	59.20	0.10	6.60	52.80
Lined Channel	200 ft./day	41.00	0.50	6.60	52.80
Unlined Dikes	500 ft./day	139.00	1.00	10.40	83.20
Lined Dikes	200 ft./day	139.00	1.40	10.40	83.20
Detention Basin	0.36 acres/day	192.40	20.00	10.80	86.40
Debris Basin	0.12 acres/day	38.00	15.80	10.80	86.40
Bridges	2.5 ft./day	6.90	0.20	3.70	29.60
Floodway	500 ft./day	277.20	4.40	20.80	166.40

[1] Emission estimates are based upon typical equipment operation and earthwork described in Section 2.3, and emission factors for USEPA Document No. AP-42. Daily emissions (lb/day) were calculated assuming an 8-hour working day. Annual emissions (ton/yr) were calculated on a facility-by-facility basis assuming an average facility size (i.e., average pipeline legth, average basin area, etc.).

TABLE 14-2

TOTAL SUSPENDED PARTICULATES
THRESHOLD AMBIENT CONCENTRATION INCREASES
(in ug/m^3)

SUBAREA	BACKGROUND CONCENTRATIONS		STANDARDS		POTENTIALLY SIGNIFICANT INCREASES[1]	
	24-Hour	Annual	24-Hour	Annual	24-Hour	Annual
Northern Las Vegas Valley	208	91.9	260	75	52	1
Central Las Vegas Valley	188	104.7	260	75	72	1
Southwest Las Vegas Valley	184	76.9	260	75	76	1
Henderson	142	70.9	260	75	118	1
Boulder City	N.D.[2]	N.D.[2]	150	75	N.D.[2]	1

[1] Potentially significant increases were determined as increases that could result in total ambient concentratiions in excess of ambient air quality standards, background concentrations equal to the highest measured value in the subarea in question are assumed for 24-hour increases. Annual average significant increases are defined as deminimus increases in subareas currently showing standard exceedances or managed as if in non-attainment

[2] N.D. = No Data available

TABLE 14-3

TOTAL SUSPENDED PARTICULATES
THRESHOLD EMISSIONS INCREASES

SUBAREA	EMISSION THRESHOLD 24 HR (lb/day)[1] Without Basin	With Basin	ANNUAL TOTAL (T/yr)[2]
Northern Las Vegas Valley	39	57	41
Central Las Vegas Valley	54	71	41
Southwest Las Vegas Valley	57	97	41
Henderson	89	129	41
Boulder City	N.D.[3]	N.D.[3]	41

[1] 24 hour significant emissions were determined by modeling facility emissions predicted to result in ground-level concentrations equal to potentially significant ambient concentrations (presented in Table 13-2) at locations 200 feet or more from the source assuming neutral atmospheric conditions (Pasquill Class D) and an hourly wind speed of 5 miles per hour

[2] Annual significant emissions are defined as deminimis levels that are not expected to represent a net District particulate emissions increase greater than 0.1 percent of the existing fugitive dust component of the emission inventory. Although Henderson and Boulder City are currently in compliance with annual air quality standards, the same deminimis emissions level is applied in these areas to reflect the APCD management approach treating these areas as non-attainment areas

[3] N.D. = No Data Available

TABLE 14-4

CARBON MONOXIDE
THRESHOLD AMBIENT CONCENTRATIONS AND RELATED EMISSIONS INCREASES

	AMBIENT CONCENTRATIONS ASSUMED POTENTIALLY SIGNIFICANT (ug/m^3)		EMISSIONS INCREASE THRESHOLDS OF SIGNIFICANCE (lb)	
	1-Hour	8-Hour	1-Hour	8-Hour
Outside Exceedance Zone[1]	20,000	5,000	906	2592
Within Exceedance Zone[1]	1,150	575	52	296

[1] Exceedance zone is defined as any location within one-mile of identified CO exceedances of 1-hour or 8- hour standards. The current area of CO exceedances is shown on Figure 4-1.

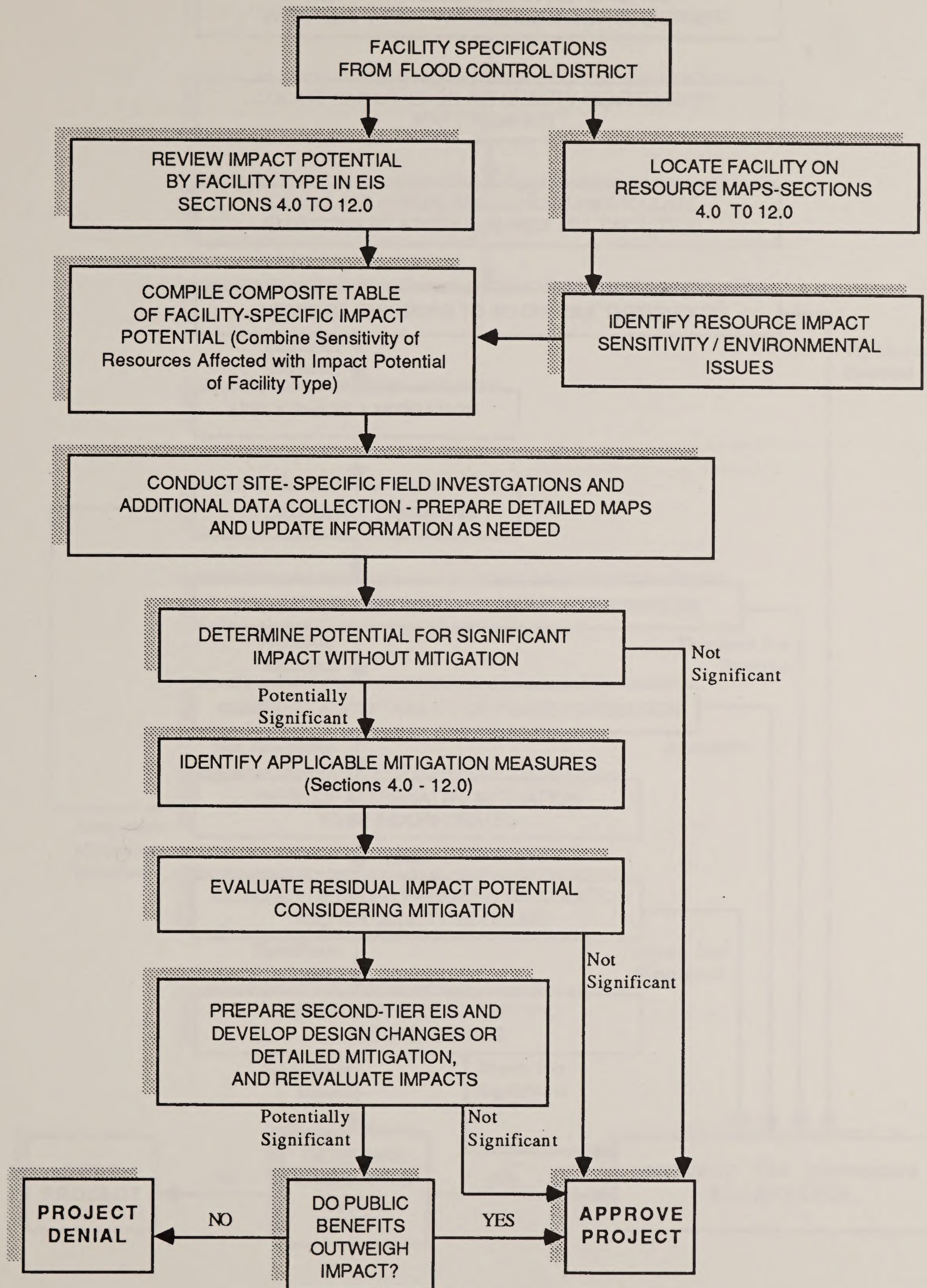


FIGURE 14-1

OVERALL PROJECT-SPECIFIC ANALYSIS PROCEDURE

DAMES & MOORE

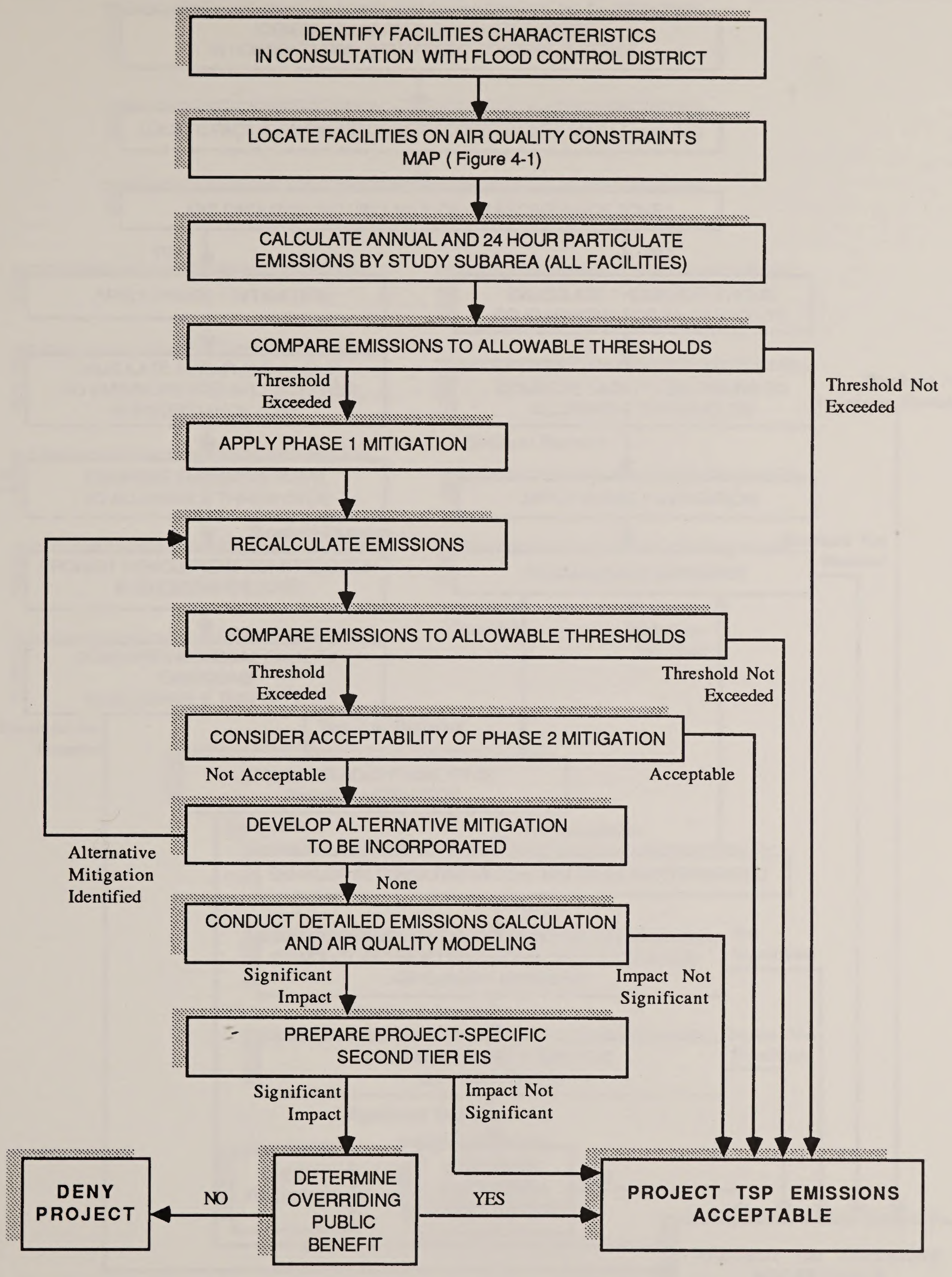


FIGURE 14-2

PROJECT-SPECIFIC ANALYSIS PROCEDURE AIR QUALITY IMPACTS TOTAL SUSPENDED PARTICULATES

DAMES & MOORE

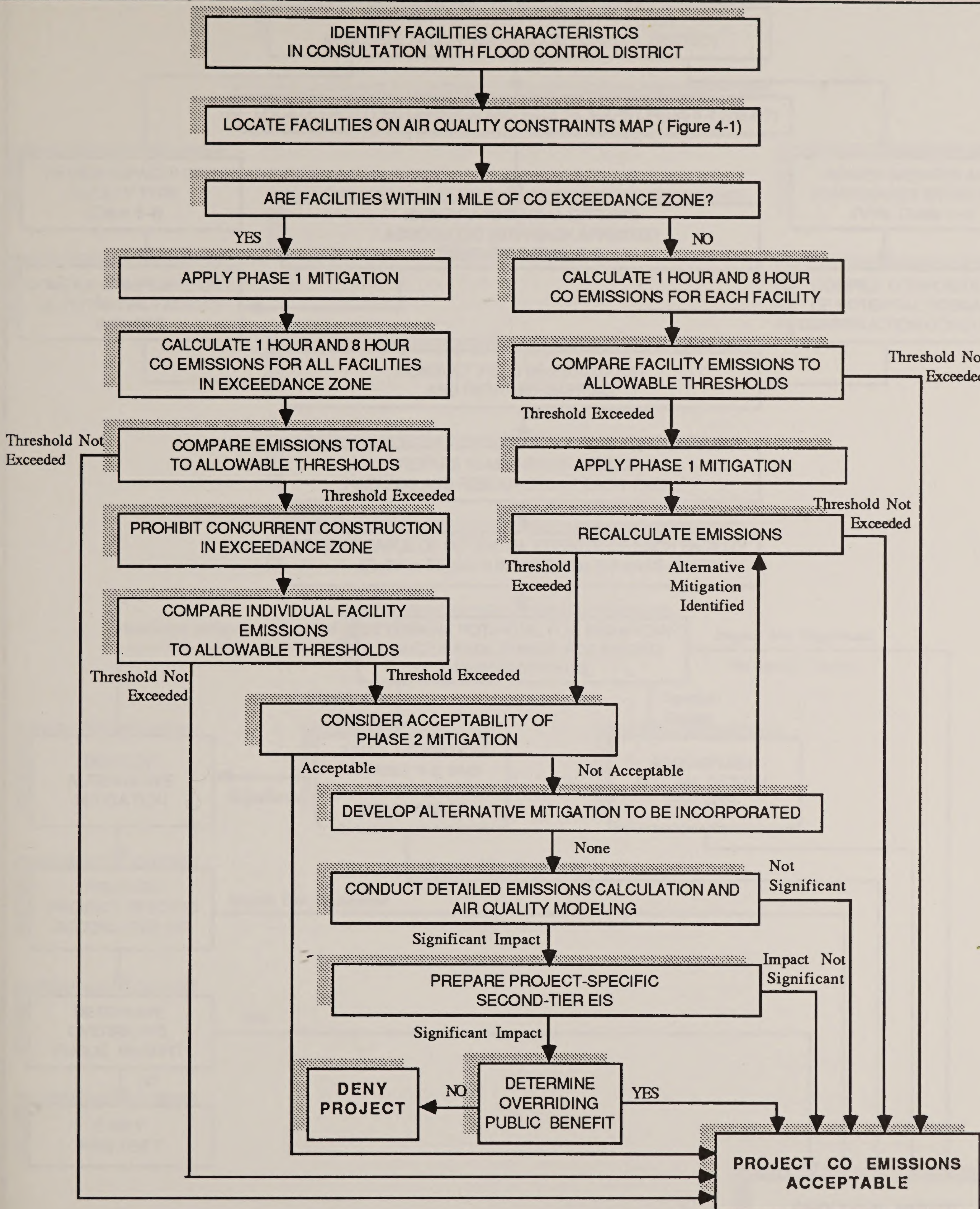


FIGURE 14-3

PROJECT-SPECIFIC ANALYSIS PROCEDURE AIR QUALITY IMPACTS CARBON MONOXIDE

DAMES & MOORE

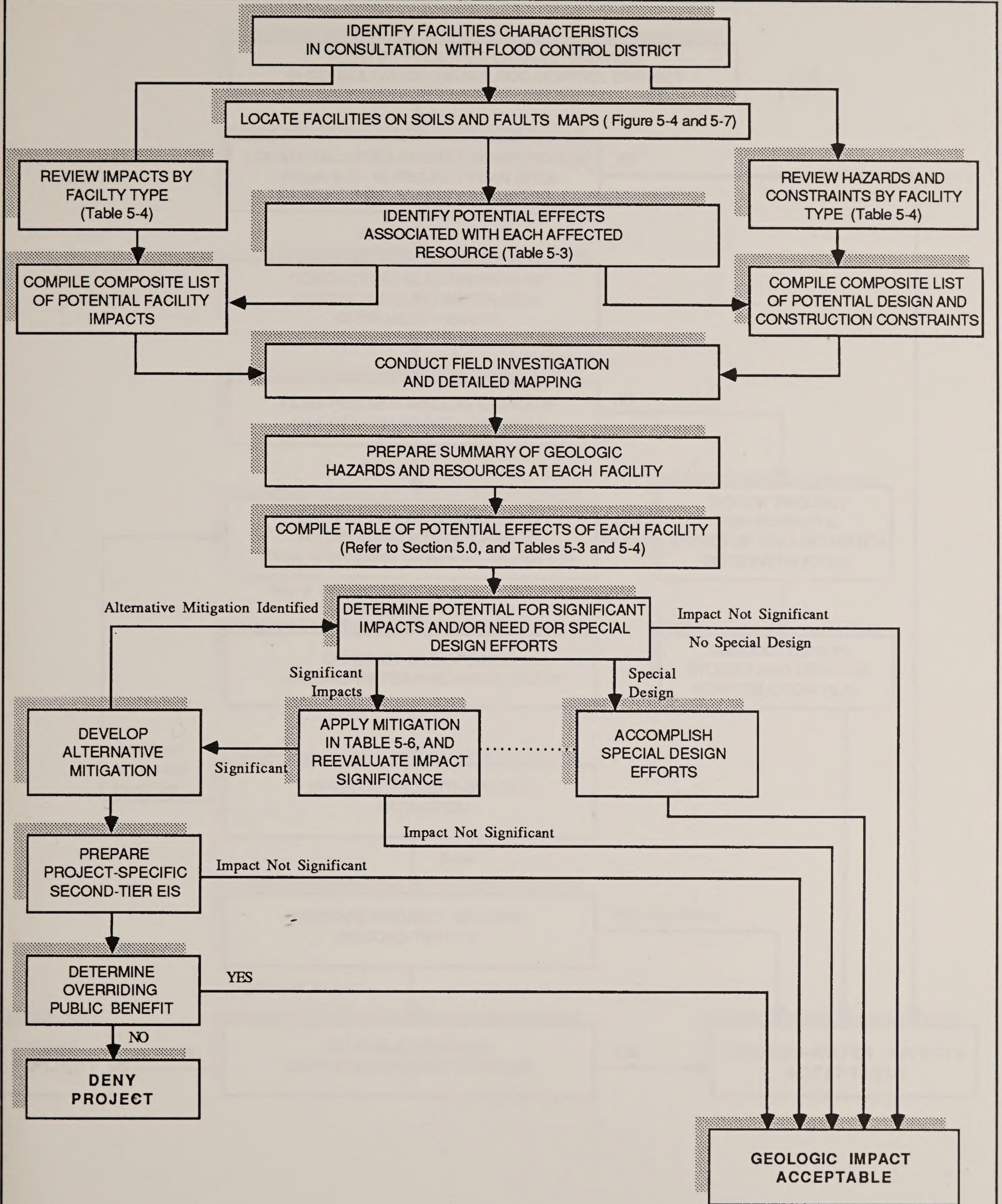


FIGURE 14-4

PROJECT-SPECIFIC ANALYSIS PROCEDURE GEOLOGY AND SOILS

DAMES & MOORE

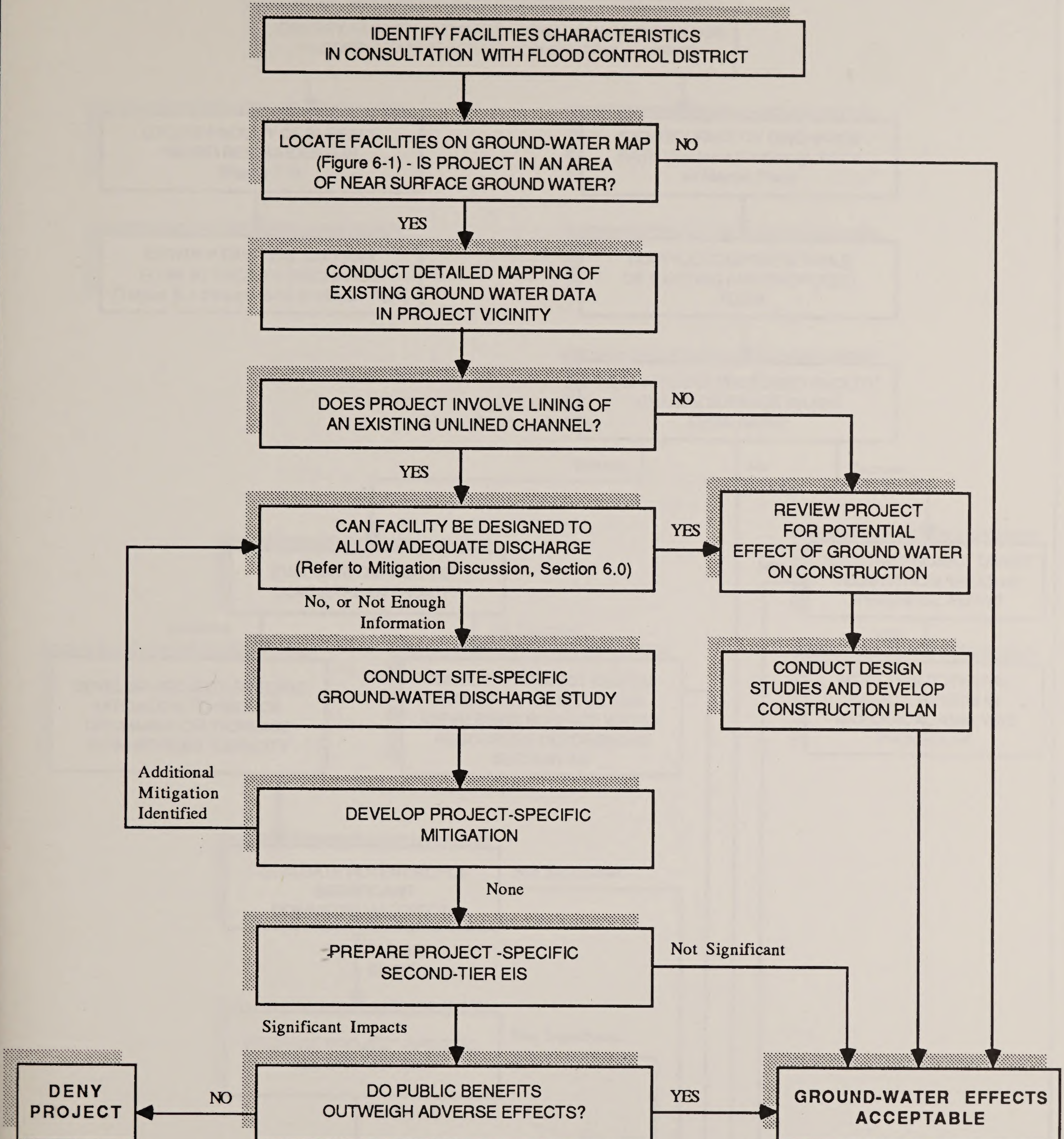


FIGURE 14-5

PROJECT-SPECIFIC ANALYSIS PROCEDURE GROUND WATER

DAMES & MOORE

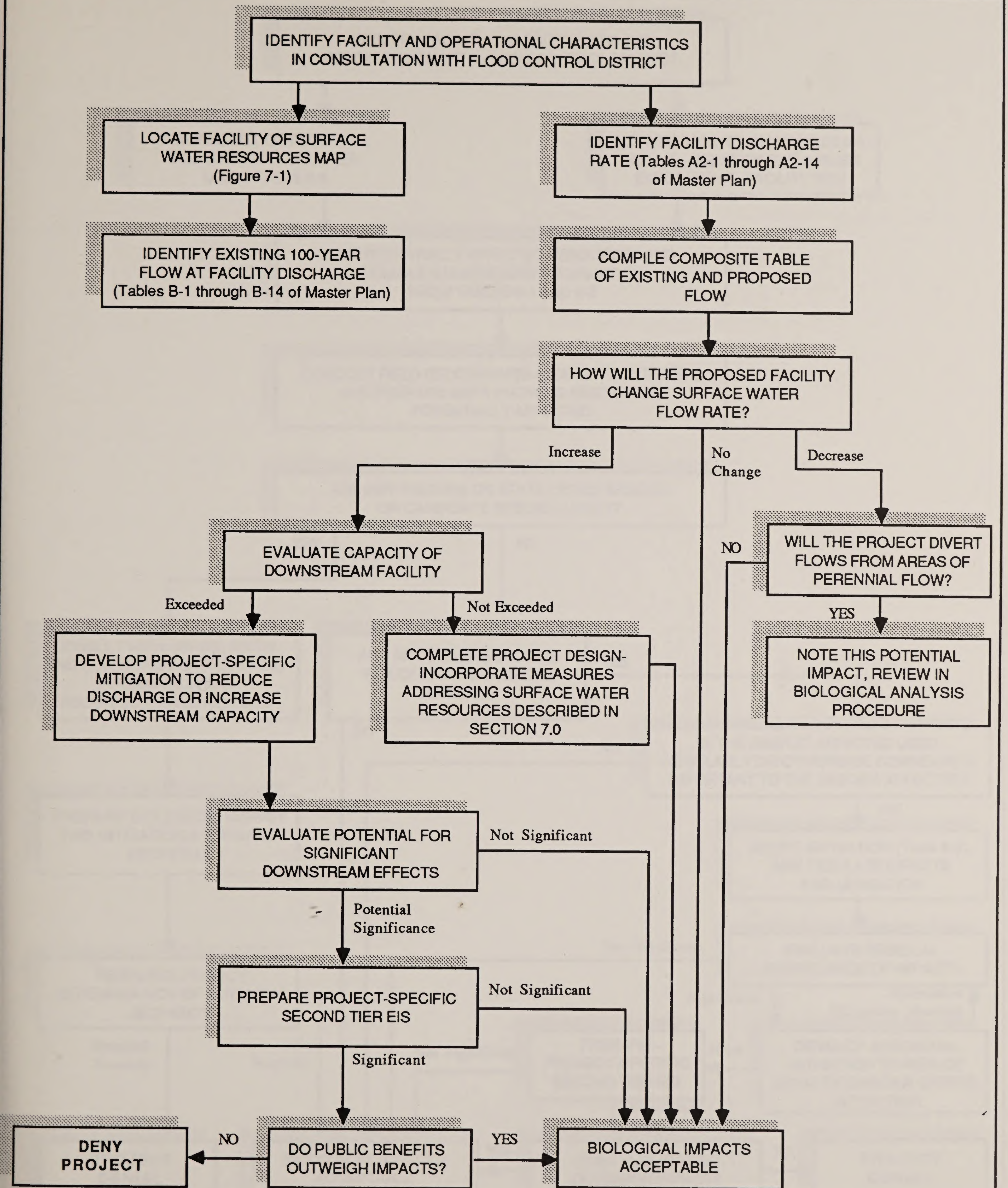


FIGURE 14-6

PROJECT-SPECIFIC ANALYSIS PROCEDURE SURFACE WATER RESOURCES

DAMES & MOORE

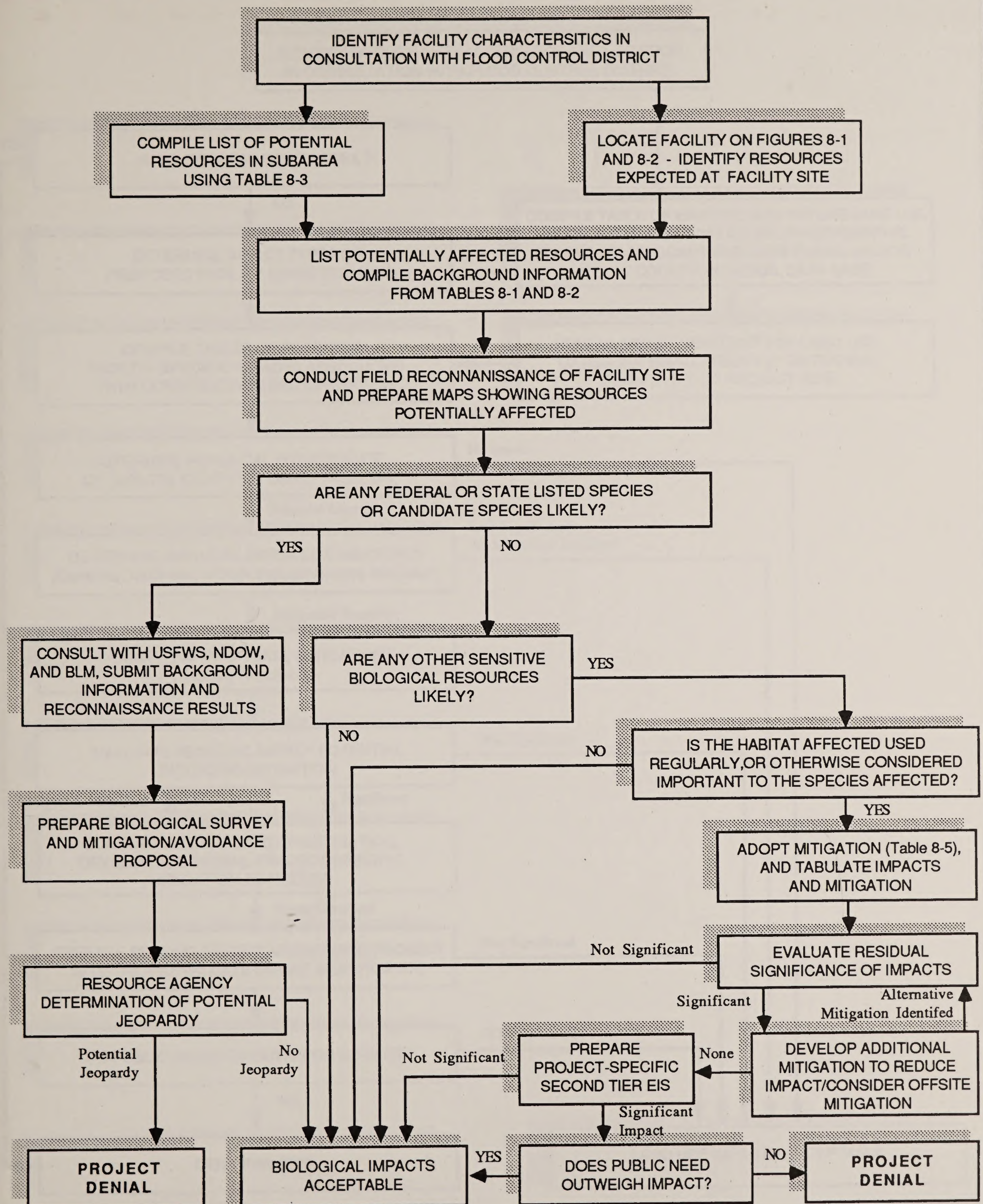


FIGURE 14-7
PROJECT-SPECIFIC ANALYSIS PROCEDURE BIOLOGICAL RESOURCES

DAMES & MOORE

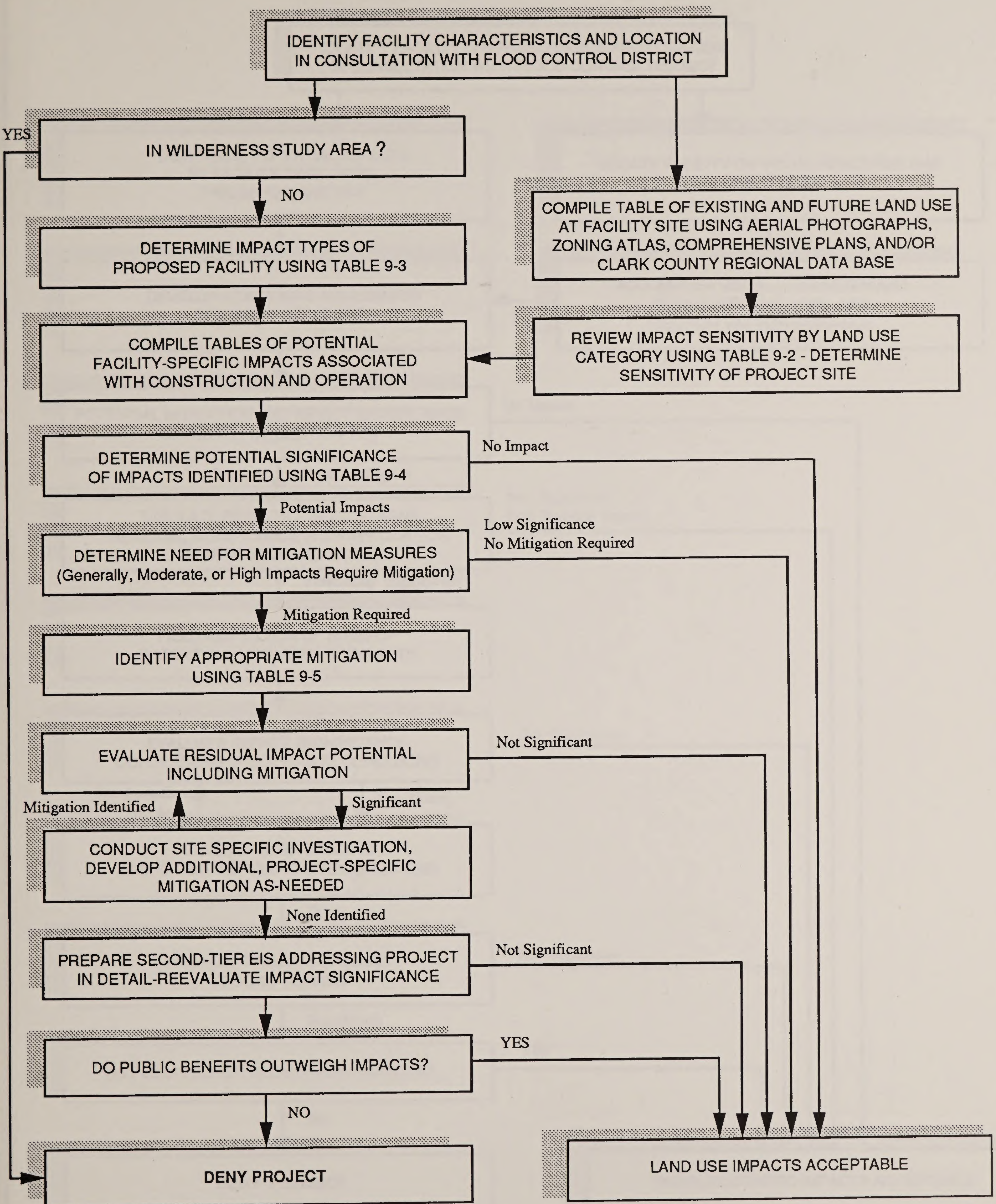


FIGURE 14-8

PROJECT-SPECIFIC ANALYSIS PROCEDURE LAND USE

DAMES & MOORE

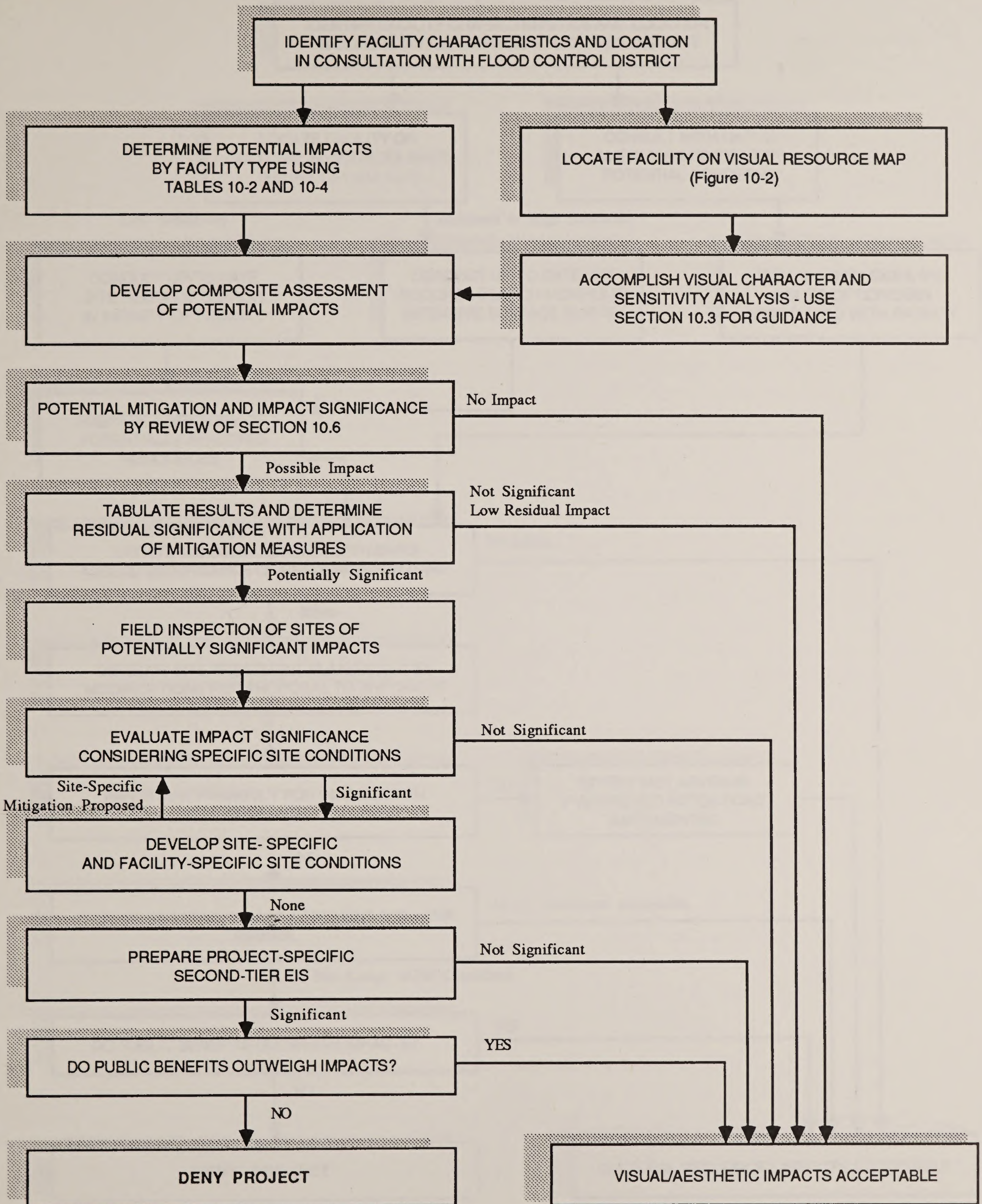


FIGURE 14-9

PROJECT-SPECIFIC ANALYSIS PROCEDURE VISUAL RESOURCES

DAMES & MOORE

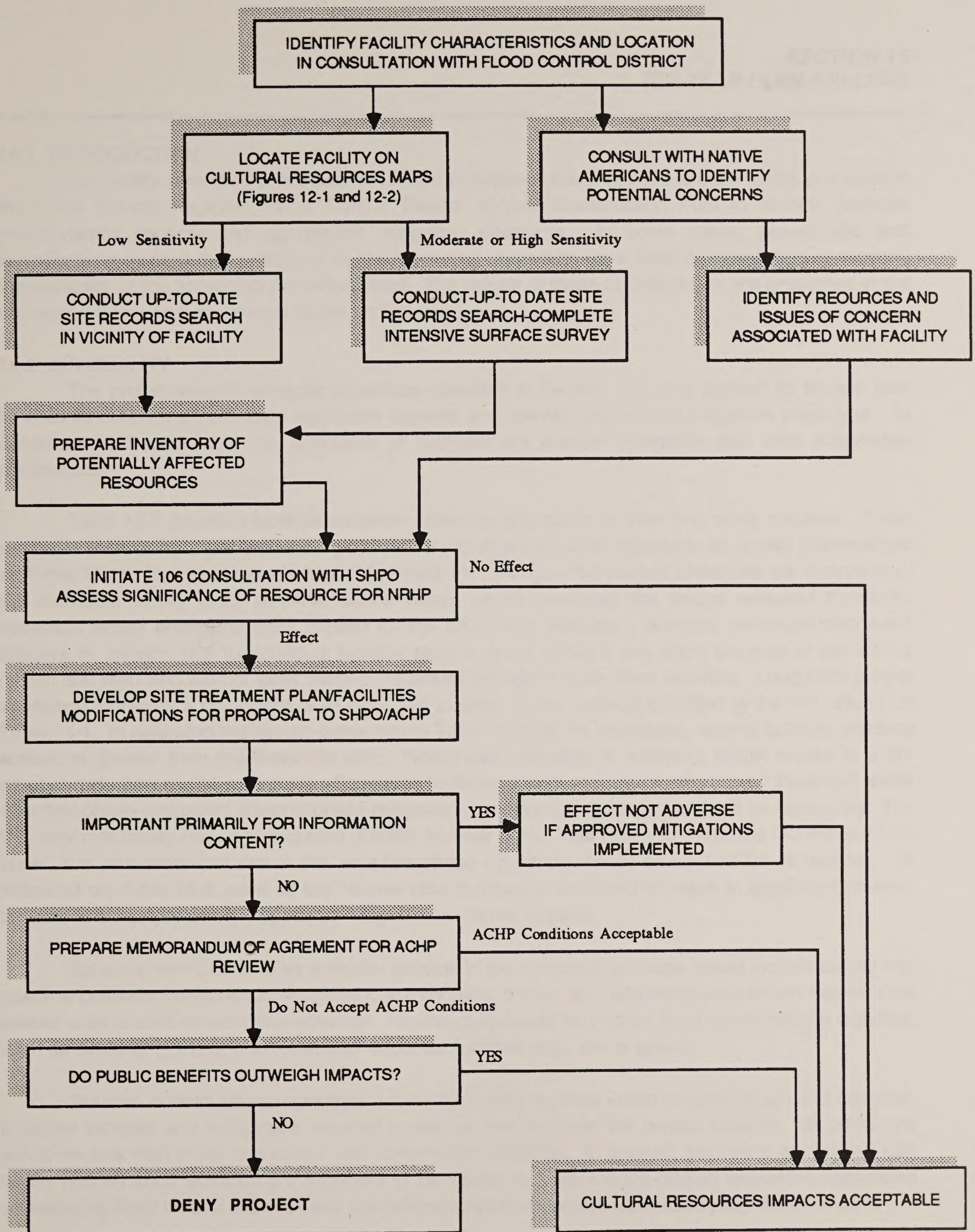


FIGURE 14-10

PROJECT-SPECIFIC ANALYSIS PROCEDURE CULTURAL RESOURCES

DAMES & MOORE

15.1 INTRODUCTION

The facility screening procedure described in Section 14 was applied to each facility proposed in the Clark County Regional Flood Control District 10-Year Construction Plan to identify potential environmental impacts and appropriate mitigation measures. In some cases, site-specific field investigations beyond those required by the screening procedure have been accomplished to evaluate the suitability of the screening procedure itself. The results of these investigations are presented in the discussion below and associated tables and figures.

15.2 AIR QUALITY

The project-specific analysis procedure specified in Section 14.2 was applied to 10-year plan facilities to determine potentially significant impacts and identify appropriate mitigation measures. As described in Section 4.4, the pollutants of concern are carbon monoxide and total suspended particulates.

Table 15-1 presents facilities emission estimates organized by year and study subarea. These estimates were used to determine the potential for significant adverse impacts to air quality (summarized on Table 15-1). The short-term (1-hour CO, 8-hour CO, 24-hour PM) project emissions are derived from the individual facility (e.g., pipeline, debris basin) which produces the lowest emission threshold. Individual facility emissions were chosen for the short-term evaluation because maximum short-term ambient air impacts due to individual facilities tend to occur within a very short distance of the activity (within 600 feet) and will not likely overlap maximum emissions from other activities. Long-term project emissions represent a composite of all individual facilities of the projects identified in the first column of Table 15-1. In reviewing the results presented in Table 15-1 for PM emissions, several facilities produce emissions greater than the threshold limit. First-phase mitigation is watering, which results in a 50-percent reduction in PM emissions. For those facilities whose emissions still exceed threshold levels after first-phase mitigation, second-phase mitigation (construction management) will be necessary. For CO, only one facility requires mitigation (Facility Number S24). This facility is within the CO exceedence zone. It is recommended that in this area first-phase mitigation should be applied for all facilities. As indicated on Table 15-2, none of the 10-year plan facilities is expected to result in significant adverse impacts to air quality with the specified mitigation measures applied.

Sources contributing to air emission impacts in the construction phase would include diesel- and gasoline-powered construction equipment, automobiles, trucks, and additional wind-blown fugitive dust related to increased construction activities. Fugitive dust would be emitted from soil-disturbing activities, such as clearing, grading, and travel over unpaved surfaces (e.g., dirt or gravel).

Sources contributing to operation activity air quality impacts would include diesel- and gasoline-powered vehicles and equipment required to service and maintain the project facilities. All emissions would be less than those associated with construction activities. In general, emissions associated with facility maintenance activities are expected to be similar to maintenance-related emissions associated with existing flood control activities and are not expected to represent a potentially significant impact.

15.3 GEOLOGY AND SOILS

Information presented in the programmatic EIS was reviewed in accordance with the facility screening process described in Section 14.3. As recommended by this process, a reconnaissance-level field inspection was conducted on areas of particular concern identified during this review. Based on the information obtained, maps were prepared which outline known potential geologic hazards/constraints and soils along the proposed 10-year facilities (Figures 15-1 through 15-15). The results of this analysis are summarized in Tables 15-3 and 15-4. Information on soil characteristics such as reclamation potential, erosion potential, and corrosivity are summarized in Table 5-1 and more detailed information on other characteristics is presented by Speck (1980). This information provides much of the basis for Tables 15-3 and 15-4. The numbers on Figures 15-2 through 15-15 are keyed to Table 5-1 and data presented in Speck (1980) and can be used to evaluate soil conditions underlying the proposed 10-year plan facilities.

A review of the information collected for each facility indicates that 20 of the proposed facilities are located in areas of high water erosion potential. Although this could indicate a potential for environmental impact, special attention to facility design should be adequate to reduce impacts to less than significant levels. Particular attention should be directed to the dissipation of discharge flow energy and the use of geofabrics to control erosion at unlined discharge locations or along unlined channels.

Potential effects on mineral resource operations are identified with respect to seven facilities. These facilities should be relocated to avoid the mineral extraction operations, or fair compensation may be necessary to get operators to relinquish valid claims

Other impacts identified are primarily associated with geologic hazards or constraints that should be considered during final facility engineering and may require site-specific investigations to provide data needed for design. None of the hazards or constraints is expected to lead to significant environmental impacts as a result of project implementation.

The application of mitigation measures listed for each facility on Table 15-3 is expected to effectively reduce potential environmental impacts associated with 10-year plan facilities. Residual impacts are not expected to be significant.

15.4 GROUND WATER

As discussed in Section 6.0, potentially significant effects on ground-water levels and flow could be associated with potential reduction in discharge from the shallow aquifer at some of the locations of the proposed 10-year facilities. These potential impacts are associated with areas of shallow ground water where existing channels allow ground water discharge. These impacts are not expected to be significant if mitigated as described in that section.

Shallow ground-water also may represent an important construction consideration, since special construction practices and possible increased construction expense could be associated with the installation of facilities in areas of shallow ground-water. This concern does not represent a potential environmental impact and is presented in this document only to provide information that may be of use to the District. The mitigation suggested is not necessary to reduce environmental impacts.

Proposed flood-control facilities that are located in areas of known shallow ground water are shown in Table 15-5. Facilities marked "no data" are in parts of the Valley outside the contoured area shown on Figure 6-6. Prior to design and construction of proposed flood control facilities, the monitoring well network must be extended to defined the actual extent of shallow ground water in the Valley.

15.4.1 Mitigations for Impacts Associated with Reduction in Discharge from the Shallow Aquifer

Ten year plan facilities which have the potential to affect ground-water discharge were determined using the facility screening procedure described in Section 14.4. These facilities are listed in Table 15-5 and areas of shallow ground-water are mapped on Figures 15-16 through 15-29. Impacts associated with discharge reductions are expected to be less than significant in most cases, but mitigation measures that may minimize potential effects are relatively straightforward. For this reason, implementation of the measures outlined below is recommended for all facilities identified as having the potential to affect discharge of shallow ground water. These measures are summarized on Figure 6-8.

- Select mitigation option considered most appropriate based on site-specific investigation. Identified options include: 1) resite project into an area where impacts will not occur, 2) construct the project and monitor ground-water levels in the site vicinity to evaluate more adequately possible impacts from increasing water levels, if such increases occur, and 3) design lining to allow discharge to occur.

- Monitor ground-water levels by periodic observation of water levels in nearby wells completed in the shallow aquifer. If such wells are not available, they may have to be constructed. If monitoring indicates that water-level increases are occurring as a result of the project and that these increases are causing adverse impacts in the area, post-construction modification to the lining, such as installation of weep holes to allow discharge of ground water, could be conducted.

- If it is undesirable to conduct long-term monitoring of water levels in the area, design the lining to accommodate ground-water discharge. Such design measures might consist of weep holes or drainage blankets. These measures should be sized to accommodate the same amount of discharge that would occur under natural conditions.

15.4.2 Mitigations for Impacts of Ground Water on Construction

In order to mitigate the potential impacts of shallow ground water on construction/excavation of potentially affected facilities listed on Table 15-5, the following measures are recommended:

- Conduct a site-specific geotechnical investigation to evaluate whether shallow ground water is present at a depth which could affect excavation or placement of materials during construction. If ground water will not affect excavation or placement of materials, no further mitigation is required. If ground water could affect excavation or placement of materials, proceed with investigation/design.

- Conduct additional investigations and/or design special measures to minimize impact of shallow ground water on excavation or placement of materials. Such design measures might include local dewatering of the aquifer, or excavation or placement of shoring to restrict entry of shallow ground water into the excavations.

15.5 SURFACE WATER

Potential to increase flood hazards and changes in perennial flows were identified as potentially important surface water issues. In accordance with procedures discussed in Section 14.5, Table 15-6 compares peak flow rates for the 10-year plan facilities and for the No Project alternative. The purpose of this comparison is to identify areas of increased downstream flood hazard that may occur as a result of construction of 10-year plan facilities.

As indicated in Table 15-6, none of the 10-year plan facilities will result in an increased flow rate as compared to the No Project alternative. No additional analysis is necessary if no increased downstream flow rates occur as a result of construction of 10-year plan facilities.

> Construction of 10-year plan facilities will not increase peak flows in the Lower Las Vegas Wash. Since flood flows are expected to be less than those under the No Project alternative, it is not considered likely that more sediment would be deposited. The scour potential is not expected to change noticeably. Perennial flows created from discharges from WWTPs are not expected to be affected.

15.6 TERRESTRIAL AND AQUATIC BIOLOGY

Based on information presented in Section 8.0, the 10-year program was analyzed for presence of, and potential impacts to, sensitive biological resources due to construction and operation of individual facilities in accordance with the procedures specified in Section 14.6. As described in Section 8.1.2, sensitive biological resources of the project area are classified into the following categories: 1) state-listed plant species, 2) federal candidate and BLM sensitive plant species, 3) plants determined to be sensitive by NNNPS, 4) wetland habitats, 5) federal-listed wildlife species, 6) state-listed and BLM wildlife species, 7) federal candidate and state-protected wildlife species, and 8) game and furbearer species. The 10-year program is comprised of flood control facilities including floodways, dikes, levees, channels, pipeline/box conduits, detention and debris basins, culverts, and bridges. Potential impacts that would be caused by the construction and operation of these facilities are described in Sections 8.4 and 8.5.

Most of the 10-year plan facilities will potentially impact at least two sensitive biological resources (Table 15-7). An exception is S10, an existing, lined channel within a residential area. Because appropriate habitat is lacking and the surrounding areas are quite intensively developed, no sensitive resources are likely to occur at this facility. Some facilities such as C5 would be constructed in primarily residential areas and would potentially affect only a few sensitive species that are quite widespread. In contrast, facilities N7 and H3 would be constructed in or immediately adjacent to the Las Vegas Wash. As such, these facilities would potentially impact as many as 31 different sensitive resources in eight categories.

The sensitive resources vary in their potential to be affected by construction and operation of the facilities. Some are widespread and, although protected by the state of Nevada, are also quite common. These taxa which are protected, but not relatively rare nor highly sensitive, include species of cactus and yucca, as well as the desert cottontail, a game species. Each would potentially occur throughout the project area at nearly all facility sites (Table 15-7, Figures 15-30 through 15-43). Other taxa are relatively rare and sensitive, yet are wide-ranging throughout the project area. These species also potentially occupy many of the facility sites. Examples are the golden bear poppy (Arctomecon californica), desert tortoise, and Gila monster. Several raptors and bats (Swainson's hawk, ferruginous hawk, prairie falcon, spotted bat, greater mastiff bat) potentially forage and travel over many of the proposed facilities, but would be directly impacted at very few individual sites. As such, these species are infrequently included in Table 15-7 and Figures 15-30 to 15-43.

Impacts to wetlands would be adverse, as well as beneficial. Adverse impacts would include both permanent (for example, due to the construction and operation of lined channels) and temporary (due to construction and operation of unlined channels) disturbance to wetland vegetation and aquatic species. The construction and operation of detention basins could potentially result in the establishment of undesirable wetland vegetation, characterized by weedy species such as smotherweed (Bassia hyssopifolia), salt cedar (Tamarix spp.), and Russian thistle (Salsola australis). Beneficial impacts would be represented by engineered water courses, which could potentially reduce the likelihood of erosion, as well as facilitate the expansion of existing desirable wetlands. Implementation of mitigation measures would reduce impacts to wetlands to a less than significant level.

Construction and operation of 10-year plan facilities would result in adverse impacts to desert tortoise, including displacement and removal of individual animals, as well as loss of habitat and special features (e.g. burrows). Some losses of habitat would be temporary, such as disturbance due to construction access along channels, dikes, and floodways. Tortoises would return to these temporarily disturbed areas. Some disturbances to this species could be significant, such as removal of tortoises, permanent habitat loss, and segmentation of habitat by installation of lined channels. These impacts cannot be reduced to less than significant levels by project-specific mitigation and may require participation in a regional-scale tortoise preserve establishment in an area outside of the Las Vegas Valley to adequately compensate for potential adverse effects. It should be noted that this habitat loss could also result from land development activities in the study area unrelated to the construction of flood control facilities. The U.S. Fish & Wildlife Service has reviewed the potential impact of the proposed 10-year construction plan, and has concluded that the proposed flood control facilities would not jeopardize the continued existence of the desert tortoise. This conclusion, and the analysis supporting it, is presented in a formal Biological Opinion (USF&WS, 1990), and is incorporated into this EIS by reference. The Biological Opinion includes specific mitigation measures to be implemented in connection with the construction and operation of flood control facilities, and establishes a program for the compensation of habitat loss. The Clark County Regional Flood Control District has agreed to comply with the mitigation and compensation requirements described in the Biological Opinion.

Programmatic mitigation measures developed for Section 8.6 are included in Table 15-7. Of the 12 mitigation measures designed to reduce potential impacts to non-significant levels, four each were developed for sensitive plants, wetlands, and sensitive wildlife. These measures are described in Table 8-5. Implementation of programmatic mitigation measures and accomplishment of required consultation with the USF&WS and Nevada Division of Wildlife prior to project implementation will avoid or substantially reduce potentially significant impacts of the 10-year plan facilities.

15.7 LAND USE AND RECREATION

15.7.1 Methodology

The impact analysis for land use and recreation resources was performed for the 10-year plan facilities following the procedure outlined in Section 14.7. Aerial photographs (1 inch = 1200 feet) and the accompanying Las Vegas Zoning Atlas (Landis, 1988) were used to inventory existing land uses in the vicinity of structures included in the 10-year plan analysis. Comprehensive plans from the respective cities were also used where available to indicate future land use.

For each structure, the existing and future land use was identified as required by the project-specific analysis procedure. Results of the analysis are presented in Table 15-7. The first two columns lists the figure number and facility identification number corresponding to facility number listed in the 10-year plan project description (Section 3.0). The third column lists the jurisdiction(s) within which the facility would be located. The next column is a description of the existing land use. The future land use column includes two items: the zoning classification(s) for the structure site and any description of land use classification from the appropriate general or comprehensive plans. Zoning classification code lists for each jurisdiction are also included in Table 15-8.

Facility information and land use characteristics presented in Table 15-8 were compared to land use impact sensitivity information and potential facilities impact data presented on Tables 9-2, 9-3, and 9-4 to develop an analysis of potential facility-specific impacts. The results of this analysis are presented in two sets of tables, one addressing potential construction-related impacts to existing and future land uses (Tables 15-9 and 15-10), and another addressing potential operational impacts to existing and future land uses (Tables 15-11 and 15-12).

15.7.2 Summary of Significant Results

The majority of all structures evaluated in this analysis are located on vacant land, or coincident with existing flood control corridors or facilities. Therefore, there are no direct impacts recorded in these cases. In several locations, structures would be constructed adjacent to residential or commercial areas, indicating potential short-term, construction impacts. In many of these cases, direct impacts may also result from encroachment on adjacent developed areas, but site surveys should be conducted once the detailed facility design is available to determine the extent of any encroachment of this type. Following are descriptions of impacts from specific structures.

N3, N5 - A major part of this floodway, and the entire channel and dike system is located on the Bureau of Land Management Quail Spring Wilderness Study Area (WSA NV-050-411), along the Las Vegas Wash. Construction and operation of this facility would be prohibited unless Congress does not designate this as a Wilderness Area. According to BLM management policies, all WSAs are considered potential wilderness areas; and, therefore, the construction and operation of any man-made structures would not be permitted under BLM policy.

N6 - Improvements to the Lower Las Vegas Wash will create a number of temporary inconveniences associated with lining the existing channel. These are considered to be short-term impacts that can be mitigated.

C2, C3, C4 - These facilities include the Angel Park/Gowan Road detention basin conveyance system, Gowan detention basin and outfall, and the conveyance system on Carey Avenue and Lake Mead Boulevard. These facilities convey flood flows collected in several detention basins to an existing channel along Interstate 15. Land use impacts identified include potential conflicts with existing and future proposed land uses, new residential developments, and temporary construction related impacts. The extent of these impacts will depend upon available ROWs at the time the projects are designed.

C9 - This pipeline, located in the City of Las Vegas at the corner of Las Vegas Boulevard and Washington Avenue, would cross an existing mortuary building diagonally. Recommended mitigation would be to relocate the pipeline to avoid removing this building. Potential conflicts may occur with recreation programs at Fantasy Park.

S10 - Construction of this lined channel on Buffalo Road may conflict with new residential development in the area. The extent of these impacts will depend upon the final ROW selected.

S22 - Improvements to the floodway on the west branch of Duck Creek may conflict with adjacent residences in the area depending upon the final ROW. It is expected that these potential conflicts can be avoided by implementation of recommended mitigation measures.

S24 - Rawhide Channel will be a major conveyance system located in a heavily urbanized area. The proposed system consists of new and existing facilities including lined channels, box culverts and pipelines. Construction of the systems is expected to result in numerous short-term construction impacts. Long-term impacts depend upon the final ROW selected and the locations of individual facilities. Health and safety impacts are expected, as well as impacts related to creation of barriers and divisions of communities, substantial inconveniences, and potential attraction to the facilities for unauthorized uses.

S25 - This major conveyance system, the Van Buskirk Channel, will result in impacts similar to those created by construction of the Rawhide Channel.

4110 - Construction of a lined channel and box culvert along the Hemenway Wash floodway north of US Highway 93 would displace eight houses depending upon the ROW selected.

15.8 VISUAL RESOURCES

The visual impacts of the proposed 10-year plan facilities were determined by applying the project-specific visual resource analysis procedure described in Section 14.8. The 10-year assessment includes the following steps:

- Review the project description of the proposed facility.
- Determine the visual dominance level of the facility.
- Determine the visual sensitivity of the significant resources affect by the facility.
- Assess the potential impacts based on cross evaluating the visual dominance level of the facility with the visual sensitivity of the visual character unit.
- Recommend mitigation measures to reduce impacts.

A matrix for the 10-year assessment was compiled to illustrate the potential impacts of the construction program and the associated mitigation measures. Table 15-13 is set up with the facilities in the first column, which are numbered corresponding to facilities numbers presented in Section 3.0. The second column is a description of the flood control structure facility type. The third column represents the dominance level of the proposed facility. The remaining table entries list the significant resources or the visual character units, with the respective visual sensitivity noted above each column. The last column presents recommended mitigation measures.

Application of the mitigation measures identified in Table 15-13 is expected to effectively reduce the potential impacts of the proposed facilities. Although residual impacts of some facilities may be considered locally significant to some viewers, the overall public benefit of the flood protection afforded by these facilities is expected to outweigh potential residual impacts if the suggested mitigation measures are applied.

15.9 SOCIOECONOMICS

The 10-year plan facilities listed in Section 3.0 were subjected to the project prioritization process described in the District's Policy and Procedures Manual (Bax-Valentine, 1988). The process seeks to avoid locating facilities on developed property such as residential, commercial or institutional in order to minimize costs of land acquisition and relocation of established activities. It is not necessary, therefore, to test the current list of proposed facilities for intrusion into developed properties or intersection/displacement of vital public services. The principal impact on the proposed list of facilities will be to necessitate improvements to highway crossings over flood channels, the costs of which have already been taken into account in the prioritization process.

As noted earlier in Section 11.4, should modifications or additions be proposed to the current 10-year plan list of projects, these would have to be evaluated for possible displacement or disruption of existing property developments. The procedure would consist of locating the site of the proposed flood control facility on suitable maps or photographs, augmented possibly by an on-site inspection, to assess the potential for developed property disruption. Were such to be the case, an appraiser would have to be retained to estimate costs of damages and relocation.

15.10 CULTURAL RESOURCES

15.10.1 Archaeological Resources

The facilities of the 10-year program for the Detention/Conveyance alternative were analyzed for the presence of, and potential impacts to, cultural resources by construction and/or operation of individual facilities. Impacts would occur to individual cultural resources, archaeological sites and isolated artifacts, as well as to archaeological sensitivity areas. Tabulations of impacts to previously recorded archaeological resources are presented in Table 15-14 while impacts to archaeological sensitivity areas are listed in Table 15-15. The relationship of project facilities to individual archaeological resources are categorized into three levels. These are: 1) "on," where the site and facilities locations are coterminous, 2) "adjacent," where the site is within 0.2 mile of the facility, and 3) "within 0.5 mile," where the site is located between 0.2 and 0.5 mile of the facility.

Facility types included floodways, detention and debris basins, dikes, levees, lined and unlined channels, pipeline/box conduits, culverts, and bridges. Of the 10-year plan projects, 11 will be located on, adjacent to, or within 0.5 mile of specific archaeological cultural resources (Table 15-14). Five archaeological sensitivity areas will be directly affected by 24 of the 10-year program facilities (Table 15-15). A total of 13 sites are "on," seven are "adjacent" to and 17 are located within 0.5 mile of an individual facility.

As noted in Section 14.10 and in accordance with the mitigation measures detailed in Section 12.6.1, the District will conduct an updated record search on all facilities in the 10-year program. Based on this records search and the sensitivity analysis presented in 12.3.1, the District will consult with BLM and SHPO to determine survey requirements. It is expected that intensive survey will be required in areas of high and moderate sensitivities and for all facilities that are sited within 0.5 mile of a known archaeological site. Following completion of the survey, CCFCD will consult with BLM and SHPO on the significance of inventoried resources. If any are found to be eligible for the National Register, a treatment plan will be developed in consultation with BLM, SHPO, and ACHP.

One known archaeological site, 26-Ck-948 (the Las Vegas Springs Site), is on the National Register of Historic Places. CCFCD will consult with BLM, SHPO, and ACHP regarding appropriate treatment of this site.

15.10.2 Ethnographic Resources

The 10-year program would not affect any specific resources in the ethnographic inventory. Nonetheless, Native American groups have expressed general concern for archaeological resources. In accordance with the mitigation measures described in Section 12.6.2 (above), appropriate members of the Las Vegas Paiute Indian Tribe and Moapa Paiute Indian Tribe will be consulted regarding treatment of significant archaeological sites. During the archaeological survey, knowledgeable elders will be consulted about specific resources of concern. Any mitigation measures that may be necessary will be discussed with participating elders and other appropriate Southern Paiute leaders.

15.10.3 Historic Resources

Twenty historic resources could be subject to either direct or indirect impact from the 10-year program (Table 15-16). Direct impacts would occur to Historic Site #1 (Las Vegas Springs) and Historic Site #3 (Mormon Fort), both of which are on the National Register. Additionally, indirect effects could occur to Historic Site #13, a structure that has been determined eligible for the National Register. CCFCD will consult with BLM, SHPO, and ACHP regarding appropriate treatment of these three sites.

In accordance with the mitigation measures presented in section 12.6.3, CCFCD will conduct an updated historical inventory when all facilities have been sited. This will include review of existing registers of historic sites and primary historic documents that record potential site locations. Field reconnaissance will be conducted at all recorded sites and locations of potential historic resources as revealed by the review of primary documents. Informal consultation with SHPO has been initiated to identify the potential significance of inventoried resources. If any are found to qualify for the National Register, BLM, SHPO, and ACHP will be consulted to determine appropriate treatment necessary to adequately avoid or mitigate potential impacts.

TABLE 15-1

FACILITIES EMISSIONS ESTIMATES AND THRESHOLD EXCEEDANCES BY YEAR
10-YEAR PLAN FACILITIES[1]

FACILITY	FIRST YEAR OF CONSTRUCTION	EMISSIONS PM Daily (lbs.)	EMISSIONS PM Total (T)	EMISSIONS CO 1 hr. (lbs.)	EMISSIONS CO 8 hrs (lbs.)	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) PM Daily	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) PM Annual	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) CO 1 hr.	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) CO 8 hrs.
1988									
C6[2]	1988	--	--	--	--	--	--	--	--
B1[3]	1988	--	--	--	--	--	--	--	--
Annual Total									
1989									
N6	1989	13.0	0.0	3.1	24.8	39	41	52	296
N10	1989	192.4	32.1	34.7	277.6	57	41	906	2592
C1	1989[4]	13.0	0.0	3.1	24.8	64	41	906	2592
C4	1989	192.4	4.5	27.6	220.8	71	41	906	2592
S1	1989	192.4	18.7	10.8	86.4	97	41	906	2592

[1] Emissions based on composite emissions factors (Table 13-1) applied to facility details presented on Table 3-1
[2] Under construction
[3] Predesign only
[4] Outlet structure

TABLE 15-1 (continued)

FACILITY	FIRST YEAR OF CONSTRUCTION	EMISSIONS PM Daily (lbs.)	PM Total (T)	CO 1 hr. (lbs.)	CO 8 hrs (lbs.)	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) PM Daily	PM Annual	CO 1 hr.	CO 8 hrs.
B2	1989	13.0	0.0	3.1	24.8	89	41	906	2592
B3	1989	41.0	0.3	6.6	52.8	89	41	906	2592
B5[5]	1989	41.0	1.6	13.2	105.6	89	41	906	2592
4108	1989	277.2	2.7	37.7	301.6	129	41	906	2592
4114[3]	1989	--	--	--	--	--	--	--	--
H3	1989	41.0	1.7	26.8	214.4	89	41	906	2592
GVBR	1989	6.9	0.1	3.7	29.6	89	41	906	2592
GVBX	1989	13.0	0.0	3.1	24.8	89	41	906	2592
Annual Total		1023.3	61.7	170.4	1363.2	927	451	9112	26216
<u>1990</u>									
C5	1990	192.4	6.7	10.8	86.4	71	41	906	2592
S2	1990	41.0	0.3	6.6	52.8	57	41	906	2592
2618	1990	41.0	1.1	6.6	52.8	89	41	906	2592
Annual Total		274.4	8.1	24.0	192.0	217	123	2718	7776

TABLE 15-1 (continued)

FACILITY	FIRST YEAR OF CONSTRUCTION	EMISSIONS PM Daily (lbs.)	EMISSIONS PM Total (T)	EMISSIONS CO 1 hr. (lbs.)	EMISSIONS CO 8 hrs (lbs.)	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) PM Daily	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) PM Annual	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) CO 1 hr.	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) CO 8 hrs.
1991									
N1	1991	41.0	1.2	12.8	102.4	39	41	906	2592
N3-8 ALT	1991	192.4	7.2	21.2	169.6	57	41	906	2592
C2	1991	41.0	2.2	37.5	300.0	54	41	906	2592
C3	1991	192.4	117.9	25.8	206.4	71	41	906	2592
C7	1991	139.0	1.3	59.2	473.6	54	41	52	296
C9	1991	192.4	7.2	54.2	433.6	71	41	52	296
S23	1991	6.9	0.3	7.4	59.2	57	41	906	2592
B4	1991	41.0	0.9	19.8	158.4	89	41	906	2592
Annual Total		846.1	138.2	237.9	1903.2	492	328	5540	16144
1992									
S29	1991/2	192.4	15.8	27.8	222.4	129	41	906	2592
S24	1992	41.0	0.9	76.3	610.4	57	41	906	2592
S25	1992	41.0	0.5	37.1	296.8	57	41	52	296
Annual Total		274.4	17.2	141.2	1129.6	243	123	1864	5480

TABLE 15-1 (continued)

FACILITY	FIRST YEAR OF CONSTRUCTION	EMISSIONS PM Daily (lbs.)	PM Total (T)	CO 1 hr. (lbs.)	CO 8 hrs (lbs.)	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) PM Daily	PM Annual	CO 1 hr.	CO 8 hrs.
1993									
N4	1993	192.4	14.7	19.0	152.0	57	41	906	2592
N12	1993	192.4	63.8	38.6	308.8	57	41	906	2592
S6	1993	13.0	0.2	3.1	24.8	57	41	906	2592
4110	1993	277.2	1.1	27.0	216.0	129	41	906	2592
Annual Total		675.0	79.8	87.7	701.6	300	164	3624	10368
1994									
S3	1994	13.0	0.1	3.1	24.8	57	41	52	296
Annual Total		13.0	.1	3.1	24.8	57	41	52	296
1995									
N7	1995	13.0	0.0	3.1	24.8	39	41	52	296
S10	1995	41.0	0.4	6.6	52.8	57	41	906	2592
S12	1995	6.9	0.1	3.7	29.6	57	41	52	296
S15	1995	6.9	0.1	20.8	166.4	57	41	906	2592

TABLE 15-1 (continued)

FACILITY	FIRST YEAR OF CONSTRUCTION	EMISSIONS PM Daily (lbs.)	EMISSIONS PM Total (T)	EMISSIONS CO 1 hr. (lbs.)	EMISSIONS CO 8 hrs (lbs.)	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) PM Daily	THRESHOLD EXCEEDANCE PM Annual	THRESHOLD EXCEEDANCE CO 1 hr.	THRESHOLD EXCEEDANCE CO 8 hrs.
S30	1995	41.0	0.9	6.6	52.8	57	41	906	2592
Annual Total		108.8	1.5	40.8	326.4	267	205	2822	8368
1996									
S9	1996	41.0	0.9	6.6	52.8	57	41	52	296
S11[3]	1996	--	--	--	--	--	--	--	--
S17[3]	1996	--	--	--	--	--	--	--	--
S26	1996	192.4	3.7	31.6	252.8	97	41	906	2592
S27	1996	6.9	0.1	3.7	29.6	57	41	52	296
H1	1996	192.4	21.1	33.7	269.6	129	41	906	2592
Annual Total		432.7	25.8	75.6	604.8	340	164	1916	5776
1997									
N3[3]	1997	--	--	--	--	--	--	--	--
N5[3]	1997	--	--	--	--	--	--	--	--
"N"[2]	1997	41.0	.7	19.8	158.4	39	41	906	2592

TABLE 15-1 (concluded)

FACILITY	FIRST YEAR OF CONSTRUCTION	EMISSIONS PM Daily (lbs.)	PM Total (T)	CO 1 hr. (lbs.)	CO 8 hrs (lbs.)	THRESHOLD EXCEEDANCE (POTENTIALLY SIGNIFICANT) PM Daily	PM Annual	CO 1 hr.	CO 8 hrs.
S4[3]	1997	--	--	--	--	--	--	--	--
S18[3]	1997	--	--	--	--	--	--	--	--
S19[3]	1997	--	--	--	--	--	--	--	--
S20[3]	1997	--	--	--	--	--	--	--	--
S21[3]	1997	--	--	--	--	--	--	--	--
S22[3]	1997	--	--	--	--	--	--	--	--
4109	1997	277.2	4.3	20.8	166.4	129	41	906	2592
Annual Total		318.2	5.0	40.6	324.8	168	82	1812	5184

TABLE 15-2

AIR QUALITY MITIGATION MEASURES
10-YEAR PLAN FACILITIES

FACILITY	CARBON MONOXIDE MITIGATION: Management of Activity	CARBON MONOXIDE MITIGATION: Equipment Inspection and Maintenance Program	PARTICULATES MITIGATION: Fugitive Dust Control	PARTICULATES MITIGATION: Management of Activity	Residual Impact (With Mitigation)
NORTHERN LAS VEGAS VALLEY					
N1	No	No	No	No	No
N3	No	No	Yes	Yes	No
N3-8 ALT	No	No	Yes	Yes	No
N4	No	No	No	No	No
N5	No	No	Yes	Yes	No
N6	Yes	Yes	No	No	No
N7	Yes	Yes	No	No	No
N10	No	No	Yes	Yes	No
N12	No	No	No	No	No
N12-9 ALT	No	No	No	No	No
"N" Channel	No	No	No	No	No
CENTRAL LAS VEGAS VALLEY					
C1	Yes	Yes	No	No	No
C2	No	No	No	No	No
C3	No	No	No	No	No
C4	No	No	Yes	Yes	No
C5	No	No	Yes	Yes	No
C6	Yes	Yes	Yes	Yes	No
C7	Yes	Yes	No	No	No
C9	Yes	Yes	No	No	No

TABLE 15-2 (continued)

FACILITY	CARBON MONOXIDE MITIGATION: Management of Activity	CARBON MONOXIDE MITIGATION: Equipment Inspection and Maintenance Program	PARTICULATES MITIGATION: Fugitive Dust Control	PARTICULATES MITIGATION: Management of Activity	Residual Impact (With Mitigation)
SOUTHWEST LAS VEGAS VALLEY					
S1	No	No	Yes	No	No
S2	No	No	No	No	No
S3	Yes	Yes	No	No	No
S4	No	No	Yes	Yes	No
S6	No	No	No	No	No
S9	Yes	Yes	No	No	No
S10	No	No	No	No	No
S11	No	No	Yes	No	No
S12	Yes	Yes	No	No	No
S15	No	No	No	No	No
S17	No	No	Yes	No	No
S18	No	No	Yes	No	No
S19	No	No	Yes	No	No
S20	No	No	Yes	No	No
S21	No	No	Yes	No	No
S22	No	No	Yes	Yes	No
S23	No	No	No	No	No
S24	No	No	No	No	No
S25	Yes	Yes	No	No	No
S26	No	No	No	No	No
S27	Yes	Yes	No	No	No

TABLE 15-2 (concluded)

FACILITY	CARBON MONOXIDE MITIGATION: Management of Activity	CARBON MONOXIDE MITIGATION: Equipment Inspection and Maintenance Program	PARTICULATES MITIGATION: Fugitive Dust Control	PARTICULATES MITIGATION: Management of Activity	Residual Impact (With Mitigation)
BOULDER CITY					
B1	No	No	Yes	No	No
B2	No	No	No	No	No
B3	No	No	No	No	No
B4	No	No	No	No	No
B5	No	No	No	No	No
4108	No	No	No	Yes	No
4109	No	No	Yes	Yes	No
4110	No	No	Yes	No	No
4114	No	No	No	No	No
HENDERSON					
H1	No	No	No	No	No
H3	No	No	No	No	No
2618	No	No	No	No	No
S29	No	No	No	No	No
S30	No	No	No	No	No
Green Valley Bridge	No	No	No	No	No
Green Valley Box	No	No	No	No	No

TABLE 15-3

POTENTIAL GEOLOGIC IMPACTS AND HAZARDS
10-YEAR PLAN FACILITIES

FACILITY NUMBER	IMPACTS TO THE ENVIRONMENT		GEOLOGIC HAZARDS											GEOLOGIC CONSTRAINTS	
	Topographic Alteration	Mineral Resources	Strong Ground Motion	Surface Fault Rupture	Slope Instability	Expansive Soils	Collapsing Soils	Subsidence	Liquefaction	Water Erosion	Wind Erosion	Deposition	Caliche	Corrosive Soils
N1			x[1]	X[2]		X	x	X	x		X		X	X
N3			x			X				x	X		X	
N3-8 ALT			X				x	x		X	X		X	X
N4	x		X			X	X		X			X		X
N5	x		X							X	X	X		
N6			x	X		X	x	x	x		X			X
N7			X						x		X			
N10	x	x	X							X	X	X	X	
N12	x		X			X	X			X	X	X	X	X
N12-9 ALT	x	x							X		x	X		
"N" Channel			x					X		X				

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[1] x = Potential geologic impacts and hazards specific to geographic location

[2] X = Potential geologic impacts and hazards specific to proposed facility types

TABLE 15-3 (continued)

FACILITY NUMBER	IMPACTS TO THE ENVIRONMENT		GEOLOGIC HAZARDS										GEOLOGIC CONSTRAINTS	
	Topographic Alteration	Mineral Resources	Strong Ground Motion	Surface Fault Rupture	Slope Instability	Expansive Soils	Collapsing Soils	Subsidence	Liquefaction	Water Erosion	Wind Erosion	Deposition	Caliche	Corrosive Soils
C1			X											X
C2			X						X				X	
C3	x	x	X	X	X					X	X	X	X	
C4	x		x	X	X	x	x		x		X	X		X
C5	x		X	X					X		X	X	X	
C6	x		X	X		X	X		X	X	X	X	X	X
C7			x	X		X	x		x		X			X
C9	x		X	X	X	X	X		X		X	X		X
S1	x		X							X	X	X	X	
S2		x	x								X		X	
S3			x	X		x	x		x					X
S4	x		x							X	X	X	x	
S6			x							X	X		X	
S9			x	X		X	x		x		X		X	X
S10			x							X				

TABLE 15-3 (continued)

FACILITY NUMBER	IMPACTS TO THE ENVIRONMENT		GEOLOGIC HAZARDS										GEOLOGIC CONSTRAINTS	
	Topographic Alteration	Mineral Resources	Strong Ground Motion	Surface Fault Rupture	Slope Instability	Expansive Soils	Collapsing Soils	Subsidence	Liquefaction	Water Erosion	Wind Erosion	Deposition	Caliche	Corrosive Soils
S11	x		X									X		
S12			X											
S15			X						X				X	
S17	x	x	X							X		X		
S18	x	x	X							X	X	X		
S19	x		X							X	X	X		
S20	x		X							X	X	X	X	
S21	x		X							X	X	X	x	
S22			x										X	
S23			X						X					X
S24			x	X		X	x		x		X			X
S25			x			X	x		x		X		X	X
S26	x		X	X		X				X	X	X		
S27			X			X	X		X					X
B1			x											
B2			x								X			

TABLE 15-3 (concluded)

FACILITY NUMBER	IMPACTS TO THE ENVIRONMENT		GEOLOGIC HAZARDS										GEOLOGIC CONSTRAINTS	
	Topographic Alteration	Mineral Resources	Strong Ground Motion	Surface Fault Rupture	Slope Instability	Expansive Soils	Collapsing Soils	Subsidence	Liquefaction	Water Erosion	Wind Erosion	Deposition	Caliche	Corrosive Soils
B3			x							X				
B4			x								X			
B5			x								X			
4108			X								X			
4109			x								X			
4110			x								X			
4114			X									X		
H1	x	x	X							X	X	X		
H3			X	X	X	X	X				X		X	X
2618			x			X	x				X		X	X
S29	x		X							X	X	X	X	
S30			x								X		X	
GVBR			X								X			
GVBX			x			x	x				X			X

TABLE 15-4

POTENTIAL GEOLOGIC AND SOILS EFFECTS AND MITIGATION, 10-YEAR PLAN FACILITIES

Facility Number[2]	POTENTIAL EFFECTS[1]: Facility Struct. Damage/Special Design Require.	Routine Facil. Operational Prob.	Construction Difficulty	Increased Erosion	Off-site Surface Changes/Potential Structural Prob.	Interference With Mineral Production and Increased Demand	Mitigation[3]
N1	X	X	X	X	X		B,C,D,E,H,I
N3	X	X	X	X	X		B,C,D,E,H
N3-8 ALT	X	X		X		X	B,C,D,E,H,I
N4	X	X		X	X		B,C,D,E,I
N5	X	X		X	X		B,C,D,E
N6	X	X		X	X		B,C,D,E,I
N7	X	X		X	X		B,C,D,E
N10	X	X	X	X	X	X	B,C,D,E,F,H
N12	X	X	X	X	X		B,C,D,E,H,I
N12-9 ALT	X	X		X	X	X	B,C,D,E,F
"N" Channel	X	X		X	X		B,C,D,E

[1] Potential effects correspond to effects described in Section 5.0 and listed in Tables 5-3 and 5-4
[2] Facility numbers refer to 10-Year Plan facilities as described in Section 3.0
[3] Mitigation measures refer to mitigation described in Section 5.0 and listed in Table 5-6

TABLE 15-4 (continued)

POTENTIAL EFFECTS

Facility Number	Facility Struct. Damage/Special Design Require.	Routine Facil. Operational Prob.	Construction Difficulty	Increased Erosion	Off-site Surface Changes/Potential Structural Prob.	Interference With Mineral Production and Increased Demand	Mitigation
C1	X						B,C,D,I
C2	X		X				B,C,D,H
C3	X	X	X	X	X	X	B,C,D,E,F,G,H
C4	X	X		X	X		B,C,D,E,G,I
C5	X	X	X	X	X		B,C,D,E,H
C6	X	X	X	X	X		B,C,D,E,H,I
C7	X	X		X	X		B,C,D,E,I
C9	X	X		X	X		B,C,D,E,G,I
S1	X	X	X	X	X		B,C,D,E,H
S2	X	X	X	X	X	Possible	B,C,D,E,F,H
S3	X						B,C,D,I
S4	X	X	X	X	X		B,C,E
S6	X	X	X	X	X		B,C,E,H
S9	X	X	X	X	X		B,C,D,E,H,I
S10	X	X		X	X		B,C,E

TABLE 15-4 (continued)

POTENTIAL EFFECTS

Facility Number	Facility Struct. Damage/Special Design Require.	Routine Facil. Operational Prob.	Construction Difficulty	Increased Erosion	Off-site Surface Changes/Potential Structural Prob.	Interference With Mineral Production and Increased Demand	Mitigation
S11	X	X		X	X		B,C,D,E
S12	X	X					C,D
S15	X	X	X				B,C,D,H
S17	X	X		X	X	X	B,C,D,E,F
S18	X	X		X	X	X	B,C,D,E,F
S19	X	X		X	X		B,C,D,E
S20	X	X	X	X	X		B,C,D,E,H
S21	X	X	X	X	X		B,C,D,E,H
S22	X	X	X				B,C,D,H
S23	X	X					B,C,D,I
S24	X	X		X	X		B,C,D,E,I
S25	X	X	X	X	X		B,C,D,E,H,I
S26	X	X		X	X		B,C,D,E
S27	X	X					B,C,D,I
B1							None

TABLE 15-4 (concluded)

POTENTIAL EFFECTS

Facility Number	Facility Struct. Damage/Special Design Require.	Routine Facil. Operational Prob.	Construction Difficulty	Increased Erosion	Off-site Surface Changes/Potential Structural Prob.	Interference With Mineral Production and Increased Demand	Mitigation
B2	X	X		X	X		B,C,E
B3	X	X		X	X		B,C,E
B4	X	X		X	X		B,C,E
B5	X	X		X	X		B,C,E
4108	X	X		X	X		B,C,D,E
4109	X	X		X	X		B,C,E
4110	X	X		X	X		B,C,E
4114	X	X		X	X		B,C,D,E
H1	X	X		X	X	X	B,C,D,E,F
H3	X	X	X	X	X		B,C,D,E,G,H,I
2618	X	X	X	X	X		B,C,D,E,H,I
S29	X	X	X	X	X		B,C,D,E,H
S30	X	X	X	X	X		B,C,E,H
GVBR	X	X		X	X		B,C,D,E
GVBX	X	X		X	X		B,C,D,E,I

TABLE 15-5

POTENTIAL FOR ENVIRONMENTAL EFFECT ON GROUND WATER
10-YEAR PLAN FACILITIES

FACILITY	SHALLOW GROUND-WATER MAY AFFECT CONSTRUCTION OF FLOOD CONTROL FACILITIES	PROJECT MAY IMPACT DISCHARGE OF SHALLOW GROUND WATER
NORTHERN LAS VEGAS VALLEY		
N1	No	No
N3	No	No
N3-8 ALT	No	No
N4	No	No
N5	No	No
N6	Yes	Yes
N7	Yes	Yes
N10	No	No
N12	No	No
N12-9 ALT	No	No
"N" Channel	No	No
CENTRAL LAS VEGAS VALLEY		
C1	No	No
C2	No	No
C3	No	No
C4	No	No
C5	No	No
C6	Yes	No
C7	Yes	No
C9	Yes	No

TABLE 15-5 (continued)

FACILITY	SHALLOW GROUND-WATER MAY AFFECT CONSTRUCTION OF FLOOD CONTROL FACILITIES	PROJECT MAY IMPACT DISCHARGE OF SHALLOW GROUND WATER
SOUTHWEST LAS VEGAS VALLEY		
S1	No	No
S2	No	No
S3	Yes	No
S4	No	No
S6	Yes	No
S9	Yes	Yes
S10	No	No
S11	No	No
S12	Yes	No
S15	Yes	No
S17	No	No
S18	No	No
S19	No	No
S20	No	No
S21	No	No
S22	No	No
S23	Yes	No
S24	Yes	Yes
S25	Yes	Yes
S26	No	No
S27	Yes	No
BOULDER CITY		
B1	No	No
B2	No	No
B3	No	No
B4	No	No
B5	No	No

TABLE 15-5 (concluded)

FACILITY	SHALLOW GROUND-WATER MAY AFFECT CONSTRUCTION OF FLOOD CONTROL FACILITIES	PROJECT MAY IMPACT DISCHARGE OF SHALLOW GROUND WATER
BOULDER CITY (cont.)		
4108	No	No
4109	No	No
4110	No	No
4114	No	No
HENDERSON		
H1	No	No
H3	Yes	Yes
2618	No	No
S29	No	No
S30	No	No
GVBR	No	No
GVBX	No	No

TABLE 15-6

COMPARISON OF 10-YEAR AND NO ACTION PLAN PEAK FLOW RATES

SYSTEM OUTFALL LOCATION (AS SHOWN ON MASTER PLAN)			PEAK FLOW RATE (CFS) FOR 100-YEAR EVENT	
Figure Number	Identification Number	Structure Number	No-Action Plan[1]	10-Year Plan
A2-2	9	2300	9660	9600
A2-2	12	2303	4853	360
A2-2	13	2304	4853	360
A2-5	62	1240	320	200
A2-5	103	1374	1400	770
A2-6	9	2520	7090	500
A2-7	16	1345	1740	200
A2-7	48	3004	3440	410
A2-7	60	3012	3580	2810
A2-7	61	3010	4560	770
A2-8	33	3017	8780	1840
A2-8	36	3018	6210	1840
A2-8	52	3057	14400	5140
A2-8	67	3031	1950	370
A2-8	92	3626	13700	530
A2-8	117	3616	710	650
A2-8	125	3534	25000	3380
A2-8	127	3535	25000	3380
A2-8	168	3052	8780	1840
A2-8	188	3062	2720	770
A2-9	3	2232	23830	5570
A2-9	4	2234	23830	5570
A2-9	15	2616	24460	6490
A2-10	25	3503	11000	1580
A2-11	4	3512	1800	570
A2-11	14	3515	630	10
A2-11	18	3519	1160	200
A2-11	24	3523	5230	160
A2-11	39	3200	11800	3630
A2-11	45	3204	1760	770
A2-12	10	2708	5500	1080
A2-14	6	4101	830	830
A2-14	26	4108	950	950
A2-14	44	4113	2020	2020

[1] Not all outfalls correspond directly to a point in the No-Action plan where peak flow rates were estimated. Some peak flow rates shown in this table were selected at the next downslope peak flow rate location

TABLE 15-7

SUMMARY OF POTENTIAL IMPACTS TO SENSITIVE BIOLOGICAL RESOURCES[1]
10-YEAR PLAN FACILITIES

FACILITY NUMBER	LISTED PLANTS[2] AND CACTUS/ YUCCA SPECIES	FEDERAL CANDIDATE/BLM SENSITIVE PLANT SPECIES	NNNPS SPECIES	WETLANDS	FEDERAL-LISTED WILDLIFE SPECIES	STATE-LISTED/ BLM SENSITIVE WILDLIFE SPECIES	FEDERAL CANDIDATE/ STATE-PROTECTED WILDLIFE SPECIES	GAME, AND OTHER SENSITIVE SPECIES	MITIGATION[3] MEASURES
N1	1,3,5		15,17,22	27,28,29	33	34	42	47,49	A,C,D,E,F,J,K,L,M
N3	1,3,5,6	10,14	15,17,22	28,29	33	34		46,47,49,50,51,55	A,B,C,D,F,H,J,L,M
N3-8 ALT	1,3,5,6	10,14	15,17,22	28,29	33	34		46,47,49,50,51,55	A,B,C,D,F,H,J,L,M
N4	1,3,5,6	10	15,17,22	28,29	33	34		46,47,49,50,51	A,B,C,D,F,J,L,M
N5	1,3	14	17	28	33	34		47,49	A,B,C,D,F,G,H,J,L,M
N6	1,3,5		15,17,22	26,27,28,29				47	A,C,D,E,F
N7	1		17	26,27,28,29	31,32,33	34	36,40,41,42	47,49,50,51	A,C,E,F,I,J,K,L,M
N10	1,5,6	10	15,22	28,29	33	34		47	A,B,C,D,F,G,H,J,M
N12	1,3		15	28,29	33	34	39	46,47,49	A,C,D,F,G,H,J,K,L,M
N12-9 ALT			15	28,29	33	34	39	46,47,49	A,C,D,F,G,H,J,K,L,M
"N" Channel			15,17,22	27,28,29	33	34		47,49	A,C,D,E,F,J,L,M

[1] Sensitive biological resources: numbers correspond to sensitive resources listed in Tables 8-1 and 8-2
[2] NNNPS plant species not included in columns 1 and 2 (i.e., "other rare" and "watch list" species)
[3] Mitigation measures: letter designations correspond to mitigation measures described in Table 8-5

TABLE 15-7 (continued)

FACILITY NUMBER	LISTED PLANTS AND CACTUS/ YUCCA SPECIES	FEDERAL CANDIDATE/BLM SENSITIVE PLANT SPECIES	NNNPS SPECIES	WETLANDS	FEDERAL-LISTED WILDLIFE SPECIES	STATE-LISTED/ BLM SENSITIVE WILDLIFE SPECIES	FEDERAL CANDIDATE/ STATE-PROTECTED WILDLIFE SPECIES	GAME, AND OTHER SENSITIVE SPECIES	MITIGATION MEASURES
C1	1,3		17	28	33			47,49	A,C,D,F,J,L,M
C2	1,3		17	28	33	34		47,49	A,C,D,F,J,L,M
C3	1,3		17	28,29	33	34		47,49	A,C,D,F,G,J,L,M
C4	1,3		17	28,29	33			47,49	A,C,D,F,G,J,L,M
C5	1		17					47	A,D,G
C6	1,5		17,22	29				47	A,C,F,G
C7	1,5		17,22	29				47	A,C,F
C9	1,5			26,27				47	A,E
S1	1,3,6		16,17	28,29	33	34		47,49	A,C,D,F,G,J,L,M
S2	1,3,6		16,17	28,29	33	34		47,49	A,C,D,F,J,L,M
S3	1,3		17	26,27,28,29				47	A,C,D,E,F
S4	1,3,6,7	9,12,14	16,17,19	28,29	33	34		45,46,47,49, 50,51,53,54	A,B,C,D,F,G,H,J,L,M
S6	1,3,6		16,17	28,29	33	34		47,49	A,C,D,F,J,L,M
S9	1,3		17	28,29	33			47	A,C,D,F,J,M
S10	1,3		17	29	33			47,49	A,C,D,F,J,M

TABLE 15-7 (continued)

FACILITY NUMBER	LISTED PLANTS AND CACTUS/ YUCCA SPECIES	FEDERAL CANDIDATE/BLM SENSITIVE PLANT SPECIES	NNNPS SPECIES	WETLANDS	FEDERAL-LISTED WILDLIFE SPECIES	STATE-LISTED/ BLM SENSITIVE WILDLIFE SPECIES	FEDERAL CANDIDATE/ STATE-PROTECTED WILDLIFE SPECIES	GAME, AND OTHER SENSITIVE SPECIES	MITIGATION MEASURES
S11	1,3,6,7	9,12,14	16,17,19	28,29	33	34		45,46,47,49, 50,51,53,54	A,B,C,D,F,G,H,J,L,M
S12	1,3		17	28,29	33			47	A,C,D,F,J,M
S15				28,29				47	F
S17	1,3,6	13,14	16,17	28,29	33	34		46,47,49,54	A,B,C,D,F,G,J,L,M
S18	1,3,6	13,14	16,17	28,29	33	34		46,47,49,54	A,B,C,D,F,G,J,L,M
S19	1,3,6	13,14	16,17		33	34		46,47,49,54	A,B,C,D,G,J,L,M
S20	1,3,6	13,14	16,17,18	28,29	33	34		46,47,49,54	A,B,C,D,F,G,H,J,L,M
S21	1,3,6,7	9,12,14	16,17,19	28,29	33	34		46,47,49,54	A,B,C,D,F,G,H,J,L,M
S22	1,3,6,7	9,12,14	16,17,19	28,29	33	34		46,47,49,54	A,B,C,D,F,J,L,M
S23				26,27					E
S24				26,27,28,29	33	34		47	E,F,J,M
S25				26,27,28,29					E,F
S26	1,3,6		16,17	28,29	33	34		47,49	A,C,D,F,G,H,J,L,M
S27				26,27					E
B1	1,3		18	28,29	33	34		46,47,50,51,54	A,C,D,F,H,J,L,M
B2	1,3				33	34		47	A,C,J,M

TABLE 15-7 (concluded)

FACILITY NUMBER	LISTED PLANTS AND CACTUS/ YUCCA SPECIES	FEDERAL CANDIDATE/BLM SENSITIVE PLANT SPECIES	NNNPS SPECIES	WETLANDS	FEDERAL-LISTED WILDLIFE SPECIES	STATE-LISTED/ BLM SENSITIVE WILDLIFE SPECIES	FEDERAL CANDIDATE/ STATE-PROTECTED WILDLIFE SPECIES	GAME, AND OTHER SENSITIVE SPECIES	MITIGATION MEASURES
B3	1,3				33	34		47	A,C,J,M
B4	3				33	34		47,54	D,J,L,M
B5	1,3		18	28,29	33	34		46,47	A,C,D,F,J,L,M
4108	1,3		18	28,29	33	34		46,47	A,C,D,F,J,L,M
4109	1,3		18	28,29	33	34		46,47,51,54	A,C,D,F,J,L,M
4110	1,3				33	34		47	A,D,J,M
4114	1,3				33	34		47	A,D,J,M
H1	1,3		16,18	28,29	33	34		46,47	A,C,D,F,G,J,L,M
H3	1,3,6	13,14	16,18	26,27,28,29	30,31 32,33	34,35	36,37,38,39, 40,41,42,43	46,47,48,49, 50,51	A,B,C,D,E,F,I,J,K,L,M
2618	1,3,6	13,14	16,18	28,29	33	34		47,49	A,B,C,D,F,J,L,M
S29	1,3,6	13,14	16,18	28,29	33	34		47,49	A,B,C,D,F,G,H,J,L,M
S30	1,3,6	13,14	16,18	28,29	33	34		47,49	A,B,C,D,F,G,H,J,L,M
GVBR	1,3,6	13,14	16,18	28,29	33	34		46,47,49	A,B,C,D,F,G,H,J,L,M
GVBX	1,3,6	13,14	16,18	28,29	33	34		47,49	A,B,C,D,F,G,H,J,L,M

TABLE 15-8

LAND USE SUMMARY
10-YEAR PLAN FACILITIES

FIG A2-	FACILITY NUM/I.D.[1]	JURISDICTION[2]	EXISTING LAND USE[3]	FUTURE LAND USE ZONING[4]	/ PLAN[5]	COMMENTS
5	N1/2-3	NLV	V	R-1	LD,OS	
5	N1/4	NLV	V	R-E,R-1,M-2	OS	Adj to Sunset Lawns cemetery (600′)
5	N1/6	NLV	V (Exist channel)	R-1	OS	Portion follows exist channel
5	N1/7	NLV	V (Exist channel)	R-1	OS	Portion follows exist channel
2	N3/1	CC/NLV/BLM	V (Exist wash)	N/A,O-L	FGA	Uses LV Wash in WSA
1	N3/8	CC/NLV/BLM	OS/R (WSA)	N/A	Wilderness?	Channel/dike in WSA
1	N3-8 ALT	CC	V	R/E,R-U	N/D	
2	N4/2	CC	V (Exist conc. struc)	R-E	N/D	
2	N4/3	CC/NLV	V (Exist channel)	R-E	N/D	
2	N4/8	NLV	V	O-L	N/D	Expand existing basin
5	N4/22,24,26	NLV	V (Exist channel)	M-2	OS,I	Uses existing channel
5	N4/23	CC	V	M-2	OS,I	
5	N4/25	CC	V	R-E	N/D	Culvert under UPRR
1	N5/1	CC	V	R-U	N/D	
1	N5/2	CC	V	R-U,H-2	N/D	
1	N5/3	CC	V	R-U	N/D	
1	N5/4	CC	V	R-U	N/D	
1	N5/5	(LV)	V	(R-E,C-2)	R	
1	N5/6	(BLM)	OS/R (WSA)	N/A	Wilderness?	WSA
1	N5/7	CC/BLM	OS/R (WSA)	N/A	Wilderness?	WSA
5	N6/8,10	NLV	V (Exist channel)	R-1,R-4	OS	Uses existing drainage channel
5	N6/11-15	CC	V (Exist channel)	T-C,R-2,R-T	N/D	Uses existing drainage channel
5	N6/16	LV	PF (Exist street)	R-1,R-E,R-MHP	M,ML,L,GC	

[1] Facility numbers correspond to numbers presented in the 10-year plan project description (Section 3.0)
[2] See key to jurisdictions
[3] See key to existing land use
[4] See key to zoning designations by jurisdiction
[5] See key to plan designations by jurisdiction

TABLE 15-8 (continued)

FIG A2-	FACILITY NUM/I.D.	JURISDIC-TION	EXISTING LAND USE	FUTURE LAND USE ZONING /	PLAN	COMMENTS
6	N6/27	NLV	V (Exist channel)	R-1,R-4	N/D	
5	N7/18-21	CC	V (Exist channel)	R-3	N/D	Uses existing drainage channel
8	N7/1-3	CC	V (Exist channel)	R-1	N/D	Uses existing drainage channel
9	N7/2-4	CC	V (Exist channel)	R-1	N/D	Uses existing drainage channel
5	N7/17	CC	V (Exist channel)	R-3	N/D	Uses existing drainage channel
5	N10/9-10	NLV	V	O-L	FGA	Unknown use, Section 17
2	N10/11	NLV	V	O-L	N/D	
5	N10/13	CC	V	R-U, M-2	N/D	Culvert under UPRR
6	N12/9-11	CC	V	P-F,R-U	N/D	
6	N12/9Alt	CC	V	P-F	N/D	Appears excavated
5	"N"/28,30,31	NLV	V (Exist channel)	M-2,C-3,R-3,R-1	MXC,HD,LD	Uses existing channel, CC Community College
4	C1/45	LV	V (Exist det basin)	C-V	N/D	Multiple-use/golf course/park
4	C2/47	LV	V	N-U,C-V	Husite Plan. Com	Crosses Angel Pk. Golf Course
4	C2/46	LV	V	N-U	N/D	
4	C2/48	LV	V	N-U	N/D	
4	C2/49	LV	V	N-U	N/D	Near LV Technical Center
4	C2/51	LV	V	N-U	N/D	
4	C2/52	LV	PF	N-U	N/D	
4	C2/53	LV	V	N-U	N/D	
4	C3/56-57	CC/LV	PF (Exist street)	N-U,R-CL,R-E	N/D	Depends on available ROW
4	C3/55	LV	V,Indus,Com	C-V,R-E	PF,ML/L,R	LV Tech Center under constr., South parcel vacant
5	C4/54-57,59, 60,62	LV/CC	PF (Exist street)	Mult. zones	LD Res	Uses existing street ROW
5	C4/61	NLV	V	C-1	LD Res	Potential indirect impact
4	C4/68	LV/CC	PF (Exist street)	R-PD,R-1,R-E	N/D	Depends on available ROW
7	C5/13	LV	V	N-U	N/D	Potential indirect impacts
5	C6/103	LV	V	R-E	N/D	
8	C7/20-21	CC	V	M	N/D	Adjacent to I-15
8	C7/22-24	LV	V	Mult zones	N/D	Adjacent to I-15
5	C7/115,117-21	LV	V	M	N/D	Follows exist I-15 ROW, additional ROW req unknown
5	C9/123-127	LV	PF (Exist street)	M,C-M,C-V,C-2	N/D	Avoid mortuary bldg.

TABLE 15-8 (continued)

FIG A2-	FACILITY NUM/I.D.	JURISDIC-TION	EXISTING LAND USE	FUTURE LAND USE ZONING /	PLAN	COMMENTS
5	C9/129	LV	OS/R	C-V	N/D	Compatible w/Fantasy Park rec programs?
5	C9/131-140	LV	PF (Exist street)	R-1,R-3,EV, R-E,R-MPH,O-1	N/D	Follows Washington Ave
7	S1/59	CC	V	R-E	N/D	
7	S2/61	CC	V (Exist wash)	R-E	N/D	
8	S3/36	CC	PF (Exist street)	H-1,R-5	N/D	Winnick Ave. street ROW
10	S4/23	CC	V	R-E	N/D	
10	S4/24	CC	V	R-E	N/D	No recent photo coverage
7	S6/48	CC	V (Rds under constr)	R-E,R-2	N/D	Assumes structure is in Durango Rd. row
8	S9/33	CC	V (Flood Control ROW)	M-1,R-E	N/D	Uses exist flood control corridor
7	S10/60	CC	Res	R-E	N/D	New residential development/ may conflict/depends on Buffalo Dr. ROW
10	S11/2	CC	V	R-U	N/D	
10	S11/3	CC	V	R-U	N/D	
8	S12/168	CC	V (Exist street)	M-1	N/D	
8	S15/188	CC	V (Exist street)	R-E	N/D	
11	S17/4	CC	V	R-E	N/D	
11	S18/14	CC	V	H-1	N/D	
11	S19/24	CC	V	R-E	N/D	
11	S20/17	CC	V	R-E	N/D	
11	S20/18	CC	V	R-E	N/D	
10	S21/28	CC	V	R-E	N/D	
10	S21/29	CC	V	R-E	N/D	
10	S22/25	CC	V,Res	R-E	N/D	Possible conflict with adj residences/depends upon ROW
8	S23/125-127	CC	Res	R-E	N/D	Depends on ROWs available
8	S24/93-117	CC	Res	R-E,R-1,C-P	N/D	Uses exist channel/pipeline ROW, impacts depend on new ROW
8	S25/79-92	CC	Com/Res/PF (Exist street)	C-C,C-2,R-4, R-1,C-1	N/D	Uses portions of existing channel, impacts depend on new ROW
8	S26/66-67	CC	V	R-E	N/D	
7	S26/85	CC	V	R-E	N/D	
8	S27/52	CC	PF	H-2	N/D	Replaces bridge on Boulder Highway

TABLE 15-8 (concluded)

FIG A2-	FACILITY NUM/I.D.	JURISDICTION	EXISTING LAND USE	FUTURE LAND USE ZONING	/ PLAN	COMMENTS
14	B1/4,5	Boulder	V	GM,S	N/D	
14	B2/35	Boulder	V	R1-8,C2,GM	LD Res	Located at highway intersection
14	B3/39	Boulder	V	C2,R1-8,R-3	Com,Res	May affect future land use
14	B4/36,41,44	Boulder	V	C2,S	Com,Pub	Adjacent to highway
14	B5/21-22	Boulder	V (Existing channel)	S	LD Res,Pub	No recent Landis aerial-S part
14	4108/23,24	Boulder	V	S	LD Res	
14	4108/26	Boulder	V	R1-80,R1-15	LD Res	May affect future use, no recent aerial photo
14	4108/45	Boulder	V	S	LD Res	No recent aerial photo
14	4109/28	Boulder	V	CO,R1-70,S	LD Res,cor-als,cemetery	Uses exist wash, no recent aerial photo, Crosses exist transmission corridor
14	4110/30	Boulder	V, Res	R1-8	LD Res	Would displace approx. 8 houses
14	4110/40	Boulder	PF (Exist street)	S	N/D	
14	4110/43	Boulder	V	C2	Com,Pub	Adjacent to highway
14	4114/31	Boulder	V	R1-8	LD Res	
14	H1/10-14	Hen	V	RR,C-2,R-1, MP	Res,Tour Com, Hwy Com,Lt Indus	Potential regional commercial center S of Boulder Hwy
11	H3/12-18	CC/Hen	V	R-E,H-2/M,RR	Res,Spec	
11	H3/31	CC/Hen	V	R-E,H-2/M,RR	Res,Spec	
11	H3/56	CC	V	M-2	Res,Spec	Uses exist drainage corridor, N end crosses transitional, area, crosses exist transmission corridor
11	2618/57	Hen	V	MP,R1,CV,RR	Master plan	Depends on ROW, north/south of UPRR
11	S29/37	Hen	V	M	Runway	Conflict w/future Sky Harbor runway
11	S29/38	Hen	V	M	Runway	Conflict w/future Sky Harbor runway
11	S29/39	Hen	V	M	Runway	Conflict w/future Sky Harbor runway
11	S30/45	CC/Hen	V (Exist street)	R-E	N/D	On municipal boundary line, Eastern Ave.
11	GVBR	Hen	V (Exist street)	CV	N/D	
11	GVBX	Hen	V (Exist street)	CV	N/D	

KEY TO TABLE 15-8

KEY TO JURISDICTIONS

BLM	Bureau of Land Management
Boulder	Boulder City
CC	Unincorporated Clark County
Hen	Henderson
LV	City of Las Vegas
NLV	City of North Las Vegas

KEY TO EXISTING LAND USE

Com	Commercial
Indus	Industrial
OS/R	Open Space and Recreation
PF	Public Facility
Res	Residential
V	Vacant
WSA	Wilderness Study Area

KEY TO ZONING DESIGNATIONS

CLARK COUNTY

R-U	Rural Open Land District
R-A	Residential Agric. District
R-E	Rural Estate District
R-D	Suburban Estates Residential District
C-3	General Commercial District
R-1	Single Family District
R-1a	Single Family District
R-T	Mobile Home District
R-2	Medium Density District
R-3	Multiple Family District
R-4	Multiple Family District High Density

LAS VEGAS

N-U	Non Urban
R-A	Ranch Acres
R-E	Residence Estates
R-D	Single Family Residence; Restricted
R-PD	Residential Planned Development
R-1	Single-Family Residence
R-MH	Mobile Home Residence
R-CL	Single-Family Compact Lot
R-2	Two-Family Residence
R-3	Limited Multiple Residence
R-4	Apartment Residence

NORTH LAS VEGAS

O-L	Open Land District
R-E	Ranch Estates District
R-EL	Ranch Estates Limited District
R-1	Single Family Residential District
R-CL	Single Family Compact Lot District
R-2	Two Family Residential District
R-3	Multiple Family Residential District
R-4	High Density Residential District
C-P	Professional Office Commerical District
C-1	Neighborhood Commerical District
C-2	General Commercial District

KEY TO ZONING DESIGNATIONS (continued)

CLARK COUNTY

R-5	Apartment Residential District
R.V.P.	Recreation Vehicle Park District
C-P	Office & Professional District
C-1	Local Business District
C-C	Shopping Center District
C-2	General Business District
M-D	Designed Manufacturing District
M-1	Light Manufacturing District
C-1	Limited Commercial
M-2	Industrial (w/o dwell.) District
M-3	Heavy Industrial District
H-1	Limited Resort & Apartment District
H-2	General Highway Frontage District
T-C	Mobile Home Park District
O-S	Open Space District
P-F	Public Facilities District

LAS VEGAS

R-5	Downtown Apartment
R-6	High-Rise Apartment
R-MHP	Residential Mobile Home Park
P-R	Professional Offices and Parking
C-C	Neighborhood Commercial District
C-D	Designed Commercial
C-1	Limited Commercial
C-2	General Commercial
C-M	Commerical Industrial
C-PM	Planned Business Park
M	Industrial
C-V	Civic

NORTH LAS VEGAS

C-3	General Service District
M-1	Business Park Industrial District
M-2	General Industrial District
M-3	Heavy Industrial District
PUD	Planned Unit Development District

BOULDER CITY

R1	Single-Family Residential
R3	Multiple Family Residential
ME	Mobile Home Estate
MP	Mobile Home Park
RV	Recreational Vehicle
CP	Commerical Professional
CH	Commerical Hotel
C1	Neighborhood Commercial
C2	General Commercial
BC	Business Center
CB	Central Business District

HENDERSON

RR	Rural Residence District
RE	Ranch Estates District
RA	Single Family Residence District
R1	One Family Residence
R2	Two Family Residence
R3	Limited Multi-Res. District
R4	Apartment Residence District
TE	Trailer Estates Residence District
TEH	Trailer Estates Res. Dist. with Horses
TR	Mobile Home Park Residence District
C1	Limited/Neighborhood Commercial District

KEY TO ZONING DESIGNATIONS (concluded)

BOULDER CITY

CM	Commercial Manufacturing
GP	Government Park Recreation
GM	Government Municipal
GFC	Government Flood ControlCV
GO	Government Open Space
CO	Corral
S	Interim Study Area
PUD	Planned Unit Development
H	Hospital

HENDERSON

C2	General Commercial District
MP	Industrial Park District
M	Industrial District
Civic	Civic District

KEY TO PLANNED LAND USE

CLARK COUNTY

N/D	No Data Available

LAS VEGAS NORTH LAS VEGAS

R	Rural Residential	LD	Low Density Residential
M	Medium Density Residential	OS	Open Space
ML	Medium Low Density Residential	FGA	Future Growth Area
L	Low Density Residential	I	Industrial
GC	General Commercial	MXC	Mixed Use Commercial
PF	Public Facility	HD	High Density Residential
ML/L	Medium Low to Low Density Residential		

BOULDER CITY

LD Res	Low Density Residential
Res	Residential
Com	Commercial
Pub	Public Facility
Corrals	Corrals (Horse)
Cemetery	Cemetery

HENDERSON

Res	Residential
Tour Com	Tourist Commercial
Hwy Com	Highway Commercial
Lt Indus	Light Industrial Business Park
Spec	Special Study Area
Master Plan	Special Master Plan Areas

TABLE 15-9

LAND USE IMPACTS AND FACILITY CONSTRUCTION MITIGATION
EXISTING LAND USE CONDITIONS
10-YEAR PLAN FACILITIES

FACILITY[1] NUMBER	TYPE OF[2] LAND USE	IMPACT TYPE[3] Inconvenience	Safety	IMPACT LEVEL[4]	MITIGATION[5]
N1	V	--	--	N[6]	None
N3	V,OS/R	X	X	L-M	C,E,G
N3-8 ALT	V	--	--	N	None
N4	V	--	--	N	None
N5	V,OS/R	X	X	H	C,E,G
N6	V,PF	X	X	H	C,E,G
N7	V	--	--	N	None
N10	V	--	--	N	None
N12	V	--	--	N	None
N12-9 ALT	V	--	--	N	None
"N" Channel	V	--	--	N	None

1 Facility numbers correspond to facility numbers presented in the 10-year plan project description (Section 3.0)

2 Refer to Table 14-8 for key to land use designations

3 Impact type refers to the nature of potential land use impact as described in Section 9.0 and assessed by a review of impact sensitivity of land uses affected by the proposed facility (Table 14-8) as reported in Table 9-2, and facility impacts reported in Table 9-3

4 Impact level refers to potential facility impact level in the land use affected as reported in Table 9-4

5 Mitigation measures letters refer to mitigation designations reported in Table 9-5

6 None anticipated

TABLE 15-9 (continued)

FACILITY NUMBER	TYPE OF LAND USE	IMPACT TYPE Inconvenience	Safety	IMPACT LEVEL	MITIGATION
C1	V	--	--	N	None
C2	V,PF	X	X	H	C,E,G
C3	V,PF,Indus,Com	X	X	H	C,E,G
C4	V,PF	X	X	H	C,E,G
C5	V	--	--	N	None
C6	V	--	--	N	None
C7	V	--	--	N	None
C9	PF,OS/R	X	X	H	C,E,G
S1	V	--	--	N	None
S2	V	--	--	N	None
S3	PF	X	--	L	E,G
S4	V	--	--	N	None
S6	V	--	--	N	None
S9	V	--	--	N	None
S10	Res	X	X	H	C,E,G
S11	V	--	--	N	None
S12	V	--	--	N	None

TABLE 15-9 (continued)

FACILITY NUMBER	TYPE OF LAND USE	IMPACT TYPE Inconvenience	Safety	IMPACT LEVEL	MITIGATION
S15	V	--	--	N	None
S17	V	--	--	N	None
S18	V	--	--	N	None
S19	V	--	--	N	None
S20	V	--	--	N	None
S21	V	--	--	N	None
S22	V,Res	X	--	M-H	E,G
S23	Res	X	--	L	E,G
S24	Res	X	X	H	C,E,G
S25	Com,Res,PF	X	X	H	C,E,G
S26	V	--	--	N	None
S27	PF	X	--	L	E,G
B1	V	--	--	N	None
B2	V	--	--	N	None
B3	V	--	--	N	None
B4	V	--	--	N	None
B5	V	--	--	N	None

TABLE 15-9 (concluded)

FACILITY NUMBER	TYPE OF LAND USE	IMPACT TYPE Inconvenience	Safety	IMPACT LEVEL	MITIGATION
4108	V	--	--	N	None
4109	V	--	--	N	None
4110	V,PF	X	--	M	E,G
4114	V	--	--	N	None
H1	V	--	--	N	None
H3	V	--	--	N	None
2618	V	--	--	N	None
S29	V	--	--	N	None
S30	V	--	--	N	None
GVBR	V	--	--	N	None
GVBX	V	--	--	N	None

TABLE 15-10

LAND USE IMPACTS AND FACILITY CONSTRUCTION MITIGATION
FUTURE LAND USE CONDITIONS
10-YEAR PLAN FACILITIES

FACILITY[1] NUMBER	TYPE OF[2] LAND USE	IMPACT TYPE[3] Inconvenience	Safety	IMPACT LEVEL[4]	MITIGATION[5]
N1	Res,Indus	X	X	H	C,E,G
N3	OS/R	X	X	M-H	C,E,G
N3-8 ALT	OS/R	X	X	M-H	C,E,G
N4	OS/R,Res,Indus	X	X	H	C,E,G
N5	OS/R,Res,Com,PF	X	X	H	C,E,G
N6	Res	X	X	H	C,E,G
N7	Res	X	X	H	C,E,G
N10	OS/R,Indus	X	X	M-H	C,E,G
N12	OS/R,PF	X	X	H	C,E,G
N12-9 ALT	PF	X	X	H	C,E,G
"N" Channel	Res,Com,Indus	X	X	H	C,E,G

1 Facility numbers correspond to facility numbers presented in the 10-year plan project description (Section 3.0)
2 Refer to Table 14-8 for key to land use designations
3 Impact type refers to the nature of potential land use impact as described in Section 9.0 and assessed by a review of impact sensitivity of land uses affected by the proposed facility (Table 14-8) as reported in Table 9-2, and facility impacts reported in Table 9-3
4 Impact level refers to potential facility impact level in the land use affected as reported in Table 9-4
5 Mitigation measures letters refer to mitigation designations reported in Table 9-5

TABLE 15-10 (continued)

FACILITY NUMBER	TYPE OF LAND USE	IMPACT TYPE Inconvenience	Safety	IMPACT LEVEL	MITIGATION
C1	PF	N/A	N/A	N/A	N/A
C2	Res[6],PF	X	X	H	C,E,G
C3	Res[6],Com,PF	X	X	H	C,E,G
C4	Res[6],Com,Indus	X	X	H	C,E,G
C5	Res[6]	X	X	H	C,E,G
C6	Res	X	X	H	C,E,G
C7	Res,Com,Indus	X	X	H	C,E,G
C9	Res,Com,Indus	X	X	H	C,E,G
S1	Res	X	X	H	C,E,G
S2	Res	X	X	H	C,E,G
S3	Res,Com	X	--	L	E,G
S4	Res	X	X	H	C,E,G
S6	Res	X	--	L	E,G
S9	Res,Indus	X	X	H	C,E,G
S10	Res	X	X	H	C,E,G

[6] Zoned as non-urban, most likely use is residential

TABLE 15-10 (continued)

FACILITY NUMBER	TYPE OF LAND USE	IMPACT TYPE Inconvenience	Safety	IMPACT LEVEL	MITIGATION
S11	OS/R	X	X	L-M	C,E,G
S12	Indus	X	--	L	E,G
S15	Res	X	--	L	E,G
S17	Res	X	X	H	C,E,G
S18	Res,Com	X	X	H	C,E,G
S19	Res	X	X	H	C,E,G
S20	Res	X	X	H	C,E,G
S21	Res	X	X	H	C,E,G
S22	Res	X	--	M-H	E,G
S23	Res	X	--	L	E,G
S24	Res,Com	X	X	H	C,E,G
S25	Res,Com	X	X	H	C,E,G
S26	Res	X	X	H	C,E,G
S27	PF	X	--	L	E,G
B1	PF	X	--	M	E,G
B2	Res,Com,PF	X	--	L	E,G
B3	Res,Com	X	X	H	C,E,G

TABLE 15-10 (concluded)

FACILITY NUMBER	TYPE OF LAND USE	IMPACT TYPE Inconvenience	Safety	IMPACT LEVEL	MITIGATION
B4	Com	X	X	M-H	C,E,G
B5	Res[7],PF	X	X	H	C,E,G
4108	Res[7]	X	X	H	C,E,G
4109	Res[8]	X	--	M-H	E,G
4110	Res[7],Com	X	--	M-H	E,G
4114	Res[7],Com	X	X	H	C,E,G
H1	Res,Com,Indus	X	X	H	C,E,G
H3	Res,Indus,PF	X	X	H	C,E,G
2618	Res,Indus,PF	X	X	H	C,E,G
S29	Indus	X	X	M-H	C,E,G
S30	Res	X	X	H	C,E,G
GVBR	PF	X	--	L	E,G
GVBX	PF	X	--	L	E,G

[7] Zoned as part of interim study area. Proposed general plan uses listed
[8] Also zoned for canals and a cemetery

TABLE 15-11

LAND USE IMPACTS AND FACILITY OPERATION MITIGATION
EXISTING LAND USE CONDITIONS
10-YEAR PLAN FACILITIES

FAC[1] NUMBER	TYPE OF[2] LAND USE	IMPACT TYPE[3] Eliminate	Barrier	Divide	Inconvenience	Safety	Health	Attract	Beneficial Recreation	IMPACT LEVEL[4]	MITIGATION[5]
N1	V	--	--	--	--	--	--	--	--	N[6]	None
N3	V,OS/R	--	--	--	--	X	X	--	X	L-M	C,D
N3-8 ALT	--	--	--	--	--	--	--	--	--	N	None (D)
N4	V	--	--	--	--	--	--	--	X	N	None (D)[7]
N5	V,OS/R	X	--	--	--	X	X	--	X	H	A,B,C,D,H
N6	V,PF	--	X	X	X	X	X	X	--	H	C,E,F,G,H
N7	V	--	--	--	--	--	--	--	--	N	None
N10	V	--	--	--	--	--	--	--	X	N	None (D)

[1] Facility workers correspond to facility numbers presented in the 10-year plan project description (Section 3.0)
[2] Refer to Table 14-8 for key to land use designations
[3] Impact type refers to the nature of potential land use impact as described in Section 9.0 and assessed by a review of impact sensitivity of land uses affected by the proposed facility (Table 14-8) as reported in Table 9-2, and facility impacts reported in Table 9-3
[4] Impact level refers to potential facility impact level in the land use affected as reported in Table 9-4
[5] Mitigation measures letters refer to mitigation designations reported in Table 9-5
[6] None anticipated
[7] Consider possibility of developing joint recreation uses at detention basins and floodways located on vacant lands

TABLE 15-11 (continued)

FACILITY NUMBER	TYPE OF LAND USE	IMPACT TYPE Eliminate	Barrier	Divide	Inconvenience	Safety	Health	Attract	Beneficial Recreation	IMPACT LEVEL	MITIGATION
N12	V	--	--	--	--	--	--	--	X	N	None (D)
N12-9 ALT	V	--	--	--	--	--	--	--	X	N	None (D)
"N"	V	--	--	--	--	--	--	--	--	N	None
C1	V	--	--	--	--	--	--	--	--	N	None
C2	V,PF	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
C3	V,PF,Indus,Com	X	X	X	X	X	X	X	X	H	A,B,C,E,F,G,H,I (D)
C4	V,PF	X	X	X	X	X	X	X	X	H	A,C,E,F,G,H,I (D)
C5	V	--	--	--	--	--	--	--	X	N	None (D)
C6	V	--	--	--	--	--	--	--	X	N	None (D)
C7	V	--	--	--	--	--	--	--	--	N	None
C9	PF,OS/R	X	X	X	X	X	X	X	X	H	A,B,C,D,E,F,G,H,I
S1	V	--	--	--	--	--	--	--	X	N	None (D)
S2	V	--	--	--	--	--	--	--	--	N	None
S3	PF	--	--	--	X	--	--	--	--	L	E,G
S4	V	--	--	--	--	--	--	--	X	N	None (D)
S6	V	--	--	--	--	--	--	--	--	N	None

TABLE 15-11 (continued)

FACILITY NUMBER	TYPE OF LAND USE	Eliminate	Barrier	Divide	Inconvenience	Safety	Health	Attract	Beneficial Recreation	IMPACT LEVEL	MITIGATION
		IMPACT TYPE									
S9	V	--	--	--	--	--	--	--	--	N	None
S10	Res	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
S11	V	--	--	--	--	--	--	--	X	N	None (D)
S12	V	--	--	--	--	--	--	--	--	N	None
S15	V	--	--	--	--	--	--	--	--	N	None
S17	V	--	--	--	--	--	--	--	X	N	None (D)
S18	V	--	--	--	--	--	--	--	X	N	None (D)
S19	V	--	--	--	--	--	--	--	X	N	None (D)
S20	V	--	--	--	--	--	--	--	X	N	None (D)
S21	V	--	--	--	--	--	--	--	X	N	None (D)
S22	V,Res	X	X	X	X	X	X	X	X	M-H	A,B,C,E,F,G,H,I (D)
S23	Res	--	--	--	X	--	--	--	--	L	E,G
S24	Res	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
S25	Com,Res,PF	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
S26	V	--	--	--	--	--	--	--	X	N	None (D)
S27	PF	--	--	--	X	--	--	--	--	L	E,G

TABLE 15-11 (concluded)

FACILITY NUMBER	TYPE OF LAND USE	IMPACT TYPE: Eliminate	Barrier	Divide	Inconvenience	Safety	Health	Attract	Beneficial Recreation	IMPACT LEVEL	MITIGATION
B1	V	--	--	--	--	--	--	--	X	N	None
B2	V	--	--	--	--	--	--	--	--	N	None
B3	V	--	--	--	--	--	--	--	--	N	None
B4	V	--	--	--	--	--	--	--	--	N	None
B5	V	--	--	--	--	--	--	--	--	N	None
4108	V	--	--	--	--	--	--	--	X	N	None (D)
4109	V	--	--	--	--	--	--	--	X	N	None (D)
4110	V,PF	--	X	X	X	--	--	X	X	M	E,F,G,H,I (D)
4114	V	--	--	--	--	--	--	--	X	N	None (D)
H1	V	--	--	--	--	--	--	--	X	N	None (D)
H3	V	--	--	--	--	--	--	--	--	N	None
2618	V	--	--	--	--	--	--	--	--	N	None
S29	V	--	--	--	--	--	--	--	--	N	None
S30	V	--	--	--	--	--	--	--	--	N	None
GVBR	V	--	--	--	--	--	--	--	--	N	None
GVBX	V	--	--	--	--	--	--	--	--	N	None

TABLE 15-12

LAND USE IMPACTS AND FACILITY OPERATION MITIGATION
FUTURE LAND USE CONDITIONS
10-YEAR PLAN FACILITIES

FACILITY[1] NUMBER	TYPE OF[2] LAND USE	Eliminate	Barrier	Divide	IMPACT TYPE[3] Inconvenience	Safety	Health	Attract	Beneficial Recreation	IMPACT LEVEL[4]	MITIGATION[5]
N1	Res,Indus	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
N3	OS/R	--	--	--	--	X	X	--	X	M-H	C,D
N3-8 ALT	OS/R,Res	X	X	X	X	X	X	X	X	M-H	A,B,C,D,E,F,G,H,I
N4	OS/R,Res,Indus	X	X	X	X	X	X	X	X	H	A,B,C,D,E,F,G,H,I
N5	OS/R,Res,Com,PF	X	X	X	X	X	X	X	X	H	A,B,C,D,E,F,G,H,I
N6	Res	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
N7	Res	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
N10	OS/R,Indus	X	--	X	--	X	X	--	X	M-H	A,B,C,D,F,H
N12	OS/R,PF	X	X	X	X	X	X	X	X	H	A,C,D,E,F,G,H,I
N12-9 ALT	PF	X	X	X	X	X	X	X	--	H	A,C,E,F,G,H,I
"N"	Res,Com,Indus	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I

1 Facility numbers correspond to facility numbers presented in the 10-year plan project description (Section 3.0)
2 Refer to Table 14-8 for key to land use designations
3 Impact type refers to the nature of potential land use impact as described in Section 9.0 and assessed by a review of impact sensitivity of land uses affected by the proposed facility (Table 14-8) as reported in Table 9-2, and facility impacts reported in Table 9-3
4 Impact level refers to potential facility impact level in the land use affected as reported in Table 9-4
5 Mitigation measures letters refer to mitigation designations reported in Table 9-5

TABLE 15-12 (continued)

FACILITY NUMBER	TYPE OF LAND USE	Eliminate	Barrier	Divide	IMPACT TYPE Inconvenience	Safety	Health	Attract	Beneficial Recreation	IMPACT LEVEL	MITIGATION
C1	PF	X	X	X	X	X	X	X	--	N/A	N/A
C2	Res[6],PF	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
C3	Res[6],Com,PF	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
C4	Res[6],Com,Indus	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
C5	Res[6]	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
C6	Res	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
C7	Res,Com,Indus	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
C9	Res,Com,Indus	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
S1	Res	X	X	X	X	X	X	X	--	H	A,B,C,D,E,F,G,H,I
S2	Res	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
S3	Res,Com	--	--	--	X	--	--	--	--	L	E,G
S4	Res	X	X	X	X	X	X	X	--	H	A,B,C,D,E,F,G,H,I
S6	Res	--	--	--	X	--	--	--	--	L	E,G
S9	Res,Indus	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
S10	Res	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I

[6] Zoned as non-urban, most likely use is residential

TABLE 15-12 (continued)

FACILITY NUMBER	TYPE OF LAND USE	Eliminate	Barrier	Divide	IMPACT TYPE Inconvenience	Safety	Health	Attract	Beneficial Recreation	IMPACT LEVEL	MITIGATION
S11	OS/R	X	--	--	--	X	X	--	X	L-M	A,B,C,D,H
S12	Indus	--	--	--	--	--	--	--	--	L	None
S15	Res	--	--	--	X	--	--	--	--	L	E,G
S17	Res	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
S18	Res,Com	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
S19	Res	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
S20	Res	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
S21	Res	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
S22	Res	--	X	X	X	--	--	X	--	M-H	C,E,F,G,H,I
S23	Res	--	--	--	X	--	--	--	--	L	E,G
S24	Res,Com	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
S25	Res,Com	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
S26	Res	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
S27	PF	--	--	--	X	--	--	--	--	L	E,G
B1	PF	--	X	X	X	--	--	X	--	M	E,F,G,H,I
B2	Res,Com,PF	--	--	--	X	--	--	--	--	L	E,G

TABLE 15-12 (concluded)

FACILITY NUMBER	TYPE OF LAND USE	Eliminate	Barrier	Divide	IMPACT TYPE Inconvenience	Safety	Health	Attract	Beneficial Recreation	IMPACT LEVEL	MITIGATION
B3	Res,Com	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
B4	Com	--	X	X	X	X	X	X	--	M-H	C,E,F,G,H,I
B5	Res[7], PF	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
4108	Res[7]	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
4109	Res[8]	--	X	X	X	--	--	X	--	M-H	E,F,G,H,I
4110	Res[7],Com	--	X	X	X	--	--	X	--	M-H	E,F,G,H,I
4114	Res[7],Com,Indus	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
H1	Res,Com,Indus	X	X	X	X	X	X	X	--	H	A,B,C,E,F,G,H,I
H3	Res,Indus,PF	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
2618	Res,Indus,PF	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
S29	Indus	X	--	X	--	--	--	--	--	M-H	A,B,F,H
S30	Res	--	X	X	X	X	X	X	--	H	C,E,F,G,H,I
GVBR	PF	--	--	--	X	--	--	--	--	L	E,G
GVBX	PF	--	--	--	X	--	--	--	--	L	E,G

[7] Zoned as part of interim study area. Proposed general plan uses listed
[8] Also zoned for canals and cemetaries

TABLE 15-13

VISUAL RESOURCE IMPACT ANALYSIS
10-YEAR PLAN FACILITIES

Facility Number	Figure Number	ID Number	Overall Dominant Level	Downtown M	Strip M	Urban M	Sig. Urban H	Rural H	Air/H L	Landscap H	WSA Exclude	Recrea H	Basin L	Range M	LV-Wash M	Mitigation
N5	A2-1	1-2	1					Dom 2 H-M					Dom 1 M	Dom 2 M-H		F1,F2,F4,L1, L2,L3,C1,T1, T2,T3,T4
N5	A2-1	3	1					Dom 2 H-M					Dom 1 M	Dom 2 M-H		F1,F3,F4,C1, C2,T1,T2,T3, T4
N5	A2-1	4-7	3					Dom 3 M					Dom 3 L	Dom 2 M-H		F3,L2,C1,C2 T1,T2,T4
N3	A2-1	8	1					Dom 1 H			Exclude H		M	Dom 1		F1,F2,F4,L1, L2,L3,C1,T4, T3,T2
N3	A2-2	1	No Impact													None
N3-8 ALT	A2-1	--	4					Dom 1 H						Dom 1 M-H		F1,F2,F3,F4 L2,L3,T2,T3
N4	A2-2	2-3	4					Dom 4 M-L					Dom 4 L			F1,F2,L3,C1, T2,T3
N4	A2-2	8	3					Dom 3 M					Dom 3 L			F1,F2,L3,C1, T2,T3
N10	A2-2	9-10	1					Dom 2 H-M					Dom 1 M			F1,F2,F4,L3, C1,C2,T1,T2, T3,T4
N10	A2-2	11	1					Dom 1 H					Dom 1 M			F1,F2,F3,L3, C1,C2,T1,T2, T3,T4
N10	A2-2	13	No Impact													None
C1	A2-4	45	No Impact													None
C2	A2-4	46-49 51-53	3			Dom 3 M-L							Dom 2 M	Dom 2 M-H		F3,L1,L2,L3, L4,C1,T1,T2 T3,T4

TABLE 15-13 (continued)

Facility Number	Figure Number	ID Number	Overall Dominant Level	Downtown M	Strip M	Urban M	Sig. Urban H	Rural H	Air/H L	Landscap H	WSA Exclude	Recrea H	Basin L	Range M	LV-Wash M	Mitigation
C3	A2-4	55	1			Dom 2 M-H		Dom 1 H					Dom 1 M			F1,F2,F3,F4, L1,L3,L4,C1, C2,T1,T2,T3, T4
C3	A2-4	56-57	No Impact													None
C4	A2-4	68	No Impact													None
N1	A2-5	2-3	4			Dom 4 L		Dom 4 M-L					Dom 4 L			L1,L3,C1,T1, T2,T3
N1	A2-5	4	3					Dom 3 M		Dom 2 H-M			Dom 2 M			L1,L2,L3,L4, C1,C2,T1,T2, T3,T4
N1	A2-5	6-7	4					Dom 4 M-L					Dom 4 L			L1,L2,L3,L4, C1,C2,T1,T2, T4
N6	A2-5	8,10-13	4			Dom 4 L		Dom 4 M-L								L1,L2,L3,L4, C1,C2,T1,T2, T4
N6	A2-5	14-16	4			Dom 4 L		Dom 4 M-L								L1,L2,L3,L4 C1,C2,T1,T2, T4
N7	A2-5	17-21	4			Dom 4 L		Dom 4 M-L								L1,L2,L3,L4 C1,C2,T1,T2, T4
N4	A2-5	22	4					Dom 4 M-L					Dom 4 L			L1,L2,L3,L4 C1,C2,T1,T2, T4
N4	A2-5	23	No Impact													None

TABLE 15-13 (continued)

Facility Number	Figure Number	ID Number	Overall Dominant Level	Downtown M	Strip M	Urban M	Sig. Urban H	Rural H	Air/H L	Landscap H	WSA Exclude	Recrea H	Basin L	Range M	LV-Wash M	Mitigation
N4	A2-5	24	4					Dom 4 M-L					Dom 4 L			L1,L2,L3,L4, C1,C2,T1,T2 T4
N4	A2-5	26	4					Dom 4 M-L					Dom 4 L			L1,L2,L3,L4 C1,C2,T1,T2, T4
N6	A2-5	27	4			Dom 4 L							Dom 4 L			L2,L2,L3,L4 C1,C2,T1,T2, T4
"N"	A2-5	28,30,31	4			Dom 4 L		Dom 4 M-L				Dom 4	L			L1,L2,L3,L4 C1,C2,T1,T2, T4
C4	A2-5	54-60, 62	No Impact													None
C4	A2-5	61	1			Dom 1 H-M										F1,F2,F3,F4, L1,L4,C1,C2, T3,T4
C6	A2-5	103	1			Dom 1 H-M	Dom 1 H									F1,F2,F3,F4, L1,L4,C1,C2, T3,T4
C7	A2-5	115, 117	No Impact													None
C7	A2-5	119	No Impact													None
C7	A2-5	118, 120- 121	2	Dom 2 M-H		Dom 2 M-H										F3,L1,L2,C1 T1,T4
C9	A2-5	123- 127	No Impact													None

TABLE 15-13 (continued)

Facility Number	Figure Number	ID Number	Overall Dominant Level	Downtown M	Strip M	Urban M	Sig. Urban H	Rural H	Air/H L	Landscap H	WSA Exclude	Recrea H	Basin L	Range M	LV-Wash M	Mitigation
C9	A2-5	129	1	Dom 2 M-H		Dom 1 H-M	Dom 1 H									F1,F2,F3,F4, L1,L2,L4,C1, C2,T1,T2,T4
C9	A2-5	131- 140	No Impact													None
N12	A2-6	9	1			Dom 2 M-H		Dom 2 H-M	Dom 1 M				Dom 1 M	Dom 1 H-M		F1,F2,F3,F4, L1,L2,L4,C1 T1,T2,T3,T4
N12	A2-6	9ALT	1			Dom 1 H-M		Dom 1 H		Dom 2 H-M			Dom 1 M			F1,F2,F3,F4, L1,L2,L4,C1, C2,T1,T2,T3, T4
N12	A2-6	10	1			Dom 1 H-M		Dom 1 H		Dom 2 H-M			Dom 1 M			F1,F2,F3,F4, L1,L2,L4,C1, C2,T1,T2,T3, T4
N12	A2-6	11	3			Dom 3 M-L		Dom 3 M								F3,L1,L2,L3, C1,C2,T1,T3, T4
C5	A2-7	13	1			Dom 1 H-M		Dom 3 M								F1,F3,F2,F4, L1,L2,L3,C1, C2,T1,T3,T4
S6	A2-7	48	No Impact													None
S1	A2-7	59	1			Dom 1 H-M		Dom 2 H-M		Dom 1 H			Dom 1 M	Dom 2 M-H		F1,F3,F2,F4, L1,L2,L3,C1, C2,T1,T3,T4
S10	A2-7	60	3			Dom 3 M-L		Dom3 M								L1,L2,L4,C1, T1,T2,T4

TABLE 15-13 (continued)

Facility Number	Figure Number	ID Number	Overall Dominant Level	Downtown M	Strip M	Urban M	Sig. Urban H	Rural H	Air/H L	Landscap H	WSA Exclude	Recrea H	Basin L	Range M	LV-Wash M	Mitigation
S2	A2-7	61	2			Dom 2 M-H		Dom 3 M		Dom 1 H						F1,F3,L1,L2, L4,C1,C2,T1, T2,T4
S26	A2-7	85	1					Dom 1 H					Dom 1 M			F1,F2,F4,L1, L2,L3,L4,C1, T4,T2,T3
N7	A2-8	1-3	4			Dom 4 L							Dom 4 L			F3,L1,L2,L3, L4,C1,T1,T2, T3,T4
C7	A2-8	20-21	4			Dom 4 L										F3,L1,L2,L3, L4,C1,T1,T2, T3,T4
C7	A2-8	22-24	No Impact													None
S9	A2-8	33	3			Dom 3 M-L		Dom 3 M					Dom 4 L			L1,L2,L3,L4, C1,C2,T1,T2, T3,T4
S3	A2-8	36	No Impact													None
S27	A2-8	52	4			Dom 4 L										C1,T4
S26	A2-8	66-67	1			Dom 2 M-H		Dom 1 H					Dom 1 M			F1,F2,F3,F4, L1,L2,L3,C1, C2,T1,T2,T3, T4
S25	A2-8	79-80	No Impact													None
S25	A2-8	81	4			Dom 4 L										C1,C2,T3,T4, T1,L2
S25	A2-8	82-88	No Impact													None

TABLE 15-13 (continued)

Facility Number	Figure Number	ID Number	Overall Dominant Level	Downtown M	Strip M	Urban M	Sig. Urban H	Rural H	Air/H L	Landscap H	WSA Exclude	Recrea H	Basin L	Range M	LV-Wash M	Mitigation
S25	A2-8	89	4			Dom 4 L		Dom 4 M-L								L1,L2,L3,C1, C2,T1,T2,T3, T4
S25	A2-8	90-92	No Impact													None
S24	A2-8	93	No Impact													None
S24	A2-8	94	4			Dom 4 L										L1,L2,L3,C1, C2,T1,T2,T3 T4
S24	A2-8	95	No Impact													None
S24	A2-8	96	4			Dom 4 L										L1,L2,L3,C1, C2,T1,T2,T3 T4
S24	A2-8	97	No Impact													None
S24	A2-8	98	4			Dom 4 L										L1,L2,L3,C1, C2,T1,T2,T3 T4
S24	A2-8	99	No Impact													None
S24	A2-8	100-103	4			Dom 4 L										L1,L2,L3,L4, C1,C2,T1,T3, T4
S24	A2-8	104	3			Dom 3 M-L										L1,L2,L3,L4, C1,C2,T1,T3, T4
S24	A2-8	105	No Impact													None

TABLE 15-13 (continued)

Facility Number	Figure Number	ID Number	Overall Dominant Level	Downtown M	Strip M	Urban M	Sig. Urban H	Rural H	Air/H L	Landscap H	WSA Exclude	Recrea H	Basin L	Range M	LV-Wash M	Mitigation
S24	A2-8	106	3			Dom 3 M-L							Dom 3 L			L1,L2,L3,L4, C1,C2,T1,T3, T4
S24	A2-8	107-117	4			Dom 4 L		Dom 4 M-L								L1,L2,L3,L4, C1,C2,T1,T3, T4
S23	A2-8	125, 127	3			Dom 3 M-L		Dom 4 M-L								C1,T4,C2
S12	A2-8	168	3					Dom 3 M					Dom 3 L			L1,L2,L3,L4, C1,C2,T1,T3, T4
S15	A2-8	188	3					Dom 3 M					Dom 3 L			L1,L2,L3,L4, C1,C2,T1,T3, T4
N7	A2-9	2-3	4			Dom 4 L		Dom 4 M-L					Dom 4 L			F3,L1,L2,L3 L4,C1,C2,T1, T2,T4
N7	A2-9	4	No Impact													None
H3	A2-9	12	No Impact													None
H3	A2-9	13	3					Dom 4 M-L					Dom 3 L		Dom 2 M-H	F3,L2,L3,C1, T1,T2,T3,T4
H3	A2-9	14	No Impact													None
H3	A2-9	15-18	4					Dom 4 M-L					Dom 4 L			L2,L3,C1,T1, T2,T4
H3	A2-9	31	3					Dom 4 M-L					Dom 3 L		Dom 2 M-H	L2,L3,C1,T1, T2,T4

TABLE 15-13 (continued)

Facility Number	Figure Number	ID Number	Overall Dominant Level	Downtown M	Strip M	Urban M	Sig. Urban H	Rural H	Air/H L	Landscap H	WSA Exclude	Recrea H	Basin L	Range M	LV-Wash M	Mitigation
S11	A2-10	2-3	1					Dom 1 H					Dom 1 M	Dom 2 M-H		F1,F2,F3,F4, L2,L3,C1,C2, T1,T2,T3,T4
S4	A2-10	23	1					Dom 2 H-M					Dom 1 M	Dom 1 H-M		F1,F2,F3,F4, L1,L3,L4,C1, C2,T1,T2,T3, T4
S4	A2-10	24	1					Dom 2 H-M					Dom 1 M	Dom 1 H-M		F1,F2,F3,F4, L1,L3,L4,C1, C2,T1,T2,T3, T4
S22	A2-10	25	No Impact													None
S21	A2-10	28-29	1					Dom 2 H-M					Dom 1 M	Dom 1 H-M		F1,F2,F3,F4, L1,L3,L4,C1, C2,T1,T2,T3, T4
S17	A2-11	4	1					Dom 1 H					Dom 1 M			F1,F2,F3,F4, L1,L3,L4,C1, C2,T1,T2,T3, T4
S18	A2-11	14	1			Dom 1 H-M		Dom 1 H					Dom 1 M			F1,F2,F3,F4, L1,L3,L4,C1, C2,T1,T2,T3, T4
S20	A2-11	17-18	1					Dom 2 H-M					Dom 1 M	Dom 2 M-H		F1,F2,F3,F4, L1,L3,L4,C1, C2,T1,T2,T3, T4
S19	A2-11	24	1					Dom 1 H					Dom 1 M	Dom 2 M-H		F1,F2,F3,F4, L1,L3,L4,C1, C2,T1,T2,T3,

TABLE 15-13 (continued)

Facility Number	Figure Number	ID Number	Overall Dominant Level	Downtown M	Strip M	Urban M	Sig. Urban H	Rural H	Air/H L	Landscap H	WSA Exclude	Recrea H	Basin L	Range M	LV-Wash M	Mitigation
																T4
S29	A2-11	37-38	1					Dom 2 H-M	Dom 1 M				Dom 1 M			F1,F2,F3,F4, L1,L3,L4,C1, C2,T2,T3,T4
S29	A2-11	39	2					Dom 3 M	Dom 2 M				Dom 2 M			L1,L2,C1,C2, T1,T2,T3,T4
S29	A2-11	45	4					Dom 4 M-L					Dom 4 L			L1,L2,C1,C2, T1,T2,T3,T4
H3	A2-11	56	4			Dom 4 L		Dom 3 M					Dom 4 L			L1,L2,C1,C2, T1,T2,T3,T4
2618	A2-11	57	3			Dom 3 M		Dom 3	M				Dom 4 L			L1,L2,C1,C2, T1,T2,T3,T4
GVBR	A2-11	--	3					Dom 4 M-L					Dom 3 L			C1,T4,F1
GVBX	A2-11	--	No Impact													None
H1	A2-12	10-13	4			Dom 4 L		Dom 4 M-L	Dom 4 L							L1,L2,C1,C2 T1,T2,T3,T4
H1	A2-12	14	1			Dom 1 H-M		Dom 2 H-M					Dom 1 M			F1,F2,F3,F4, L1,L3,L4,C1, C2,T2,T3,T4
B1	A2-14	4-5	1			Dom 2 M-H		Dom 2 H-M					Dom 2 M	Dom 1 M		F2,F4,L1,L2, C1,L3,T1,T2, T4
B5	A2-14	21-22	4			Dom 4 L							Dom 4 L			L1,L2,L3,C1, C2,T1,T4
4108	A2-14	23	4			Dom 4 L		Dom 4 M-L					Dom 4 L			L1,L2,L3,C1, C2,T1,T4
4108	A2-14	24	3			Dom 3 M-L		Dom 4 M-L								L1,L2,L3,C1, C2,T1,T4
4108	A2-14	26,28	No Impact													None

TABLE 15-13 (concluded)

Facility Number	Figure Number	ID Number	Overall Dominant Level	Downtown M	Strip M	Urban M	Sig. Urban H	Rural H	Air/H L	Landscap H	WSA Exclude	Recrea H	Basin L	Range M	LV-Wash M	Mitigation
4110	A2-14	30	No Impact													None
4114	A2-14	31	2			Dom 2 M-H		Dom 2 H-M					Dom 3 L			F1,F2,F4,L2, L4,C1,C2,T1, T1,T2,T4,T3
B2	A2-14	35	No Impact													None
B4	A2-14	36	3			Dom 4 L		Dom 3 M								L1,L2,L3,C1, C2,T1,T2
B3	A2-14	39	2			Dom 2 M-H		Dom 3 M					Dom 3 L	Dom 3 M-L		F3,L1,L2,L3, L4,C1,C2,T1, T2,T4
4110	A2-14	40,43	No Impact													None
B4	A2-14	41	2			Dom 2 M-H		Dom 3 M					Dom 3 L	Dom 2 M-H		F3,L1,L2,L3, L4,C1,C2,T1, T2,T4
B4	A2-14	44	1			Dom 1 H-M		Dom 2 H-M					Dom 1 M	Dom 2 M-H		F1,L1,L2,L3, L4,C1,C2,T1, T2,T3,T4
4108	A2-14	45	3			Dom 4 L		Dom 3 M								C1,C2,T4,F1

TABLE 15-14

PREVIOUSLY RECORDED ARCHAEOLOGICAL SITES
10-YEAR PLAN FACILITIES

FACILITY/I.D. NUMBER	FIGURE NO.	ARCHAEOLOGICAL RESOURCE	SITE DESCRIPTION	DISTANCE TO FACILITY	USGS QUADRANGLE
N3-1	A2-1	26-CK-1639	1 core & bone	w/in 1/2 mile	Tule Springs Park 7.5
N3-1	A2-1	26-CK-1638	Isolated scraper	w/in 1/2 mile	Tule Springs Park 7.5
N3-1	A2-2	26-CK-3655	Small scatter of fossil bone	"on"	Gass Peak 7.5′
N3-1	A2-2	26-CK-3654	30 x 10 m scatter of bones	"on"	Gass Peak 7.5′
N3-1	A2-2	26-CK-246	Heavy conc. of charcoal & mammal bones	"on"	Gass Peak 7.5′
N3-1	A2-2	26-CK-245	Charcoal, bone, possible bone tools	"on"	Gass Peak 7.5′
N3-1	A2-2	26-CK-244	Lithic scatter, burned wood, bone	"on"	Gass Peak 7.5′
N3-1	A2-2	26-CK-247	Bone scatter	"on"	Gass Peak 7.5′
N3-1	A2-2	26-CK-248	Charcoal, tools (bones & lithic)	"on"	Gass Peak 7.5′
N3-1	A2-2	26-CK-3652	Small scatter of lithic tools; 2 groundstone, 1 flake	"adjacent"	Gass Peak 7.5′
N3-1	A2-2	26-CK-3650	Isolated basalt groundstone	"on"	Gass Peak 7.5′
N3-1	A2-2	26-CK-3651	Isolated scraper	"adjacent"	Gass Peak 7.5′
N3-1	A2-2	26-CK-3141	Isolated, retouched, point base	"on"	Gass Peak 7.,5′
N3-1	A2-2	26-CK-3143	1 point, 2 scrapers & 2 flakes	"on"	Gass Peak 7.5′
N3-1	A2-2	26-CK-3142	Isolated flake	"adjacent"	Gass Peak 7.5′
N3-8 ALT	A2-1	26-CK-1638	Isolated chert scraper	"adjacent"	Tule Springs Park 7.5
N3-8 ALT	A2-1	26-CK-1639	Chopper-like cove and flake scatter	"adjacent"	Tule Springs Park 7.5
N3-8 ALT	A2-1	26-CK-3654	Locus of bone	"adjacent"	Gass Peak 7.5
N3-8 ALT	A2-1	26-CK-3655	Small scattering of fossil bone	"adjacent"	Gass Peak 7.5
N4-3	A2-2	26-CK-3144	Lithic scatter, small camp	"adjacent"	Gass Peak 7.5′
N4-3	A2-2	26-CK-3140	Isolated scrapper	"adjacent"	Gass Peak 7.5′
N1-2	A2-5	26-CK-3747	Small fire-affected rock scatter	"on"	Las Vegas N.W. 7.5′
N1-2	A2-5	26-CK-3748	Small fire-affected rock scatter	"on"	Las Vegas N.W. 7.5′
N1-4	A2-5	26-CK-3738	Site-lithics, groundstone, F.A.R.[1]	w/in 1/2 mile	Las Vegas N.W. 7.5

[1] F.A.R. = Fire-affected rock

TABLE 15-14 (concluded)

FACILITY NUMBER	SHEET NO.	ARCHAEOLOGICAL RESOURCE	SITE DESCRIPTION	DISTANCE TO FACILITY	USGS QUADRANGLE
N1-7	A2-5	26-CK-3754	Basalt flake, basalt groundstone	w/in 1/2 mile	Las Vegas N.E. 7.5′
C6-103	A2-5	26-CK-948	National Register site	"on"	Las Vegas N.E. 7.5
S24-109	A2-8	26-CK-1335	Small hearth w/scat. lithics	w/in 1/2 mile	Las Vegas S.E. 7.5′
S24-111	A2-8	26-CK-1440	Small camp disturbed by historic trash	w/in 1/2 mile	Las Vegas S.E. 7.5′
S24-112	A2-8	26-CK-1336	Large preceramic lithic scatter	"adjacent"	Las Vegas S.E. 7.5′
S24-112	A2-8	26-CK-1430	Chert lithic scatter	"adjacent"	Las Vegas S.E. 7.5′
S24-112	A2-8	26-CK-1428	Small lithic scatter, w/poss. hearth	w/in 1/2 mile	Las Vegas S.E. 7.5′
S24-112	A2-8	26-CK-1429	Small lithic work stat. w/diag. art	w/in 1/2 mile	Las Vegas S.E. 7.5′
H3-56	A2-11	26-CK-3366	2 rhyolite cores	w/in 1/2 mile	Las Vegas S.E. 7.5′
H3-56	A2-11	26-CK-3365	Scatter of basalt & rhy. flakes	w/in 1/2 mile	Las Vegas S.E. 7.5′
H3-56	A2-11	26-CK-3363	Scatter of basalt & rhy flakes	w/in 1/2 mile	Las Vegas S.E. 7.5′
H3-56	A2-11	26-CK-3587	Small chert lithic scatter	w/in 1/2 mile	Las Vegas S.E. 7.5′
H3-56	A2-11	26-CK-3583	Lithic scat. & 3 circular depressions	w/in 1/2 mile	Las Vegas S.E. 7.5′
H3-56	A2-11	26-CK-3584	3 chert flakes & 1 scraper	w/in 1/2 mile	Las Vegas S.E. 7.5′
H3-56	A2-11	26-CK-3581	1 small rock circle, 2 basalt flakes, 1 chert scraper	w/in 1/2 mile	Las Vegas S.E. 7.5′
H3-56	A2-11	26-CK-3580	No data	w/in 1/2 mile	Las Vegas S.E. 7.5′
S20-18	A2-11	26-CK-4038	3 rock shelters w/midden	w/in 1/2 mile	Sloan, 15′

TABLE 15-15

ARCHAEOLOGICAL SENSITIVITY AREAS EFFECT
10-YEAR PLAN FACILITIES

FACILITY/ I.D. NUMBER	SENSITIVITY AREA	SENSITIVITY LEVEL	IMPACT LEVEL
N1-2	C4	Moderate	Direct
N3-1	N5	High	Direct
N3-8 ALT	N5	High	Direct
N4-2	N5	High	Direct
N4-3	N5	High	Direct
C3-57	C4	High	Direct
C6-103	C7	High	Direct
C7-118	C5	Moderate	Direct
C7-119	C5	Moderate	Direct
C7-120	C5	Moderate	Direct
C7-121	C5	Moderate	Direct
C9-127	C6	Moderate	Direct
C9-129	C6	Moderate	Direct
C9-131	C6	Moderate	Direct
S23-125	S7	Moderate	Direct
S23-127	S7	Moderate	Direct
S24-108	S7	Moderate	Direct
S24-109	S7	Moderate	Direct
S24-110	S7	Moderate	Direct
S24-111	S7	Moderate	Direct
S24-112	S7	Moderate	Direct
S24-113	S7	Moderate	Direct
S24-114	S7	Moderate	Direct
S24-115	S7	Moderate	Direct
S24-116	S7	Moderate	Direct
S24-117	S7	Moderate	Direct
H3-15	N7	High	Direct
H3-56	H1	High	Direct
2618-57	H1	High	Direct

TABLE 15-16

HISTORIC RESOURCES AFFECTED
10-YEAR PLAN FACILITIES

INVENTORY NUMBER	FACILITY NUMBER	SITE DESCRIPTION	IMPACT LEVEL
1	C6-103	Las Vegas Springs National Register site	Direct
3	C9-127 C9-129	Las Vegas Mormon fort National Register building	Direct
13	C7-121	Railroad storehouse building National Register eligible	Indirect
20	S11-2	Historic railroad	Direct
28	S23-125 S23-127 S24-111 S24-112 S24-115 S24-116 S24-117 H3-12 H3-13 H3-14 H3-15 H3-16 H3-17 H3-18	Las Vegas Wash Paradise Valley/Duck Creek	Direct
29	4108-26 B5-21 B5-22	Historic road	Direct
30	B1-4 B1-5	Historic road	Indirect
31	H3-13 H3-14 H3-15	Historic road	Direct
32	S4-23 S4-24 S24-108 S24-109 S24-110 S24-111 S24-112 S24-113	Historic road	Direct Indirect Direct

TABLE 15-16 (concluded)

INVENTORY NUMBER	FACILITY NUMBER	SITE DESCRIPTION	IMPACT LEVEL
32 (cont.)	S24-114		
	S24-115		
	S24-116		
34	C5-13	Historic road	Direct
	C6-103		
	C9-127		
	C9-129		
	N6-12		
36	N5-7	Historic road	Direct
39	N5-5	Historic road	Direct
	N5-6		
44	4110-30	Railroad grade	Direct
	4114-31		Indirect
	B2-35		Indirect
	B3-39		Indirect
	B4-36		Direct
	B4-40		Direct
	B4-41		Direct
46	"N"-30	Historic road	Direct
	N6-11		Direct
	N10-9		Direct
	N10-10		Direct
47	S22-25	Pipeline	Direct
48	C7-121	Railroad underpass	Indirect
	C9-123		
49	N5-7	Historic railroad grade	Direct
53	C7-117	Railroad yards	Direct
	C7-118		
	C7-119		
	C7-120		
	C7-121		
56	S17-4	Historic road	Direct
69	4110-30	Historic settlement/ McKeeversville	Indirect

FIGURE 15-1

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FIGURES 15-2 TO 15-15

KNOWN POTENTIAL GEOLOGIC HAZARDS/CONSTRAINTS AND SOILS

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FIGURES 15-31 TO 15-43

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16.8 VISUAL RESOURCES

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16.11 CUMULATIVE IMPACTS

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PROJECT MANAGEMENT

Bureau of Land Management	Frank Maxwell, Donn Siebert
Clark County Regional Flood Control District	Virginia Bax-Valentine, P.E., Principal-in-Charge Tim Sutko, Project Coordinator
Dames & Moore	Dean Hargis, Supervising Partner Pandora Snethkamp, Ph.D., Project Manager

DAMES & MOORE TECHNICAL STAFF

Air Quality	Principal Investigator	Tom Umenhofer
	Technical Staff	Cynthia Elliot Steven Radis Mark Strobin Douglas Wolf
Geology and Soils	Principal Investigator	Mark Molinari
	Technical Staff	Sonja Donaldson Clare Zucker
Ground Water	Principal Investigator	Mark Grivetti
	Technical Staff	Elizabeth Hughes Thomas Vinckier
Surface Water	Principal Investigator	George Geiser
Biology	Principal Investigator	John Gray, Ph.D.
	Technical Staff	David Magney Thomas Olson
Land Use	Principal Investigator	Rodney Heller
	Technical Staff	Michael Siegel Jim Olsten
Visual Resources	Principal Investigator	Tim Tetherow
	Technical Staff	Dennis Papilion
Socioeconomics	Principal Investigator	Robert Mott
	Technical Staff	Carmen Fraser Christine Roloff
Cultural Resources	Principal Investigator	Jamie Cleland, Ph.D.
	Technical Staff	Rebecca Apple Gene Davis Clyde Woods, Ph.D. Jan Wooley

18.1 INTRODUCTION AND PROJECT DESCRIPTION

Bax-Valentine, Virginia, General Manager, Clark County Regional Flood Control District, Las Vegas, NV, 1988, 1989

Burton, Bill, USACOE, Phoenix, AZ, 1988, 1989

Fraser, II, Gale William, Assistant General Manager, Clark County Regional Flood Control District, Las Vegas, NV, 1988, 1989

Maxwell, Frank, Environmental Coordinator, Bureau of Land Management, Las Vegas, NV, 1988, 1989

Myles, A.J., Engineering Technical, Clark County Regional Flood Control District, Las Vegas, NV, 1989

Sutko, Tim, Senior Hydrologist, Clark County Regional Flood Control District, Las Vegas, NV, 1988, 1989, 1990

Taylor, Bob, District Landscape Architect, Bureau of Land Management, Las Vegas, NV, 1988

18.2 AIR QUALITY

Glasser, Harold, Clark County Air Pollution Control Division, Las Vegas, NV, 1988

Harris, Jeff, Principal Planner, Clark County Department of Comprehensive Planning, Las Vegas, NV, 1988

Hughes, John, National Weather Service, Nuclear Support Office, Las Vegas, NV, 1988

Kashner, Lt. and AIC Henry, USAF, Nellis Air Force Base, NV, 1988

Naylor, Mike, Director, Clark County Air Pollution Control Division, Las Vegas, NV, 1988

Peterson, Ray, Environmental Specialist, Clark County Health District, Las Vegas, NV, 1988

18.3 GEOLOGY AND SOILS

Bell, James, City Engineer, North Las Vegas Engineering Department, North Las Vegas, NV, 12/6/88

Bell, John, Engineering Geologist, Nevada Bureau of Mines and Geology, Reno, NV, 12/6/88

Bohannon, Robert, Geologist, U.S.Geological Survey, Menlo Park, CA, 1/19/89

DePolo, Diane, Seismologist, Seismological Laboratory, University of Nevada, Reno, NV, 12/14/88

Dixon, Gary, Geologist, U.S.Geological Survey, Las Vegas, NV, 12/14/88

Hamsen, Steve, Seismologist, U.S.Geological Survey, Golden, CO, 12/14/88

Wele, James, Geologist, Converse Consultants, Las Vegas, NV, 1/23/89

18.4 GROUND WATER

Brothers, Kayrene, Hydrologist,Las Vegas Water District, Las Vegas, NV, 1/26/89

Coache, Robert A., Hydraulic Engineer, Nevada Division of Water Resources, Las Vegas, NV, 12/2/88

Dorbin, Joe, Flood Control Engineer, City of Las Vegas, Department of Public Works, Las Vegas, NV, 1/29/89

Jacobsen, Roger, Associate Research Professor, Desert Research Institute, Las Vegas, NV, 12/2/88

Katzer, Terry L., Director of Conservation and Research, Las Vegas Valley Water District, Las Vegas, NV 11/22/88, 12/1/88, 1/17/89, and 1/26/89

Tischer, Kenneth J., Chief of Quality Control, Clark County Department of Public Works, Las Vegas, NV, 12/2/88

Wild, Jr., Harry Stephen, Hydrologic Research Assistant, Desert Research Institute, Las Vegas, NV, 11/22/88 and 12/1/88.

18.5 SURFACE WATER

Blakey, Paul, Project Manager, USACOE, Phoenix, AZ, 1/19/89

Burton, Bill, USACOE, Phoenix, AZ, 1/6/89

Sutko, Tim, Senior Hydrologist, Clark County Regional Flood Control District, Las Vegas, NV, 11/23/88 and 2/8/89

18.6 TERRESTRIAL AND AQUATIC BIOLOGY

Austin, George, Curator, Southern Division of the Nevada State Museum, Las Vegas, NV, 11/17/88

Baepler, Don, Director, Museum of Natural History, University of Nevada, Las Vegas, NV, 11/15/88 and 11/28/88

Biology Department, University of Nevada, Las Vegas, NV, 11/10/88

Bostick, Vern, Naturalist, Las Vegas, NV, 11/16/88 and 4/11/89

Clemmer, Glenn, Research Scientist/Biologist, Nevada Natural Heritage Program, Carson City, NV, 11/10/88

Cole, Jennie, Bureau of Land Management, Las Vegas, 11/16/88

Deacon, James, Professor, Biological Sciences Department, University of Nevada, Las Vegas, NV, 11/14/88

Elpers, Mary Jo, Biologist, U.S. Fish and Wildlife Service, Reno, NV, 11/10/88

Furlow, Robert, Assistant Manager, Desert National Wildlife Refuge, U.S. Fish and Wildlife Service, Las Vegas, NV, 11/14/88

Hanebury, Lou, Biologist, U.S. Fish and Wildlife Service, Fort Collins, CO, 11/29/88

Hardenbrook, Brad, Wildlife Biologist, Bureau of Land Management, Las Vegas, NV, 11/16/88

Jones, K. Bruce, Biologist, Environmental Protection Agency, Las Vegas, NV, 11/30/88

Jones, John L., Resource Manager, Southern Region, Nevada Department of Forestry, Las Vegas, NV, 11/16/88

Knight, Teri, Research Scientist/Botanist, Nevada Heritage Program, Carson City, NV, 11/10/88 and 12/6/88

Maley, Mark, Area Biologist, Bureau of Land Management, Las Vegas, NV, 11/16/88

Marlowe, Ron, Wildlife Biologist, Nevada Department of Wildlife, Las Vegas, NV, 11/16/88

Monroe, Leslie, Environmental Engineer, Nellis Air Force Base, Las Vegas, NV, 11/10/88

Mowbray, M.V., Naturalist, Red Rock Audubon Society, Las Vegas, NV, 12/29/88

O'Farrell, Joan, Assistant Curator, Herbarium, University of Nevada, Las Vegas, NV, 11/15/88

O'Farrell, Michael, Wildlife Biologist, WESTEC, Inc., Santa Barbara, CA, 3/15/88

Padilla, Butch, Wildlife Biologist, Nevada Department of Wildlife, Las Vegas, NV, 11/16/88

Paulson, Larry, Research Scientist, Environmental Research Center, University of Nevada, Las Vegas, NV, 11/15/88

Pratt, Dr. William, Herpetologist, Natural History Museum, University of Nevada, Las Vegas, NV, 11/15/88

Rice, Patti, Biologist, U.S. Fish and Wildlife Service, Laguna Niguel, CA, 11/10/88

Semonsen, Vince, Biologist, Storrer & Semonsen, Santa Barbara, CA, 12/15/88

Slone, Sid, District Biologist, Bureau of Land Management, Las Vegas, NV, 11/16/88

Sutko, Tim, Senior Hydrologist, Clark County Regional Flood Control District, Las Vegas, NV, 11/10/88 and 11/30/88

Turner, Robert, Wildlife Biologist, Nevada Department of Wildlife, Las Vegas, NV, 11/16/88

18.7 LAND USE AND RECREATION

Beckstead, Matt, GIS Coordinator, Clark County Department of Comprehensive Planning, Las Vegas, NV, 1988

Bourbeau, David, Building Official, City of Boulder City, Boulder City, NV, 1988

Burk, Vern, District Planning, Clark County School District, Las Vegas, NV, 1988

Chandler, Curt, Flood Control, City of Henderson, Henderson, NV, 1988

Dickens, Dusty, Supervisor of Real Estate and Land Acquisition, Clark County School District, Las Vegas, NV, 1988

Dorbin, Joe, Flood Control Planning Engineer, Las Vegas Public Works Department, Las Vegas, NV, 1988

Dubiel, David, Urban Planner, City of Boulder City, Boulder City, NV, 1988

Faircloth, Jerry, Zoning Coordinator, Clark County Zoning Department, Las Vegas, NV, 1988

Farkis, Paul, Department of Design and Development, City of Las Vegas, Las Vegas, NV, 1988

Gove, Alan, Public Works Director, City of Boulder City, Boulder City, NV, 1988

Harney, Kathy, Director of School Planning, Clark County School District, Las Vegas, NV, 1988

Harris, Jeff, Principal Planner, Clark County Department of Comprehensive Planning, Las Vegas, NV, 1988

Heckendorf, Dick, Planning Director, City of Henderson, Henderson, NV, 1988

Kuhn, Bill, Development Engineer Supervisor, Clark County Public Works, Las Vegas, NV, 1988

Maxwell, Frank, Environmental Coordinator, Bureau of Land Management, Las Vegas, NV, 1988

Monroe, Les, Environmental Coordinator, Nellis Air Force Base, NV, 1988

Moran, Mike, Lands Officer, Bureau of Land Management, Las Vegas, NV, 1988

Morine, Mike, Black & Veatch, Clark County Sanitation District, Las Vegas, NV, 1988

Murchie, John, Development and Flood Control Administrator, City of North Las Vegas, North Las Vegas, NV, 1988

Palm, John, Dam Safety Inspector, State of Nevada, Division of Water Resources, Las Vegas, NV, 1988

Quinn, Bill, Chief Engineer, State of Nevada, Division of Water Resources, Las Vegas, NV, 1988

Schneider, Julie, Technician, Clark County Public Works, Las Vegas, NV, 1988

Schumaker, Stanley, Civil Engineer, Clark County Sanitation Department, Las Vegas, NV, 1988

Serfas, Dick, Planning Coordinator, Clark County Department of Comprehensive Planning, Las Vegas, NV, 1988

Smith, Bill, City Manager, City of Henderson, Henderson, NV, 1988

Snider, Barbara, Planning, Clark County School District, Las Vegas, NV, 1988

Sutko, Tim, Senior Hydrologist, Clark County Regional Flood Control District, Las Vegas, NV, 1988

Taylor, Bob, District Landscape Architect, Bureau of Land Management, Las Vegas, NV, 1988

Trowbridge, Glenn, Director, Clark County Department of Parks & Recreation, Las Vegas, NV, 1988

White, Tony, Planning Technician, City of North Las Vegas, North Las Vegas, NV, 1988

18.8 VISUAL RESOURCES

Beckstead, Matt, GIS Coordinator, Clark County Department of Comprehensive Planning, Las Vegas, NV, 1988

Bourbeau, David, Building Official, City of Boulder City, Boulder City, NV, 1988

Burk, Vern, District Planning, Clark County School District, Las Vegas, NV, 1988

Chandler, Curt, Flood Control, City of Henderson, Henderson, NV, 1988

Dickens, Dusty, Supervisor of Real Estate and Land Acquisition, Clark County School District, Las Vegas, NV, 1988

Dorbin, Joe, Flood Control Planning Engineer, Las Vegas Public Works Department, Las Vegas, NV, 1988

Dubiel, David, Urban Planner, City of Boulder City, Boulder City, NV, 1988

Faircloth, Jerry, Zoning Coordinator, Clark County Zoning Department, Las Vegas, NV, 1988

Farkis, Paul, Department of Design and Development, City of Las Vegas, Las Vegas, NV, 1988

Gove, Alan, Public Works Director, City of Boulder City, Boulder City, NV, 1988

Harney, Kathy, Director of School Planning, Clark County School District, Las Vegas, NV, 1988

Harris, Jeff, Principal Planner, Clark County Department of Comprehensive Planning, Las Vegas, NV, 1988

Heckendorf, Dick, Planning Director, City of Henderson, Henderson, NV, 1988

Kuhn, Bill, Development Engineer Supervisor, Clark County Public Works, Las Vegas, NV, 1988

Maxwell, Frank, Environmental Coordinator, Bureau of Land Management, Las Vegas, NV, 1988

Monroe, Les, Environmental Coordinator, Nellis Air Force Base, NV, 1988

Moran, Mike, Lands Officer, Bureau of Land Management, Las Vegas, NV, 1988

Morine, Mike, Black & Veatch, Clark County Sanitation District, Las Vegas, NV, 1988

Murchie, John, Development and Flood Control Administrator, City of North Las Vegas, North Las Vegas, NV, 1988

Palm, John, Dam Safety Inspector, State of Nevada, Division of Water Resources, Las Vegas, NV, 1988

Quinn, Bill, Chief Engineer, State of Nevada, Division of Water Resources, Las Vegas, NV, 1988

Schneider, Julie, Technician, Clark County Public Works, Las Vegas, NV, 1988

Schumaker, Stanley, Civil Engineer, Clark County Sanitation Department, Las Vegas, NV, 1988

Serfas, Dick, Planning Coordinator, Clark County Department of Comprehensive Planning, Las Vegas, NV, 1988

Smith, Bill, City Manager, City of Henderson, Henderson, NV, 1988

Snider, Barbara, Planning, Clark County School District, Las Vegas, NV, 1988

Sutko, Tim, Senior Hydrologist, Clark County Regional Flood Control District, Las Vegas, NV, 1988

Taylor, Bob, District Landscape Architect, Bureau of Land Management, Las Vegas, NV, 1988

Trowbridge, Glenn, Director, Clark County Department of Parks & Recreation, Las Vegas, NV, 1988

White, Tony, Planning Technician, City of North Las Vegas, North Las Vegas, NV, 1988

18.9 SOCIOECONOMICS

Botkin, Kip, Assistant Chief, Henderson Police Department, Henderson, NV, 12/16/88

Braybrook, Nick, Engineer, Las Vegas Valley Water District, Las Vegas, NV, 12/12/88

Brubaker, Leslie, Secretary, Boulder City Police Department, Boulder City, NV, 12/16/88

Canez, Bob, Assistant Treasurer, Clark County Treasurers Office, Las Vegas, NV, 5/1/89

Carrasco, Ted., Planner, Clark County Planning Department, Las Vegas, NV, 12/14/88

Clement, Joe, Industrial Gas Engineer, Southwest Gas Company, Las Vegas, NV, 12/16/88

Faulkner, Bucky, Civil Engineer, Clark County Sanitation District, Las Vegas, NV, 12/12/88

Galati, Sally, Supervisor, Special Projects, Builders Services Department, Nevada Power Company, Las Vegas, NV, 12/19/88

Gallagher, Nicolas, Realtor, Coldwell Banker, Las Vegas, NV, 11/16/88

Gerstler, Arlyne, Broker, Jack Matthews & Company, Las Vegas, NV, 12/13/88

Ginser, Bob, Principal Planner, City of Las Vegas Planning Department, Las Vegas, NV, 12/16/88

Goodell, Neil, Public Relations Manager, Central Telephone Company, Las Vegas, NV, 12/16/88

Harris, Jeff, Principal Planner, Clark County Planning Department, Las Vegas, NV, 12/14/88

Hulbert, Ed, Firefighter, Boulder City Fire Department, Boulder City, NV, 12/16/88

Jenner, Chuck, Manager, Environmental Control and Management Division, Clark County Public Works Department, Las Vegas, NV, 1988

June, Clark County Assessors Office, Las Vegas, NV, 5/1/89

Kinnee, Jane, Director, North Las Vegas Community Planning and Development Department, North Las Vegas, NV, 12/15/88

Loveday, Denise, Multiple Listing Service Secretary, Las Vegas Board of Realtors, Las Vegas, NV, 11/17/88

MacDonald, Gloria, Senior Accountant, Nevada Department of Taxation, Carson City, NV, 12/16/88

McCormick, John, Operations and Maintenance Supervisor, Henderson Public Works Department, Henderson, NV, 1988

McKee, Lieutenant, Las Vegas Metropolitan Police Department, Las Vegas, NV, 12/15/88

Mills, Robert, Fire Marshall, North Las Vegas Fire Department, North Las Vegas, NV, 12/15/88

Murdock, Bob, Labor Economist, Nevada Employment Security Department, Carson City, NV, 12/15/88

Nehl, Linda, Administrative Secretary, Clark County School District, Las Vegas, NV, 1988

O'Neil, Jim, Clark County Emergency Management Department, Las Vegas, NV, 1988

Price, George, Battalion Chief, Henderson Fire Department, Henderson, NV, 12/19/88

Rubin, Kellie, Residential Relocation Specialist, Levy Realty, Las Vegas, NV, 12/13/88

Rubin, Marv, Owner-Broker, Levy Realty, Las Vegas, NV, 12/13/88

Sheoburne, Rex, Chief, Las Vegas Fire Department, Las Vegas, NV, 12/16/88

Sutko, Tim, Clark County Flood control District, Las Vegas, NV, 12/14/88

Trowbridge, Glen, Director, Clark County Department of Parks and Recreation, Las Vegas, NV, 12/16/88

Williams, Bill, Clark County Fire Department, Las Vegas, NV, 11/16/88

Zohner, Jerry, Chief, North Las Vegas Police Department, City of North Las Vegas, NV, 12/15/88

18.10 CULTURAL RESOURCES[1]

Becker, Alice, Staff Archaeologist, Nevada Division of Historic Preservation and Archaeology, Carsen City, NV, 11/1/88 and 12/2/88

Becksted, Matthew, Planner 2, Clark County Comprehensive Planning, Las Vegas, NV, 11/7/88

Blair, Linda, Research Specialist, Division of Anthropological Studies, Environmental Research Center, Museum of Natural History, University of Nevada, Las Vegas, NV, 11/1/88, 11/22/88, and 10/28/89

Janice, City Planning Department, City of Las Vegas, Las Vegas, NV, 1988

Jarvis, Susan, Librarian, Special Collections, Dickinson Library, University of Nevada, Las Vegas, NV, 11/22/88 and 11/23/88

Lichty, Alan S., Programmer/Analyst, Archaeological Center, Department of Anthropology, University of Utah, Salt Lake City, UT, 10/28/88

Manry, Pat, Planner, Office of Development and Planning, Las Vegas, NV, 11/21/88

Myhrer, Keith, Archaeologist, Bureau of Land Management, Stateline Resource Area, Las Vegas, NV, 10/28/88 and 11/4/88

Special Collections Department, Dickinson Library, University of Nevada, Las Vegas, NV, 1988

Warren, Claude, N., Professor, Department of Anthropology, University of Nevada, Las Vegas, NV, 11/3/88

Warren, Elizabeth, Executive Director, Cultural Focus, Las Vegas, NV, 11/2/88, 11/22/88, and 11/23/88

Wolf, Art, Nevada State Museum and Historical Society, Lorenzi Park, Las Vegas, NV, 11/7/88 and 11/21/88

Wright, Frank, Curator of Education, Nevada State Museum and Historical Society, Las Vegas, NV, 11/9/88, 11/21/88 and 11/23/88

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[1] Also see Table 12-13, Contact Program Summary

19.0 INTRODUCTION

Public participation and comment on potential environmental concerns has been encouraged through a series of noticed mailings, three public scoping meetings, and a DEIS public workshop. Two public hearings on the DEIS are also scheduled. Dames & Moore attempted to contact each individual or organization that provided written or verbal comments during the public scoping period.

19.1 PUBLIC SCOPING

19.1.1 Public Scoping Comment Period

The public scoping comment period was from September 2, 1988 to October 7, 1988. The scoping comment period was announced by publication in the Federal Register (Vol. 53, No. 175), September 9, 1988 and in a public mailing to over 100 agencies and individuals. The close of the scoping period was also advertised in the Las Vegas-Review Journal on October 3 and 4, 1988 and in the Las Vegas Sun on October 4, and 5, 1988.

19.1.2 Public Scoping Meetings

19.1.2.1 Public Agency Scoping Meeting, September 28, 1988

A scoping meeting for public agencies was held on September 28, 1988 at the Las Vegas Municipal Airport. Following a short introduction by Mr. Tim Sutko of the CCRFCD and Mr. Bob Taylor of BLM, Mr. Dean Hargis of Dames & Moore discussed the objectives and format of the EIS. Mr. Hargis discussed the fact that the EIS would combine both a programmatic analysis of the entire flood control Master Plan project and a project-specific analysis of facilities proposed as part of the District's 10-year facilities construction program. He then discussed particular issues that would be addressed in the analysis of air quality, geology and soils, ground water, surface water, terrestrial and aquatic biology, land use and recreation, visual resources, socioeconomics, and cultural resources.

Comments from representatives of public agencies included questions relating to the level of effort that would be completed at facilities; methods to mitigate impacts associated with housing impacts; the extent which flood control facility would address ground water problems; practical problems associated with use of lined and unlined channels on plants and wildlife; need to identify cultural resources; potential cumulative impacts on plants and wildlife at each facility; and potential for joint use areas.

19.1.2.2 Henderson Public Scoping Meeting, September 28, 1988.

The second scoping meeting was held at the City of Henderson Convention Center on September 28, 1988. The format of the presentation was the same as at the public agency scoping meeting, although comments were received during the course of the presentation. Comments were limited, but those received included: concern for erosion; potential for localized pockets of high ground water becoming an issue; and the potential growth-inducing aspect of the project.

19.1.2.3 Las Vegas Public Scoping Meeting, September 29, 1988

The Las Vegas scoping meeting was held at the Clark County School District Board Room on September 29, 1988. The format was the same as that followed at Henderson. Public comments focused on potential impacts to the Desert Tortoise and proposed mitigation measures. Other comments included: potential impacts to riparian habitats, BLM exchange lands, and joint use of facilities.

19.2 DEIS WORKSHOP, PUBLIC COMMENT PERIOD, AND PUBLIC HEARINGS

19.2.1 DEIS Public Workshop

A DEIS public workshop was held at the Clark County School District Board Room on January 4, 1989. The workshop was lead by Mr. Dean Hargis of Dames & Moore. After a brief introduction Mr. Hargis discussed the status and results of studies completed in air quality, geology and soils, surface water, ground water, terrestrial and aquatic biology, land use and recreation, visual resources, socioeconomics, and cultural resources.

Most comments were related to surface water. The potential for channel scour due to sediment load was discussed as well as changes in flood flow velocities. Recharging of ground water systems was also addressed, especially in relationship to the use of water in restoration of wetlands.

Other comments received related to identification and treatment of cultural resources, and use of floodways rather than lined channels, especially in areas with caliche soils.

19.2.2 DEIS Public Review and Comment

The DEIS will be made available to all parties requesting a copy. During the public comment period, a DEIS public hearing is scheduled. The date and time and location of this hearing will be sent to individuals and organizations that have been previously noticed or have requested to be noticed. It will also be published in local newspapers. The FEIS is expected to be distributed six weeks after the close of the DEIS public comment period.

19.3 EIS DISTRIBUTION LIST

A notice of DEIS availability has been circulated to all individuals that previously expressed a desire to receive this document or submitted comments during public scoping or at the EIS workshop. Additional copies are available from the Clark County Regional Flood Control District or BLM offices in Las Vegas. A list of all individuals, organizations, and agencies which were sent copies of this EIS is presented in Table 19-1. This list will be updated to include additional parties receiving copies during the public comment period for presentation in the FEIS.

TABLE 19-1

EIS DISTRIBUTION LIST

Chief
Env. Impact Assessment Program
U.S. Geo. Survey, MS-760
U.S. Dept. of the Interior
Reston, VA 22092

Regional Director
Heritage Conservation and
Recreation Service
P.O. Box 36062
San Francisco, CA 94102

U.S. Dept. of the Interior
Bureau of Reclamation
P.O. Box 427
Boulder City, NV 89005

Mr. Richard Macias
U.S. Army Corps of Engineers
Env. Section SPLPD-RP
P.O. Box 2711
Los Angeles, CA 90053-2325

District Manager
Bureau of Land Management
P.O. Box 26569
Las Vegas, NV 89126

Jerry Wickstrom
Bureau of Land Management
P.O. Box 26569
Las Vegas, NV 89126

Regional Director (AFWE)
Fish & Wildlife Service
500 N.E. Multnomah Street
Portland, OR 97232

Env. Protection Agency
999 18th Street, Suite 500
Denver, CO 80202-2405

U.S. Dept. of the Interior
National Park Service
P.O. Box 36063
San Francisco, CA 94102

U.S. Env. Protection Agency
Region IX
215 Fremont Street
San Francisco, CA 94102

Mr. Paul Blakey
U.S. Army Corps of Engineers
Planning Section C
3636 North Central,
Suite 740
Phoenix, AZ 85012-1936

Director
Division of NEPA Affairs
Dept. of Energy
Mail Station E-201, GTN
Washington, DC 20545

U.S. Dept. of the Interior
Regional Env. Officer
Pacific Southwest Region
P.O. Box 36098
San Francisco, CA 94102

Mr. Bob Junell, Chief
Unit 2 Regulatory Section
Army Corps of Engineers
650 Capitol Mall
Sacramento, CA 95821

Mr. Richard Navarse
U.S. Fish & Wildlife
4600 Kietzke Lane, Bldg. C
Reno, NV 89502

National Park Service
601 Nevada Highway
Boulder City, NV 89005

U.S.G.S.
Water Resources Division
Room 224, Federal Bldg.
705 North Plaza Street
Carson City, NV 89701

Documents Librarian
University of Nevada, Las Vegas
4505 South Maryland Parkway
Las Vegas, NV 89154

Colorado River Commission
1515 E. Tropicana Ave., #400
Las Vegas, NV 89119

Mr. Lou Dodgion
Dept. of Env. Protection
201 South Fall Street
Carson City, NV 89710

State Historic Preservation Officer
700 Twin Lakes Drive
Las Vegas, NV 89108

Ms. Ann Zorn, Chairwoman
Citizens Advisory Committee
1591 Gabriel Drive
Las Vegas, NV 89101

Mr. Richard Holmes, Director
C.C. Dept. of Comprehensive
Planning
225 East Bridger Avenue
Las Vegas, NV 89101

Mr. Michael Dyal, City Manager
City of North Las Vegas
2200 Civic Center Drive
No. Las Vegas, NV 89030

Phil Speight, City Manager
City of Henderson
243 Water Street
Henderson, NV 89015

Mr. John Walker
State Office of Community Services
1100 E. Williams, Suite 118
Carson City, NV 89701

Mr. Peter Morros
Dept. of Conservation and
Natural Resources
123 W. Nye Lane
Capitol Complex
Carson City, NV 89710

Director
Nevada Dept. of Wildlife
P.O. Box 10678
Reno, NV 89520

Mr. R. Michael Turnipseed, P.E.
Division of Water Resources
123 W. Nye Lane
Capitol Complex
Carson City, NV 89710

Mr Bruce Woodbury, Chairman
C.C. Regional Flood Control
District Board of Directors
225 East Bridger Avenue
Las Vegas, NV 89101

Mr. Donald L. 'Pat' Shalmy
County Manager
225 East Bridger Avenue
Las Vegas, NV 89101

Mr. Ashley Hall, City Manager
City of Las Vegas
400 East Stewart Avenue
Las Vegas, NV 89101

Mr. George Forbes, City Manager
City of Boulder City
P.O. Box 367
Boulder City, NV 89005

Ms. Betty Burge
TORT-Group
5157 Poncho Circle
Las Vegas, NV 89119

Charleston Heights Library
800 Brush Street
Las Vegas, NV 89107

Green Valley Library
2797 N. Green Valley
Parkway
Henderson, NV 89015

Rainbow Library
6010 W. Cheyenne Ave.
Las Vegas, NV 89108

Sunrise Library
5400 Harris Ave.
Las Vegas, NV 89110

Las Vegas Paiute Tribe
#1 Paiute Drive
Las Vegas, NV 89106

Moapa Paiute Tribe
P.O. Box 340
Moapa, NV 89025

Bret Braden
Gifford-Hill & Company, Inc.
660 North Diamond Bar Blvd.
P.O. Box 4904
Diamond Bar, CA 91765

Clark County Library
1401 E. Flamingo
Las Vegas, NV 89119

Las Vegas Public Library
201 S. Las Vegas Blvd.
Las Vegas, NV 89101

Spring Valley Library
4280 S. Jones Blvd.
Las Vegas, NV 89103

West Las Vegas Library
951 West Lake Mead Blvd.
Las Vegas, NV 89106

Department of Transportation
Carter M. Schleicher
1263 S. Stewart Street
Carson City, NV 89712

Roger J. Patton
Louis Berger & Associates
1110 East Missouri Ave.,
Suite 200
Phoenix, AZ 85014