AD-A126 407 DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE MX: BURIED TRENCH CONSTRUCTION AND TEST PROJECT(U) DEPARTMENT OF THE AIR FORCE WASHINGTON DC 1977 1/2

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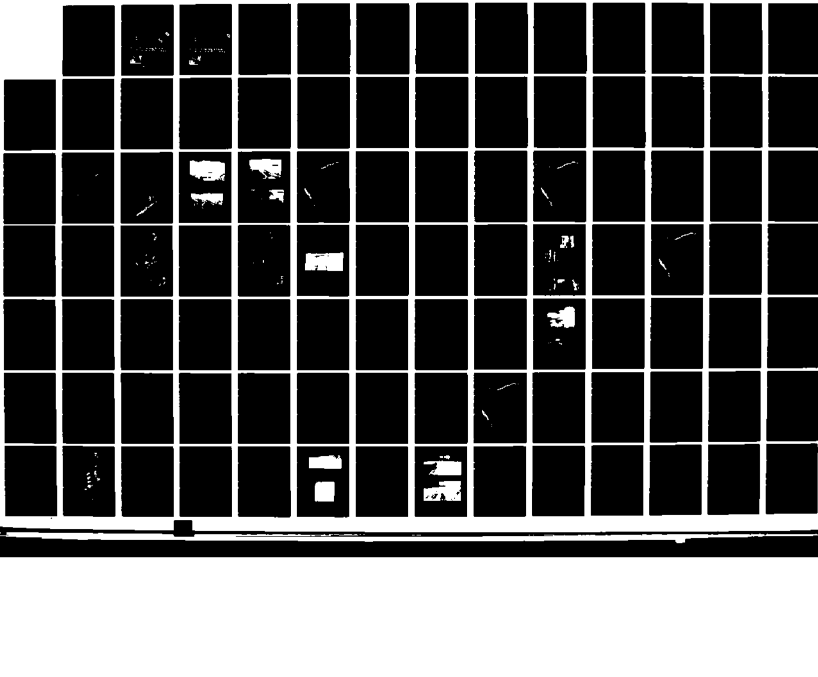

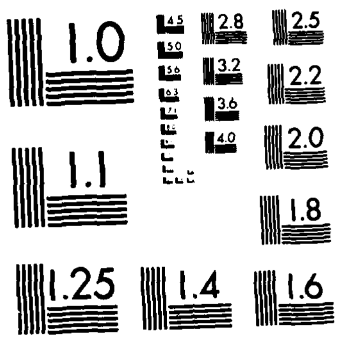

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Environmental Impact Analysis Process

DRAFT ENVIRONMENTAL IMPACT STATEMENT

MX: BURIED TRENCH CONSTRUCTION AND TEST PROJECT

1977

DEPARTMENT OF THE AIR FORCE

Environmental Impact Analysis Process

DRAFT ENVIRONMENTAL
IMPACT STATEMENT

MX: BURIED TRENCH CONSTRUCTION
AND TEST PROJECT

DEPARTMENT OF THE AIR FORCE

DRAFT ENVIRONMENTAL IMPACT STATEMENT

for the

MX: BURIED TRENCH CONSTRUCTION AND TEST PROJECT

DEPARTMENT OF THE AIR FORCE

DRAFT
ENVIRONMENTAL IMPACT STATEMENT
FOR
THE MX BURIED TRENCH CONSTRUCTION AND TEST PROJECT
(ADMINISTRATIVE ACTION)

SUMMARY

CONTACT FOR INQUIRIES

This statement was prepared by the United States Air Force. Any inquiries concerning this proposed action should be addressed to the Deputy for Environment and Safety, Office of the Secretary of the Air Force (SAF/MIQ), Washington, D.C., 20330.

SUMMARY OF PROPOSED ACTION

The United States Air Force proposes to construct two sections of underground tunnel in the San Cristobal Valley on the Luke Air Force Range in Yuma County, Arizona. The proposed construction project will provide essential cost and construction data to analyze conceptual protective structures for the mobile, land-based Intercontinental Ballistic Missile (ICBM) System known as MX. The trench will also serve as a test bed for mechanisms designed to punch through the tunnel roof and erect a dummy missile to simulate launch position.

Both tunnels will involve trench excavations approximately 22 ft (6.7 m) deep by 17 ft (5.2 m) wide to allow continuous slip-form placement of two concrete tunnels with dimensions of 13 ft (4 m) and 16.5 ft (5 m) inside and outside diameter, respectively. The two tunnels would total approximately 21,500 ft (6,553 m): a 1,500 ft (457 m) section providing procedure and equipment shakedown and the breakout test bed; and a 20,000 ft (6,096 m) section providing cost and construction data. The construction project, known as MX: Buried Trench Construction and Test Project, would span eight months from February through September 1978.

The MX program was established in 1973 and is an ICBM technology program. The FY78 budget request is for $134.4 million. The results of the MX: Buried Trench Construction Test Project will provide baseline data for future decisions regarding the MX system. Deployment of a force of MX missiles will not be determined until approved by the U.S. Congress.

The major environmental impact of the proposed action will be long-term aesthetic degradation caused by removal of vegetation and disruption of varnished desert pavement for tunnel construction. This impact will occur within the 200 acre test site, less than 0.3 percent of the bajada's total land area. Other temporary impacts during the term of the project could include intermittent disturbance to desert bighorn sheep in the Mohawk Mountains, the loss of some reptiles and burrowing rodents along the trench alignments, and increased wind and water erosion of disturbed soils within the project area. These temporary impacts are, however, not expected to be significant due to scheduling of project events, fugitive dust control measures, and final grading procedures.

Total cost of the construction project is estimated to be $20 million. Most of the construction work force are expected to come from Yuma and Maricopa counties in Arizona. The labor force will peak in April 1978 with approximately 238 employees.

The MX program is being managed by the ICBM System Program Office, Space and Missile Systems Organization (SAMSO), located at Norton Air Force Base, California.

Alternatives to the proposed action are:

- No Action
- Project Postponement
- Construction of the Project at a Different Scale
- Alternative Siting
- Alternative Construction Methods

This Draft Environmental Impact Statement was made available to the Council on Environmental Quality and the public in August 1977.

DISTRIBUTION OF DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR COMMENT

Copies of the Draft Environmental Impact Statement have been provided to addresses as listed below for review and comment.

FEDERAL AGENCIES

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401 M Street, S.W.
Washington, D.C. 20460

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100 California Street
San Francisco, CA 94111

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Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

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Western Region
P.O. Box 92007
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Los Angeles, CA 90009

U.S. Department of Commerce (2 cys)
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

U.S. Department of Agriculture (2 cys)
Washington, D.C. 20250

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18th and C Street, N.W.
Washington, D.C. 20240

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Office of Environmental Programs
Federal Energy Administration
New Post Office Building
12th & Pennsylvania Avenue, N.W.
Washington, D.C. 20461

U.S. Department of Transportation
Federal Highway Administration
Office of Environmental Policy
400 7th Street, S.W.
Washington, D.C. 20590

Defense Nuclear Agency, LGEC
Washington, D.C. 20305

Headquarters, U.S. Marine Corps (3 cys)
Code LFF
Washington, D.C. 20380

STATE AND LOCAL AGENCIES

Governor's Office
Phoenix, Arizona 85007

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State of Arizona
1624 West Adams Street
Phoenix, Arizona 85007

Maricopa Association of Governments
1820 West Washington Street
Phoenix, Arizona 85007

District IV Council of Governments
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Yuma, Arizona 85364

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Arizona Atomic Energy Commission
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Arizona Commission of Agriculture and Horticulture
1688 West Adams
Phoenix, Arizona 85007

Arizona Department of Transportation
206 South 17th Avenue
Phoenix, Arizona 85007

Arizona Department of Emergency and Military Affairs
5636 East McDowell Road
Phoenix, Arizona 85008

Arizona Farm Bureau Federation
2618 South 21st Street
Phoenix, Arizona 85009

Arizona Game and Fish Department
2222 West Greenway Road
Phoenix, Arizona 85023

Arizona Game and Fish Department
3005 South Pacific Avenue
Yuma, Arizona 85364

Arizona Office of Economic Planning and Development
1700 West Washington
Phoenix, Arizona 85007

Arizona Office of Economic Planning and Development
Clearinghouse and Planning Division
1700 West Washington
Phoenix, Arizona 85007

Arizona Outdoor Recreation Coordinating Commission
4433 North 19th Avenue
Phoenix, Arizona 85015

Arizona State Land Department
1624 West Adams
Phoenix, Arizona 85007

Arizona State Natural Resource Conservation Council
1624 West Adams
Phoenix, Arizona 85007

Arizona State Parks Board
1688 West Adams
Phoenix, Arizona 85007

Arizona Water Commission
222 North Central Avenue
Phoenix, Arizona 85004

City Council
251 West Washington
Phoenix, Arizona 85003

City Council of Governments, District #4
377 South Main Street
Yuma, Arizona 85364

City of Yuma Planning Department
180 West 1st Street
Yuma, Arizona 85364

Cooperative Extension Service
University of Arizona
1047 South 4th Avenue
Yuma, Arizona 85364

Governor's Commission on Arizona Environment
206 South 17th Avenue
Phoenix, Arizona 85007

Reclamation Bureau of Arizona
201 North Central Avenue
Phoenix, Arizona 85004

Maricopa County Board of Supervisors
111 South 3rd Avenue
Phoenix, Arizona 85003

Town Office
202 North Euclid Avenue
Gila Bend, Arizona 85337

Yuma County Board of Supervisors
168 South 2nd Avenue
Yuma, Arizona 85364

Yuma County Parks and Recreation Department
2703 South Avenue B
Yuma, Arizona 85364

Yuma County Planning Department
2703 South Avenue B
Yuma, Arizona 85364

LOCATION OF REFERENCE COPIES

Copies of the Draft Environmental Impact Statement have been sent to the following libraries for the convenience of the citizens in the local communities who wish to review the document.

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Mesa, Arizona 85203

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Mrs. Frances E. Thomas, Librarian
Yuma City County Library
Regional Headquarters
350 South 3rd Street
Yuma, Arizona 85364

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Tempe, Arizona 85281

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Regional Headquarters
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Tucson, Arizona 85701

REQUEST FOR COPIES

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Civil Engineering Division
SAMSO/MNND
Norton AFB, California 92409

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SECTION 1
THE PROJECT AND THE EXISTING ENVIRONMENT

1.1 THE PROJECT

1.1.1 Background

In 1973, the Air Force established the Missile X or MX Advanced Development program within the broad framework of the continuing Advanced Intercontinental Ballistic Missile (ICBM) technology program. The MX program had two specific objectives: the first objective was to develop technology for an advanced missile; the second objective was to study ways to assure continued survivability of the land based missile force. These objectives were established to respond to the Soviet Union's large-scale ICBM modernization program which includes the current deployment of four new ICBMs. Forecast increases in the number of Soviet weapons, combined with improved targeting accuracy, could make the U.S. silo based missile force vulnerable to a Soviet first-strike attack which would decrease the credibility of our strategic deterrent forces.

The MX program has concentrated on technology aimed at developing a new missile with increased throw weight and improved accuracy. Various mobile basing concepts were studied as follow-on alternatives to deployment in existing Minuteman silos. In 1976, two mobile basing concepts were selected for further study: the shelter and the buried trench. In-depth studies of these concepts, including results from this project, will be used to validate their technical feasibility and cost. Future decisions regarding the MX system will be affected by these and other key technology questions.

Both trench and shelter concepts are Multiple Aim Point (MAP) configurations. That is, in each concept a missile moves randomly among a number of locations so that the missile's exact position is unknown to an attacker. This makes it necessary for an enemy to attack all possible locations to ensure destruction of any one missile. If many potential missile locations can be constructed relatively inexpensively, then it is possible to present an enemy with more target area than his weapons can cover, making it impossible to destroy the United States ICBM force, with the projected Soviet weapon systems. This will assure force survivability allowing us an ICBM force for retaliation which in turn enhances the credibility of our strategic deterrent.

On a first-cost basis, both the trench and shelter concepts are roughly equal, but the buried trench concept has promise of lower manpower requirements for operation and greater survivability from a variety of possible attack options. A Multiple Aim Point Validation (MAV) program has been initiated to resolve key technical and cost issues related to these two mobile basing concepts.

The MX Buried Trench Construction and Test Project, as a major part of the MAV program, seeks to validate the estimates for cost and construction rate and to prove the basic technical feasibility of large-scale construction of buried trenches. Construction proposed under this project is being preceded by a year of planning and development of special construction equipment. Cost and production estimates would then be verified by construction of the proposed structures. A section of the buried trench is planned for demonstration of prototype breakout and erection hardware developed under another contract. The breakout and erection device is the subsystem contained on the missile transporter-launcher which physically erects the canistered MX missile through the trench headworks and overburden to achieve a launch-ready position. For the test, the device will be fitted with a dummy load to simulate the missile and canister. No actual launch will occur. Breakout and erection tests will be conducted to validate the design of the breakout and erection subsystem.

A second part of the MAV effort is the HAVE HOST test program conducted by the Air Force Weapons Laboratory (AFWL) on a site near the proposed trench construction location (Figure 2). The HAVE HOST test program consists of a series of high explosive tests to evaluate the vulnerability of subscale trench and shelter facilities to induced air blast and ground shock. These tests will provide data for trench and shelter designs and will assist in resolving key technical and cost issues. These tests will be conducted over approximately a two-year period beginning in April 1977. A separate Environmental Assessment on the HAVE HOST test program has been prepared.

A proposed third element of the MAV effort, to be conducted by the Defense Nuclear Agency, is MISER'S BLUFF, which is a series of high explosive tests similar to the HAVE HOST tests but at larger scales. The proposed test site is on Planet Ranch in west central Arizona. Current plans are for these tests to begin in the fall of 1977 and extend over a one-year time period. A separate Environmental Analysis is currently being prepared on the MISER'S BLUFF program by the Defense Nuclear Agency.

This Environmental Impact Statement deals only with the MX trench construction project. It is one of a series of environmental documents that will assess the environmental consequences of key decisions on the MX program. Future environmental analyses will be prepared to analyze major MX program milestones (e.g., Basing Mode Selection; Full-Scale MX System Development; Deployment Site Selection; and Full-Scale Production and Deployment) after the key technology goals are met and the system can be more clearly defined.

1.1.2 MX Buried Trench Concept

Under the Buried Trench Concept, MX missiles would be installed in buried cylindrical reinforced concrete tunnels termed protective structures (PSs). These structures would typically be 13 miles (21 km) long, 13 ft (4.0 m) in inside diameter, and have flat floors. The inside widths of the floors and diameters of the tunnels would be suitable to permit MX missiles, installed in wheeled transporter/launchers (TLs), to move between selected launch points in the PS, so that their exact location at any given time would be denied to a potential aggressor.

Accompanying each missile transporter/launcher would be a pair of blast plugs at either end of the missile train. Within each buried trench, an unmanned train consisting of a transporter/launcher and a pair of blast plugs could be moved from point to point on command. The depth of burial of the tunnel and strength of the protective structure would provide a selected level of protection from nuclear blast overpressures at the surface. The blast plugs would similarly provide protection from shock waves produced within the protective structure should it be breached during an attack.

In some buried trenches, a manned mobile launch control center (MLCC), capable of controlling the launch of several missiles, would also be present between the missile and a blast plug. This configuration is shown in Figure 1. The MLCCs would be moved deceptively among available tunnels in a launch complex, so that the locations of the specific tunnels containing an MLCC (a preferred target) would also be unknown.

Launch from the buried trench would require erection of the missile (protected by a suitable enclosing structure) through the top of the protective structure and its earth cover.

As noted previously, the buried trench concept has promise of several potential advantages; however, it is necessary to resolve specific technical uncertainties before it can be established that the concept is technically feasible and will thus permit these advantages to be achieved in practice.

1.1.3 The Proposed Action in Brief

The proposed action will involve construction of two sections of the buried trench PS at a site on Luke Air Force Range in southwestern Arizona. A short [(1,500 ft) (457 m)] straight section of buried trench, complete with entrance and exit structures, will be constructed first. This effort will provide initial validation of construction techniques and experience in construction practices. The resulting buried trench section will provide a suitable test bed for subsequent tests of missile breakout capability so that the tests can proceed without interference with continued validation construction.

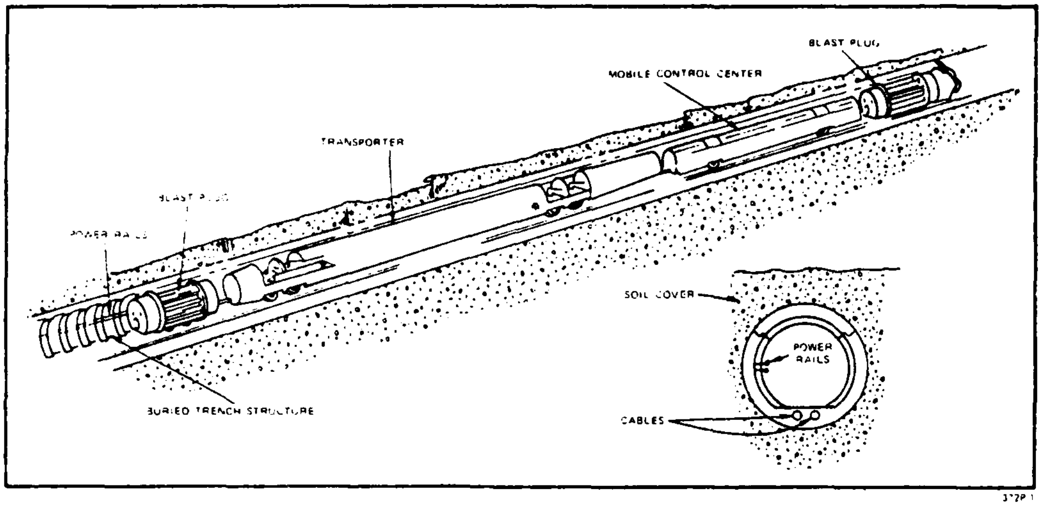


Figure 1. Buried trench concept.

Following completion of the short section of buried trench, the construction equipment will be moved to the initial point of the long section [(20,000 ft) (6.1 km)]. This operation will establish the probable rates at which the equipment can be moved between sites, and any potential problems involved.

At the final construction stage, the long section of buried trench will be constructed. This section will traverse areas of varying soil conditions and differing slopes, crossing one major and approximately twenty minor ephemeral streams, and will have straight sections and horizontal and vertical curves. Entrance and exit structures will also be installed at each end of the long buried trench. Construction of this section is to provide data on the achievable construction rate, on the problems encountered in traversing a suitable range of soil and topographic conditions, and in maintaining the desired accuracy of alignment.

Breakout tests will be conducted in the short section of trench, using prototype configurations of the transporter/launcher as described in Section 1.1.10. No missile will be launched from the site.

In addition to engineering, cost, and productivity data, confirmatory information will also be developed on the probable environmental impacts and the efficacy of mitigative measures.

Upon completion of the trench construction and breakout tests, it is planned to seal the trenches and abandon them. Access to roads constructed for the project will be eliminated.

1.1.4 Site Location and General Features

The proposed project site is in southwestern Arizona, in the San Cristobal Valley adjacent to and east of the Mohawk Mountains and south of the right-of-way of the Southern Pacific Railroad and Interstate Highway 8/U.S. Highway 80. Figure 2 shows the general location of the site, and the approximate locations of the two buried trench sections.

The site is approximately equidistant between Yuma, Arizona (1975 population 30,000) to the west, and Gila Bend, Arizona (1975 population 2,100) to the east. Both are approximately 60 miles (111 km) away from the site along Interstate Highway 8. The nearest communities are Dateland, Arizona (estimated population less than 100) and Tacna, Arizona (estimated Population 210). Dateland is approximately 7 miles (13 km) easterly along U.S. Highway 80 from the intersection of San Cristobal Wash and the highway, and lies in the San Cristobal Valley. Tacna is approximately 19 miles (30 km) westerly of this intersection, across the Mohawk Mountains in the Mohawk Valley. The town site known as Mohawk, shown on some highway maps as relatively close to the site to the west along Interstate Highway 8/ U.S. Highway 80, is unpopulated.

Current access to the site from improved roads is by jeep trails, with four-wheel-drive vehicles generally required.

Figure 3 is an aerial view of the project area indicating the positions of the trench alignments and the fields of view of Figures 4 through 7, which are oblique aerial photographs of selected areas of the site.

Figure 4 is a view from the east showing the Mohawk Mountains and their accompanying alluvial fan (bajada). The upper end of the alignment of the long trench is superimposed on the photo. In this region the alluvial fan is covered with well varnished desert pavement dissected by watercourses which contain water only after rains. The watercourses range in depth from a few inches to as much as 16 ft (5 m). Throughout this Environmental Statement the larger of these are referred to as arroyos, the smaller ones as washes. Those referred to as arroyos have a depth of at least 7 ft (2 m) at some point along their lengths. The deeper the watercourses are, the greater the volume of water they have transported, and the more dense their vegetation. The largest watercourses are lined with ironwood and yellow paloverde trees reaching heights of 16 ft (5 m), occasional sahuaro cacti, and many shrubs. The smaller channels support fewer and smaller trees; the smallest channels have only stunted shrubs (creosote bush and brittle bush predominantly). The interwash areas of desert pavement are barren.

Figure 5 is an oblique aerial view showing the upper third of the alignment of the long trench. It shows the varnished desert pavement giving way in places to unvarnished pavement and sand, indicating geologically recent changes of watercourse position and recent sand and silt deposition. Creosote bush and white bur sage begin to appear in the interwash areas, the sahuaro disappear, and the blue paloverde occur alongside the yellow paloverde in the major arroyos.

Figure 6 is an oblique aerial view showing the lower third of the alignment of the long trench. In this region, the surface watercourses are much less distinct, and appear to confine only minor runoff. In major storms, the runoff spreads over the entire alluvial surface, depositing silt. There is no desert pavement in this part of the alignment. Most of the shrubs are creosote bush, with galleta grass clumps and occasional stunted ironwood trees lining the washes.

Figure 7 is an oblique aerial view looking northward toward Texas Hill from a point above Stoval Airfield in the middle of the San Cristobal Wash. The substrate is a playa with little vegetation except in slightly raised areas where saltbush, creosote bush, and mesquite occur. The downhill end of the short trench is located to the left of field of view of the photograph. The equipment lay-down areas and batch plant will be located on the runway shown in the photograph.

1.1.5 Facilities to be Constructed

The facilities to be constructed consist of two sections of buried trench, with terminal ramps. Figure 8 shows the locations of the two sections of buried trench, with their associated ramps. Two different ramp types are to be used: the "X" configuration with a terminal level pad (Figure 9), and the "Y" configuration without a pad (Figure 10). The X configuration is associated only with the short section of buried trench, which is to be used for breakout tests.

The shorter section of buried trench is straight in plan view, and nominally 1,500 ft (457 m) long. The ground surface at the northeastern end of this section is at approximately 360 ft (110 m) above mean sea level (MSL), and at the upper end, it is approximately 370 ft (113 m). The vertical profile of the buried trench is to be recommended by the construction contractor, and may include vertical curves of 2,000 ft (610 m) radius to avoid the presence of angular discontinuities between the ramp surfaces and the running surfaces of the buried trench. This trench section will have an X configuration ramp at its northeastern end, and a Y configuration ramp at its southern end, increasing the nominal overall length to 2,960 ft (902 m).

The northeast terminus of the short tunnel section will be approximately 4,950 ft (91.5 km) and the initial point of the associated ramp will be approximately 4,550 ft (1.4 km) from the centerline of the railroad right-of-way.

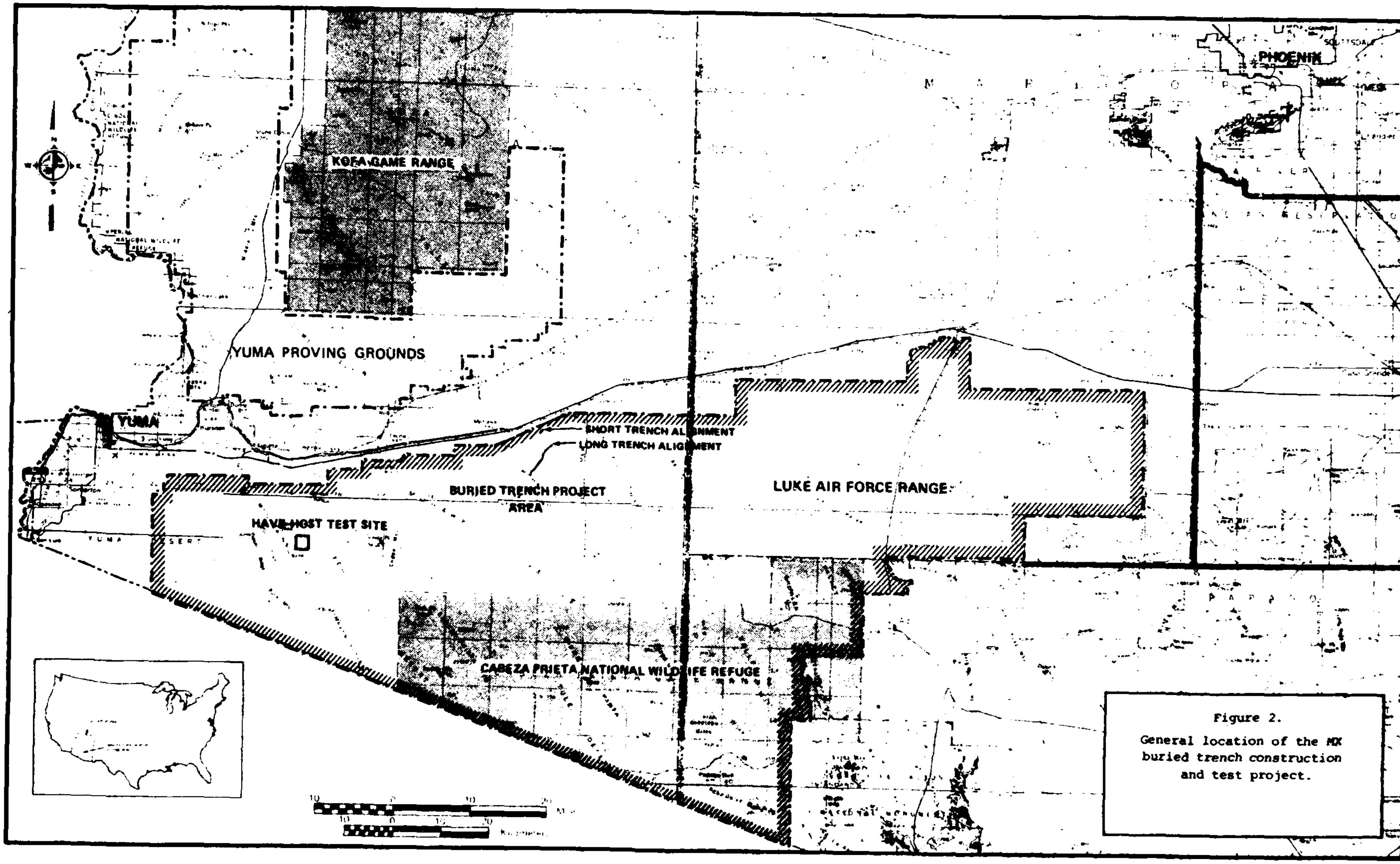


Figure 2.
General location of the MX buried trench construction and test project.

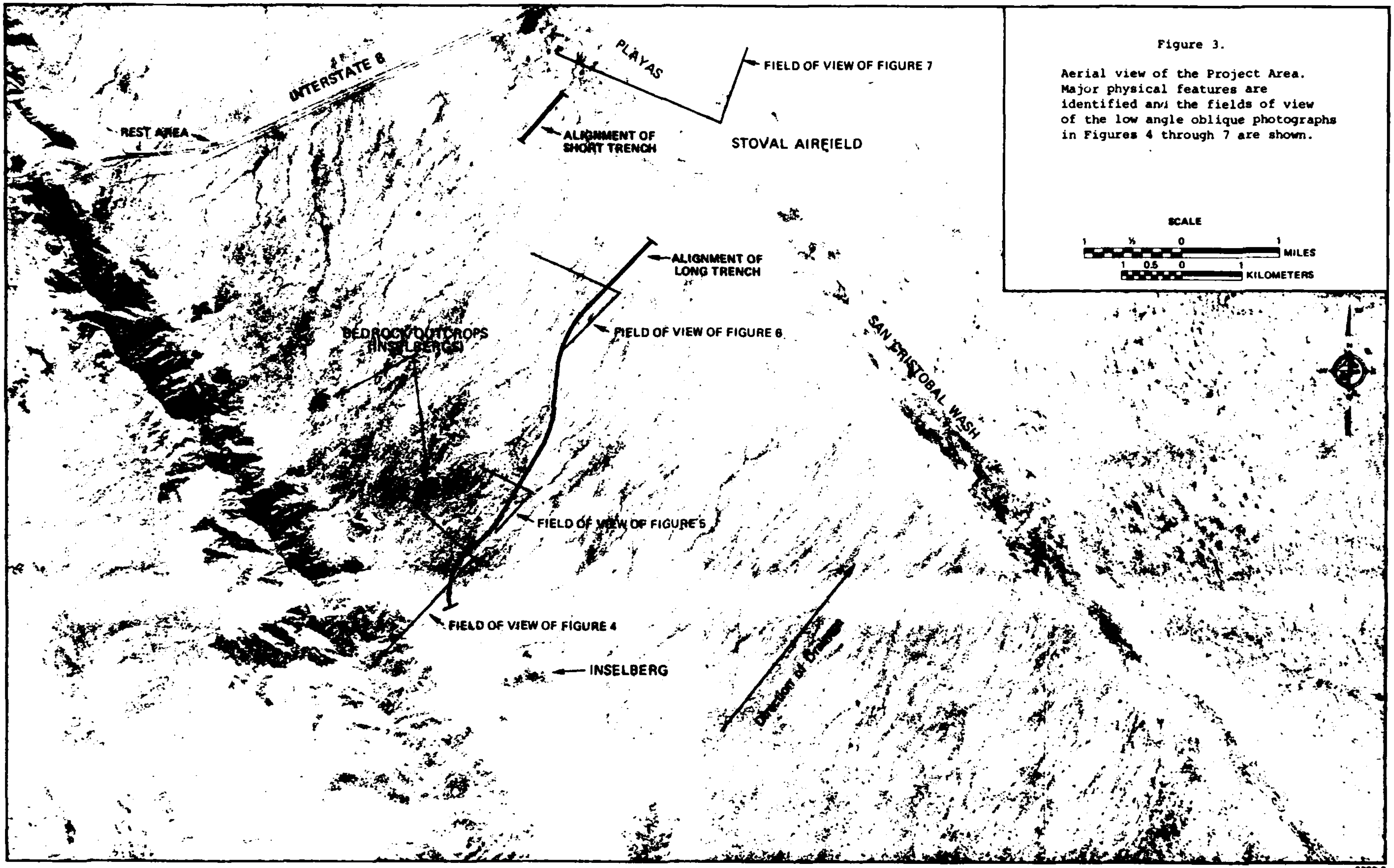
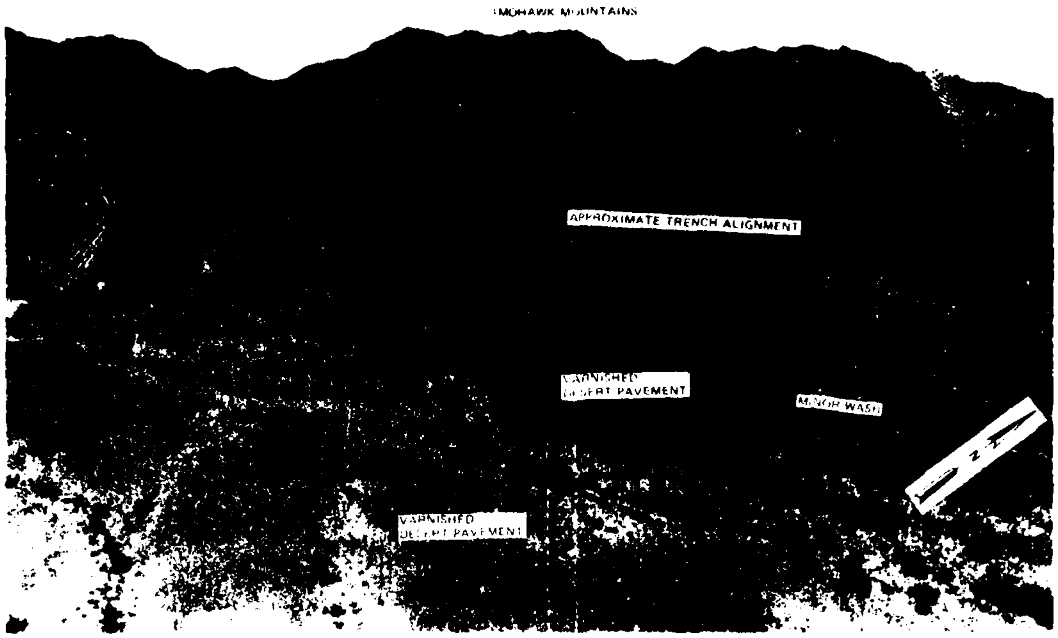


Figure 3.

Aerial view of the Project Area. Major physical features are identified and the fields of view of the low angle oblique photographs in Figures 4 through 7 are shown.

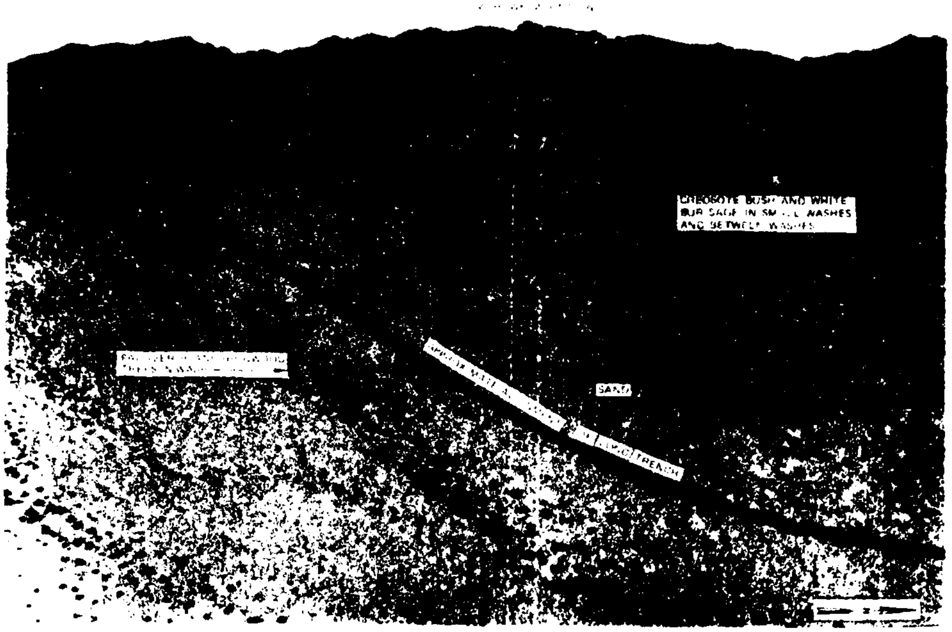


372P-4

Figure 4. An oblique aerial view of the southwestern end of the proposed alignment of the long trench. The trench terminates approximately 800 ft (240 m) to the left of the photo, at a position within 1,600 ft (480 m) of the base of the Mohawk Mountains, and extends 19,200 ft (6 km) to the right, to its lower terminus in San Cristobal Valley.

372P-5

Figure 5. An oblique aerial view of the upper third of the proposed alignment of the long trench, as viewed from the east.



372P-6

Figure 6. An oblique aerial view of the (northeast) third of the proposed alignment of the long trench, as viewed from the east.

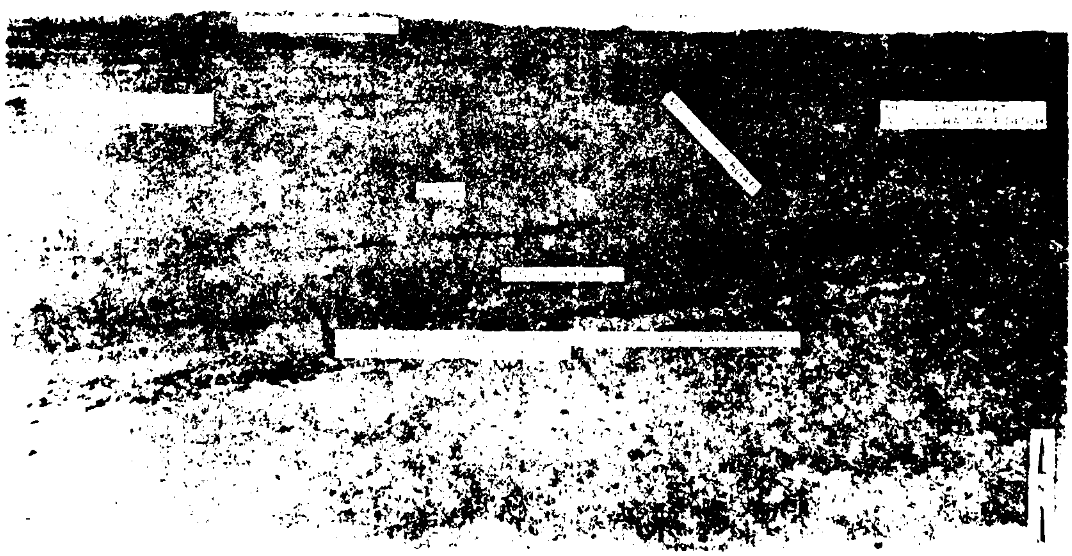


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Figure 7. An oblique aerial view looking northward toward Texas Hill and Interstate 8 from a point above Stoval Airfield (abandoned). The lower end of the proposed alignment of the short trench is to the left of the left center of the figure. The northeast-southwest runway of Stoval Airfield is in the foreground. North of the airfield is part of the playa area of San Cristobal Wash.

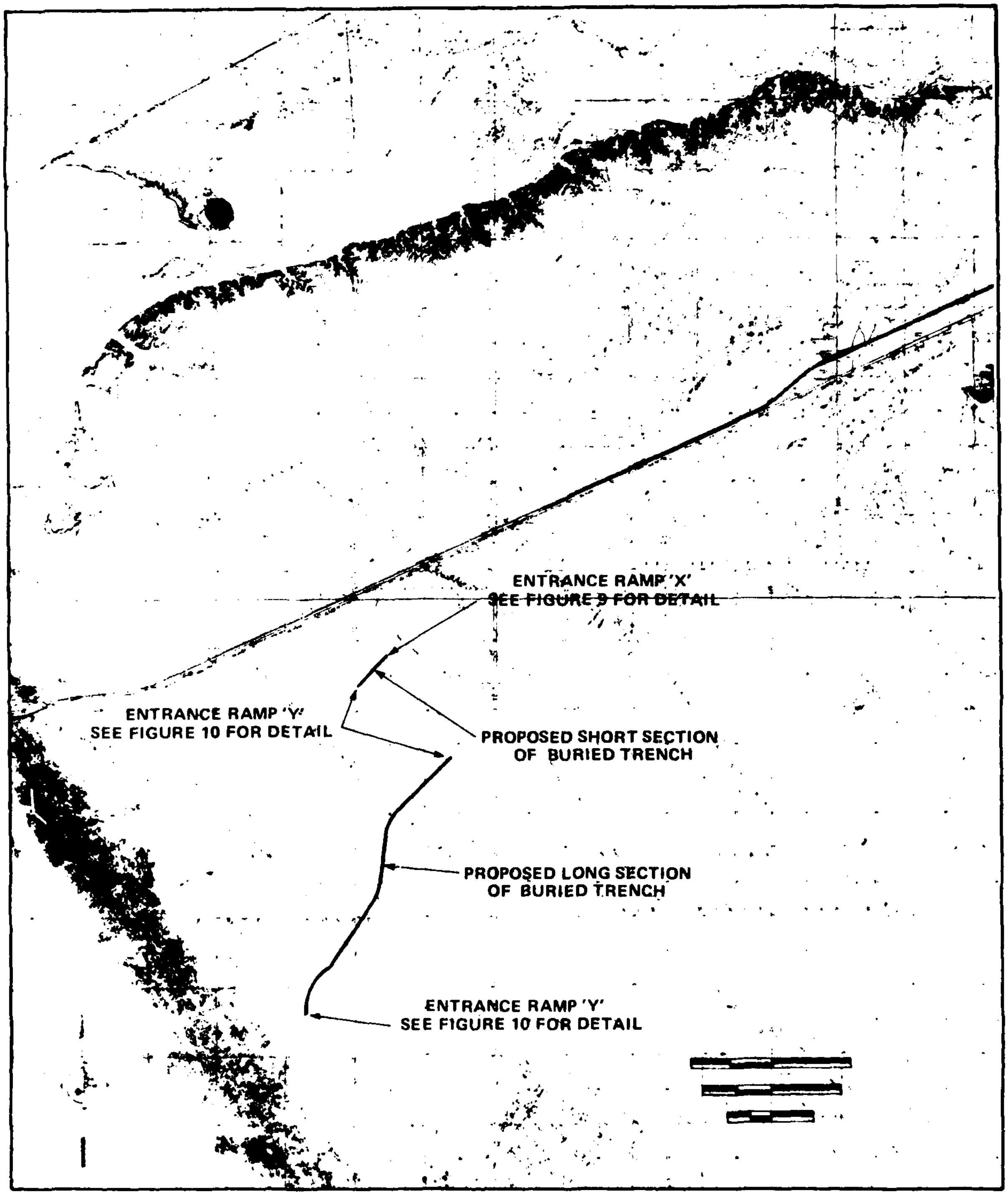

Figure 8. Trench alignments and locations of entrance ramps.

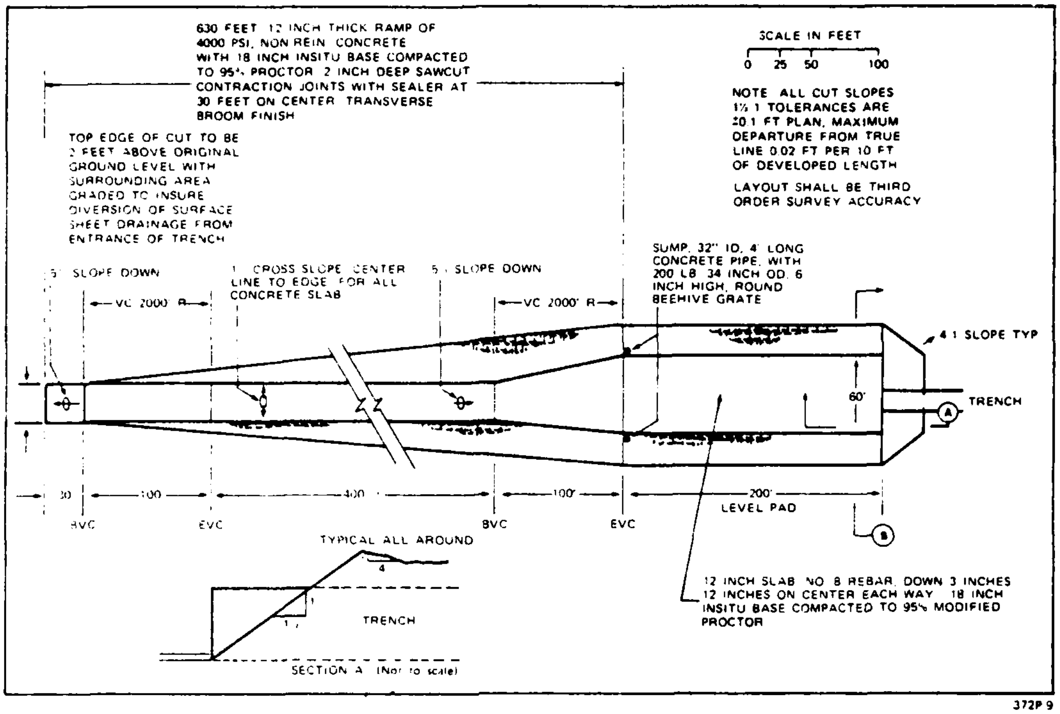

Figure 9. Configuration of entrance ramp "X".

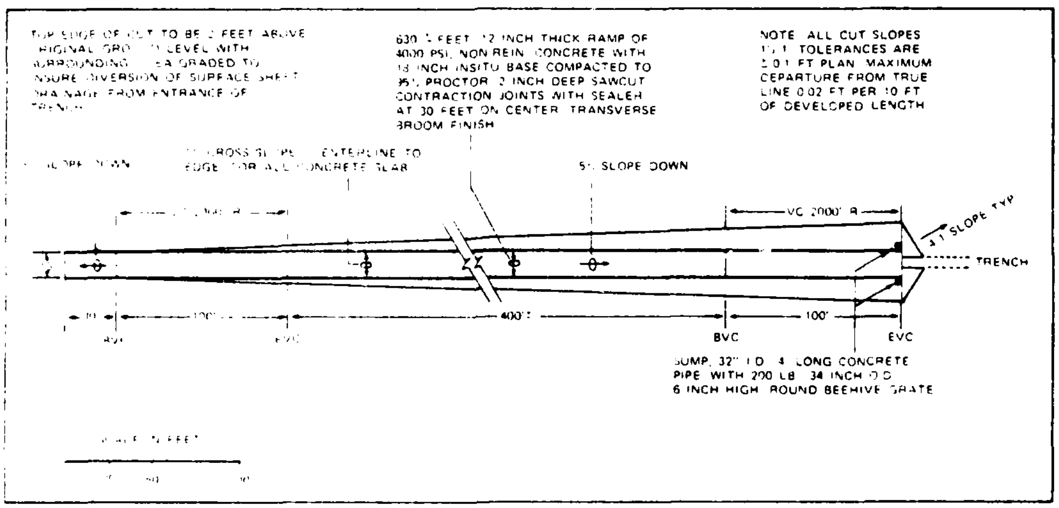

Figure 10. Configuration of entrance ramp "Y".

The lower terminus of the long trench is approximately 9,000 ft (2.74 km) southeast of the eastern terminus of the shorter section. This buried trench section is 20,000 ft (6.1 km) long in plan view, and includes both straight sections and five 2,000-foot-radius (610 m) horizontal curves. Entrance ramps of the Y configuration will be provided at both ends, increasing the nominal length of the complete structure by 1,260 ft (384 m) for a nominal overall length of 21,260 ft (6.48 km).

The vertical profile of the long buried trench will include some sections of compound horizontal/vertical curves in addition to straight (sloping) sections. The vertical profile of the buried trench will be such that arroyos will not be blocked except as an incident of construction; i.e., the buried trench will be carried under all arroyos so that the existing drainage pattern will not be permanently disrupted.

The configuration of the protective structure is shown in Figure 11. The structure is 16.5 ft (5.03 m) in outside diameter, and is to be covered with 5 ft (1.52 m) of compacted fill. Wall thickness, rib thickness, and rib spacing are selected to provide the desired degree of resistance from external overpressures; however, external longitudinal and transverse cuts in the structure reduce its resistance to upward-thrusting forces, permitting missile breakout from the structure.

The protective structure is to be constructed from steel-fiber-reinforced concrete, to facilitate its fabrication by a "slipforming" process to be described later. Conventional reinforced-concrete construction will be used for the ramps.

1.1.6 Construction Support Facilities and Delivery Routes

This site is currently accessible only by unimproved roads, preferably using four-wheel-drive vehicles, and except for the abandoned Stoval Airfield, is essentially undeveloped. It will thus be necessary to provide access roads for men, materials, and equipment, and support facilities such as a concrete batch plant for construction of the tunnel.

The proposed locations of these supporting facilities are shown in Figure 12.

1.1.6.1 ACCESS

Both rail and highway supporting facilities will be provided for the project.

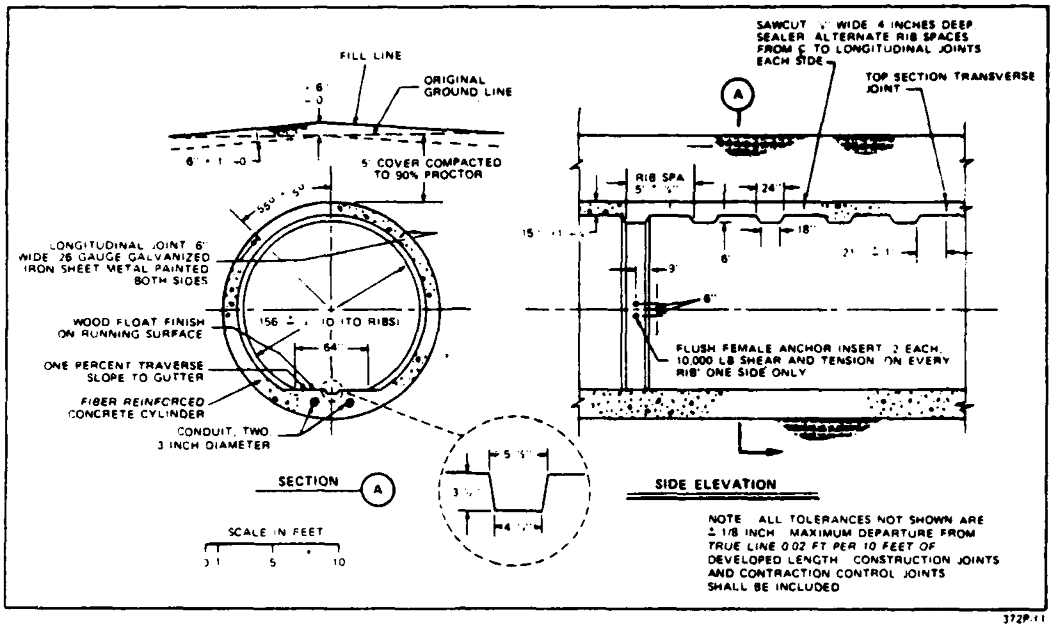

Figure 11. Configuration of the Protective Structure (PS).

A temporary offramp will be constructed from Interstate 8 eastbound at the position shown in Figure 12, providing access to the project via a temporary signalized grade crossing of the railroad and a semi-improved road to Stoval Airfield. There will be no access from westbound I-8 at this point.

An existing road accessible from the Dateland I-8 interchange that presently runs between the highway and the railroad, part of the way from Dateland to the site, will be extended and improved to intersect the project access road. This road will accommodate incoming traffic from the east, and all outgoing traffic.

On site, semi-improved roads will also be constructed from Stoval Airfield to the near ends of the two buried trench sections as shown. Temporary roads (not shown) will also be constructed along the buried trench alignments as construction progresses.

It is planned to extend an existing rail spur near Stoval by 330 ft (101 m) approximately doubling its present length, and to provide temporary facilities for offloading materials and heavy equipment, which will then move to the site by the road.

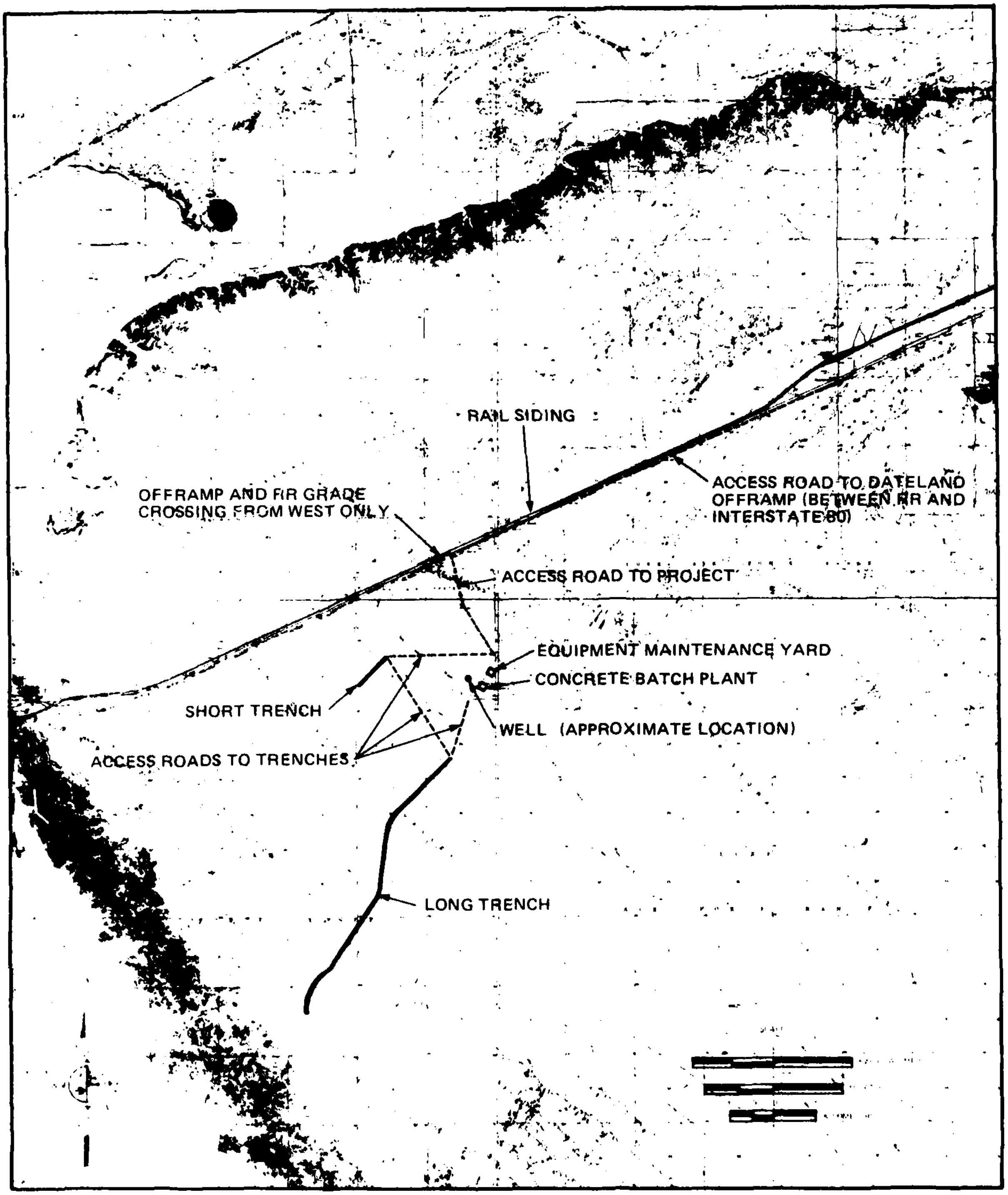

Figure 12. Support facility locations for project construction.

1.1.6.2 SUPPORT FACILITIES

The principal support facilities for the project will be a concrete batch plant (150 yd^3/hr) (114.50 m^3/hr) and a fenced equipment storage and maintenance yard, both of which will be installed at the abandoned Stoval Airfield either on the existing runways or toward the interior of the airfield. The total area will be approximately 10 acres (4.05 ha). A well is planned to be drilled immediately adjacent to the field (precise location not yet determined) to provide water necessary for the project (estimated at 500 gpm continuous withdrawal). A 20,000 gallon (76 m^3) water storage tank and a 100,000 gallon (379 m^3) lined storage pond will be constructed adjacent to the well to store water pumped during non-construction hours.

Approximately 2 MW of electricity will be produced on site with diesel-powered generators. No new electrical transmission lines will be required.

1.1.6.3 DELIVERY ROUTES

The following delivery routes are expected for the major items of construction materials and equipment required for the project:

1) Sand and gravel for concrete aggregate will be derived either from an existing commercial source approximately 5 miles north of Tacna or from existing abandoned pits north of Dateland redeveloped specifically for this project. If this material comes from Tacna, it will be trucked to the site via I-8 and the highway offramp near Stoval, and the empty trucks will return via the Dateland access to I-8. If the Dateland source is used, all access will be via Dateland.

2) Cement will be obtained from local commercial sources and trucked to the site via I-8, the Dateland offramp, and the connecting access roads.

3) Reinforcement will arrive by rail, and will be procured from the most cost-effective source, probably in the eastern United States.

4) Heavy construction equipment will arrive by rail.

1.1.7 Construction Methods

The following general procedures are anticipated for construction of the buried trenches, and have been used for environmental analysis:

1) A 100 ft (30 m) wide path, 50 ft (15 m) to either side of the centerline of the horizontal alignment will be graded to provide a smooth working surface. Cuts are expected to be in the range of 3 to 5 ft (1 to 1.5 m) deep. Excess materials will be stored adjacent to the 100 ft (30 m) wide path on both sides of the alignment.

The width of the disturbed zones along the trench alignments will vary with the topography and soil conditions encountered. A width of up to 328 ft (100 m) is anticipated and has been used for this assessment.

2) Conventional equipment, or possibly combinations of conventional and specialized equipment, will excavate a trench to the approximate final depth of the springline (half vertical dimension) of the Protective Structure. The trench may have either vertical sides or as much as a 45° side slope. The width of the base of the excavation will be between 17 and 20 ft (5 and 6 m). If vertical slopes are used, temporary shoring will be installed where soil strengths are not adequate to maintain them (it is estimated that approximately 90 to 95 percent of the trench can be excavated without support). Excavated material will be stockpiled at a distance sufficient not to interfere with the progress of subsequent pieces of equipment, but within the 328 ft (100 m) zone of disturbance. Water will be applied as necessary for dust suppression.

   This equipment will move sufficiently far ahead of the subsequent pieces that delays encountered as a result of nonoptimum excavation conditions (e.g., shoring requirements for loosely consolidated deposits, or the need to rip or blast hard deposits) would not impede progress of the overall operation. However, it would not be so far ahead that the probability of slumping of unsupported vertical sections would be large.

3) Another piece of equipment may be used to excavate the trench to its final depth and precise horizontal and vertical alignment, shaping its bottom to the external configuration of the Protective Structure. The additional excavated materials will be stockpiled with the materials previously excavated.

4) Another piece of equipment will emplace slip forms defining the upper external and internal surfaces of the Protective Structure to the required degree of dimensional and alignment tolerance. Steel-fiber-reinforced concrete will then be emplaced in the forms, with appropriate measures (e.g., vibration) taken to eliminate voids, and allowed to set. The slip forms and the equipment will be moved forward continuously.

   Concrete will be trucked to the slip-forming site along semi-improved roads parallel to the trench alignment within the cleared zone.

5) When the protective structure has achieved adequate strength, the trench will be backfilled (using conventional or specialized equipment), using the adjacent excavated materials to the extent that they are suitable for compaction (usually with added water to provide the optimum moisture content). This material would be compacted to 90 percent Proctor density to at least the top of the Protective Structure.

6) The remaining (excess) excavated materials will be spread over the disturbed zone in such a way as to provide drainage away from the centerline of the alignment, and all arroyos disrupted by construction will be restored to their original drainage pattern. The volume of spoil may vary depending on the final configuration of the excavated trench, the tunnel structure and the degree of compaction for backfill. Assuming near-vertical trench walls with nominal space for the tunnel structure and the access ramp configurations proposed, it is estimated that the net surplus volume of soil remaining after completion of all trench and ramp backfill and compaction will equal a spoil volume of about 180,000 yd^3 (137,000 m^3) for the project.

The spoil will be spread over the 328 ft (100 m) wide trench construction zone while maintaining a maximum of 5 ft (1.5 m) of fill over the top of the trench structure. The resultant spoil pile heights will be approximately 0.7 ft (0.2 m) above the original ground surface.

In areas where varnished desert pavement occurs, the top layer of rocks will be stockpiled during excavation and will be spread evenly over the final graded compacted surface.

The entrance ramps will be constructed after the corresponding terminal sections of Protective Structure, and the terminal sections of the ramps will match the PS floor exactly in elevation and angle.

1.1.8 Materials Consumption

The following quantities of materials are expected to be used on construction of the project.

1.1.8.1 WATER

Total water consumption is estimated as 68.6 million gallons (Mgal) budgeted as follows:

Concrete Preparation	2.0 Mgal	(7.57 Ml)
Soil Compaction	35.5 Mgal	(134.47 Ml)
Dust Control	20.0 Mgal	(75.76 Ml)
Domestic Uses	1.0 Mgal	(3.79 Ml)
Equipment Washing	1.5 Mgal	(5.68 Ml)
Sand Washing	8.6 Mgal	(32.58 Ml)
TOTAL	68.6 Mgal	(259.85 Ml)

If sand is procured from the commercial source at Tacna, the 8.6 Mgal (32.58 Ml) budgeted for sand washing would not be required to be produced on site.

1.1.8.2 CONCRETE CONSTITUENTS

Concrete constituents have been estimated to be required in the following quantities to produce the required 46,000 cu yds (35,167 m^3).

Material	Quantity	Probable Sources
Cement	675 truckloads	Phoenix
Fly Ash	90 truckloads	Phoenix
Sand	1200 truckloads	Tacna
Aggregate	1900 truckloads	Tacna
Steel Fibers	50 rail carloads	Eastern Seaboard

1.1.9 Construction Costs and Schedule

Construction costs have been estimated as follows:

Engineering	2.0 million dollars
Construction materials	10.5 million dollars
Construction labor	3.5 million dollars
Special equipment	4.0 million dollars
TOTAL	20.0 million dollars

Detailed project schedules by activity phase are in a late state of evaluation, but subject to minor changes that are not expected to have a substantial influence on impacts. The project is scheduled to start February, 1978, with peak activities in April and May, with completion scheduled for the end of September. The intensity of activity is shown by the following table of estimated total labor force applied (contractor, craftsman, and government).

Month (1978)	Estimated Labor Force
February	112
March	171
April	238
May	199
June	58
July	33
August	24
September	17

A standard 40-hour work week consisting of five 8-hour work days beginning at approximately 7 a.m. will be followed throughout the project. Some personnel will probably put in as much as 3 hours overtime daily to accomplish routine maintenance on construction equipment.

1.1.10 Buried Trench Breakout, Erection, and Demonstration Test

Following completion of the short tunnel section, a simulated launch canister and simulated load will be positioned within the tunnel, and one or two breakout demonstration tests will be performed. The demonstration will consist of actuating the breakout and erection subsystem which consists of a series of gas generator-driven ballistic actuators. One actuator will provide lift for the initial breakout. Following initial breakout, two smaller five-stage telescoping pistons will effect erection of the simulated missile.

The breakout demonstration will take place near 15 August 1978. Preparation will begin approximately 15 April. Personnel are expected to commute from Yuma, Arizona to the test site daily. There will be approximately 20 personnel (in addition to those listed in Section 1.1.9) on site throughout this period, with some visitors expected prior to and during the breakout demonstration.

1.2 THE EXISTING ENVIRONMENT (AFERN 3.0)

1.2.1 Physical Environment

1.2.1.1 GENERAL SETTING AND GEOLOGY (AFERN 3.1)

The project site is located northeast of the Mohawk Mountains on a northeasterly sloping, nearly planar, alluvial surface which forms the southwestern flank of San Cristobal Valley. The alluvial surface reaches elevations of 860 ft (262 m) at the base of the Mohawk Mountains and gently slopes downward to the northeast at an average rate of 83 ft/mile (15 m/km) to an elevation of about 355 ft (108 m) in San Cristobal Wash. The slopes of the rugged Mohawk Mountains rise steeply from the alluvial surface to elevations greater than 2,000 ft (610 m). Scattered remnant bedrock knobs (inselbergs) situated not more than 1 mile (1.6 km) from the mountain front, remain unburied by the alluvial deposits and form small resistant outlying hills.

The proposed trench alignments roughly parallel the slope of the alluvial surface. The slope of the trench reaches a maximum of 3 percent grade at the southwestern end of the proposed long alignment (elevation 600 ft [183 m]) and gradually flattens to the northeast as it approaches the flat central portion of San Cristobal Wash.

The general geologic setting of the San Cristobal Valley area consists of a broad structural basin, bordered by the Mohawk Mountains and the Aztec Hills. The Mohawk Mountains consist of a complex assemblage of metamorphic and granitic rocks. Detritus from these rocks, ranging in grain size from boulders to clay, have been deposited over the bedrock terrain and have filled the San Cristobal Valley basin. These sediments have a thickness of approximately 3,700 ft (1,121 m) in the vicinity of Stoval Airfield (1). The depth to bedrock, and thus the thickness of the overlying sediments, decreases toward the Mohawk Mountains. Drillhole and seismic refraction data indicate that bedrock material (compressional wave velocity 7,000 ft/s,[2.1 km/s]) along the proposed trench alignments is not likely to be encountered within 100 ft (30 m) of the surface along most of the alignment and within 70 ft (21 m) of the surface along the southwestern portion of the alignment of the long trench.

The near surface alluvial sediments of the site have been divided into several geologic units based on their geomorphic, geophysical and soil engineering characteristics (Figure 13). The majority of the trench alignments cross the "Alluvial Fan Deposits." This geologic unit has been further divided into three subunits: the intermediate, young and recent fan deposits. These subunits consist of various proportions of loose to well consolidated admixtures of silt, sand, gravel, pebbles and cobbles. The coarser intermediate fan deposits are located in the southwestern portion of the long alignment while the finer grained recent fan deposits are restricted to the northeast portion of the long alignment and underly the majority of the short alignment. The "Stream Channel and Flood Plain Deposits" represent the youngest geologic unit in the siting area and are reported to consist of loosely consolidated silt, fine to coarse sand, gravel and cobbles. Along the trench alignment, these deposits are generally restricted to the arroyos and washes. The very fine grained portion also makes up the flat floor of San Cristobal Valley. The "Undifferentiated Surficial Deposits" are restricted to local areas at the northeastern end of the proposed trench alignments and consist predominately of loose silt and fine sand with scattered residual coarse sand and fine gravel. Isolated stabilized sand dunes are also associated with these deposits.

1.2.1.2 GEOMORPHOLOGY (AFERN 3.1)

The overall geomorphic character of the alluvial surface consists of a series of coalescing fans (bajada) derived from detritus eroded from the Mohawk Mountains. The bajada gradually grades into the flat playa (ephemeral lake) of San Cristobal Valley. Three generations of alluvial fans, in addition to other associated geomorphic features, have been recognized on the bajada at the site.

The oldest fans are generally restricted to the southwest portion of the long alignment, (see Figure 13, geologic unit $A5_1$). These old fans have well-developed dark desert-varnished, desert pavement surfaces (visible on Figures 3 and 4). With progressively younger age and increasing distance down the alluvial surface toward the playa, the surfaces of the fans have less well-developed pavements and totally lack the desert varnish. The surfaces of the fans in the lower (youngest) portions of the

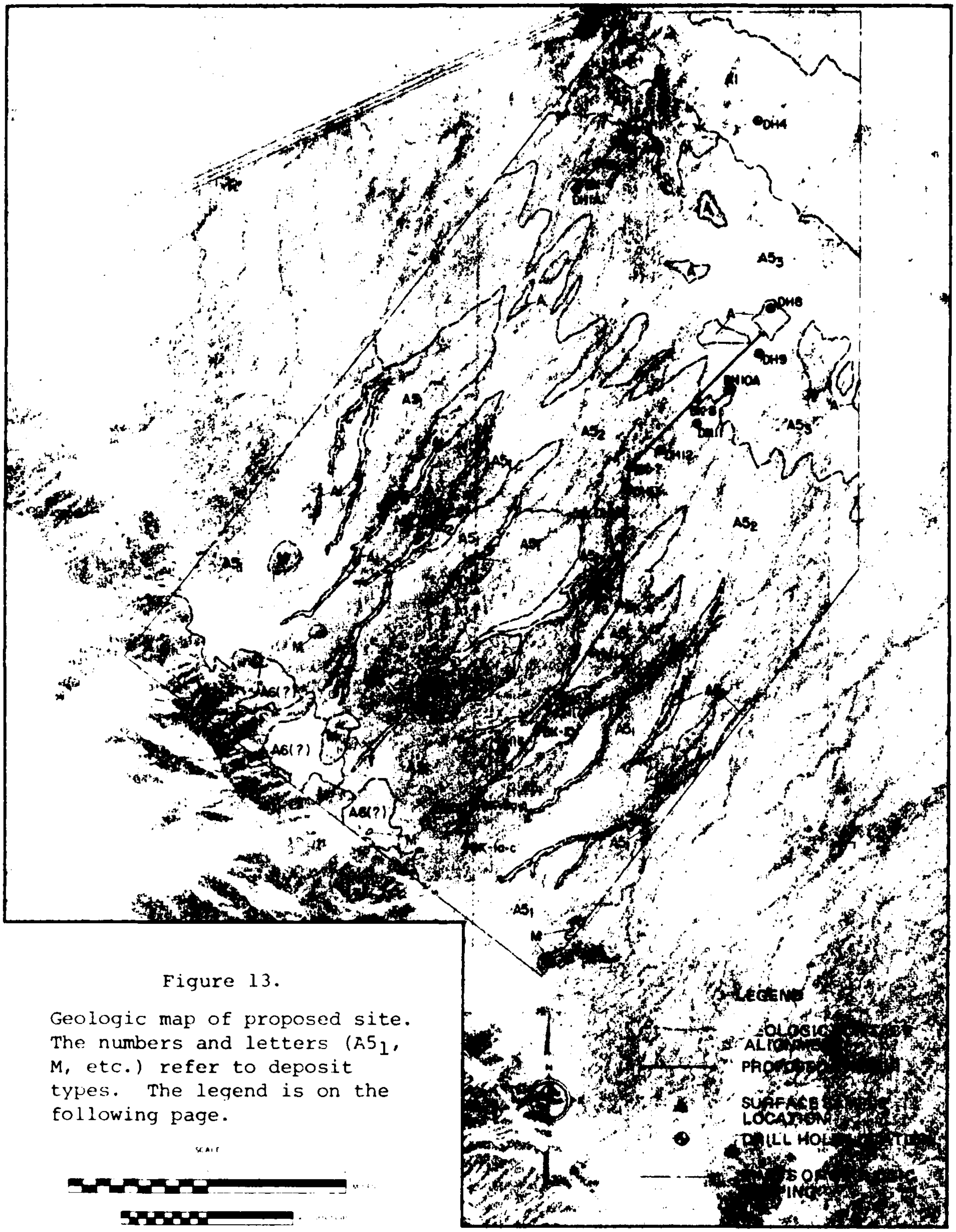

Figure 13.

Geologic map of proposed site. The numbers and letters ($A5_1$, M, etc.) refer to deposit types. The legend is on the following page.

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Figure 13. (cont.) Legend for map on preceding page.

BASIN FILL

Quaternary

A — UNDIFFERENTIATED SURFICIAL DEPOSITS - Predominantly loose silt and fine sand; poorly graded with scattered residual coarse sand and fine gravel on the surface. Deposited primarily by wind and water processes upon low gentle swales on the basin floor.

A1 — STREAM CHANNEL AND FLOODPLAIN DEPOSITS - Loosely consolidated fine to coarse sand and silt occurring near the valley axis. Grain size increases to fine gravel and cobbles in incised channels nearer the mountain front. Presently, deposition is along San Cristobal Wash and numerous tributary washes.

A5 (Increasing Relative Age)

$A5_3$ — ALLUVIAL FAN DEPOSITS - $A5_3$ - Loosely consolidated admixtures of fine to coarse sand and silt with scattered fine lag-gravel. This fan is an unvarnished, active surface of sediment transport grading to the same base level as the stream channel and floodplain deposits.

$A5_2$ — $A5_2$ - Unconsolidated to poorly consolidated sand, silt and sandy gravel, with variable amounts of unvarnished surface gravels forming isolated areas of desert pavement. This fan in various stages of abandonment as a surface of sediment transport.

$A5_1$ — $A5_1$ - Well consolidated to moderately indurated admixtures of silt, sand, gravel and cobbles. This fan, a deeply varnished, well-paved surface, is an abandoned surface of sediment transport elevated three to five feet above the $A5_2$ and $A5_3$ alluvial fans. These fans form a near-continuous apron adjacent to the Mohawk Mountains.

A6 — PEDIMENT DEPOSITS - Loosely consolidated gravel - to boulder-sized material derived from adjacent granitic and metamorphic rock complexes. Deposits are generally less than 10 feet thick and mantle planated rock shelves in shallow mountain re-entrants.

ROCK

Pre-Quaternary

M — GRANITIC/METAMORPHIC ROCK ASSEMBLAGE - Complex rock assemblage composed predominantly of granite, gneiss and schist.

bajada (the northeast portion of the long alignment and all of the short alignment) are soft and fine-grained with little to negligible pavement development. The most recent deposits occur in the active ephemeral stream channels and on the playa surface.

The southwestern portion of the bajada has been dissected by a dendritic pattern of recent ephemeral stream channels (Figure 14). In the northeast portion of the bajada the channels are less well-defined and generally produce a braided stream pattern.

The flat-floored playa has extensive areas of barren, smooth, sun-baked silty to clayey mud-cracked ground. The surface is hard when dry; however, during and after storms the playa surface can be inundated with shallow waters making it very soft.

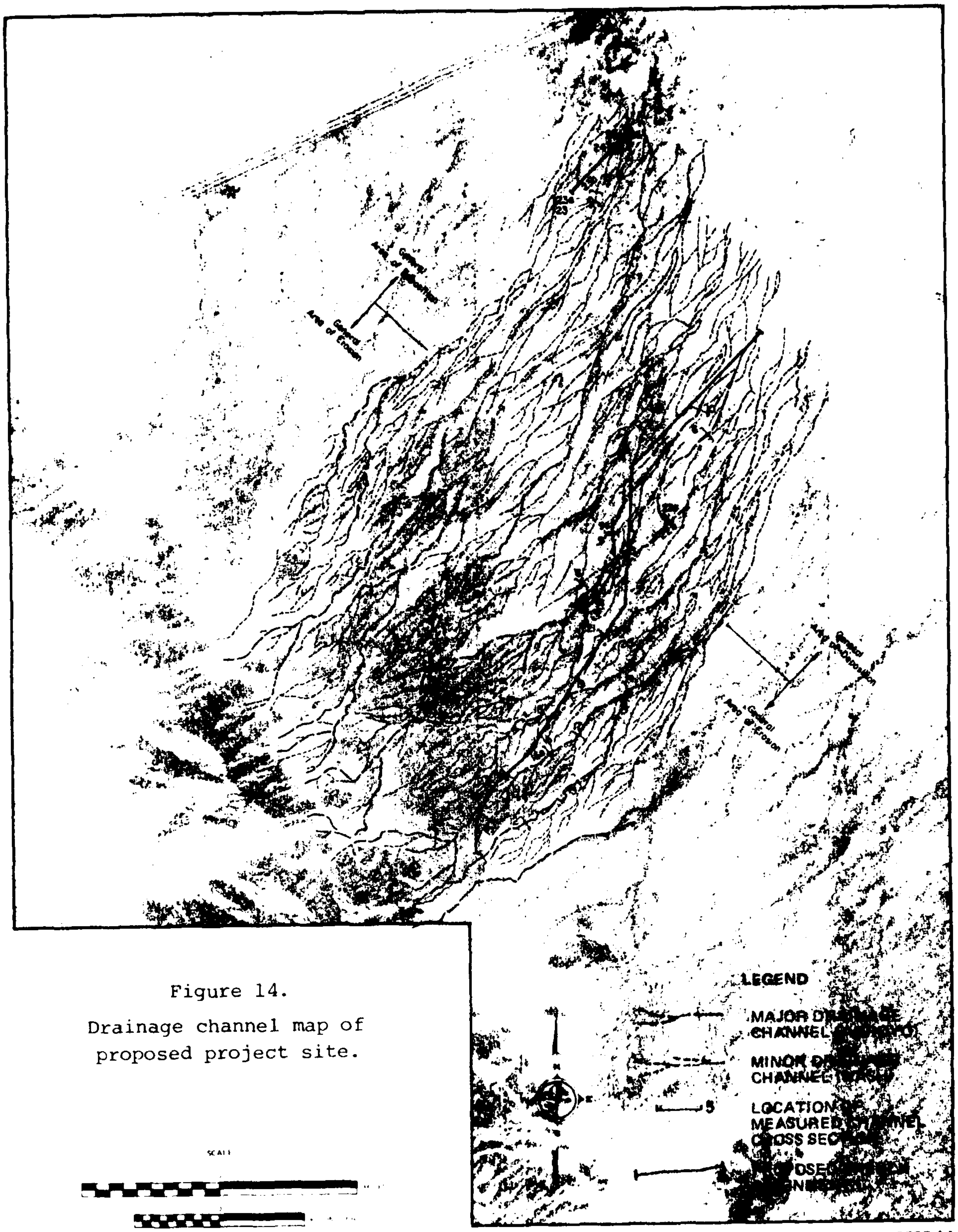

Figure 14.
Drainage channel map of proposed project site.

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The smaller scale geomorphic features on the surface of the bajada, such as desert pavements, are expressions of a natural state of equilibrium between erosional and depositional processes. In their natural state these features prevent any unbalanced erosion or deposition from occurring.

The desert pavements of the southwestern portion of the long alignment are composed of a tightly-packed mosaic of angular, coarse clasts, one stone thick, overlying a thin layer of loose silt (Figure 15). These pavements are formed by wind and water erosional forces which remove the fine-grained surface materials and leave the coarse clasts. When mature, the pavements tend to retard the eroding forces that formed them (2).

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Figure 15. Smooth, barren desert pavement between washes on the upper bajada near the long trench alignment. No perennial vegetation occurs in these areas.

The bajada surfaces at the short alignment and the northeastern portion of the long alignment are protected from wind and water erosion primarily by scattered vegetation and a thin (3 to 5 mm) silt and clay surface crust (carapace). The carapace crust coats the underlying loose sediments and is formed by the settling of silt and clay on the surface after raindrop impact or a sheet flow of water. The vegetation traps small volumes of windblown sand in the form of coppice sand dunes. This tends to retard further movement of the sand by the wind.

1.2.1.3 SOIL PROPERTIES (AFERN 3.1)

The near-surface soils along the proposed trench alignments are principally silty sands with varying amounts of boulders (as large as 30 in [76 cm] in diameter), cobbles, gravels, silt, and clay. Generally the silt content of the soil increases with increasing distance down the bajada toward the playa.

Based on the results of laboratory tests, an overall volumetric soil shrinkage of 10 to 15 percent is expected from the inplace density of the native soils to the compacted density of the backfill material (compaction will be carried out to a nominal 90 percent of the maximum density, as determined by the ASTM D1557-70 test method). Further, a comparison of average *in situ* moisture contents and the optimum moisture contents indicates that less than 5 percent additional moisture by weight will be required for compaction, assuming some drying out of materials.

1.2.1.4 MINERAL RESOURCES

Silver and barite form veins of minor economic importance, and minor mineralization of gold, copper, lead, and molybdenum have been found in the Mohawk Mountains. The more dominant barite and silver-bearing veins appear to be of epithermal character. There is presently no active mining in the area; however, since the turn of the century, there have been about a half dozen mines and prospects consisting mainly of shallow shafts extending to depths up to 70 ft (21 m) below the ground surface, surface cuts to 25 to 30 ft (8 to 9 m) deep, and a tunnel about 300 ft (91 m) long.

1.2.1.5 HYDROLOGY (AFERN 3.2.1)

1.2.1.5.1 Surface Hydrology

The drainage channels that affect the project site are delineated on the drainage channel map (Figure 14).

Surface runoff from precipitation on the eastern slopes of the Mohawk Mountains collects in the canyons and flows down into well-defined drainage channels that have become incised up to 10 ft (3.05 m) into the upper portion of the bajada over the last several thousand years. Rain falling directly on the bajada collects in a dendritic pattern of small channels that formed initially as shallow rills generally a few feet wide and only a few inches deep. These small rills converge into larger channels that either join the large channels from the mountains, or flow on down the alluvial surface to form additional drainage channels. Fluvial processes are predominantly in a state of erosion in the area of dendritic channel patterns characteristic of the higher southwest portions of the bajada.

In an area located approximately midway between the mountains and San Cristobal Wash, the drainage channels take on a braided pattern that continues on to the valley floor. The fluvial processes in this braided channel portion of the bajada are generally in a state of deposition. In this area the main channels become shallower and progressively less well defined toward the valley floor, continually dividing into smaller distributary channels.

At some localities within this area, especially in areas near San Cristobal Wash, runoff has been in the form of sheet flow.

The arroyo shown in cross sections 1 through 6 on Figure 16 typifies the large arroyos that originate in the mountains and are deeply incised in the southwest or upper portion of the bajada. The locations of cross sections 1 through 6 are shown on Figure 14. This arroyo becomes progressively smaller down the bajada surface toward the playa. The arroyo ranges from 7 to 9 ft (2.1 to 2.7 m) deep and has a gradient of from 1.7 percent to more than 3.3 percent in the southwestern portions of the bajada. The arroyo is sinuous with an irregular bottom formed by silt, gravel and boulders. Downstream from measured Section 3, the arroyo maintains similar characteristics for another mile (1.6 km) or so, and then changes character, becoming narrower, shallower, and less sinuous. About 2 miles (3.2 km) downstream from measured Section 3, the channel is greatly reduced in size (Section 5), averaging only 10 ft (3 m) wide and 1.8 ft (0.5 m) deep. At this point, the channel bottom is covered by sand, fine gravel, and silt, and its course is nearly straight.

The change in channel shape and size, as shown in Figure 16, reflects the dramatic loss of storm waters through infiltration into the sands underlying the wash during periods of storm runoff. Infiltration rates of more than 3.80 inches/hr (9.4 cm/hr) have been measured adjacent to the site, (3). As a storm wave passes down the alluvial fan, this marked reduction in volume reduces the erosive power of the stream and thus limits the size of channel excavation by flowing water, resulting in the noted changes in size and character of the channels.

Two major arroyos which originate in the mountains, and therefore have the largest potential flow volumes, cross the long trench alignment. The first of these arroyo crossings is located at cross section No. 5, (located on Figures 14 and 17). The second of these arroyo crossings is located about 0.3 miles (0.5 km) downstream of cross section No. 9a (Figure 14). As seen in Figure 16, the cross-sectional area of these arroyos in this portion of the bajada is relatively small.

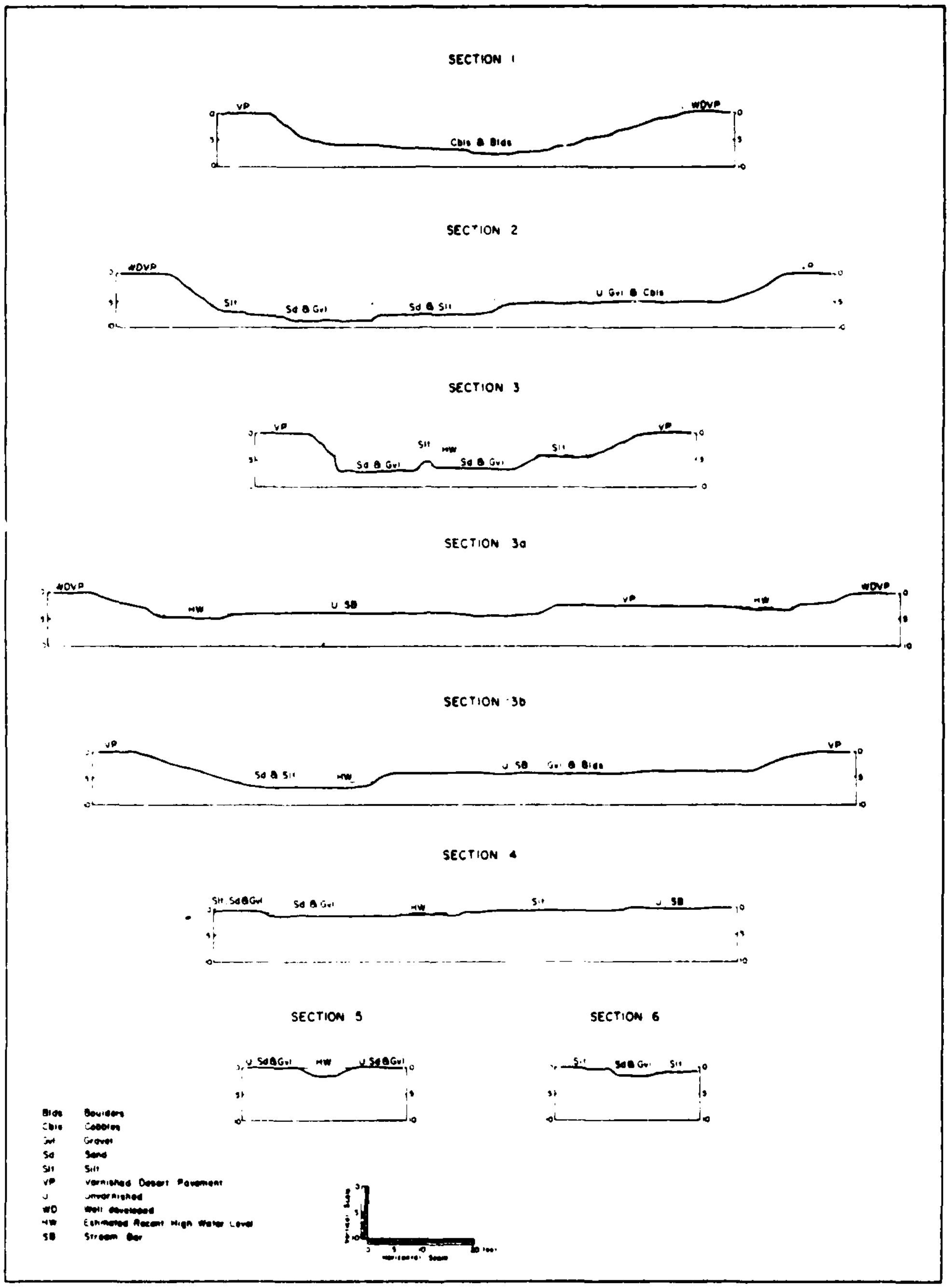

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Figure 16. Measured channel cross sections 1 through 6, San Cristobal Valley, Arizona. The locations of these sections are shown on Figure 15. They demonstrate the size reduction in an arroyo from the mountains (Section 1) to the lower bajada (Section 6).

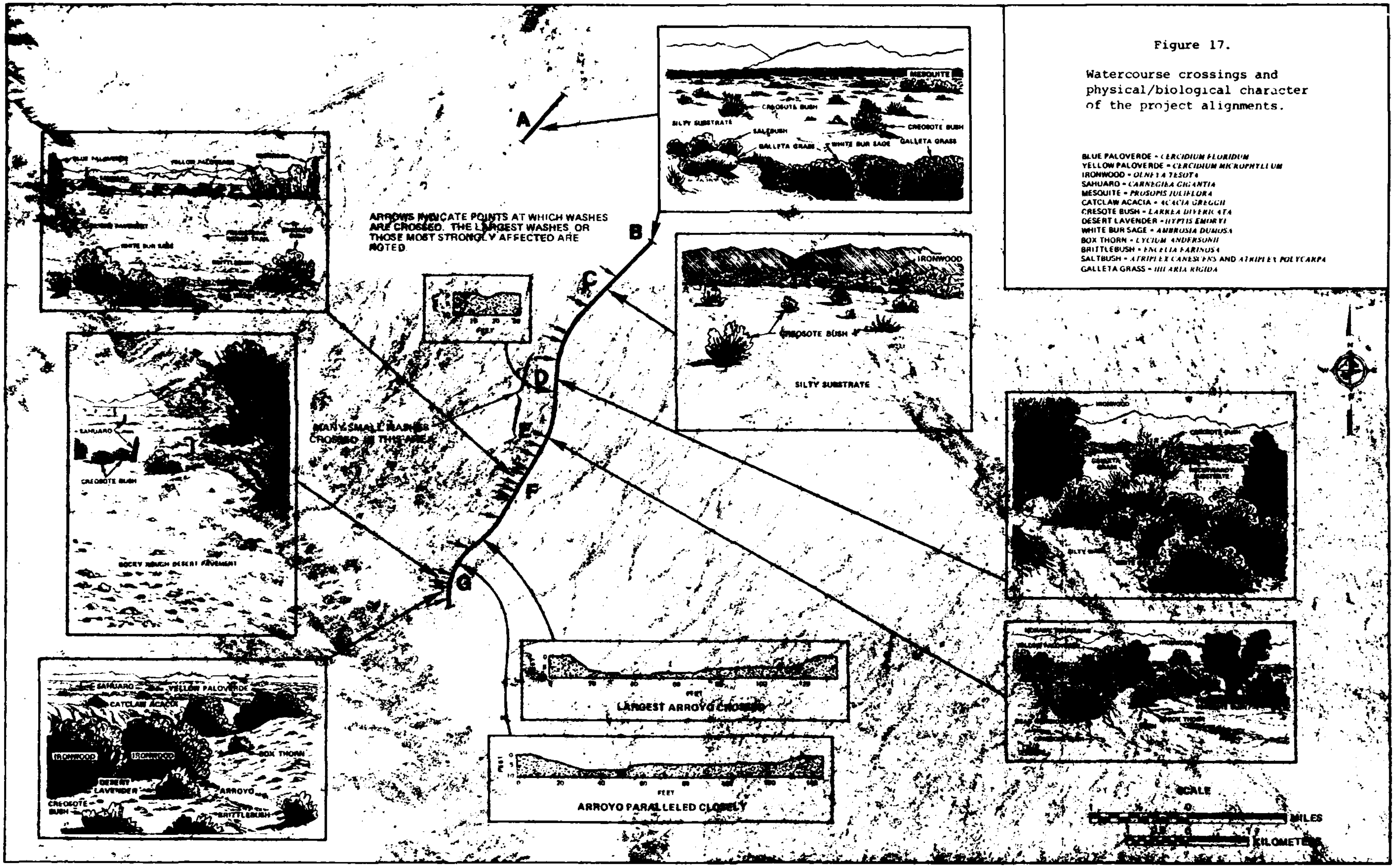

Figure 17.

Watercourse crossings and physical/biological character of the project alignments.

BLUE PALOVERDE = *CERCIDIUM FLORIDUM*
YELLOW PALOVERDE = *CERCIDIUM MICROPHYLLUM*
IRONWOOD = *OLNEYA TESOTA*
SAHUARO = *CARNEGIEA GIGANTIA*
MESQUITE = *PROSOPIS JULIFLORA*
CATCLAW ACACIA = *ACACIA GREGGII*
CRESOTE BUSH = *LARREA DIVERICATA*
DESERT LAVENDER = *HYPTIS EMORYI*
WHITE BUR SAGE = *AMBROSIA DUMOSA*
BOX THORN = *LYCIUM ANDERSONII*
BRITTLEBUSH = *ENCELIA FARINOSA*
SALTBUSH = *ATRIPLEX CANESCENS* AND *ATRIPLEX POLYCARPA*
GALLETA GRASS = *HILARIA RIGIDA*

The largest arroyo crossed by the alignment (shown in Figure 17) carries water only when water levels in the adjacent arroyo (cross Sections 1 through 6, Figures 14 and 17) exceed 1 ft (0.3 m). Cross section 2 of Figures 16 and 17 shows the size of this adjacent main arroyo where it passes within 42 ft (14 m) of the southwestern portion of the long alignment. Many smaller tributary and distributary washes cross the trench alignments.

1.2.1.5.2 Groundwater Availablility and Quality (AFERN 3.2.2)

There are a number of producing wells within a few miles of the project site. Two of the nearby wells are operated by the Arizona Highway Department, one at the rest stop on Interstate 8 just off the NW corner of the site (pump rate 27 gpm) and one at Dateland (pump rate 110 gpm) (4). In addition, the Arizona State Land Department lists 27 wells in the two townships on either side of Dateland. Twelve were not in use at the time the list was obtained, and seven were producing over 1,000 gpm (four of these were producing over 2,000 gpm) (4). The average specific yield of wells in the area is about 42 gpm per foot (.52 m^3/min per m) of drawdown (5). Nearby wells have high total dissolved solids, 700-1,000 ppm, and high fluoride content, 5-8 ppm (6).

Studies are in progress to determine the yield and drawdown of wells on the project site. Most wells in the vicinity from which these data are available are on or adjacent to the Gila River Floodplain, and extrapolation to conditions on site is not possible.

1.2.1.6 METEOROLOGY (AFERN 3.3.1)

Wind

There are no preexisting wind data available for the site area. For this reason, two isolated measurements were made, one in the month of October 1976 and one in the month of April 1977. The hourly average wind speeds at selected hours from these measurements made in April 1977 are presented in Figure 18.

These two field measurements do not conclusively characterize wind fields on site because of the short durations; however, they depict the characteristic diurnal wind direction cycle. This diurnal direction cycle is controlled by the local uneven surface heating. In the early part of the day, the east-facing slopes of the Mohawk Mountains are heated and cause air to rise from the San Cristobal Valley. Consequently, the prevailing wind direction is from the northeast of the site. In the late afternoon and early evening hours the east-facing slopes cool off at a faster rate than in the Valley. Subsequently, the air flows from the slopes to the valley and causes westerly and southerly winds in the site area.

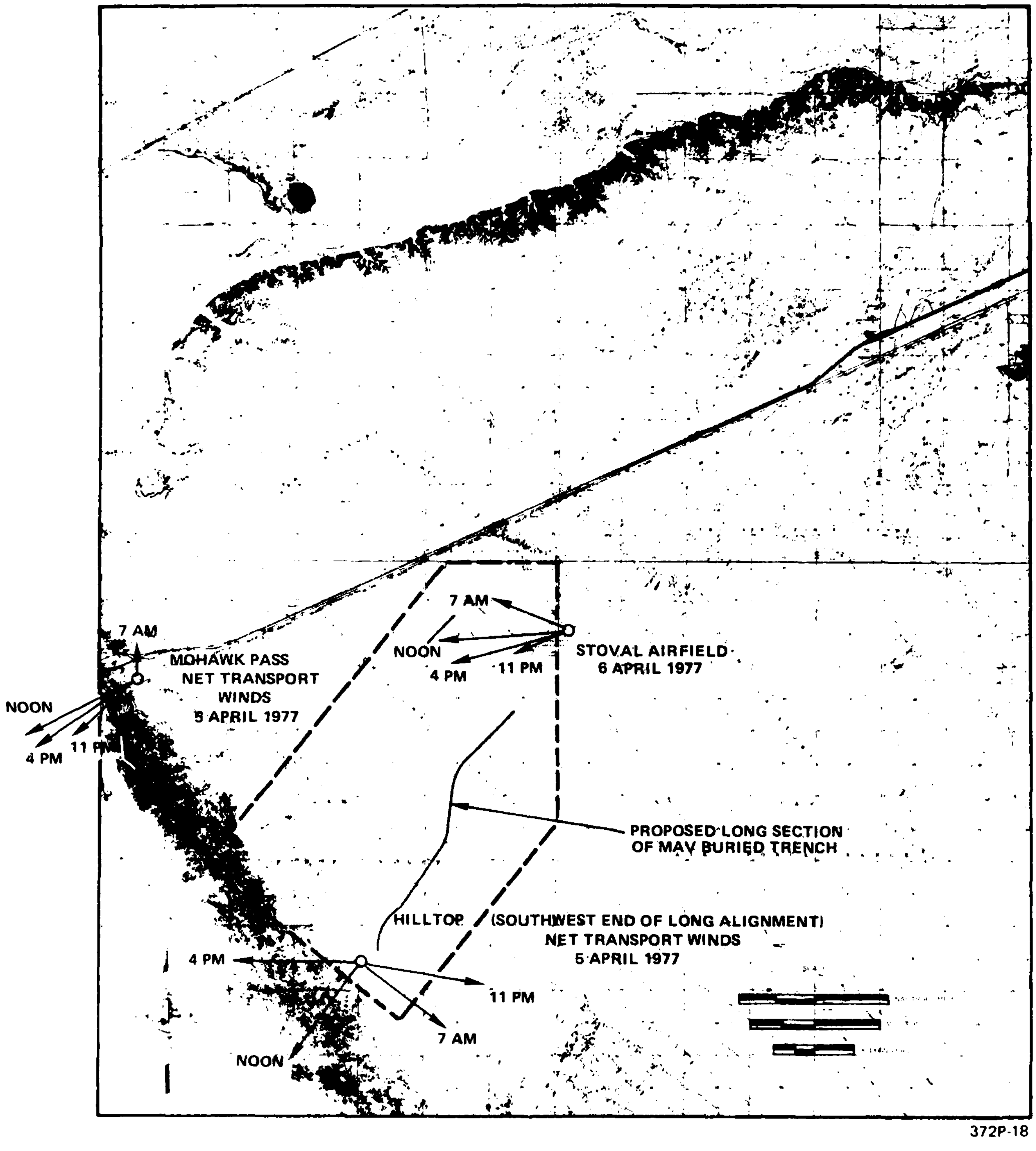

Figure 18. Hourly average wind speeds and directions at three locations on the project site on 5 and 6 April, 1977. The lengths of the arrows are drawn to scale in miles and represent miles per hour. The dotted outline is the part of the area mapped geologically (See Figure 13) from which the soil types are used in calculation of impacts to air quality.

The diurnal valley/slope wind patterns dominate the wind pattern in the site area with synoptic systems occasionally superseding this mesoscale diurnal variation.

Table 1 indicates the present frequency of occurrence of wind of various speeds at Yuma and Gila Bend over a period of record extending from 1948 to 1975.

Table 1. Percent frequency of occurrence of winds of various speeds (from Reference 17).

LOCATION	WIND SPEEDS (mph)						
	0-1.2	1.3-4.6	4.7-6.9	7.0-11.5	11.6-18.4	18.5-24.2	24.3-31.1
Yuma[1]	9.6%	10.8%	33.8%	29.6%	13.8%	2.1%	0.3%
Gila Bend[2]	29.2%	7.0%	29.2%	16.8%	6.2%	1.2%	0.3%

[1]Period of Record 1948-1971.

[2]Period of Record 1948-1960, 1971-1975.

Climate

The project site climate is given below:

The climate is emphatically that of the desert. While the period from October to mid-May is quite pleasant, the remainder of the year is almost unbearably hot. Temperatures of 120 degrees or higher have been recorded in July, August, and September.

During the cooler seven and one-half months of the year, the area has very mild weather. Below freezing temperatures are rare, occurring, on the average, only occasionally during January and the last two-thirds of December. The lowest temperature on record, 16 degrees, was recorded in January 1937. During the daylight hours in winter, temperatures normally rise into the high sixties or low seventies.

Rainfall amounts at Mohawk Station (8) are normally very small. Only in August and December is the normal rainfall more than one-half of an inch. A large fraction of the total precipitation falls in a very short period of time. The heaviest warm season rains are associated with tropical storms originating in the Pacific Ocean off the coast of Mexico. Such a storm dumped 3.55 inches of rain on Mohawk on 10 August 1941. The winter rains are usually gentler and longer lasting than those of summer.

Table 2 shows the frequency of occurrence of storms of various intensities at Yuma and Gila Bend, the two closest sites for which such data are available.

Table 2. Estimated maximum precipitation from short duration storms at Yuma and Gila Bend (9). Frequency of occurrence shown.

DURATION OF STORM	LOCATION	(AMOUNT OF PRECIPITATION (INCHES)		
		1 YEAR	10 YEARS	100 YEARS
3 Hours	Gila Bend	0.75	1.92	3.08
	Yuma	0.40	1.54	2.61
1 Hour	Gila Bend	0.64	1.74	2.78
	Yuma	0.36	1.35	2.25
0.5 Hour	Gila Bend	0.55	1.37	2.20
	Yuma	0.28	1.07	1.78

The seasonal distribution of rainfall, in general, follows the same pattern in the southwestern region of Arizona as it does in the more rugged northern and eastern sections. The precipitation from showers is greatest in July, August, and September and least in April, May, and June. The southwestern region of Arizona receives 48 percent of its rainfall between May and October while the much wetter (about twice as much rainfall) central and plateau regions of the state receive 48 and 55 percent of their annual totals in the same period. On a daily basis most of the rain in the desert areas occurs in the evening coincident with the peak in thunderstorm activity, rather than in mid to late afternoon as occurs farther north and east over the plateau.

1.2.1.7 AIR QUALITY (AFERN 3.3.3)

Except for the presence of suspended dust, air pollution in the desert regions of Arizona is considered to be well below the National Ambient Air Quality Standards (10) and the standards set by the Arizona State Department of Health (11).

Ambient airborne dust levels that exceed the national primary standard for particulates do occur at the project site. In a study of diurnal dust variation in the United States (12), the normally reported visibility of 7 mi (11.3 km) used by the National Weather Service to indicate the first presence of significant blowing dust, results from an estimated dust concentration of about 2.7 mg/m^3 or just over 10 times the air quality standard. A day with 50 mi (80 km) visibility would have 0.715 mg/m^3 dust in the air on the average, about three times the national standard of 0.260 mg/m^3. Figure 19 shows that 7 mi (11.3 km) visibility at the site is exceeded approximately 99.5 percent of the time.

Relationships have been developed relating wind speed, particulate concentration, and visibility at lower wind speeds than those reducing visibility to 7 mi (11.3 km). Table 3 derived from references (12) and (82) indicates the wind speeds and related dust loads to reduce visibility over soils similar in grain size distribution to those at the project site. At wind speeds of 12 to 18 miles per hour, the primary federal ambient air quality standard for particulates (260 $\mu g/m^3$) can be exceeded by windborne dust from an undisturbed surface. Visibility reduction to less than 50 mi (80 km) from windborne particulates will occur from winds more than approximately 30 mi (48 km) per hour. For winds up to 11 mph the visibility will be unaffected. Intermediate winds (11 to 18 mph) will cause some restriction.

Thunderstorms also generate dust and cause what have been called "American Haboobs" or dust storms (13, 14). Frequently, individual storms form lines or systems that move north or northwest across Arizona under the influence of upper level winds. Since the formation of these systems occurs most frequently in the area south and west of Tucson, the western desert areas are subjected to more frequent dust storms than other parts of Arizona. Visibility in the most severe of these storms would be reduced to less than 0.25 mi (0.4 km).

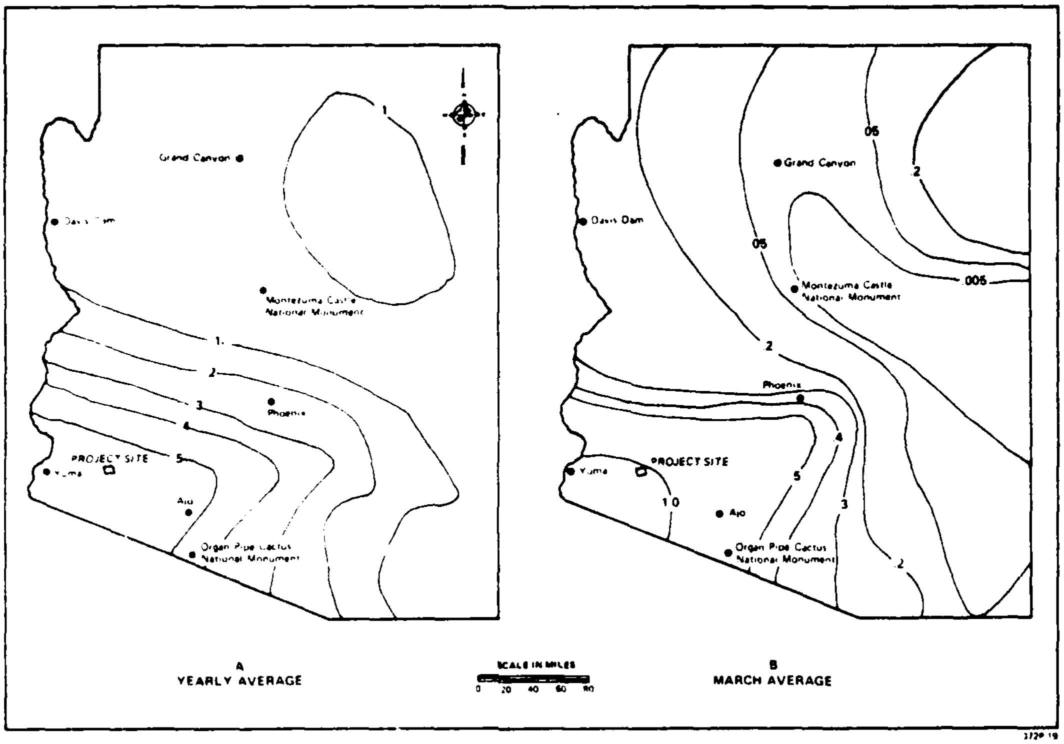

Figure 19. Locations of Arizona Particulates Monitoring Network Stations; and the percentage frequency (based on hourly observations from military stations not shown on this map) when prevailing visibility was less than 7 mi (11.3 km). Period of record 1940 to 1970 (12).

Table 3. Expected wind speed, dust, and visibility relationship for the undisturbed site (derived from references 12 and 82).

WIND SPEED		DUST LOAD	VISIBILITY	
ms	mph	$\mu g/m^3$	km	mi
0.7- 1.8	1.5- 4	0.4 - 5.	UNAFFECTED	
1.9- 3.4	4.1- 7.5	5.- 22.	UNAFFECTED	
3.5- 5.2	7.6-11.5	25 - 80	UNAFFECTED	
5.3- 8.4	11.6-18.4	90 - 330	SOME RESTRICTION	
8.5-11.0	18.5-24.2	350 - 600	140 to 95	90 to 60
11.1-14.1	24.3-31.1	650 - 1200	82 to 44	50 to 27

Table 4. **Existing air quality data for the southwestern Arizona monitoring stations nearest the project site. Circled numbers exceed both federal* and state** air quality standards (15, 16, 17, 10, 11).**

PARTICULATES (ANNUAL GEOMETRIC MEAN, $\mu g/m^3$)	1969	1970	1971	1972	1973	1974	1975
DESERT BACKGROUND SITES:							
Davis Dam	29	31	33	36	32	30	17
Montezuma Castle National Monument	-	-	21	26	28	27	27
Organ Pipe Cactus National Monument	26	37	34	29	34	23	28
Grand Canyon	15	21	30	12	18	17	14
SMELTER/MINE:							
Ajo	87	83	75	70	71	59	83
URBAN:							
Yuma	-	98	94	97	110	111	147
FEDERAL STANDARDS:	Annual Geometric Mean				24 Hour Average		
Primary[1]	75				260		
Secondary[2]	60				150		
STATE STANDARDS:	60				150		
SULFUR DIOXIDE Annual Average (mg/m^3)							
Ajo	98	189	50	47	37	55	39
Davis Dam	-	-	-	1	2	7	10
FEDERAL STANDARDS:	Annual Geometric Mean				One Hour Average		
Primary	80 (0.03 ppm)				365 (0.14 ppm)		
Secondary	-				-		
STATE STANDARDS:	50 (0.2 ppm)				260 (0.1 ppm)		
CARBON MONOXIDE Max. 1 hr ave ($\mu g/m^3$)							
Yuma	-	-	-	-	-	3	7
FEDERAL STANDARDS:	8 Hour Average				24 Hhour Average		
Primary	10 (9 ppm)				40 (35 ppm)		
Secondary	10				40		
STATE STANDARDS:	10				40		
OXIDANTS Max. 1 hr avg ($\mu g/m^3$)							
Yuma	-	-	-	-	-	330	245
FEDERAL STANDARDS:					One Hour Average		
Primary	-				160 (0.08 ppm)		
Secondary	-				160		
STATE STANDARDS	-				160		

* Primary standards are those necessary to protect human health.

** Secondary standards are those necessary to protect public welfare and the environment from known or anticipated adverse impact.

In the smallest washes on the fans, vegetation consists of *Encelia farinosa* (brittlebush), *Larrea divaricata* (creosote bush), and *Ambrosia dumosa* (white bur sage), with occasional *Krameria grayi* (ratany), and *Hibiscus denudatus*. The latter is characteristic of the lower rock-slopes above the alignment and occurs in washes only in the uppermost part of the bajada. As these washes deepen slightly, stunted *Olneya tesota* (ironwood) and *Cercidium microphyllum* (yellow paloverde) also occur. These latter species form trees characteristic of washes virtually throughout the Sonoran Desert. Occasional sahuaro cactus (*Carnegiea gigantea*) complete the perennial flora of the minor washes. Most large sahuaros on the site have several nest holes formed originally by Gila woodpeckers and common flickers but utilized by other bird species including elf owl. A number of the older sahuaros have galleries spiraling up the trunk, evidently gnawed by wood rats (*Neotoma*). Characteristic *Neotoma* stick nests were observed adjacent to several of the large washes and arroyos.

The barrel cactus (*Ferocactus wislizeni*) is the only other conspicuous cactus along the alignments. It occurs as scattered individuals on sandy *Larrea* flats on the lower bajada and flood plain at the lower end of the alignments.

Opuntia acanthocarpa (buckhorn cholla) exists as a few scattered individuals at the lower end of the alignment, and it and *O. bigelovii* (Teddybear cholla) are common at the extreme upper end of the alignment. *Mammillaria tetrancistra* (pincushion cactus) is uncommon in rocky places in the upper and mid-bajada and on rockslopes, and two individuals of *Cereus greggii* (night blooming cereus) were observed, one at the upper end of the long alignment and another near Interstate 8 midway down the bajada. The latter species is often inconspicuous (when not in flower it resembles dead sticks where it grows under large trees along washes), and it may be more common than site observations suggest.
The ocotillo (*Fouquieria splendens*) occurs as a few scattered individuals near the uppermost end of the alignment. It and many of the cacti become more common on the rockslopes of the Mohawk Mountains immediately above the upper end of the alignment.

The arroyos of the upper bajada support the most diverse perennial flora of the alignment area. All the above species occur here (*Olneya* and *Cercidium* as well-developed trees, as well as the tree *Cercidium floridum* (blue paloverde), which reaches its maximum numbers in arroyos about one-third of the way down the alignment. Characteristic shrubs include *Hyptis emoryi* (desert lavender), *Acacia greggii* (catclaw acacia), *Ambrosia ilicifolia* (holly-leaf bur sage - restricted to this part of Arizona), *Trixis californica* (California trixis), *Bebbia juncea* (tortoise's delight), *Lycium andersonii* (box thorn), *Condalia lycioides* var. *canescens* (gray thorn), *Teucrium glandulosum* (glandular germander, uncommon in Arizona), *Sphaeralcea ambigua* (desert mallow), *Fagonia californica* subsp. *laevis* (California fagonia), and *Ditaxis lanceolata* (narrow-leaved ditaxis). Two perennial vines grow on the larger shrubs and trees: *Sarcostemma cynanchoides* var. *hartwegii* (climbing milkweed) and

The site area (except at the extreme upper end of the long alignment is somewhat unusual for the Sonoran Desert as a whole because of the marked paucity of cacti and ocotillo. Sahuaro cactus (*Carnegiea gigantea)* is conspicuous by virtue of its size and form along drainageways in the upper and mid bajada but does not reach the density it has over much of its range. Here it is almost invariably associated with large shrub or tree "nurse plants" under which it becomes established.

At the upper end of the alignment the most conspicuous topographic feature is the presence of barren, flattish areas of darkly varnished desert pavement dissected by shallow washes to deep arroyos. The deeper arroyos originate in the mountains while the washes originate upon the pavement fans themselves. These pavement areas, which represent old alluvial fan surfaces, are devoid of perennial vegetation except in the arroyos.

1.2.2.2 VEGETATION (AFERN 3.4.1)

The bajada on which the proposed site is located extends a distance of 6 miles (10 km) from the base of the Mohawk Mountains to the playa of the San Cristobal Wash with an elevational drop of 500 ft (15 m). Along this elevational gradient there are substantial changes in drainage patterns and surface that substantially influence the species composition and distribution of vegetation. The characteristics of the vegetation in turn influence the distribution of animals.

Perennial Vegetation

The plant associations encountered by the project include the paloverde-sahuaro associations in the upper bajada with the addition of ocotillo at the mountains, grading into creosote bush-scrub associations with white bur sage in the middle bajada. Mesquite hummocks and patches of saltbush are common near San Cristobal Wash. Along the major arroyos the blue paloverde-yellow paloverde-ironwood complexes form a desert riparian community. As the small washes grade into the playa, mesquite and saltbush become common.

Vegetation of the site falls within the lower Colorado Valley subdivision of the Sonoran Desert (20). It also retains some elements of the Arizona Upland region to the east. Along the elevational gradient traversed by the long alignment there occur interrelated changes in the topography, drainage pattern, and substratum (soil) characteristics. These changes have a pronounced effect on the aspect and species composition of the vegetation. Figure 17, as well as showing watercourse crossings, gives a visual characterization of vegetation encountered at different elevations of the bajada.

In the smallest washes on the fans, vegetation consists of *Encelia farinosa* (brittlebush), *Larrea divaricata* (creosote bush), and *Ambrosia dumosa* (white bur sage), with occasional *Krameria grayi* (ratany), and *Hibiscus denudatus*. The latter is characteristic of the lower rock-slopes above the alignment and occurs in washes only in the uppermost part of the bajada. As these washes deepen slightly, stunted *Olneya tesota* (ironwood) and *Cercidium microphyllum* (yellow paloverde) also occur. These latter species form trees characteristic of washes virtually throughout the Sonoran Desert. Occasional sahuaro cactus (*Carnegiea gigantea)* complete the perennial flora of the minor washes. Most large sahuaros on the site have several nest holes formed originally by Gila woodpeckers and common flickers but utilized by other bird species including elf owl. A number of the older sahuaros have galleries spiraling up the trunk, evidently gnawed by wood rats (*Neotoma)*. Characteristic *Neotoma* stick nests were observed adjacent to several of the large washes and arroyos.

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Brandega bigelovii (brandega). Perennial herbs include two spurges or sand-mats, *Euphorbia polycarpa* and *E. glyptosperma*, and the four o'clock, *Mirabilis bigelovii*. The epiparasite *Phoradendron californicum* (desert mistletoe), grows on *Olneya*, *Cercidium*, and *Acacia*, and the root parasite *Orobanche ludoviciana* (broom rape) - in this area parasitic on the roots of *Ambrosia*, *Encelia*, and occasionally *Opuntia* - sends its spikes of flowers up in good years.

At about the midpoint of the long trench alignment (Areas D and E), well-developed desert pavement areas cease to exist, and the arroyos and washes become shallower. During storms, sheet flooding and deposition occur, preventing the development of desert pavement and allowing the development of vegetation in the interfluvial areas. Between drainageways, *Larrea* occurs in the sandy-silty to sandy-gravelly soils with occasional *Ambrosia dumosa* as an associate. Scattered small ironwoods and yellow paloverde occur in washes and in the arroyos: many of the same species as those in arroyos higher on the bajada occur with the addition of occasional *Hymenoclea salsola* (cheese bush) in sandy wash soils. *Cercidium floridum* (blue paloverde) reaches its greatest development in arroyos here but several of the uppermost bajada shrub species including *Trixis*, *Teucrium*, *Condalia*, *Fagonia*, and *Sphaeralcea* have either dropped out or become quite uncommon.

A gradual transition occurs between this region (which has many tree-lined shallow washes winding their way through *Larrea* flats) and the area of the base of the alignment (which has a less rocky, sandy-silty soil with a more or less uniform stand of *Larrea*). Vegetation of washes less than a foot deep is distinguished from the surrounding *Larrea* flats only by a greater frequency and size of the characteristic shrubs of the area (*Larrea*, *Ambrosia dumosa*, *Atriplex canescens* [four wing saltbush], *A. confertifolia* [cattle-spinach]) and by the addition of the conspicuous shrubby Galleta grass (*Hilaria rigida*), which is confined to drainageways on the lower part of the bajada and adjacent flood plain. Scattered colonies of the tall herbaceous *Argemone intermedia* (prickly poppy) are also characteristic of this area.

In spring, the diminutive annual *Plantago insularis* (Indian wheat) carpets the area with densities up to 400 individuals/m^2, ranging in height from 2 cm or less to 20 cm or more depending upon the favorableness of the situation. Maximum size is attained in small depressions. Table 5 compares size and reproductive output of a *Plantago* population growing adjacent to 6 inch deep tire ruts and a population less than 3 ft (1 m) away on an undisturbed soil surface.

Table 5. Comparison of size and reproductive characteristics of the annual, *Plantago insularis*, growing adjacent to 6-inch deep tire ruts near base of long alignment and on undisturbed soil 1 meter away. Data are expressed as mean ± standard error; p indicates the probability that the difference between means is not significant (Student's t test). Seventeen plants were measured for each sample. April 9, 1977.

	TALLEST STEM (cm)	LONGEST LEAF (cm)	# INFLORESCENCES PER PLANT	# CAPSULES PER INFLORESCENCE*
Tire Rut	14.1 ± 2.5	6.4 ± 1.2	45 ± 14	30.4 ± 7.0
Undisturbed Soil	4.7 ± 1.6	3.6 ± 1.2	22 ± 10	14.4 ± 3.8
Student's t	12.51	6.49	5.41	8.04
p	< 0.001	< 0.001	< 0.001	< 0.001

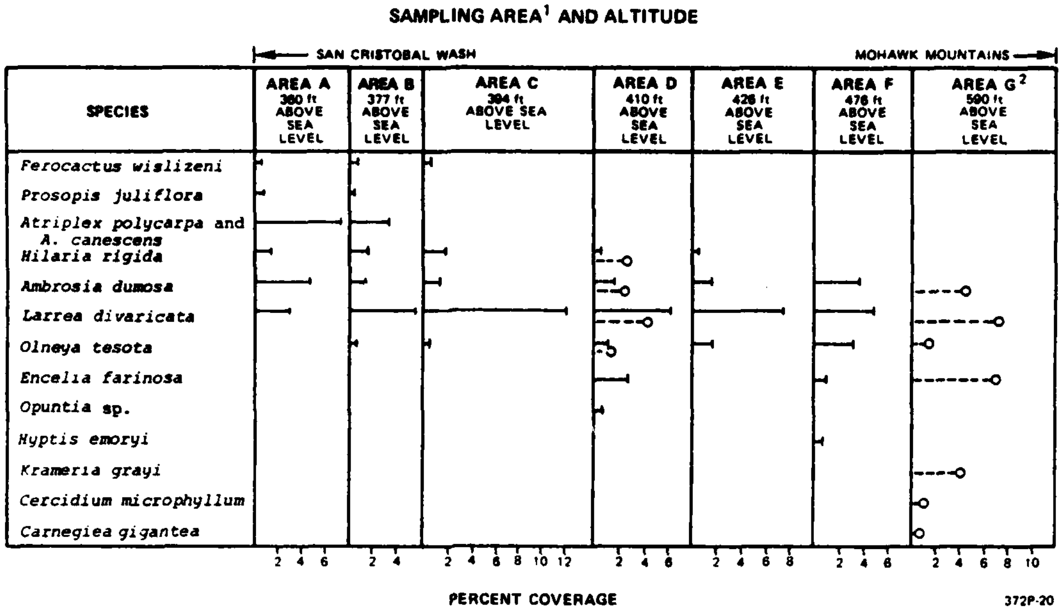
*Each capsule contains two seeds.

On the lower bajada and flood plain the shrubs are usually less than 3 ft (1 m) tall and there are occasional small trees (*Olneya* and both species of *Cercidium*) as tall as 6 ft (2 m) growing along the larger washes. There are also individuals of the barrel cactus (*Ferocactus wislizeni*), a characteristic species of sandy flats, here occurring at the western limit of its distribution.

Below the lower end of the alignments there are small sand hummocks held in place by mesquite (*Prosopis juliflora* var. *torreyana*), which also grows in small washes here, and by *Larrea* and *Hilaria*. The transition to the playa is marked by an increase in frequency of the somewhat salt-tolerant saltbushes (*Atriplex canescens* and *A. polycarpa*) and by the succulent-leaved halophytic subshrub *Suaeda torreyana* var. *torreyana* (Torrey's Sea-blite). Mesquite also occurs on the playa fringe.

The clear altitudinal zonation of tree and shrub species composition is shown in Figure 20, which includes data from San Cristobal Wash to the base of the Mohawk Mountains. Data from interwash transects and from small washes are included in this figure. Figures 21 and 22 are photographs of the characteristic vegetation.

In some areas of all elevations on the bajada, in addition to perennial flowering plants, there are extensive growth of soil lichens, which appear to add considerable stability to the soil.



1 AREAS MAPPED ON FIGURE 17

2 THE COVERAGE FOR AREA G IS RESTRICTED TO A TRANSECT DOWN WASH AND IGNORES THE BARREN DESERT PAVEMENT BETWEEN WASHES

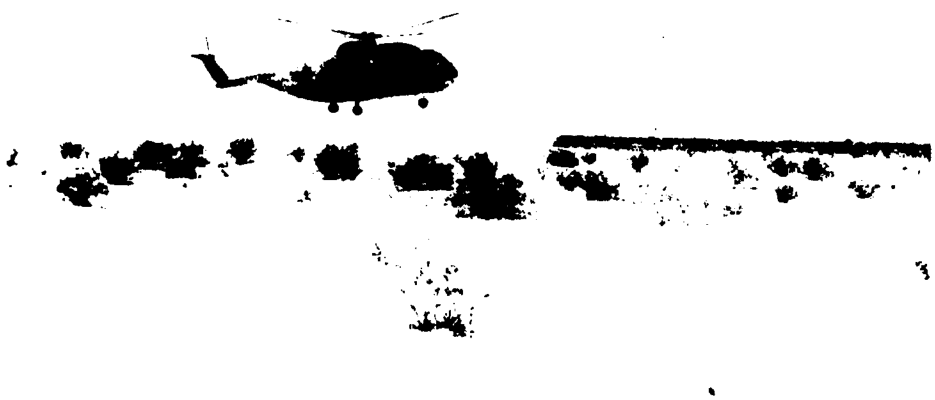
Figure 20. Percent vegetation coverage on interwash transects (solid lines; bare ground had a value of greater than 80 percent and is not included), or the number of plants per 15 m length of small wash (dotted lines) on an altitudinal gradient from San Cristobal Wash (Area A) to the base of the Mohawk Mountains (Area G) parallel to the proposed trench alignment. There is a clear altitudinal zonation of species composition but creosote bush (*Larrea divaricata)*, white bur sage (*Ambrosia dumosa)*, and ironwood (*Olneya tesota)* are present at all elevations.

Ephemeral Annual Plant Species

Ephemeral annual species vary greatly from year to year in distribution and abundance owing to the great temporal and spatial variability of rainfall, and to specific germination-regulation mechanisms which restrict germination of a species to times when sufficient soil moisture [usually the equivalent of 1 in (2.5 cm) or more precipitation] coincides with temperatures favorable to that species' germination (22). Both winter and summer annuals occur on the site.

372P-21

Figure 21. A Sahuaro Cactus and Paloverde Tree in minor watercourses on the Upper Bajada near the longer trench alignment.



372P-22

Figure 22. The sparse Creosote Bush community of the Lower Bajada.

Annual species occurring on the site fall into two generally recognized groups: summer and winter annuals (20, 23). These groups differ not only in germination-regulation mechanism but also in the photosynthetic pathway employed (24). From the total winter annual flora of a site, different selections of species may appear on the site from year to year depending upon local temperature and rainfall conditions for that particular year. For these reasons, annual plants are not considered in the quantitative vegetation descriptions. A serious attempt was made, however, to collect all annual species occurring on the site in summer 1976 and spring 1977, and these species are included in the plant species list in Reference 88. In addition, comprehensive plant collections were made in nearby areas having more favorable local conditions, and three species from these collections likely to occur on the site under favorable conditions are included in that species list. Due to the yearly and seasonal fluctuations in species composition and abundance of annuals on the site, they were not considered in detail in the quantitative vegetation description prepared for this statement. Annual species collected in late summer of 1976 and spring 1977 are included in the plant species list in Reference 88.

Plant Species Protected by Federal Law

An examination was made of the Department of the Interior Fish and Wildlife Service lists of endangered and threatened plant species occurring in Arizona and recently extinct or possibly extinct species in the Continental United States (25). All species reported to occur in the Sonoran Desert, or possibly occurring there as stragglers, and species reported to occur in and near Yuma County (19, 26, 27, 28, 29, 30) were noted and information on their appearance, habitat, and recorded distribution was evaluated. A careful search was made for these species during the field investigations on the project site and in the vicinity. No endangered or threatened species were found on the project site or in nearby similar habitats. There is some possibility that one or more of the endangered and threatened species occurs in the adjacent Mohawk Mountains out of range of potential disturbance from the project.

Plant Species Protected by Arizona Law

Arizona State law (31) designates certain plant groups identified by botanical names as protected. Species that occur on the site that are protected by these laws are listed in Table 6.

These taxa and other protected or endangered ones considered to have a remote possibility of occurrence on the site (*Atriplex hymenelytra,*

Table 6. Species occurring on the proposed project site protected by Arizona state law. Nomenclature follows Kearney and Peebles (27). Habitat information is contained in the annotated plant checklist for the project site 88.

CACTACEAE:
Carnegiea gigantea - sahuaro
Ferocactus wislizeni - barrel cactus
Mammillaria tetrancistra - pincushion cactus
Opuntia acanthocarpa - buckhorn cholla
O. bigelovii - teddy bear cholla
Peniocereus greggii var. *transmontanus* - night-blooming cereus
FOUQUIERIACEAE:
Fouquieria splendens - ocotillo
LEGUMINOSAE:
Cercidium floridum - blue paloverde
C. microphyllum - yellow paloverde
Olneya tesota - ironwood
Prosopis juliflora - mesquite

Dalea spinosa, Rhus kearneyi, Crassulaceae - *Dudleya arizonica* = *Echeveria pulverulenta)* were carefully searched for during the field investigations. It is considered highly unlikely that protected taxa (other than bulb-forming Liliaceae) not included in the species list occur here. The bulb-forming Liliaceae *(Hesperocallis, Allium, Triteleiopsis, Dichelostemma, Calochortus)* present a problem because, like desert annuals mentioned earlier, plants existing underground as perennial bulbs or corms may not appear above the surface except in "good" years. "Good" years for a given species at a given locality may occur infrequently. Thus, although no Liliaceae were observed at the project site during 1976-1977 - a relatively good year - the possibility that one or more species occurs here can be deemed rather unlikely but cannot be ruled out.

1.2.2.3 WILDLIFE (AFERN 3.4.2)

Wildlife of LAFR and its vicinity is generally more abundant and diversified in the paloverde-sahuaro association than in the creosote bush-scrub community. Lists of the vertebrate species expected in desert habitats occurring in the vicinity of the project site are included in Reference 88.

The only large mammals whose presence was verified during the field studies on the site were coyote, kit fox and a wild horse. Badgers and striped skunks may also occur in the vicinity but no observations or definite identification of sign were made of these species. The status of the two large mammal species in the area that are of greatest public interest (the Sonoran pronghorn antelope and the desert bighorn sheep) is discussed in detail below under "Animal Species Protected by Federal and State Law."

Six species of rodents were trapped during the two site surveys (conducted during September 1976 and April 1977). These included five species of pocket mice and the Merriam kangaroo rat. The only other species of small mammals observed were two species of ground squirrel, the desert cottontail and the blacktail jack rabbit. Trapping data, and relative abundances of species are contained in Reference 88.

Thirty-five species of birds were observed on the site. Breeding behavior was observed in 13 of these species during the April 1977 study. Most of the bird species found on the site utilize the trees and denser vegetation of the arroyos for their breeding activities although some species such as the sage sparrow and Brewer's sparrow nest in the open, flat areas. A bird species list is included in Reference 88.

Animal Species Protected by Federal Law

The most recent United States Fish and Wildlife Service List of Endangered and Threatened Wildlife (32) includes only one species of animal, the Sonoran pronghorn (*Antilocapra americana sonoriensis)* that would be likely to occur on the site. Sonoran pronghorns at one time occupied "desert plains of central western Sonora and north to southern Arizona" but in 1973 were reported to be "found in the United States only in a limited portion of the Cabeza Prieta Game Range [20 miles south of the site] and the Organ Pipe Cactus National Monument, Arizona" (33). More recent continuing observations conducted by personnel of the Cabeza Prieta National Game Range, the United States Border Patrol, the U.S. Customs Service, and the Arizona Game and Fish Department, and collected in annual Completion Reports by the Arizona Game and Fish Department (34) have recorded some 160 observations of a total of 700 pronghorns (some probably multiple observations of the same individuals) on or near LAFR (LAFR, Cabeza Prieta National Game Range, and Organ Pipe National Monument) since 1968. These are mapped on Figure 23. There have been no recorded sightings or other evidence of pronghorns in the San Cristobal Valley within 12-15 miles of the project site. The habitat is similar to that of the Mohawk Valley to the west of the Mohawk Mountains where, since 1968, ten sightings including 36 animals have been made (34). It is not known why pronghorn should occupy one and not both of these valleys, and the lack of observations does not rule out the possibility that pronghorn may occasionally be present in the San Cristobal Valley and on the project site itself.

Animal Species Protected by State Law

Because the Sonoran pronghorn is an endangered species, the United States Fish and Wildlife Service (FWS) Regional Director (Albuquerque) established a "recovery team" to study the species and determine its "critical habitat" in accordance with Section 7 of the Endangered Species Act. The "critical habitat" recommended by the recovery team is shown in Figure 23 and includes the project site. The FWS Regional Director determined that there was insufficient justification accompanying the recommendation to support the designation and returned the recommendation to the recovery team for further study. The Air Force is currently in consultation with the U.S. Fish and Wildlife Service on this issue.

Desert bighorn sheep are the only large game mammals occurring in the vicinity of the site aside from occasional visits of mule deer, and are of particular interest to the Arizona Game and Fish Department. Their population size in the Mohawk Mountains is stable and estimated to be approximately 25 individuals (37). Bighorns in this area are not particularly sensitive to nearby human activity (34) but may temporarily leave an area of noisy human activity, such as construction and blasting (37). The long trench alignment terminates at the base of the major seasonal use area for bighorns in the Mohawk Mountains. During the wetter, cooler months of January through April, bighorns frequently occupy the inselbergs (rock outcrops) protruding from the bajada to the northwest and southeast of the upper terminus of the long trench alignment, and also may be found on the bajada near the base of the mountains (37). There are no documented tanks (water catchments) on the eastern flank of Mohawk Mountains to attract sheep, but one has been reported adjacent to the abandoned mine a mile to the northwest of the terminus of the long alignment, and another putative small one was located during the archaeological survey (for this EIS) at the base of the mountains directly in line with the long alignment. Neither has been located by the Arizona Department of Game and Fish.

All vertebrates and some invertebrates are protected in Arizona to the extent that a hunting license with the appropriate stamps is required for collecting them. A few species known to occur on the project site are protected individually but for reasons unrelated to potential disturbance from construction activities. The possession of two genera of lizards for example, chuckwalla (*Sauromalus* sp.) and the horned lizard (*Phrynosoma* sp.), is restricted to prevent their collection and sale as pets.

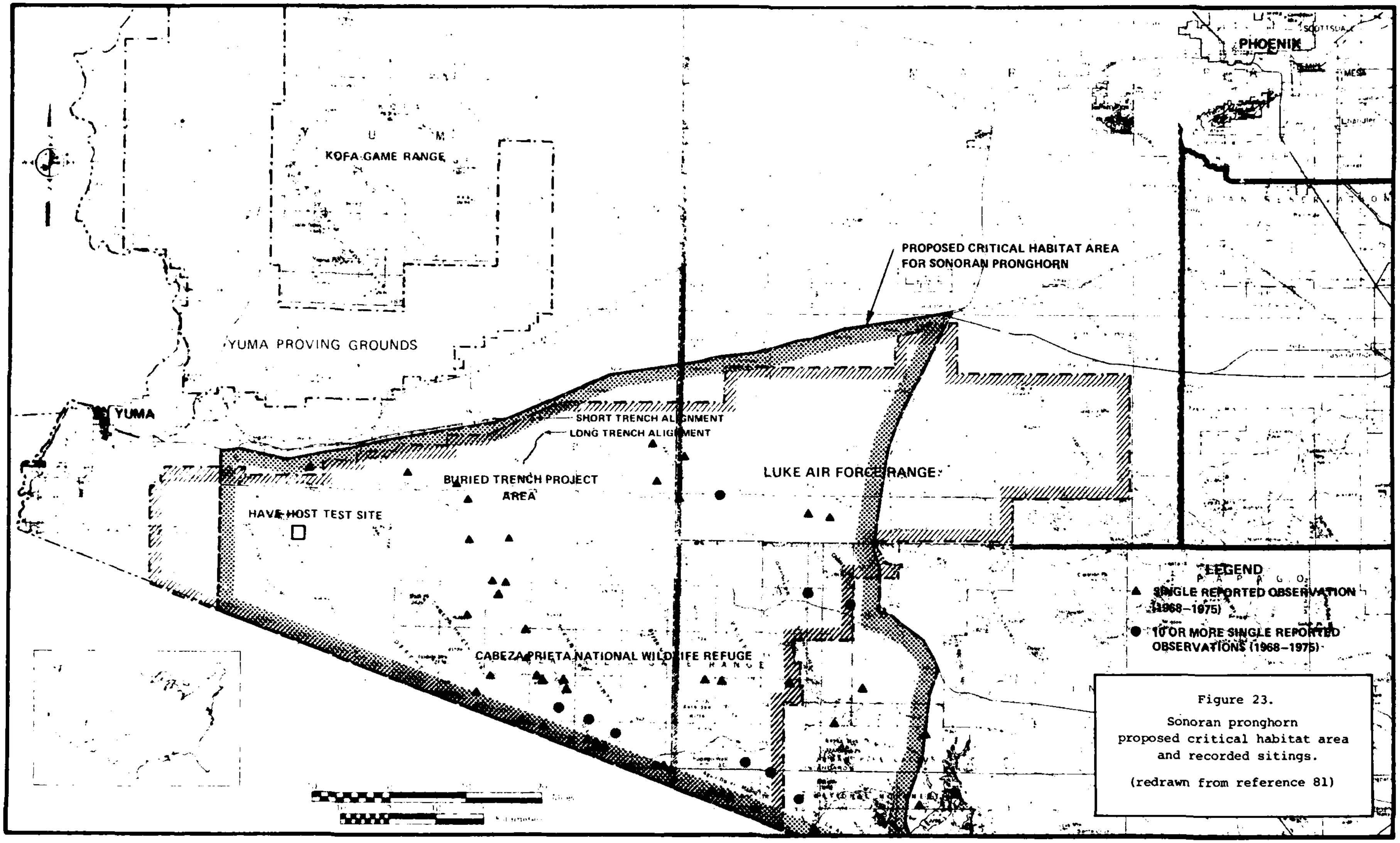


Figure 23.
Sonoran pronghorn
proposed critical habitat area
and recorded sitings.
(redrawn from reference 81)

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1.2.3 Socioeconomic Environment (AFERN 4.0)

1.2.3.1 ECONOMY AND SERVICES (AFERN 4.2)

The project site is located in a very sparsely populated portion of south central Yuma County in Southwestern Arizona. The closest major urban centers are Phoenix, Arizona; Tucson, Arizona, and San Diego, California. The only medium-sized city within 100 miles of the site is the City of Yuma, Arizona (about 54 air miles [87 km] and 64 road miles [103 km]* west). Several small agricultural and tourist service communities exist along Interstate 8 within 50 miles of the site. Dateland, Arizona is about 6 air miles (11 km) and 7 road miles (13 km) east of the site, but consists of only a lunch counter, gas station, post office and gift shop. Dateland will be the access point for traffic leaving the site. Tacna, Arizona is approximately 16 air miles (30 km) or 19 road miles (30 km) west of the site and contains the nearest motel and some other services. The closest doctor is in Wellton, Arizona, about 25 air miles (46 km) and 37 road miles (69 km) west of the site. Each of these communities has only a few hundred people. Gila Bend, Arizona has about 2,000 people and is about 46 air miles (85 km) or 48 road miles (89 km) east of the site. Yuma is about 49 air miles (91 km) and 65 road miles (100 km) west of Dateland and the closest community providing a full range of services as well as a sufficient labor force to support the project. Over 70 percent of the population of Yuma County lives in the vicinity of Yuma City. Yuma County and City are considered in some detail here because it is thought that most of the construction force will come from or relocate in Yuma.

The City of Yuma offers a socioeconomic infrastructure not unlike most communities in the population range of 25,000 to 100,000 people: schools, police, hospitals, libraries, developed recreation opportunities, shopping, housing, and water and sewerage facilities are all available in Yuma. Elementary school enrollment growth is occurring in the Cra[illegible] Elementary School District while declines are being experienced in the Yuma Elementary School District No. 1. The two schools operated by Yuma Union High School District are currently over capacity. The Police Department has a staff of 78 people to serve Yuma and the adjacent area. Fire protection in the city is provided by 59 firefighters operating from 3 stations and the Insurance Underwriters have assigned Yuma a rating of 4B**. The 26 firemen of the Yuma Rural/Metro Fire Department, Inc. provide subscription

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*Air miles are straight-line distance from Stoval Airfield; road miles are from Stoval Airfield to Dateland and then along Interstate 8.

**The National Fire Underwriters and the Insurance Services Office evaluate a community's overall fire defense and rate it according to an insurance protection class. The grades range from 1, the best, to 10.

fire protection to property outside the city. The closest comprehensive health care services to the site are in Yuma. Facilities include a hospital, convalescent center, outpatient clinic, psychological counseling center, and the County Health Department. The hospital, Yuma Regional Medical Center, an acute care facility with 60 physicians and surgeons on staff, is currently expanding from 167 beds to 220 beds. The city maintains 14 parks and recreation areas including a 240-acre recreation complex. Electricity is provided through the investor-owned Arizona Public Service Company, mainly from the Four Corners generating station. Water is provided from the Colorado River with a maximum supply of 50,000 acre feet, depending on the river level. Wastewater is treated at the city's 6.5 mgd plant. Effluent meeting Arizona State Department of Health water quality standards is discharged to the Colorado River. All of the above listed facilities, except the high schools, are considered adequate for current requirements, and will accommodate any temporary growth (unexpected) induced by the MX buried trench project.

The ethnic composition of Yuma County's population includes a large proportion of Spanish heritage people (27 percent); smaller concentrations of blacks (3 percent), native Americans (4 percent), and Orientals (1 percent); and 65 percent white. Indian populations are concentrated in reservations near the western border of the county. Blacks tend to concentrate in Yuma City, and other groups are randomly distributed throughout the population centers (38, 39).

Tourism is an important component of Yuma City's economy and has resulted in a large number of temporary housing units. These facilities are summarized in Table 7. The tourist season generally peaks in January, but extends from October to March. In the off-season, a large number of units are available; even during the season, some units are typically available. Gila Bend also provides tourist facilities including nine motels with 284 rooms (40). Tacna's one motel has 22 units, while Wellton's one motel has 14 units.

The economic region most likely to be influenced by project expenditures includes both Yuma and Maricopa (Phoenix) counties which differ widely in terms of total income. In 1972, income in Yuma County was over $241 million and in Maricopa County almost $4 billion. Earnings in the two counties in 1972 are presented, by Industrial Division, in Table 8. Yuma County's private sector is dominated by agriculture as the prime earnings generator with the combination of trade and services holding a strong position, reflecting, in part, the importance of tourism to Yuma. The government sector is about the same size as agriculture as a source of earnings, and the presence of substantial military activities in the county accounts for much of this sector's earnings. Maricopa County, on the other hand, exhibits some of the character of what has come to be termed a postindustrial economy, where a large manufacturing capacity has been overshadowed by the more rapid growth of trade services and local government, elements more oriented toward local needs.

Table 7. Temporary accommodations in the City Yuma, 1976 (39).

TYPE	NUMBER OF UNITS/SPACES	OCCUPANCY RATES	
		WINTER SEASON PERCENT	REST OF YEAR PERCENT
Mobile Home Park	7,036[1]	98	39
Apartment	2,087	100	92
Motel-Hotel	1,332	93	62

[1]An additional 262 spaces are under construction.

Table 8. Personal income in 1972 in Yuma and Maricopa counties (41).

INDUSTRIAL DIVISION	YUMA COUNTY INCOME		MARICOPA COUNTY INCOME	
	MILLIONS OF DOLLARS	PERCENT	MILLIONS OF DOLLARS	PERCENT
Farm	$ 74.8	30.9	$ 140.7	3.5
Mining	0.1	--	4.3	0.1
Construction	12.2	5.1	422.0	10.6
Manufacturing	9.5	3.9	803.2	20.3
Transportation, Communication, Public Utilities	11.5	4.8	251.6	6.3
Trade	31.3	12.9	717.4	18.1
Finance, Insurance, and Real Estate	(D)[1]	--	(D)[1]	--
Services	22.8	9.4	653.3	16.5
Other	(D)[1]	--	(D)[1]	--
Federal Govt-Civilian	22.8	9.4	114.4	2.9
Federal Govt-Military	27.4	11.3	106.1	2.7
State & Local Govt.	22.6	9.4	453.1	11.4
TOTAL Earnings by Place of Work	$241.7	100.0	$3,965.0	100.0

[1]Data not provided because of disclosure rules.

Table 9 places the labor force of the two counties in the context of conventional economic structure as defined by the Standard Industrial Classification System. Yuma County is dominated equally by agriculture, trade, and government, with services in a lesser though still significant role. Maricopa County's leading source of employment is trade (wholesale and retail combined). Services and government are a strong and equal source of jobs, second only to trade, while manufacturing also occupies a strong position.

Table 9. Employment in Yuma and Maricopa counties in 1975 and July 1976 by SIC (in 1,000s of people) (42, 43).

STANDARD INDUSTRIAL CLASSIFICATION	1975 ANNUAL AVERAGE				JULY 1976			
	YUMA COUNTY		MARICOPA COUNTY		YUMA COUNTY		MARICOPA COUNTY	
	AMOUNT	PERCENT	AMOUNT	PERCENT	AMOUNT	PERCENT	AMOUNT	PERCENT
Agriculture	5.5	23.1	10.1	2.3	5.1	21.9	10.3	2.3
Mining and Quarrying	0.0	0.1	0.4	0.1	0.0	0.1	.4	0.1
Construction	1.1	4.6	23.3	5.3	1.1	4.7	21.8	4.9
Manufacturing	1.2	5.1	71.3	16.2	1.2	5.3	72.4	16.3
Transportation, Communication and Public Utilities	0.8	3.5	23.0	5.2	0.8	3.3	23.3	5.2
Trade	5.5	23.3	113.0	25.7	5.6	24.0	115.0	25.9
Finance, Insurance & Real Estate	.6	2.5	32.2	7.3	0.6	2.6	33.1	7.4
Services	3.5	14.8	83.2	18.9	3.6	15.4	84.3	19.0
Government	5.5	23.2	83.0	18.9	5.3	22.7	83.9	18.9
TOTAL	23.7	100.0	439.5	100.0	23.3	100.0	444.5	100.0

The construction labor force of Yuma is about 1,100 people and three local projects are known to be placing demands on this supply. The Colorado River crossing of Interstate 8 is employing about 75 people. Iowa Beef is planning a processing plant in Yuma that will require about 185 construction workers. These two projects should be completed in early or mid 1978. The Bureau of Reclamation's salinity control project now employs about 180 construction workers and this labor force is expected to continue expanding through mid to late 1979.

The rapid growth that has historically characterized Yuma is expected to continue. Economic growth to support the population growth is largely manifest in the Iowa Beef Processing Plant that may employ up to 1,600 people by the early 1980s.

1.2.3.2 TRANSPORTATION (AFERN 4.4.1)

The primary form of transportation to LAFR is by highway. Construction workers will commute to the site via highways, and much of the equipment and material will be delivered by highway. Some material will be transported by rail.

Highways

The major highway in the Yuma to Phoenix transportation corridor is Interstate 8 (U.S. 80), a four-lane divided highway with limited access. Off-ramps are located at: Wellton, Roll, Tacna, Mohawk, Dateland, Aztec, and Sentinel in the vicinity of the construction site. Table 10 summarizes the traffic characteristics on Interstate 8.

Table 10. Traffic volumes on Interstate 8 between Yuma and Gila Bend (44).

TRAFFIC CHARACTERISTICS	MEASURE
ADT[1] on Highway Segment	
Yuma to Wellton	5,700 ADT
Wellton to Maricopa County Line	5,200 ADT
Maricopa County Line to Sentinel	5,600 ADT
Sentinel to Gila Bend	5,400 ADT
Traffic Composition	
Peak Hour (percentage of daily traffic occurring during the hour of most heavy usage)	12 percent
Peak Hour, Trucks (percentage of trucks during the peak hour)	10 percent
Overall Trucks (total percentage of trucks)	17 percent
Travel in heaviest direction during peak hour (percentage of traffic going in a single direction during the peak hour)	55 percent
Average Vehicle Occupancy	
Overall	1.8 persons/vehicle
Out of State	2+ persons/vehicle

[1]ADT = Average daily trips by vehicles using the highway.

Traffic characteristics are expressed in terms of average daily number of trips (ADT) occurring on different segments of Interstate 8. The traffic composition figures from Table 10 show that there is no heavy peak hourly traffic flow, nor is there a strong unidirectional flow.

No paved roads exist inside the range in the vicinity of the project site. There are a few jeep trails crossing the range but these are rarely used. The general public is not allowed to travel within the boundaries of LAFR without express permission.

Rail Transportation

Rail service is provided in southwestern Arizona by the Southern Pacific Transportation Company. One line connects Yuma, Wellton, and Phoenix and another connects Wellton, Gila Bend, and Tucson. An operational passing siding and an old spur exist opposite Stoval Airfield (abandoned). Table 11 summarizes present traffic on these two lines.

Table 11. Train traffic in the vicinity of the site (45, 46).

BETWEEN	FREIGHTS (Per Week)	PASSENGERS (Per Week)	TOTAL (Per Week)
Wellton & Tucson	140	0	140
Wellton & Phoenix	21	6	27

Air Transportation

Three airports with Federal Aviation Administration control towers exist in the vicinity of the site. They are Yuma International, Gila Bend and Pheonix Sky Harbor International. There are numerous abandoned airfields on LAFR, one of which is Stoval Airfield. Restricted flight operation areas exist around the base and the low level (under 18,000 feet [5,486 m]) flight paths. General aviation aircraft are prohibited from flying above the bombing range and typically follow low level flight paths in times of low visibility. Yuma International is used jointly by civilians and the United States Marine Corps; civilian traffic accounts for about one-sixth of the total operations (47, 48, 49).

1.2.3.3 ARCHAEOLOGICAL SITES

Two archaeological field surveys of the area likely to be affected by the project construction were conducted during the periods 28 to 30 September

1976 and 6 to 10 April 1977. A total of 23 sites were recorded during the two field surveys. These can be grouped into five categories: trails (5 sites); temporary campsites (3 sites); rock features (6 sites); isolated artifacts (2 sites); and historic artifacts (7 sites). In accordance with federal guidelines, a map of all sites has been prepared and provided to the Arizona State Historic Preservation Office (along with a copy of this EIS) and is on file at the Arizona State Museum. A determination of National Register eligibility is being pursued at this time. The map is not included in this EIS in order to minimize disturbance of sites or unauthorized removal of artifacts. However, the approximate study area is mapped in Figure 24.

The method employed on the first survey in September 1976 was to zig-zag back and forth along a corridor which extended at least 70 ft (20 m) along each side of the project centerline. Vegetation was very sparse along the line, thus visibility was good. A second intensive field survey was carried out along a 2,000 ft (614 m) wide corridor along the southeast side of the proposed long trench alignment and along a similar corridor to the southeast of the short alignment during the period 6 through 10 April 1977. Each of three archaeologists covered a transect approximately 330 ft (100 m) wide by walking in a zig-zag pattern. In this way it was possible to examine the entire 2,000 ft (614 m) corridor by walking the 1,000 ft (307 m) closest to the staked line for a given distance, and then reversing direction to cover the outer 1,000 ft (307 m).

As archaeological features were encountered they were assigned sequential field numbers (e.g., MAV-17). Then, descriptive information about the feature and its setting was recorded, the feature was mapped and photographed, and in most cases where artifacts were present they were collected. All artifacts and field notes are on file at the Arizona State Museum in Tucson, Arizona. When sites were encountered they were recorded on the Arizona State Museum site survey form. The policy followed in making artifact collections was as follows:

1. Where artifacts were found within the project right-of-way, a detailed map was made and all artifacts were collected.
2. When artifacts were found outside the project right-of-way, they were mapped and only a minimal collection for identification purposes was made.

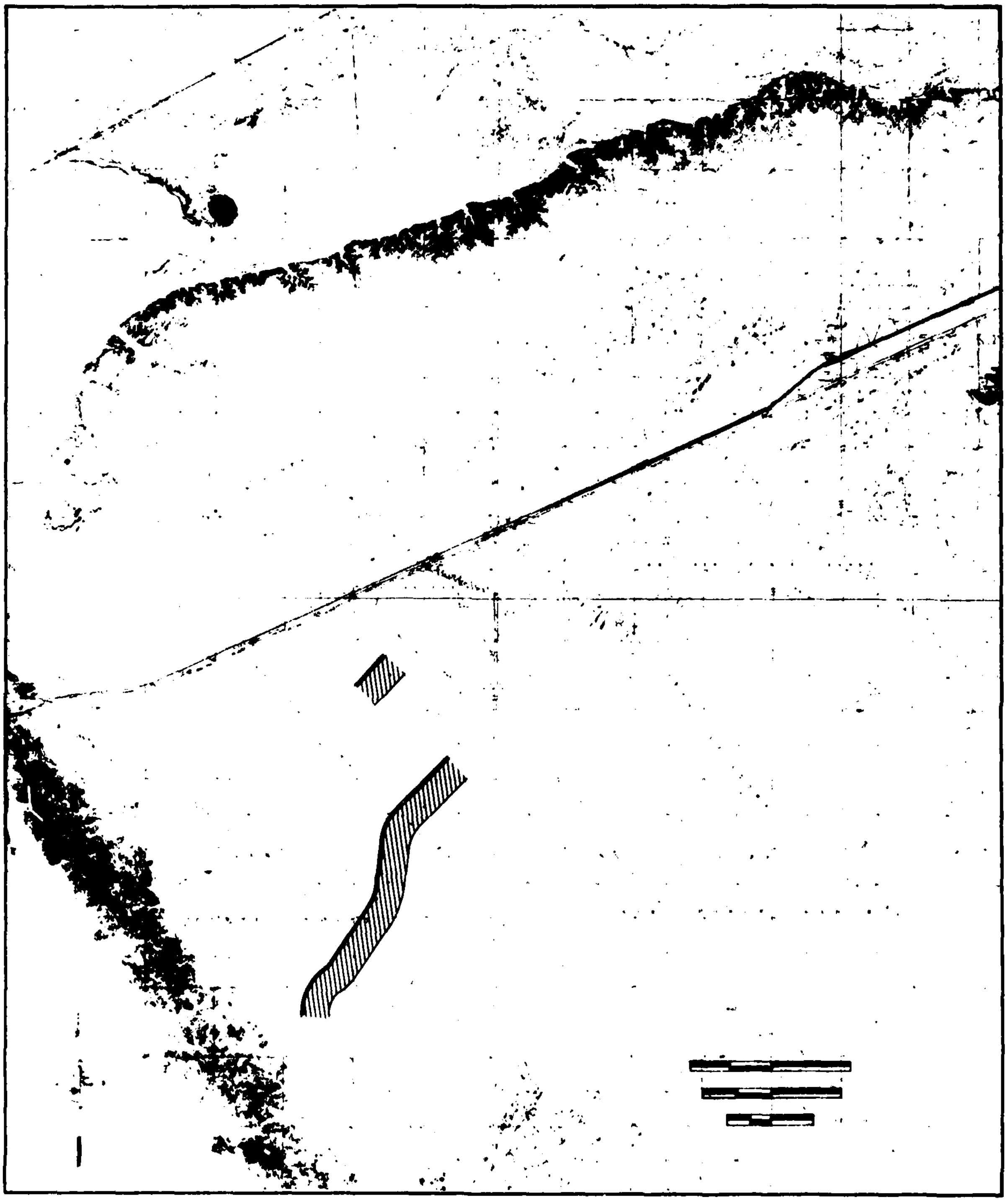

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Figure 24. Approximate areas in which detailed archaeological field surveys were made in October, 1976 and April 1977.

1.2.3.3.1 Trails

Field numbers: MAV-1, MAV-2, MAV-13, MAV-19, MAV-21

Five trails were discovered during the archaeological survey of the project area. Four of the trails run roughly parallel to one another and to the Mohawk Mountains. They occur on the lower portion of the upper bajada and they are visible only where they cross desert pavement. While it is possible that prehistoric travellers walked along the lower bajada as well, and that these trails simply were not preserved, it seems more likely that most travel was restricted to the lower portion of the upper bajada. Several reasons can be suggested in support of this contention. First, the soft soils of the lower bajada make walking more difficult in comparison to walking on the hard desert pavement. Second, by walking on the upper bajada long distance travellers would be closer to the mountains, the most likely source of water during most of the year. A third factor which may have encouraged travel on the lower portion of the upper bajada is the distribution of three species of economic plants. The ironwood, blue paloverde, and yellow paloverde all reach their highest densities in this area today.

The four trails parallel to the Mohawk Mountains can be divided into two different types. The first type, trails with associated ceramic artifacts, includes only MAV-1. The other three trails (MAV-2, MAV-13, MAV-19) had no pottery associated with them along the areas walked to date. Several interpretations of this situation are possible. First, there may be a temporal difference between the trails: those trails without ceramics may be earlier in time. Second, MAV-1, where pot breaks were relatively common, may have been used much more often than the other trails and that the high frequency of artifacts reflects this high frequency of use. A third possibility is that the trails had a different function, for example, the trails without artifacts may have been used for running, since competitive running was an important activity among many of the ethnographically known groups in southwestern North America.

The ceramics along MAV-1 provide some evidence for estimating the time period when this trail was utilized. Since the earliest reported dates for the manufacture of Lower Colorado Buff Wares are between A.D. 700-800 (50, 51), it is clear that at least some of the use of the trail postdates this time. Pottery from seven vessels was collected from along this trail, but only one of these vessels is temporally diagnostic. One large stuccoed bowl was recovered (Component 4), and according to Harner (51) the application of stucco to the outside of vessels was practiced during the period A.D. 1300-1700. Since present knowledge of the chronology of Lower Colorado Buff Wares derives largely from a single stratified site, these dates must be accepted with caution. It cannot be assumed that all use of this trail dates within this 400 year time period, for the majority of the pottery recovered from the trail cannot yet be temporally placed.

A fifth trail (MAV-21) was encountered which runs perpendicular to the mountains. This trail is outside of the direct impact zone of the project, and it heads directly toward the small rock tank (natural water catchment) in the Mohawk Mountains. Several pot breaks occur along this trail. Due to the fact that this trail lies outside the direct impact zone, it was not recorded in detail.

1.2.3.3.2 Temporary Camp Sites

Field Numbers: MAV-3, MAV-4, MAV-20

A temporary campsite is a place where everyday activities such as food preparation, eating, and sleeping take place on a short-term or seasonal basis. Specialized activities, such as hunting or plant processing, may occur at or near such a location as well, but archaeological remains of everyday activities need to be identified before a site can be classified as a temporary camp. However, the shorter the occupation of a camp the less likely it is that such material evidence will have entered the archaeological record. At MAV-3, for example, pottery, grinding tools, and a possible hearth were found in close association which strongly suggest that food preparation and consumption were occurring here. At MAV-4 several grinding tools suggest that food processing took place here, and the amount of use wear on these tools, while slight, probably required more than a single day to develop. Thus we can infer that MAV-4 served as a campsite, though probably a briefly occupied one. At MAV-20 the evidence is much less direct. Only nonlocal cobbles occur at this site, and most of them show evidence of intentional modification through hard hammer percussion. Our limited understanding of this site makes its classification as a campsite rather tentative.

An especially interesting aspect of these three camp sites is the diversity they suggest. Each is located in a different environmental zone. MAV-4 is in the upper bajada, close to the mountains and a possible water source. The large number of grinding tools present suggests that local plant resources were being exploited - possibly seeds from the leguminous trees that line the washes. MAV-20 is located on the lower bajada, and its function remains unclear for the present. MAV-3 is located within the playa. While it is difficult to understand why a camp would be set up in a location subject to flooding, two factors might account for this. First, the drainage pattern may have been different in the past, and as a result water may not have stood in the same areas as it does today. Second, the playa may have been only partially full when this camp was established. While a number of possible resources may occur in the playa area it has not been possible to determine what specific resources may have been exploited by the occupants of MAV-3.

Another interesting point about the temporary camps is that their small areal extent and the small numbers of artifacts discarded suggest that they were occupied by small groups for rather short periods of time.

Ability and willingness to live in small, mobile groups seems to have been the key to survival in this harsh environment. The large number of trails encountered within the study area is consistent with this need for mobility as well.

1.2.3.3.3 Rock Features

Field Numbers: MAV-6, MAV-7, MAV-8, MAV-9, MAV-10, MAV-11

While all occur on the desert pavement of the upper bajada, there is a great deal of variability in what have been designated here as rock features. All consist of clusters of rock which clearly are not in their natural context. In some cases the rocks are not of the same type as those which make up the surrounding desert pavement. In several cases large and medium-sized rocks have been placed in artifical clusters, two of which are roughly oval or circular in shape. In no cases were artifacts associated with these features, a fact which makes interpretation of these rock clusters especially difficult. Along the lower Colorado River roughly comparable rock features have been reported (52, 53), but they are usually in immediate association with trails and have been called "trail shrines." "Trail shrines" often have pottery "offerings" on and around them. None of the rock features from the project area is directly associated with any of the trails, however.

Since no definite conclusions can be reached as to the function of these features, a number of hypotheses is suggested.

1. These features may be shrines.
2. The rocks may be the remains of temporary shelters. For example, they may have held down brush which functioned as a windbreak.
3. The rocks may be markers. They may indicate the locations of especially productive ironwood groves, or that water and/or food are cached nearby, for example.

Aside from the trails these rock features were the only evidence of human activity on the desert pavement. All other evidence was restricted to the areas along the washes.

1.2.3.3.4 Isolated Artifacts

Prehistoric Artifacts - Field Numbers: MAV-5, MAV-12

Both prehistoric isolated artifacts were cores and both were found in close proximity to washes. MAV-12 was associated with a single flake that was derived from the core. The cores recovered from MAV-5 and MAV-12 show only unifacial retouch, and the edge thus created is backed with cortex.

The steep edge angles of 60 degrees and 65 degrees, respectively, on these two cores are similar to the mean edge angle of about 70 degrees that Goodyear (54) reports for his sample of 127 core tools. Thus the two prehistoric isolated artifacts recovered from the project area morphologically meet the definition of a core tool. Because the primary use of such tools may be wood procurement (54) close association of the cores with drainage systems (and therefore trees) suggests wood procurement as a possibility here as well.

The small sample of cores recovered from the project area does not allow us to rule out the possibility that these cores were used only for deriving flakes. In fact, the occurrence of a flake derived from the core at MAV-12 tends to support this latter hypothesis. A much larger sample of isolated cores would be necessary so that their morphology and spatial distribution could be studied in order to derive meaningful patterns.

A flake core and associated flakes were found near the trail, MAV-2, as it crossed a wash. While it still seems probable that the association of this core with the trail is a valid one, the apparent association of cores with wash systems noted above suggests that the association of the flake core with MAV-2 may be due to chance.

Historic Artifacts - Field Numbers: MAV-14, MAV-15, MAV-16, MAV-17 MAV-18, MAV-22, MAV-23

Within the direct impact zone historic artifacts were encountered only on the lower bajada. There was no indication that there had ever been an actual historic occupation of this area, rather it appears that the historic artifacts were carried to this area from elsewhere - possibly from now abandoned Stoval - to be discarded. Only one of the historic artifacts, a wine bottle that probably dates from the period 1890-1920 (MAV-22), appears to be over 50 years old. This bottle was collected and is in the collections of the Arizona State Museum.

An alternative source for the historic artifacts may have been from miners, although if this were the case it seems likely that the artifacts would have occurred on the upper bajada and at the base of the mountains where mining and prospecting activities would have taken place. A single small cluster of hole-in-cap cans was discovered very near the mountains to the southwest of the main alignment (outside the impact zone). The association of these cans with a small cleared area suggests that this was a campsite. The hole-in-cap cans suggest a date in the mid-1920s or earlier.

SECTION 2

RELATIONSHIP OF PROPOSED ACTION TO LAND USE PLANS, POLICIES, AND CONTROLS FOR THE AFFECTED AREA

2.1 LAND OWNERSHIP (AFERN 4.4.3)

The proposed site is in Yuma County, Arizona, where only 8 percent of the total area of 10,020 square miles of land is privately owned. That remaining is owned by either the federal government or by the state; some of this is leased for private and public ventures. This type of nonlocal, nonprivate ownership results in large areas of land outside the normal local land use and zoning controls, and as such, the impact of local land use policies on the project is minimal.

Only two local agencies, the City and County of Yuma, are known to have prepared land use plans for the general area. The City of Yuma's Planning Area is at least 50 miles (80 km) from the site and will not directly affect or be affected by activities at the site. County zoning does not include land on the Luke Air Force Range, but offsite alternative uses could be affected by onsite projects. This is not anticipated as a result of construction since no hazardous activities, beyond normal construction risks, are planned onsite and no long term operation phase is included in the project. The project is short term and involves few construction workers or professional and supervisory personnel.

Potentially affected privately owned land is concentrated on a strip that is adjacent to both sides of Interstate Highway 8, between the eastern county line and the City of Yuma. This strip varies in width from less than a mile to 20 miles (32 km). With the exception of the immediate area on LAFR no direct effects on land use and management are anticipated as a result of construction of the trenches on the Range. Some indirect effects will occur in the small towns located on Interstate 8 between Gila Bend and Yuma.

The closest of these to the site is Dateland. There is room for residential expansion and development in the subdivisions near this town that were planned and later abandoned. Some plots and utility connections have been laid out. However, the cost of relocating a work force of any size would be prohibitive since neither sewerage systems nor housing structures exist. Because the town is basically a way-station for travelers on Interstate 8, there is neither sufficient housing in the town nor the social amenities to encourage relocation of a work force to the area. No changes in land use are anticipated.

The same pattern emerges in each of the small towns between Dateland and Yuma; no or little acceptable vacant housing, few social attractions, and only the minimum numbers and types of retail commerce. It is, therefore, unlikely that this project will spur the development or expansion of residential areas between the project site and the closest, large urban areas. The more probable alternative is that the required work force would live in Yuma and commute the 60 miles (96 km) to the site.

The lands within the site boundary are owned by several agencies including the Bureau of Land Management (BLM), Air Force, and the State of Arizona (Figure 25). Non-Air Force lands would revert to control of these agencies and to jurisdiction of the Public Land Laws should the Department of Defense relinquish control.

State Trust Lands are parcels of land owned and administered by the Arizona State Land Department. They were deeded to the State of Arizona by the federal government through the enabling legislation that brought Arizona into the Union. The purpose was to leave the state with suitable land it could lease out for purposes such as grazing and prospecting. The revenues from these leases pay for public institutions like schools and hospitals. The State Trust Lands on the Luke Air Force Range have been withdrawn from leasing to the public and are now paid for by the Department of Defense.

2.2 LAND USE ON LAFR

The Luke Air Force Range, originally activated in 1941, is currently controlled and administered by the 58th Tactical Fighter Training Wing (TFTW), Tactical Air Command (TAC), Luke AFB, near Phoenix, Arizona. Although the physical real estate of the Range is under the control of the 58th TFTW, a use agreement exists between TAC and the U.S. Marine Corps, Yuma Marine Corps Air Station. In this agreement, Yuma MCAS is responsible for administration of the airspace over the western sector of the Range which extends westward from a buffer zone, located over the Mohawk Mountains. The western sector of the range includes two air-to-air and two air-to-ground ranges plus an air combat maneuvering instrumentation range. The use of the western sector is currently confined to radio controlled air-to-air gunnery due to the HAVE HOST project. This restriction is expected to continue throughout the proposed project duration. The eastern and central sectors are used as tactical air-to-ground bombing and gunnery ranges and air-to-air gunnery, respectively, by the 58th TFTW. The range is also routinely used by the 355 Tactical Fighter Wing (TFW) at

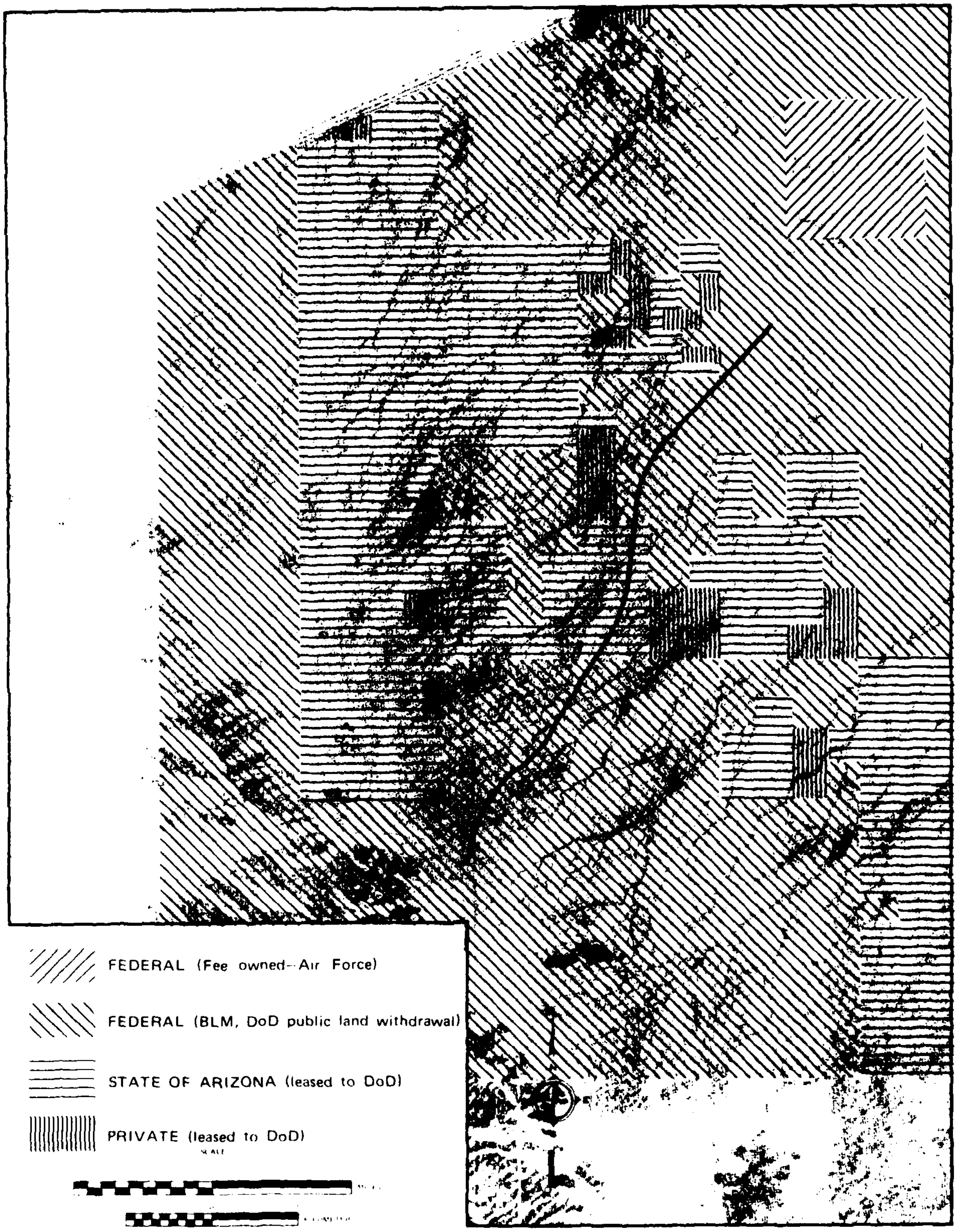


Figure 25. Land ownership in the project area.

Davis-Monthan AFB and the Air National Guard unit at Tucson. Live firings are made routinely on the eastern and central sectors, whereas the use of live ordnance occurs only one to two times yearly in the western sector (55). The proposed project site is located east of the Mohawk Mountains.

Long-range plans for LAFR include a variety of improvements in scoring, monitoring, and targets on the range compatible with the current mission. An Air Combat Maneuvering Instrumentation (ACMI) is planned for fiscal year 1979. This installation will result in an increase in the frequency of sonic overpressures in an area nominally 30 miles (48 km) diameter, and southeast of the proposed site. The earliest possible operational date is October 1978, or after trench construction, so no incompatibility of the two projects is anticipated (81). Short-range plans are to continue LAFR in its current usage, although both short- and long-range plans may be affected by future congressional action on the Cabeza Prieta Wilderness Area proposal (below).

The Mohawk Mountains and sand dunes to the west of the site currently have the status of a proposed natural area under the jurisdiction of the Arizona State Parks Board (73). Wachter et al. (74) have identified the section of the mountain range from Interstate 8 to the wind gap approximately 18.6 miles (30 km) south (including a part of the proposed site near the mountains) and all of the sand dunes as an area of highest national significance as a potential regional natural area. The reasons for this designation are the pristine character of the dunes which have not been traversed by dune buggies, the youth and striking topography of the Mohawk Mountains, the peculiar locations of the dunes on the windward side of the mountains and the interesting biology of both the dunes and the mountains. The proposed project site is separated from the dunes by the mountains.

The only designated special use area within the Range is the Cabeza Prieta National Wildlife Refuge which is jointly administered by the U.S. Fish and Wildlife Service in cooperation with the U.S. Bureau of Land Management (BLM). The Cabeza Prieta National Wildlife Refuge was established in 1939 as the Cabeza Prieta Game Range and existed as such until March 1975, when its designation was changed by Secretarial order (55). The refuge encompasses over 940,000 acres of the southeastern portion of the Range. To date, major portions of the Cabeza Prieta National Wildlife Refuge have been proposed for inclusion under the Federal Wilderness Act of 3 September 1964 (56). The proposal and draft environmental statement were submitted in 1971 by the U.S. Fish and Wildlife Service with a request that Congressional action await completion of both aerial and ground surveys of the area by the U.S. Geological Survey to assess the mineral and geothermal power potential of the refuge. As of January 1977, the mineral assessment had not begun. There is reason to believe that Congressional action may take place within the next 5 to 10 years to designate the refuge as a Wilderness Area because of its significant ecological value for scientific and recreational uses (55).

SECTION 3

IMPACTS OF THE PROJECT ON THE ENVIRONMENT

3.1 IMPACTS ON THE PHYSICAL ENVIRONMENT

To provide a basis for comparing the amount of land and land-associated biological and archaeological resources to be disturbed by the project, the overall area of the eastern bajada of the Mohawk Mountains (bounded on the north by Interstate 8; on the west by the base of the mountains; on the east by San Cristobal Wash; and on the south by the wind gap located approximately at the border between Township 10 South and 11 South) was measured from a satellite (LANDSAT) image. The areas of varnished desert pavements that are clearly visible on the image were also measured. The overall area of the bajada is approximately 100 sq. miles (25,900 ha) and the area of varnished desert pavement is approximately 53 percent of the total area (53 sq. miles or 13,700 ha). The total area to be disrupted by construction of the trenches and ramps is approximately 183 acres (74 ha) of which approximately 36 acres (15 ha) is covered by varnished desert pavement. Additional roads and equipment yards will increase the disrupted area of the site to approximately 200 acres (81 ha).

The total area of disturbance will be approximately 0.3 percent of the total bajada. The amount of desert pavement which will be disrupted is approximately 0.1 percent of the total amount of desert pavement on the bajada. The trench alignments will disrupt a relatively small percentage (estimated to be between 0.003 and 0.03 percent) of the water courses on the bajada because they trend nearly parallel to most water courses.

3.1.1 Effects on Geomorphology

The major potential adverse impacts on the geomorphic physical environment will result mainly from: 1) the placement of the spoil material over the natural surface and; 2) the disruption of existing surface features such as desert varnish, desert pavement, thin carapace surfaces, coppice dunes, drainages and the playa by construction activities and off-road vehicle traffic. The natural surface features on the bajada are directly related to the physical processes that maintain an equilibrium between erosion and deposition by wind and water movements. Virtually all physical features of the desert environment are closely interrelated. Disruption of these variables modifies the equilibrium; this in turn accelerates erosion and deposition until a new equilibrium is established. In addition, the disruption of the physical features may produce long-lasting changes that can modify the aesthetics of the area.

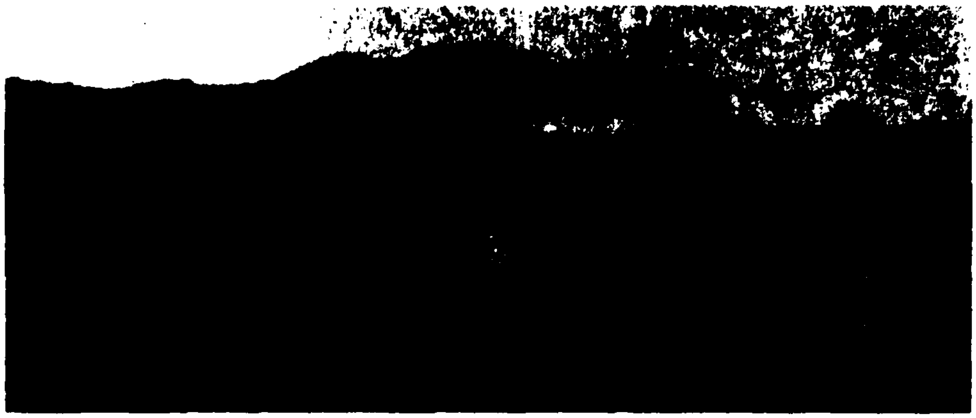
The surface character of the natural bajada and its drainages will be altered in the siting area by the excavation and backfill of the trenches and the spreading of spoil material. The physical appearance of the trench alignment after completion of construction activities will be a mounded berm reaching a height of less than 1 ft (.3 m) at its center and tapered toward the edges of the 328 ft (100 m) wide disturbance. The exact height and width of this berm will depend on the amount of backfill used in the trenches and the amount of unsuitable backfill material. The disposal of unsuitable backfill material, such as clasts larger than 6 in., will also add to the surface relief or character of the spoil berm surface.

If there is insufficient backfill material to bring the trench excavations back to finished grade, excess material will be imported from other sections of the alignments, thus reducing the amount of spoil in those sections. However, measures will be taken in using imported material to ensure that the uppermost few feet of the backfill are of a grain-size distribution similar to the natural near-surface material. This will aid in reducing the change in character of the surface and facilitate restoration of the surface toward its original state.

In order to minimize the disruption of the natural drainages and to prevent blockage of the downstream flow, the grade of the trench alignment will be lowered at stream crossings such that the tops of the finished backfill will be flush with the bottoms of the water course. Erosion of the backfill material over the trench alignment is possible at these locations. Erosion may also occur to a lesser extent on the other portions of the spoil berms, until a stable surface is re-established. The total character of the original surface along spoil berms and disturbed areas will probably never be completely restored; however, the change in surface form caused by the height of the spoil berm will be a minor impact.

The most noticeable effect of the activities is likely to occur in the southwestern portion of the alignment where it crosses the darkly varnished desert pavements. Disruption of the fragile desert pavements will result in accelerated water erosion and fugitive dust generation both during and after construction activities. Dislodging, removing or burying the pavement particles, especially the darkly varnished particles, and compaction of the surface by vehicle traffic is likely to cause significant aesthetic impacts. The time required for natural processes to rejuvenate the desert pavements depends on a number of variables and the degree of damage. If the pavement particles are stripped or dislodged, many years are required before the pavement will show signs of rejuvenation (2) and at least 2,000 years are required for the desert varnish to show signs of forming.

Figure 26 shows an example of the disruption to a desert pavement surface by active off-road rubber-tired vehicle usage. Figure 27 shows the same road several years after abandonment. It can be noted that as long as the pavement particles are not stripped or dislodged, the pavement partially recovered. However, the tire ruts shown in Figure 27 will be visible for a long period of time. Figure 28 shows a road over a desert pavement; the road has been continually used and occasionally regraded. As a result



372P-26

Figure 26. Example of a non-graded road over desert pavement. Surface disruption and dust have resulted from active rubber-tired vehicle traffic. The same road, partially recovered after several years without traffic is shown in Figure 27. Photo taken near Vidal, California in an area with desert pavement similar to that at the project site.

372P-27

Figure 27. A portion of the ungraded road over desert pavement shown in Figure 26 after several years without traffic and with normal wind and water erosion.

of the compaction of the surface and the long time required for desert varnish formation, aesthetic impacts to the desert pavement surface will probably remain indefinitely.

In the lower northeastern portion of the site, where desert pavements are lacking, construction activities and off-road vehicular activity will disrupt the fragile carapace crust and other protective surface features. This will result in accelerated fugitive dust generation and water erosion both during and after construction until the protective surfaces can be reestablished. Compaction of the surface (e.g., by vehicle traffic) will result in ruts that could remain indefinitely as permanent scars. The spoil pile berm in this area, even though its relief is low, may result in: some development erosion washes, concentration of stream flow on the upstream side, and a source of fugitive dust until a protective crust and vegetation are reestablished.

Observations of tire ruts in the lower bajada following a single rainy winter show stabilization resulting from formation of a thin clayey crust (carapace) interspersed with sand and from invasion by annual plants (Indian Wheat, see Figure 29). However, the compacted road ruts still remain as permanent scars and could concentrate surface runoff and result in local erosion. Smooth finish grading and water spraying will aid in reducing the depth of these road ruts and in accelerating the formation of the surface crust.

Improved access roads across the playa surface will remain as permanent impacts to the aesthetics of the playa.

3.1.2 Effects on Hydrology

The main impacts of the construction on the hydrology of the area will result from locally accelerated erosion and consequent sediment deposition downstream in channels that have been disturbed, blocked, or diverted. During construction, several drainages will have to be diverted away from the excavation into adjacent drainages which do not intersect the alignment downstream. Such diversion could result in a significant increase in downstream erosion and siltation if precipitation occurs during the construction period. Following construction, accelerated erosion and possible siltation might occur in sections of channels which have been rechannelized but not returned to their natural state. In addition, any significant cuts made in the channel banks to maintain the required 5 ft of cover as the alignment passes under channels will be potential areas of erosion.

372P-28

Figure 28. Graded road over varnished desert pavement. Photograph taken near Vidal, California.

372P-29

Figure 29. An example of soil stabilization and revegetation in tire ruts (left center foreground) on the project site following a single winter season. The ruts may remain indefinitely. Active tracks are shown on the right. Photo taken April 1977.

3.1.3 Groundwater and Water Quality

Self-contained portable chemical toilets at the construction sites will prevent sanitary waste impacts on groundwater. Liquid emissions from construction activities include equipment washdown water and spilled petroleum products. These emissions will have only localized surface effects because the low relative humidity in the environment tends to evaporate any washdown water and consolidate some petroleum product spill. Hence the amount of petroleum product spill that reaches the groundwater will be insignificant.

Surface silt transport in natural drainage channels following storms is usually substantial. Any additional turbidity in surface waters and subsequent siltation resulting from construction is unlikely to be detected except in specific watercourses directly influenced by construction or adjacent to spoils.

Infiltration of surface water and shallow groundwater might concentrate in the backfill material causing either (a) a perched groundwater zone adjacent to the buried structure or (b) accelerated groundwater flow and possible underground erosion adjacent to the structure. The completed structure might also act as a barrier to natural shallow groundwater conduits.

Pumping of an onsite well will result in at least a temporary drawdown of the water table in the immediate vicinity of the site. There is some possibility that this drawdown may influence the yield, water quality, or both in any wells that might ultimately receive water by underground flow from the site; however, data are not presently available for analysis. Studies are currently in progress to define the local aquifer and any impacts which the proposed pumping may have on existing regional wells.

3.1.4 Impacts on Air Quality

The proposed action will result in a minor degradation of air quality in the vicinity of the project site as a result of:

1. combustion emissions associated with increased traffic to the site and operation of the construction and power generation equipment on site; and
2. fugitive dust generation associated with the spoils piles, vehicular movement, trenching activities, and breakout mechanism generator tests.

Due to the sparse population distribution in the project area, the only areas at which air quality impacts are expected to have a measurable effect are: the Interstate 8 rest stop near the Mohawk Pass and in the town of Dateland. These areas are of primary consideration because of their proximity to the site, approximately 3 miles (4.8 km) and 7 miles (11.3 km) respectively.

Normal vehicular emissions and ambient pollutant levels are listed in Table 12. To these are added the onsite and offsite emissions due to the construction project. Emission factors are from EPA publication AP-42, Supplement 5 (80). Commuting vehicles are assumed to be light duty automobiles or pickups with an average speed of 45 mph (72 km/hr). Construction equipment is assumed to be heavy duty diesels with an average speed of about 20 mph (32 km/hr). The emissions associated with the diesel-powered electric generators are listed in Table 13. The emission factors listed in Reference (80) are used to compute the combustion products.

The combined project-related internal combustion emissions will result in an approximate 24 percent increase in air pollutants currently being released into the San Cristobal Valley. Diffusion and dispersion of the CO pollutant was modeled using the line source HIWAY model (59). Although this model applies strictly to the nonreactive pollutants (e.g., particulates and carbon monoxide), it may be used as a guide to assess the expected levels of all pollutants at the highway's edge. Existing traffic generates an average CO level of approximately 11 ppm. This will be increased by as much as 5.0 ppm from construction traffic at peak hours. The nominal level of 16 ppm is well below the federal standard of 35 ppm for a 24-hour day (Table 4).

The impact from combustion products associated with the proposed action is thus considered minor with respect to the existing highway background air pollution levels.

The construction site is a potential source of fugitive dust emissions which may have a temporary impact on air quality. Dust emissions vary substantially from day to day depending on the level of activity, the specific operation and the prevailing weather. The movement of large particulates (> 30 μm) by wind (i.e., the erosion of exposed surface soil) is sensitive to the wind speed with a threshold value of approximately 12 mph (85) being representative of the site conditions.

The amount of material that will be entrained and suspended by the wind is a complex function of the particulate distribution in the soil, surface roughness, soil moisture, vegetation cover, and soil surface cementation. A simplified "windblown dust" equation adopted by the Environmental Protection Agency (86) and based on a method developed by the Department of Agriculture (87) has been used to estimate soil erodability of the area and is of the form:

Table 12. Combustion emissions associated with transportation of construction crews and materials.

ORIGIN AND DESTINATION	MILES	TRIPS/DAY	VMT	TOTAL LBS/DAY (ppm)			
				CO	HC	NO_x	PART.
Normal Interstate 8 Traffic	13	5,700	74,100	2,437 (0.16)	622 (0.04)	622 (0.02)	88 9 μg/m^3
Construction Equipment & Materials*	13	601	7,813	257 (0.02)	66 (0.004)	66 (0.002)	9.3 1 μg/m^3
Onsite Traffic and Construction**	5	31	155	5 (.0006)	1.3 (.002)	1.3 (.016)	0.18 .22 μg/m^3

*Includes commuting to and from the project.

**SO_2 combustion emissions = 0.2 μm/gm^3

Table 13. Combustion emissions associated with diesel-powered electric generators for an 11-hour day.

APPLICATION	POWER RATING	KWH
Office, Shop	335 kW, 2 ea	7,370
Job Water	800 kW, 1 ea	8,800
Batch Plant	150 kW, 1 ea	1,650
Trench Ventilation	500 kW, 1 ea	5,500
TOTAL KWH		23,320
TOTAL CO emissions (lbs/day)		209
TOTAL HC emissions (lbs/day)		77
TOTAL NO_x emissions (lbs/day)		968
TOTAL PARTICULATE emissions (lbs/day)		69
TOTAL SO_2 emission (lbs/day)		64

$E_s = AIKCL'V'$

where E_s = suspended particulate fraction of wind losses of tilled fields, tons/acre·year

A = portion of total wind erosion losses that would be measured as suspended particulates

I = Soil erodability (geological units), tons/acre·year

K = surface roughness (h^2/W, h = ridge height, W = ridge spacing)

C = climatic factor ($0.345\ U^3/(PE)^2$, U = wind velocity, PE = soil moisture

L' = unsheltered field width factor, dimensionless

V' = vegetative cover, lbs of air dried residue/acre

For this analysis the bajada was considered to be composed of three soil types in equal proportions (see Figure 13 for the three major geologic units), and E_s was calculated independently for each of the three. The mean effective soil erodability for the bajada soils was thereby calculated to be 9 tons/acre·year (full calculations appear in Reference 88). For the purposes of comparison, the area mapped geologically in Figure 13 (and shown as an outline in Figure 18) was considered the existing source of particulates on the site. Its total area is 14,000 acres (5668 ha). Based on the 9 tons/acre·year value, yearly wind erosion for this nominal source area are 126,000 tons/year. The calculations made some nominal assumptions about variations in soil moisture, or surface stabilizing factors such as the carapace crust, and surface vegetation. Values have not been determined experimentally onsite and the true values could result in less erosion than predicted.

The potential erodible surface of the spoils piles compacted on top of the trenches (0.7 feet or 0.2 m deep and 328 feet or 100 m wide) will have an estimated total exposed area, including access roads, of 200 acres (0.8 km^2). The initial (1st year) erodibility of this material is estimated to be approximately 17 tons/acre·year or approximately 2 times that of the undisturbed alluvium. The maximum potential soil loss due to wind erosion would be approximately 3,400 tons/year or 2 to 3 percent of the present background erosion loss. By contrast, a 200 acre (0.8 km^2) undisturbed area along the alignment would contribute an estimated 1,800 tons/year.

Under the normal low wind conditions (average velocity 5 mph), maximum particulate levels at the Mohawk Pass or at the Interstate 8 rest stop would be in the estimated range of 14 to 28 $\mu g/m^3$ which is typical of desert background sites (Table 4). Additional windblown dust could reach the rest stop from the spoils piles on the construction site during periods of winds as low as 5 mph. Winds of this speed are calculated to add approximately 3.6 $\mu g/m^3$ to the background levels. Under these conditions, total particulate levels will remain below the federal air quality standards of 60 $\mu g/m^3$ (annual geometric mean) listed in Table 4.

An increase in visible dust in the vicinity of the spoils piles is expected to become apparent at wind speeds above 12 mph (85). Substantial dust generation is not expected, however, except during the severe dust storms that occur naturally in the region. Such storms occur about 0.5 percent of the time annually or 2 to 3 days each year in southwestern Arizona, and are generally most frequent in March (12).

The amount of dust that will be raised by vehicular travel along roads and the trench alignment of the project site has been estimated at 4 to 6 lbs/mile traveled based on studies done in a similar situation near Tucson, Arizona (60). These values were used along with the projected average distances of onsite travel to provide a reasonable upper limit of 30 tons/day of dust likely to be generated as a result of construction activities. This level of particulate emissions will add less than 1 $\mu g/m^3$ to the ambient levels and will therefore not exceed the state 24-hour standards of 150 $\mu g/m^3$ (Table 4). Watering the roads, as will be done on the project site, will reduce the dust emissions by at least one half (60).

Erosion potential of the finished trench surfaces is expected to decrease rapidly because of the formation of crust (carapace) on exposed surfaces in the short term. The invasion by soil lichens and annual plants, as well as the formation of desert pavement in rocky areas, is possible in the long term. Revegetation of rutted areas (that collect water) has been observed to occur rapidly on site. Conversely, revegetation of raised berms adjacent to Stoval Airfield has not occurred at all, but the soil has nevertheless stabilized. The potential for revegetation of the spoils areas may not be great, but the erosion potential is expected to reduce rapidly.

During the two breakout tests, dust will be generated. Also exhaust gases resulting from the gas-driven hydraulic lifters will be expelled into the atmosphere. The chemical constituents of the exhaust gases are unknown since the propellant composition for the gas generator has not yet been selected. However, due to the short duration of the action time and the thermal buoyancy of the exhaust gases, the concentrations of particulates and exhaust gases are not expected to be detectable at the Interstate 8 rest stop or at Dateland.

3.1.5 Noise Impacts

Noise originating on site will be either undetectable or completely masked by nearby traffic at the two areas identified as being sensitive from a human standpoint: Dateland and the rest stop on Interstate 8 at Mohawk Pass. There will be a considerable increase in vehicular traffic through Dateland, however, and the noise will be increased substantially. Since vehicular traffic will pass only during the day, impacts are expected to be small. If aggregate is obtained from Tacna, there will be additional noise in that community associated with increased truck traffic.

3.2 EFFECTS ON THE BIOLOGICAL ENVIRONMENT

The project will disturb only a small part of the existing habitat on the eastern bajada of the Mohawk Mountains. There will be permanent losses of some vegetation and its associated fauna along the trench alignments and downstream from washes in which normal drainage patterns have been disrupted. From an areawide standpoint, these losses will be minimal. The overall characteristics of the bajada ecology will not be permanently changed and any direct losses of animals will not be of any long-term significance.

3.2.1 Effects on Vegetation

The immediate effects on the project site will be the loss of vegetation wherever construction activities occur. Since there are no threatened or endangered species of plants on site, there will be no impacts on federally protected species. Plant species protected by Arizona law may be cleared or removed from construction sites. In the paved parts of the bajada near the mountains where vegetation is confined to arroyos and washes, losses will occur only at arroyos or wash crossings. On the lower bajada, vegetation also occurs between washes so that plants will be lost wherever disturbance occurs. The total densities of plants and the species composition varies with the altitudinal gradient along the bajada so that total numbers and species of plants removed vary depending on location. Plant densities at various locations are documented in the baseline studies. The amount of vegetation that will be lost will be simply a function of the total area disturbed. As indicated in Section 3.1, the total area disturbed will be $\sim$0.3 percent of similar area along the eastern bajada of the Mohawk Mountains and only $\sim$0.03 percent maximum of watercourse area. The direct vegetation losses will not in any measurable way alter the overall biological processes or productivity of the bajada.

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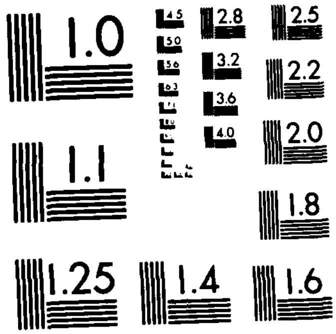

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Secondary impacts on vegetation include the probability that wherever water is sprayed on surfaces for dust suppression, adjacent vegetation is likely to thrive and to be more productive than that in the surrounding areas, which are dependent on natural precipitation and run-on. At the HAVE HOST site 32 miles (51 km) to the west, for example, ocotillo immediately adjacent to the watered roads have become considerably more lush than those even several meters away from roads. Additional secondary impacts on vegetation may occur as a result of diversion of surface and subsurface water transport away from watercourses crossed by the trenches and roads. The fact that most of the vegetation on the bajada is associated with watercourses, however small, indicates clearly the dependence of such biological communities on the periodic runoff following storms. Similarly, the vegetational pattern in each watercourse has become established in the existing flow regime and would likely change in species composition or abundance were water to be diverted to that watercourse.

Examination of arroyos that have been blocked by highway construction near the site shows that these watercourses, which once were heavily vegetated with trees, now support only a relatively uniform population of creosote bushes. A similar effect can be anticipated if any existing drainage patterns on the project site are permanently disrupted by any construction activities. Similarly, wherever new drainage channels are made intentionally, or result from erosion following surface disturbance, an increase in vegetation can be expected to result. Since procedures will be followed to prevent any permanent surface diversion in arroyos, it is unlikely that there will be significant changes in distribution of perennial vegetation except in smaller washes.

Desert plants are not generally deeply rooted except where rainwater accumulates (63,64). One of the potential deep-rooted invaders that would benefit from increased standing water on the project site that could occur following construction and clearing along the watercourses at lower elevation is saltcedar (*Tamarix sp.*). This exotic species has replaced native plant associations in much of the Gila River drainage as a result of disturbance and changes of flow regimes (66) and it is well established to the north of Stoval Airfield across Interstate 8. Disturbance of drainage patterns in San Cristobal Wash, particularly any activities that result in ponding of water (67) could result in saltcedar invasions. Historically, however, where berms and ditches have been established around Stoval Airfield, the resultant vegetation where there was increased water consisted primarily of dense thickets of mesquite. Some of these are visible on the aerial photographic base maps (Figure 3) and one of the oblique aerial photographs (Figure 7) in this EIS.

The raised berms around the edge of Stoval Airfield have remained essentially barren (after probably 30 years of no disturbance) even though they are adjacent to thickly vegetated drainage channels. Apparently they do not absorb a sufficient amount of direct precipitation to support plants. This lack of revegetation may be instructive in predicting the vegetational fate of the raised surface of the trench alignment following construction. A compacted raised surface may eliminate runon and consequently may never become vegetated.

In the lower areas of the bajada where the surface is silty and unpaved, the more than 80 percent of the surface not covered with shrubs is populated to varying degrees with a thick black crustose lichen which is clearly of structural value. Soil lichens (68) and soil algae (69,70) are ubiquitous in desert soils and there is increasing evidence that they are important in preventing soil erosion. A single vehicle traverse over moist lichen-stabilized silty surfaces appeared, during a site survey, to have disrupted the surface enough to encourage erosion.

Tire ruts produced in late summer 1976 on the project site were inspected again in April, 1977, following a season in which winter rains and annual plants had been relatively abundant. It was clear that most of the ruts had become stabilized and had been populated with stands of the annual, *Plantago insularis* (Indian wheat). Individual plants within ruts were significantly larger and had significantly more seeds than those in undisturbed areas (see Table 4). The density of plants within ruts was also higher. Rapid revegetation of depressed areas which serve to catch water can be predicted. Some of the ruts parallel to existing watercourses eroded heavily during late fall rainstorms, effectively resulting in new watercourses where previously there had been none. If, as seems likely, these new watercourses persist, then it is probable that they will become vegetated in a manner similar to the naturally occurring watercourses. The lower third of the bajada where water erosion was most severe is also the part where watercourses are least well defined, and where they probably shift from time to time naturally, so that minor alterations of drainage patterns will have little long-term vegetational significance.

3.2.2 Impacts on Wildlife

Impacts on Birds

Tomoff (71), studying an altitudinal habitat gradient comparable in many respects to that occurring on the site, concluded that there was an increasing breeding population density and species diversity of birds with habitat complexity "...extending from valley bottom *Larrea* communities upslope through bajada and rockslope *Cercidium* communities." Consequently, it can be anticipated that removal of vegetation from the lower bajadas will have less effect on birds than removal of vegetation from the upper bajada. Except for black throated sparrows which are known to construct nests in the bases of creosote bush (72) all other birds on the project site usually build nests either in cacti (chollas or sahuaro) or in trees. In the playa area, particularly in the drainageways and mesquite hummocks near Stoval Airfield, there were many bird nests in the mesquite trees. It is probable that some species will be disturbed during construction, and will not nest in the vicinity of Stoval Airfield during the spring of 1978. Because of the relatively small area involved, and the abundance of similar nesting habitat in the Gila River Floodplain a few miles to the north, the impact will be small.

In the lower third of the bajada where most of the watercourse alteration is expected to occur there are very few trees and no cacti suitable for nesting. The impact on breeding birds in this habitat will be negligible. Nesting habitat will be lost at wash crossings in the upper bajada, and during construction, nesting probably will not occur close to construction activities. The total losses, however, will be very small relative to the amount of similar habitat on the bajada, on the order of between 0.003 percent (direct vegetation loss) and 0.3 percent (total percentage of of bajada disrupted).

Impacts on Mammals

The rodents of the project site are the only group of mammals present that may be killed by construction activities. However, since most rodents are associated with shrubs, trench construction in the unvegetated areas between arroyos would probably not encounter rodent burrows. Rodent population sizes are notoriously unstable in desert environments, fluctuating with the annual seed production. The number killed during construction would not be expected to have any long-lasting effects on populations in the area.

Larger mammals or their sign observed on the site include rabbits, coyotes, kit foxes, desert bighorn sheep, and one horse. The possibility also exists that the endangered Sonoran pronghorn may occasionally use the site as well. All these species will probably avoid construction activities. It is not likely that any of them will be killed, and considering the localized nature of the project, they are not likely to be displaced for extended periods of time. The two species of most interest, bighorn sheep and Sonoran pronghorn, are discussed below.

Sonoran Pronghorn Antelope

It is probable that the project will have no impact whatever on Sonoran pronghorns, an endangered species. None has been reported within 12 to 15 miles of the project site although the habitat is suitable, and it is unlikely that pronghorns will be displaced. During the construction period, pronghorns that might otherwise visit the area will probably be excluded, but since the project is of relatively short duration and the disturbed area relatively small, no long-term exclusion is likely.

The nature of the project...continuous construction activity at one location for several months...is such that pronghorns are not likely to be startled into flight by unexpected human incursion. It is such abrupt disturbances that cause increased activity during periods of water shortage and that are of most concern to pronghorn specialists in the area (34). In order to avoid adverse modifications of the potentially critical habitat by project activities, formal consultation with the FWS will remain in effect throughout project planning and implementation.

Desert Bighorn Sheep

It is probable that the resident bighorn sheep population in the Mohawk Mountains will be aware of the construction activities of the project. Construction activities have been scheduled not to occur within several miles of the base of the mountains during the period in which the sheep normally occupy inselbergs on the bajada (January through April). It is during this period also that the sheep are lambing and are most likely to be sensitive to disturbance. It is felt by the game management official responsible for bighorn sheep in the area that any potential impact of the project on bighorn sheep will be largely alleviated by the proposed scheduling (37).

3.3 EFFECTS ON THE SOCIOECONOMIC ENVIRONMENT

3.3.1 Burden on Existing or Proposed Public Service Facilities and Utilities

Requirements for water and electrical energy will be supplied through on site facilities (wells and generators) and thus not affect community services. Indirect requirements of water and electrical energy to sustain craft and supervisory personnel who relocate to the local area will be minor and well within the fluctuation of demand normally associated with a tourism supported economy.

Effects on local housing are dependent on the total number of construction personnel required, the number imported from other areas temporarily relocating near the job, and the communities relocated workers choose for residential areas. At least 25 contractor supervisory personnel will be relocated for the life of the project. In addition, a variable number of Air Force supervisory (usually approximately 6) will be present. Most union hiring halls* are located in Phoenix but have members in the Yuma area as several Yuma locals have recently been consolidated into the Phoenix organization. From the available data a peak of 80 relocated workers (craftsmen and supervisors) has been projected in Table 14. Craftsmen are unlikely to move families because of short duration of the job (most positions last only 2 to 3 months) and the proximity of Phoenix for weekend commutes. Perhaps half the supervisory personnel will relocate an average of 1.4 dependents each so the total number of relocated people in the peak activity month, April 1978, will be about 100 people.

Although proximal communities between the site and Yuma are small, and have limited amenities, a few workers may live in Dateland, Tacna or Wellton. These should number no more than five people. Because of its location between the site and Phoenix, Gila Bend may attract five to ten people, although resources in the town are limited. Adequate housing for these people is available in these communities.

3.3.2 Effects on Transportation

A total of 765 truckloads has been estimated to be necessary to supply the site from the east and 3,100 truckloads to supply the site from the west. Materials carried will be primarily constituents of concrete. Assuming deliveries occur over a 30-day period, truck traffic will average 100 per day west of the site and 25 per day east of the site. Each truck will increase the average daily trips (ADT) by two since it will return to its point of origin. During the peak month of April, transportation of construction workers will increase ADT about 400 additional trips daily (238 workers at an average vehicle occupancy of 1.2 both entering and leaving the site). Current ADT is about 5,200 vehicles so average daily traffic volumes will increase about 11 percent. The available highway, Interstate 8, is lightly traveled and this additional traffic will not lower Level of Service below the current Level A (free-flowing traffic).

A total of 50 railcar loads will be required to transport steel fibers from the eastern United States. This volume could be handled by a single train so no impacts on train traffic should result from the project.

The only impact on air transportation will be a few incidental visits to the area by governmental and contractor personnel.

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* Construction craftsmen will not necessarily be union members but the union's membership and locations have been used to approximate the availability of crafts in the region.

Table 14. Anticipated local and relocated employment by classification and month.

CLASSIFICATION	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
Craft Labor								
From Yuma Area	56	107	158	120	20	2	0	0
From Other Areas *	25	33	49	48	7	0	0	0
Total Craft Labor	81	140	207	168	27	2	0	0
Professional and Supervisory **								
From Yuma Area	0	0	0	0	0	0	0	0
From Other Areas	31	31	31	31	31	31	24	17
Total Professional and Supervisory	31	31	31	31	31	31	24	17
Total								
From Yuma Area	56	107	158	120	20	2	0	0
From Other Areas	56	64	80	79	38	31	24	17
All Sources	112	171	238	199	58	33	24	17

* Primarily from Phoenix but some may be from Tucson or San Diego.

** All contractor and governmental supervisory personnel projected from areas other than Yuma.

Traffic Safety

The project will generate additional traffic on Interstate 8, through Dateland, and at the Dateland Interchange. Thus, there is an increased potential for vehicle-vehicle or vehicle-pedestrian accidents.

The greatest potential for highway congestion with related accidents is associated with arrival and departure of workers. A peak employment of 238 persons is projected for April, 1978. A conservative value of 1.2

riders per car has been assumed for this environmental statement, so that arrival/departure of 198 passenger vehicles per day can be assumed as a worst case. If all of these vehicles arrive and depart over a 15-minute period, and the highway is at peak load for normal traffic, conditions will remain free flowing (Level A), and no problems are anticipated. Each lane of a multilane roadway has a nominal capacity of 2,000 passenger vehicles per hour for uninterrupted flow (78). Present "worst case" existing traffic is 364 passenger-car equivalents/hr, and the increment from commuting workers is 792 per hour, for a total of 1,156 per hour. This is well within the free-flowing capacity of the highway.

At the end of the working day, all of the commuting vehicles will exit the site through Dateland. Traffic through Dateland can be expected to be highly congested for a period of 1/4 to perhaps 1/2 hour at that time. Therefore, conditions conducive to traffic accidents and hazardous to pedestrians or vehicle traffic attempting to cross the road through Dateland are expected at the end of each shift.

Commuting traffic associated with the project and its associated truck traffic are not scheduled to overlap. For analysis of truck traffic, it has been assumed as a worst case that all such traffic will occur over a one-month period, or in 20 working days. Under these conditions, during an 8-hour shift, one truck would be inbound or outbound on the average of every 2½ minutes. If all of this traffic were routed through Dateland (e.g., an aggregate source were developed north or east of the site, and all other materials were delivered from the east), one truck would pass through Dateland every 1¼ minutes. This level of truck traffic is not expected to represent a significant hazard to vehicles or pedestrians.

Highway truck traffic constitutes a negligible change with respect to the free-flowing (Level A) capacity of I-8. The most dangerous condition with respect to the Dateland interchange is expected to be at the westbound offramp at the end of the working day, when there will be considerable congestion for a period of ¼ to ½ hour as worker's cars enter I-8. One lane of the freeway is more than adequate to carry the entire traffic load under peak-hour conditions so this situation should not create severe safety hazards.

3.3.3 Impacts on Aesthetics

The proposed project is in sight of an established rest area on Interstate Highway 8, and the shorter alignment comes within approximately 1 mile (1.6 km) of that highway. During construction, the project will be highly visible, particularly activities on the short alignment. Following completion of the project, it is expected that the short trench will be unnoticeable from the highway much as Stoval Airfield presently is.

The long trench alignment is far enough away from the highway that construction activities there will not be particularly noticeable. The appearance of the desert pavement along the long alignment even if it eventually becomes reestablished as a surface covering, will always be distinguishable from the original surface. The very gradual slope of the alluvial fan is such that the alterations of the surface will not be very visible from the highway but will be highly visible to persons at or above the site, an uncommon occurrence so long as public access remains restricted.

3.3.4 Effects on Surface Cultural Resources

In compliance with appropriate regulations, archaeological surveys of the project site have been performed by professional archaeologists; the Arizona State Historic Preservation Officer has been contacted; and copies of this Environmental Statement have been sent for review to the Director, Office of Environmental Project Review, Department of the Interior and to the Advisory Council on Historic Preservation.

Effects on Archaeological Sites

The trench construction, wherever it disrupts the surface, will obliterate the surface archaeological features. The only type of preservation regarded as essential by the Arizona State Museum for most of the sites identified in this environmental statement is an accurate record. The record compiled for this EIS and Reference 88 is sufficient. An exception to this conclusion is appropriate for potential subsurface features in the vicinity of sites MAV-3 and MAV-4.

Effects on Subsurface Cultural Resources

It is possible that subsurface archaeological features exist in the area of the two temporary campsites, MAV-3 and MAV-4. MAV-3 is at the periphery of the direct impact area and thus it should be possible to avoid it during construction. This would result in no impact on the site. MAV-4 is very close to the southwest terminus of the longer trench and avoidance is unlikely. This site will probable be destroyed as a result of the construction activities. This site may be of significant value for a full understanding of man's prehistoric activity in the area and it may be eligible for the National Register. If so, an appropriate data recovery program will be accomplished. A determination of National Register eligibility is currently being pursued.

3.3.5 Evaluation of Secondary or Indirect Effects

The project is short-term and involves only a limited work force. For these reasons, secondary effects are also expected to be minimal. Long-term public or private indirect investments to support the project will not occur. A brief stimulus to the local economy will be experienced but even this will be so minimal that it will probably not be separately noted by local communities. The economic and employment effects are summarized in Table 15.

Table 15. Economic and employment effects.

Output (million dollars)	37.7
Earnings (million dollars)	
Direct	3.6
Indirect	7.8
Total	11.4
Employment (manyears)	
Direct	71
Indirect	712
Total	783
Employment (job opportunities)	
Direct	238
Indirect	712
Total	950

Indirect Economic Effects

To measure indirect effects on local economies a series of assumptions has been made:

- Total project cost will be $20 million. This will include $2 million for engineering costs; $14 million for construction costs; and $4 million for specialized equipment.
- Only the construction costs portion of expenditures will occur in the local two-county area.

- The project is best approximated by Standard Industrial Classification (SIC) Industry 1625, "Construction of New Military Facilities."
- Labor costs for construction and supervision will total $3.6 million (88).
- The project will require about 71 manyears of labor effort with a peak labor force of 238 people.

The Regional Industrial Multiplier System (RIMS) has been applied to estimate the effect of Construction of New Military Facilities on the Yuma-Maricopa region. A multiplier is a measure of total economic effect of project expenditures including both the effect of direct expenditures on the project and indirect and induced effects resulting from the direct expenditures. RIMS measures each of these components by matching locally available supplier industries described in *County Business Patterns* with the 484 sector national model and generates a list of required, locally-available, supplier industries and a direct requirements coefficient for each. These direct requirements coefficients, when summed, form the direct component of the multiplier. A linear homogenous function is used to produce the indirect-induced component. The final demand multiplier is the sum of the direct component, the indirect-induced component and a component to represent the initial expenditures which is always unity or 1.00. For the construction of New Military Facilities in Yuma-Maricopa Counties, the results of this analysis are contained in Table 16.

Application of the RIMS output multiplier of 2.783 to the estimated local expenditures of $14 million yields an estimated increase in output in the two-county region from the project of $39 million. For each million dollars spent in the region directly on the project, a total of $2.8 million dollars in local economic activity will result.

The RIMS procedure also produces an output-to-earnings ratio that is region and industry specific. For the construction of New Military Facilities in Yuma-Maricopa the ratio is 0.293; that is, of each million dollars of increased output, $293,000 will be in the form of earnings. Thus, the $39 million increased regional output resulting from the project will include $11.4 million in earnings. Total direct earnings are known to be $3.6 million and indirect earnings will therefore be $7.8 million. The 1972 total earnings in Yuma-Maricopa was $5,344 million so the project will account for about 0.2 percent of 1974 regional earnings. This is a beneficial, but minor, increase.

In terms of employment, a total of 238 direct labor job opportunities has been identified. Indirect employment can be estimated through the earnings-to-employment ratio also available through the RIMS process. In the Yuma-Maricopa region, for each million dollars of direct earnings, 91.3 indirect employment job opportunities will result. Since indirect earnings were estimated at $7.8 million, about 712 indirect employment job opportunities will result in Yuma-Maricopa from the project expenditures. Total regional employment, both direct and indirect, will be about

Table 16. Regional direct requirement coefficients (Industry 1625 - New Military Facilities).

SIC CODE	INDUSTRY NAME	PROPORTION OF GROSS OUTPUT
07	Agricultural Services	.0017
14	Nonmetalic Mineral Mining and Quarrying	.0053
15-17	Contract Construction	.0003
24	Lumber and Wood Products, Exc Furniture	.0130
25	Furniture and Fixtures	.0006
26	Paper and Allied Products	.0001
28	Chemicals and Allied Products	.0010
29	Petroleum and Related Industries	.0007
30	Rubber and Miscellaneous Plastic Products	.0021
32	Stone, Clay, and Glass Products	.0930
33	Primary Metals Industries	.0107
34	Fabricated Metals Products	.0675
35	Machinery execpt Electrical	.0110
36	Electrical Machinery	.0260
38	Instruments	.0043
39	Miscellaneous Manufacturing	.0002
42	Motor Freight Transportation and Warehousing	.0108
44	Water Transportation	(1)
48	Communications	.0039
49	Public Utilities	.0009
50	Wholesale Trade	.0367
52-59	Retail Trade	.0282
60	Banking	.0027
62	Security and Commodity Brokers, Dealers, and Services	.0002
63	Insurance Carriers, including Solicitors	.0045
65-66	Real Estate and Combinations	.0005
73	Miscellaneious Business Services	.0216
75	Auto Repair and Services	.0047
81+89	Legal and Miscellaneous Professional Services	.0517
84+86	Museums and Nonprofit Membership Organizations	.0010
	Households	.2790
	SUM OF DIRECT REQUIREMENT COEFFICIENTS	.6837

RIMS MULTIPLIER AND COMPONENTS

INITIAL EXPENDITURES	DIRECT COMPONENT	INDIRECT-INDUCED COMPONENT	FINAL DEMAND MULTIPLIER
1.000	0.684	1.099	2.783

(1) Less than .00005

914 job opportunities. In July 1976, Yuma-Maricopa had nonagricultural wage and salary employment totaling 452,350 jobs.

Equating manyears and jobs results in the project accounting, directly and indirectly, for about 0.2 percent of total regional employment. As in the case of earnings, the project will result in minor but beneficial increases in employment in the two-county region.

Indirect Social Effects

It is not anticipated that the project will result in more than incidental minor social effects given the level of economic effects anticipated. Most of the required labor force will be available from the existing supply in Yuma County. Since these people are currently living in the area, no increased demands on water, wastewater, education, police, fire protection, health services or other utilities and services are anticipated. Demographic effects and changes in patterns of social activity will not occur since no long-term growth is anticipated. Up to 100 people may be temporarily relocated to the local area to live in apartments, trailers, and motels. Local winter tourist oriented facilities can accommodate this load with no problem. Local investments in roads, schools and the like will not be required for direct or indirect effects.

Because of the presence of the project and improved roads constructed for the project there exists the possibility of increased human incursion, probably exclusively by local people, into the project area. Access is possible now by four-wheel-drive vehicles, and at termination of the project, access to the improved roads on site will be made impassable, thus returning ease of access to the site to its current status.

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SECTION 4

ALTERNATIVES TO THE PROPOSED ACTION

Alternatives considered for the proposed action included (1) no project, (2) project postponement, (3) construction of the project at a reduced scale, (4) alternative site options, and (5) alternative construction methods.

4.1 NO PROJECT

The "no project" alternative would maintain the status quo at the proposed site. There would be no physical, biological, or localized socioeconomic impacts, other than those which have resulted from site investigations, and the site area would remain in its present relatively undisturbed state. On a national scale, however, the no project alternative would mean that hard data would not be available for evaluation of the buried trench option and its cost effectiveness with respect to the shelter option. The no-project option would thus result in significant technical and cost risks to the continuing development of the MX weapons system.

4.2 PROJECT POSTPONEMENT

Scheduling the construction effort for a different time of year could alter the physical, biological, and socioeconomic effects. Some of these changes would result in increased adverse environmental effects, and others would reduce the impacts of the project. On balance, the proposed project schedule results in the least adverse impact.

Adverse impacts that would result from project postponement include the increased possibility of encountering heavy rains with attendant problems of erosion, ponding of water, and increased sensitivity of land surfaces to damage. In addition, postponement into the winter season could result in project activity near the base of the Mohawk Mountains during the period of heavy usage by desert bighorn sheep. Finally, if construction activity were substantially delayed into the winter months it would overlap maximum seasonal occupancy of temporary housing in Yuma and other nearby towns, so that a temporary housing shortage could occur.

Beneficial aspects of a construction delay into the rainy season include a natural reduction of potential for dust on the project site and, therefore, the amount of water required for dust suppression. Also, the possibility of disturbing breeding activities of birds would be eliminated if the project were to take place during the fall and winter when breeding does not occur. (The disturbance to bird breeding is considered minor in any case.) Finally, a slight delay in the construction schedule would have the small but beneficial effect of spreading demand for housing more evenly. The only one of these improvements considered potentially significant is that of decreased water usage for dust control, and the size of the reduction could be very small depending on the somewhat unpredictable weather patterns in the area.

In summary, a minor delay in start of construction could slightly reduce some impacts (if, for example, there were still wet weather in February) and could increase others (were major construction activities of the project to extend into wet weather in August).

A longer delay would adversely impact the project schedule and cost without offsetting benefits to the environment.

4.3 CONSTRUCTION OF THE PROJECT AT A DIFFERENT SCALE

Construction of the project at a different scale to reduce the amount of environmental disturbance can be considered in three contexts: (1) construction at full diameter but reduced lengths, (2) construction at less than full diameter with results extrapolated to full diameter, and (3) construction of only one segment of trench to satisfy all program objectives.

Reduced scale would lessen many negative environmental impacts discussed in Section 3, although a linear reduction related to scale would not necessarily be anticipated. For example, access roads and other support facilities would still be required and their environmental impacts would remain, even if the scale of the project were reduced. In general, construction at a reduced scale would be accompanied by reduced effects on terrain-related features, air quality associated with combustion of fuels and dust generation, and noise impact because of the shorter duration of the project (although peak noise levels would likely be similar).

If the length of the long trench were shortened enough to avoid the varnished desert pavement on the upper bajada, two environmental impacts would be decreased. First, areas temporarily occupied by bighorn sheep would be avoided, and second, the essentially permanent aesthetic degradation of the pavement would be eliminated. However, bighorn sheep usage of the lower mountains and bajada is limited largely to the winter months (December through April). Since scheduled construction would not reach the upper bajada prior to May, this advantage of shortening the long trench is substantially reduced. Reducing the length of the long trench to avoid degrading the varnished pavement could result in a failure to meet project objectives. Construction of the long trench will provide data to establish what reasonable rate of construction can be achieved across a variety of geologic features, to determine potential difficulties encountered at stream crossings, and to evaluate the effect of lithology on problems encountered.

A string of specialized pieces of construction equipment will most likely be used in the project. In order to meet the objective of evaluating what rate of construction is achievable, this string of equipment must be deployed and operate over a relatively long line to ensure that a representative sample of typical excavation difficulties is encountered. In addition, once the desired rate is achieved, the equipment must operate continually over a number of sequential working days to validate the rate. These circumstances dictate the planned maximum length of 20,000 ft (6 km).

Reducing the diameter of the trenches could result in a reduction in the width of the disturbed zone along the trench alignments. However, the construction rate depends on the ability to design, fabricate, and operate large size, specialized construction equipment. Specialized equipment of the size required for a full-size trench has never been designed, fabricated, or operated and is itself a key technological challenge. Thus, it is not practical to scale up data from smaller equipment. If a smaller diameter trench were constructed, the objectives of the erection and breakout tests would not be met. Similarly, only information at full-scale will truly verify the feasibility of missile breakout, which is a primary objective of the project.

Construction of only one trench would reduce somewhat the impact on the environment. If only the long trench were constructed, plans could be adjusted to perform erection and breakout tests in it, subsequent to accomplishing construction rate objectives. This alternative would slightly reduce the terrain-related impacts since the short trench would not be constructed. However, other environmental impacts might result from the fact that equipment, personnel and activity would have to continue on site for an extended period of time beyond September. In addition, this alternative could result in adverse impacts on planned project objectives. For example, construction of the short trench will be used as a test bed to shakedown construction procedures. If the shakedown had to be done on the long trench, its length might have to be extended to accomplish all objectives. This lengthening could result in additional environmental impacts. Finally, the spacing between the short and long trench has been selected to provide information on the rates at which this large, specialized construction equipment can be deployed from one site to another. If only one trench were constructed, this objective would not be met.

In conclusion, changing the scale of the project by reducing the length, diameter, or number of trenches would at best only slightly reduce the environmental impact, while imposing a potentially large adverse impact on accomplishment of program objectives.

4.4 ALTERNATIVE SITE OPTIONS

4.4.1 Overall Site Screening

The screening process for the Buried Trench Construction and Test Project began in January 1976. The objectives of the program were:

1. Validate construction cost.
2. Validate construction rate.
3. Demonstrate breakout and erection hardware.

Criteria applied to site selection included:

1. Diversity of geologic conditions within an area of a few tens of square miles that is typical of accessible DOD controlled land.
2. Less than 10 percent topographic grade.
3. Groundwater and marginally excavatable rock conditions greater than 25 feet below the surface.
4. Reasonable physical access.
5. Accessibility around-the-clock during the construction period.
6. Compatibility with any existing activity.
7. Accessibility to an existing rail line.

Using these criteria, six candidate site areas were selected for consideration:

1. Edwards AFB, California
2. Kirtland AFB, New Mexico
3. White Sands Missile Range, New Mexico
4. Luke Air Force Range, Arizona
5. Nellis Air Force Range, Nevada
6. Fort Irwin, California

Conditions which detract from the feasibility of five of the above candidates include:

1. Kirtland and Edwards AFBs have a limited range of geologic conditions which would make it difficult to relate results obtained to those that might be encountered in any operational area.
2. Fort Irwin, a former Army base, has substantial areas of unexploded ordnance, and a high probability of rock near the surface that would be difficult to excavate (igneous intrusives).
3. Both Nellis Air Force Range and the White Sands Missile Range are intensively used by agencies other than the USAF, and potential problems of co-use with those agencies were indicated. Current activities at the Luke Air Force Range would be impacted less than at these two locations.

The Luke Air Force Range best meets the siting criteria because of its geologic conditions and accessibility both by highway and railroad. Three potential siting areas, designated the Childs Valley Site, the Sentinal Plain Site, and the San Cristobal Valley Site were then subjected to a screening process based on overall geotechnical, environmental and physical access characteristics (75).

4.4.2 Site Evaluation on LAFR*

4.4.2.1 CHILDS VALLEY SITE

The Childs Valley Site is in southwestern Maricopa County and encompasses approximately 60 miles^2 (155 km^2) between the Growler Mountains and the Crater Range. The area lies between manned Range 1 and portions of the North-South Tactical Range, and is subject to overflight by aircraft with "hot" guns and practice/live ordnance.

Around-the-clock access to the Childs Valley site would have required either terminating operations at Range 1, or construction of a new road, possibly through the Cabeza Prieta National Wildlife Refuge to the south. The Tucson, Cornelia and Gila Bend Railroad, and U.S. Highway 85 are approximately 6.3 miles (10 km) east of the siting area.

The trench construction area that was considered is the center of Childs Valley, a broad northwest-trending alluvial-filled basin bounded by the Crater Range on the north and the Growler and Childs Mountains on the south. Slopes are relatively gentle, ranging from approximately 20 to 40 ft (6 to 12 m) per mile (0.4 to 0.8 percent grade) over most of the alluviated area. Near the Growler Mountains, surface slopes average approximately 180 ft (55 m) per mile, or 3.4 percent grade.

*This information is derived principally from Reference 75.

Four distinguishable alluvial deposits were considered mappable in the area. Precise depth to bedrock was unknown. The depth to water was estimated as at least 100 ft (30 m), and probably greater than 200 ft (60 m). Most of the material was believed to be easily excavatable, with the possible exception of older deposits of relatively small areal extent near the valley edges. Here, there was some evidence that excavation might have been difficult at depths less than the nominal trench depth. Some of the materials were not expected to be sufficiently well cemented to sustain vertical slopes, so that shoring would have been required in the trenching operation.

Vegetation is present both on the alluvial surfaces and in the washes. Vegetation identified included creosote bush, cholla, paloverde, mesquite, ocotillo, and ironwood.

In summary, the Childs Valley site met most of the geotechnical criteria, but around-the-clock accessibility would have had a major impact on existing range operations.

4.4.2.2 SENTINEL PLAIN SITE

The Sentinel Plain site is in southwestern Maricopa County and encompasses approximately 73 miles^2 (187 km^2) west of the Sauceda Mountains and north of Range 2 and the Crater Range. The area borders the ordnance delivery pattern for Range 2 and Range 4, including a 22,000 ft (6706 m) strafe fan extending west from Range 1. All flights leaving all gunnery ranges overfly the area. Some recovery flights may have live or unexpended ordnance.

Both U.S. Highway 85, an unrestricted public and commercial transportation route, and the Tucson, Cornelia and Gila Bend Railroad transect the siting area.

The Sentinel Plain is a broad, northwest-trending alluvial-filled basin bounded by the Sauceda Mountains on the east and the Crater Range on the west and south. The potential trench site occupied the east central portion of this valley. Slopes are relatively gentle, approximately 20 feet per mile, or less than one percent topographic grade. Near the Growler and Sauceda Mountains, surface slopes range from 80 to 120 feet per mile (1.5 to 2.3 percent topographic grade).

Four distinguishable alluvial deposits were considered mappable in the area. Bedrock could be expected at 100 to 200 ft (30 to 60 m) below the surface within several hundred feet basinward of the volcanic bedrock outcrops in the northeastern, southeastern, and southwestern portions of the site area. Depth to bedrock is probably much greater than 250 ft (76 m) in most other portions of the area, but may be shallower than 1000 ft (305 m) as indicated by a well terminating in rock at 615 ft (184 m) depth in the south-central portion of the Sentinel Valley.

The depth to water in the basin-fill materials was believed to be greater than 100 ft (30 m) in all portions of the site area, and is probably greater than 400 ft (122 m).

Excavation conditions and slope stabilities were considered to be roughly equivalent to those of the Childs Valley site. Older deposits near the mountains were considered likely to require abnormal excavation techniques such as heavy pre-ripping or drilling and blasting. In the younger fans, where there is no cementation or where there is a predominance of sand-sized particles, vertical unsupported slopes were not considered feasible, and a shoring system would have been required or the slopes would have had to be cut back.

Vegetation is present both on the alluvial surfaces and in the washes. Vegetation includes creosote bush, cholla, bur sage, mesquite, paloverde, ironwood, greasewood, and several species of grasses.

In summary, the Sentinel Plain site met many of the geotechnical criteria, although it was somewhat limited in desired geologic diversity. Around-the-clock accessibility for proposed construction would have had a major impact on existing range operations.

4.4.2.3 SAN CRISTOBAL VALLEY SITE (PROPOSED SITE)

The San Cristobal Valley is primarily within southeastern Yuma County and extends southeastward into Pima County within the LAFR. The proposed trench siting area within this valley encompasses approximately 68 $miles^2$ (178 km^2) on the east flank of the Mohawk Mountains in the northwestern portion of the valley.

The San Cristobal Valley site area lies along the boundary between the western and eastern sectors of LAFR. The western portion encompasses part of the buffer zone jointly administered by Luke AFB and the U.S. Marine Corps Air Station (MCAS), Yuma. The eastern portion of the siting area includes a small part of the air-to-air gunnery range. The western sector is used for training of fighter/attack squadrons, and live 20 mm ordnance may be expended within the buffer zone. The eastern sector is a low-level (1000 ft, 400 m above ground level) route to Target 5 for aircraft with training munitions.

Interstate Highway 8 is approximately 0.2 mile (0.4 km) north of the northernmost site boundary (as defined by reference 75). The Southern Pacific Railroad follows the highway, approximately 0.1 mile (0.2 km) north of the site. This commercial railroad has a siding near Stoval Field, but there are no nearby railroad crossings for automotive vehicles.

San Cristobal Valley is a broad, northwest-trending alluvial-filled basin bounded within the LAFR by the Aguila and Granite Mountains on the east and the Mohawk Mountains on the west. Metamorphic and granitic detritus from the Mohawk Mountains have formed a broad planar northeast trending alluvial slope in the siting area. The alluvial slope is relatively gentle, averaging approximately 65 ft (12.3 m) per mile, or about 1.25 percent topographic grade.

One major alluvial fan was mapped. This alluvial fan was subdivided into several subunits. Recent stream-channel deposits and flood plain deposits were found in the area. Small local areas of wind-blown sand deposits were also found to be present.

The precise depth to bedrock was not determined throughout the site area, but the bedrock was expected to be within 100 to 250 ft (30 to 76 m) of the surface in areas within several hundred feet of the metamorphic rock outcrops near the Mohawk Mountains. Depth to bedrock was expected to be greater than 250 ft (76 m) elsewhere in the area. The depth to bedrock was determined to be greater than 700 ft (213 m) in the northeastern portion of the site area along San Cristobal Wash.

The depth to groundwater was judged to be more than 100 ft (30 m) in the majority of the siting area. However, groundwater could occur at depths less than 100 ft (30 m) in the northern and northeastern portions of the site. A perched groundwater table (i.e., water retained by localized impermeable layers above the true water table) was found to occur within 50 ft (15 m) of the surface along San Cristobal Wash.

Excavation conditions and slope stabilities were considered to be roughly equivalent to those of the other two sites.

Vegetation identified in Reference 75 included creosote bush, cholla, bur sage, mesquite, ironwood, paloverde, ocotillo, and several species of grasses. Areas with well-developed desert pavement were reported to be vegetation-free. In addition to the vegetation reported as present, sahuaro cactus is also known to occur in all three areas, but less abundantly in the San Cristobal Valley than at the other sites.

The San Cristobal site is proposed because it meets geotechnical criteria, provides a diversity of desired geology, is accessible by road and rail, and because it would have the least impact on existing range operations.

4.5 ALTERNATIVE METHODS OF CONSTRUCTION

There exists one major alternative method of construction of the buried trench which is currently receiving study and which may ultimately be selected as the project instead of the techniques described in Sections 1.1.7, 1.1.8, and 1.1.9 of this report. This alternative construction method would consist of precasting the concrete tunnel and trucking it to the trench site in pieces rather than forming it in place. Section 4.5.1

identifies the technical differences between the two techniques, and Section 4.5.2 discusses the differences of environmental impact that are anticipated. There is, in fact, very little difference in anticipated impact between the two.

There presently exists also a range of alternative methods for excavation and surface restoration which are under study as a part of the research effort to establish the best trench configuration. These alternatives differ in terms of width of excavation and width and height of the berm forming the finished trench surface. The environmental impacts of these alternative methods and final configuration will not differ greatly from those of the project as described. Section 4.5.3 discusses the differences in technique and impact.

4.5.1 Differences Between Slipform Concept (the Project) and Precast Concept

The precast concept proposes that in addition to the onsite concrete batch plant, there would be a casting plant to cast the tunnel sections and a storage yard to store precast sections. The sections themselves would be 30 ft (9 m) long with an inside diameter of 13 ft (4 m) and a wall thickness of 0.83 ft (0.25 m). Each section would weigh 110 tons (99 tonnes). The size of the storage yard would be increased from 10 acres (4 ha) to 60 acres (24 ha). The total area inside Stoval Airfield (not including the runways) is approximately 100 acres (40.5 ha) so that the usage of that space would increase from 10 percent to 60 percent.

There would be a 15 percent decrease in the amount of concrete required if the precast method were used: from 46,000 yd^3 (35,167 m^3) to 40,000 yd^3 (30,580 m^3). This would result in an equivalent decrease in the number of truck trips required to deliver the concrete. It is estimated there would be an approximately 10 percent increase in labor personnel (craftsmen) if the precast method is utilized. It is estimated that the decreased costs and deliveries of materials would be offset by the increased labor requirements, and no substantial cost differences between the two methods are anticipated.

The precast method would require a larger excavation than the slipform concept. In the precast method, approach ramps would be required to be excavated at 30 to 45° angles laterally from the trench to allow access by trucks carrying the precast sections. All excavation would still fall within the nominal 328 ft (100 m) wide strip, however. There are no apparent differences between the two methods in terms of the physical appearance of the completed project.

4.5.2 Differences in Impacts Between the Two Construction Methods

Decreased traffic levels resulting from decreased material requirements are expected to be essentially offset by increased traffic because of increased labor requirements. There will be a 15 percent decrease in material consumption, but the impacts of material consumption are not considered significant in either case.

A wider excavation would be required with the precast option, and there would be a resultant incremental increase in potential for dust, erosion, and emissions from internal combustion engines on site. It does not appear at this stage of planning that the differences would be significant. The increased width of excavation of the trenches would fall within the nominal 328 ft (100 m) zone of disturbance, so that loss of biota is predicted to be identical. The use of more land at Stoval Airfield would cause essentially no increase in impact because the interior of the airfield is highly altered from its original condition and largely barren.

In summary, the two potential methods of construction differ very little in characteristics likely to cause environmental impact, and at this point no significant differences of impact have been identified.

4.5.3 Alternative Trench Construction Technique

The alternative means of trench emplacement being considered could result in a higher berm over the trench surface at completion than the project now calls for. The maximum size berm would result from establishment of the top of the concrete tunnel near grade with the spoils mounded over the top to a depth of 5 ft (1.5 m) high and 12 ft (3.6 m) wide at the centerline. The berm would then be tapered toward grade at a maximum slope of 1:4, reaching the existing surface 26 ft (8 m) to either side of the centerline for a minimum total finished width of 52 ft (16 m). Intermediate approaches resulting in a lower but wider berm are also under consideration. The berm would not be of uniform height over the entire alignment. In some places the existing topography would provide the desired 5 ft (1.5 m) of cover. In other places, such as the bottoms of arroyos there would be no berm at all.

There are several potentially substantial differences in impact that could result from this alternative. First, the presence of a berm 5 ft (1.5 m) high could constitute a much more visually obvious structure than the proposed berm less than 1 ft (0.3 m) high. Consequently, the aesthetic degradation of the area could be increased. Second, the height of the berm would cause it to be more exposed to wind erosion than would the lower berm and the potential for dust resulting would be increased. Also, there is a minor increase in the potential for deposition of windborne particulates in the lee of the berm. The slopes at the sides of the berm will encourage rapid runoff of water from direct precipitation, and may erode more rapidly than would the lower berm. Increased erosion would result in increased sedimentation downstream. A concomitant result of more rapid runoff is a lack of subsurface wetting, and a decreased potential for revegetation. Based on the lack of revegetation of lower berms at Stoval Airfield, it can be assumed that revegetation of the 5 ft (1.5 m) high berm would occur very slowly if at all. Where small washes are blocked by the higher berm, there would be potential for more extensive ponding than would occur behind the lower berm.

From this analysis and from that in Section 3, it is apparent that the lower the spoils berm, the less the potential environmental impacts. There are no threshold effects, however, and during further engineering study advantages of a higher berm configuration may be found to offset incremental increases in environmental impact.

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SECTION 5

PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

5.1 PROBABLE ADVERSE IMPACTS ON THE PHYSICAL ENVIRONMENT

- Temporary degradation of air quality as the result of dust generation due to excavation activities and vehicular traffic over unpaved roads.
- Temporary degradation of air quality as the result of increased exhaust emissions from transportation vehicles to and from the site, onsite traffic, and diesel generators.
- Temporary increases in ambient noise levels near the site and in the community of Dateland.
- Disruption of approximately 200 acres (81 ha) of earth surface over the two buried trenches, on roads, and at Stoval Airfield where the office and yard facilities will be located.
- Temporary drawdown of the water table in the immediate vicinity of the well onsite. The effects are not expected to be detectable at any other wells.
- Increased potential for wind and water erosion during and following the project.
- Permanent loss of areas of well-varnished desert pavement on the upper bajada.

5.2 PROBABLE ADVERSE IMPACTS ON THE BIOLOGICAL ENVIRONMENT

- Loss of existing vegetation (except sahuaro cacti which will be salvaged) over both alignments, on roads, and in yard areas.
- Mortality of some rodents and reptiles from road kills on site and from direct effects of trenching.
- Displacement of breeding birds from the construction area for one season owing to noise and disturbance, and permanent loss of a small amount of breeding habitat in the vegetation that will be lost.
- Temporary exclusion of the Mohawk Mountains population of desert bighorn sheep from part of their range.

5.3 PROBABLE ADVERSE IMPACTS ON THE SOCIOECONOMIC ENVIRONMENT

- Minor temporary increases in traffic on Interstate 8. Major temporary increases through Dateland.
- Permanent loss of minor archaeological artifacts and remnants along the alignments and roads.
- Long term aesthetic degradation of the trench alignments, particularly in the upper bajada in areas of well varnished desert pavement.

5.4 MITIGATIONS

These unavoidable impacts will be limited, and other avoidable impacts will be mitigated by the following actions.

- Construction equipment and personnel will be limited to established access roads to and from Stoval Airfield and between the airfield and the trench alignments. No cross-country vehicular activity will be permitted. Off duty personnel will not be allowed access to areas other than the established roads. At termination of the project, access to the project site will be eliminated.
- Surface archaeological remnants that will be disturbed or destroyed should construction be implemented have been examined, cataloged, and where desirable, collected and deposited in the Arizona State Museum. If necessary, an additional data recovery program will be initiated prior to construction.
- Dust will be suppressed during the time construction activity is taking place by periodically traversing all roads and construction areas once per hour with a water spray truck.
- All arroyos disturbed by construction will be restored to their preexisting configuration, when feasible to prevent blocking of permanent drainage systems.
- Sahuaro cacti that must be removed for construction will be removed intact and made available to the Arizona Commission of Agriculture and Horticulture for whatever disposition they recommend.
- Where areas of varnished desert pavement are disturbed during construction, the surface layer of rocks will be stockpiled and spread evenly over the surface following backfilling.
- Following completion of various parts of the project, soil surfaces will be inspected periodically to be certain that soil stabilization is occurring and that erosion is minimized. In the event of severe wind or water erosion, appropriate soil stabilization measures will be taken.

- The effectiveness of environmental protection (dust suppression, confinement of vehicles and personnel to the established project area, etc.) will be under surveillance throughout the construction to be sure that environmental protection is proceeding as planned.
- Follow-up actions to determine the effectiveness of the measures adopted to protect the environment will be accomplished.

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SECTION 6

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

6.1 SHORT-TERM GAINS

- Resolution of key uncertainties and reduction of risks associated with the buried trench concept. These include construction feasibility, construction rate, economic cost, and breakout feasibility.
- Stimulated economic activity in Yuma and Maricopa Counties.

6.2 SHORT-TERM COSTS

- Temporarily increased traffic with local congestion and associated noise impacts in neighboring communities.
- Temporarily decreased air quality from combustion products and dust during construction and to a lesser extent during the breakout tests.

6.3 LONG-TERM GAINS

- Identification of cost-effective MX basing mode concepts to ensure conservation of natural resources while meeting cost, operation, maintenance and survivability criteria.
- Identification and testing of mitigative measures to reduce several environmental impacts associated with potential MX basing decisions and construction and operational activities.

6.4 LONG-TERM COSTS

- Permanent disruption of archaeological resources and of the varnished desert pavement on the upper parts of the Mohawk Mountains bajada.
- Degradation of the scenic character and natural quality of the bajada.

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SECTION 7

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES THAT WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

7.1 LOSS OF NATURAL RESOURCES

The commitments of natural resources to the project fall into two categories:

1. Consumption of permanent deposition of resources of offsite origin.
2. Alteration or destruction of some resources at the project site.

Category 1 comprises the consumption of cement, water, aggregate, steel reinforcing fibers, fuels, and time by construction personnel. Category 2 is the loss of the relatively undisturbed character of the alluvial fans of the Mohawk Mountains. Losses of biota will be irreversible only in the sense that the individuals killed or displaced will be lost. There will be no permanent change in the ecology and biology of the bajada as a whole.

7.2 LOSS OF CULTURAL RESOURCES

Destruction of some of the trail segments identified in the archaeological survey will result from construction along the present alignment. There is reason to believe that a network of trails exists in the area so that alternative alignments would affect other trails.

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SECTION 8

CONSIDERATIONS THAT OFFSET THE ADVERSE IMPACTS

Full-scale tests of construction procedures and trench breakout capabilities are required as part of the studies to determine feasibility of use of the trench concept should an eventual decision be made to proceed with MX deployment. The goal of the proposed project is to establish the technical feasibility of construction and breakout, attainable physical characteristics including strength, probable realistic construction rates, and baseline cost data for the buried trench MX deployment concept as it is currently envisioned. Additionally, mitigative measures will be identified and evaluated to reduce potential environmental impacts associated with the MX basing, construction and operation. These data and evaluations are also vital to determine accurate cost-effective analysis to be used in future decisions on selecting the final basing system for full-scale development.

Deployment of a full-scale, deceptive land-based MX missile force will require a commitment of the resources available for national defense. It is vital, therefore, that the best possible deployment method be selected, based on hard, reliable data. The full-scale construction will test equipment and technical capabilities and greatly increase the reliability of projected cost and performance estimates. The current program will provide such data at relatively modest cost and is essential to the aims of the overall MX program.

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SECTION 9

DETAILS OF UNRESOLVED ISSUES

- The existence of sufficient unappropriated water in place and the potential effects of its extraction for onsite use are not certain. Studies currently underway will provide information to help resolve this issue.
- The project site has been identified as a candidate area for designation as "critical habitat" for Sonoran pronghorn antelope. Formal consultation with the U.S. Fish and Wildlife Service has been initiated and it is probable that this issue will be resolved prior to the time construction is scheduled to begin. It is not believed by specialists in the area that the project is likely to have any adverse effects on individual Sonoran pronghorn or on their habitat requirements.

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SECTION 10
REFERENCES

1. Defense Mapping Agency, 1976, "MX Bouguer Anomaly Maps and Valley Profiles," Defense Mapping Agency, Aerospace Center, St. Louis, Missouri.

2. Cooke, R. V. and A. Warren, 1973, Geomorphology in Dirts, University of California Press, Berkeley and Los Angeles, p. 374.

3. University of Arizona, School of Earth Sciences, Office of Arid Lands Studies, October 1970. Environmental Study for the Gila River Below Painted Rock Dam: Report to the Department of the Army, Los Angeles District Corps of Engineers.

4. Arizona State Land Department, 1977. Records of wells drilled in Arizona.

5. Weist, W. G. Jr., 1965. "Geohydrology of the Dateland-Hyde Area, Maricopa and Yuma Resources," Report number 23, Arizona State Land Department.

6. Arizona Water Quality Control Division of Arizona State Department of Health Services, 1977. "Records of chemical analysis of Arizona wells."

7. Environmental Technical Applications Center (ETAC), 1976 "Climatological Summary for Gila Bend AAF, Arizona," and 1972 "Climatological Summary for Yuma, Arizona IAP," Air Weather Service, USAF.

8. Sellers, W. D., and R. H. Hill, editors, 1974. Arizona Climate 1931-1972. Revised 2nd Edition, University of Arizona Press, Tucson, Arizona.

9. Kangieser, P. C., 1969. "Estimated Return Periods for Short Duration Precipitation in Arizona," Technical Memorandum No. 44, October 1969, U.S. Weather Bureau, Western Region, Salt Lake City, Utah.

10. U. S. Government, 40 CFR 50, National Ambient Air Quality Standards.

11. Arizona State Department of Health, 1974. "Air Quality Monitoring Network Data 1973." Phoenix, Arizona.

12. Orgill, M. M., and G. A. Sehmel, 1975. "Frequency and Diurnal Variation of Dust in the Continental United States," Pacific Northwest Laboratory Annual Report for 1974 to the USAEC Division of Biomedical and Environmental Research, Part 3, Atmospheric Sciences, Richland, Washington.

13. Idso, S. B., 1976. "Dust Storms," Scientific American, vol. 235(4), October 1976.

14. Idso, S. B., Ingram, R. S. and Prichard, J., 1972. "An American Haboob," U. S. Water Conservation Laboratory/National Weather Service, Phoenix, Arizona.

15. Arizona Department of Health Services, 1976. "1975 Air Quality Data for Arizona." Phoenix, Arizona.

16. Arizona Department of Health Services, 1975. "1974 Air Quality Data for Arizona." Phoenix, Arizona.

17. Arizona Department of Health Services, 1974. "1973 Air Quality Data for Arizona." Phoenix, Arizona.

18. Lowe, C., 1964. "Biotic Communities in the Sub-mogollon Region of the Inland Southwest," J. Az. Acad. Sci., 2:40-49.

19. Simmons, N.M., 1966. "Flora of the Cabeza Prieta Game Range," J. Az. Acad. Sci., 4:93-104.

20. Shreve, F., 1951. "Vegetation and Flora of the Sonoran Desert," Vol. 1, Carnegie Institute of Publications, 591:192.

21. Musick, H.B., 1975. "Barrenness of Desert Pavement in Yuma County, Arizona," Arizona Academy of Science, 10(1):24-28.

22. Juhren, M., F.W. Went, and E.A. Phillips, 1956. "Ecology of Desert Plants IV. Combined field and laboratory work on germination of annuals in the Joshua Tree National Monument, California." Ecology 37:318-330.

23. Went, F.W., 1948. "Ecology of Desert Plants. I. Observation on germination in the Joshus Tree National Monument, California." Ecology 29:242-253.

24. Mulroy, T.W., and P.W. Rundel, 1977. "Annual Plants: Adoptations to Desert Environments." BioScience, 27:109-114.

25. Federal Register, Vol. 40., Number 127, Part V, Lists A and C.

26. Shreve, F., and I.L. Wiggins, 1964. Vegetation and Flora of the Sonoran Desert. 2 Vols. Stanford University Press, California.

27. Kearney, T.H., and R.H. Peebles, 1960. Arizona Flora, University of California, Berkeley.

28. Benson, Lyman, 1969. The Cacti of Arizona. Third edition. The University of Arizona Press, Tucson, 218 p.

29. Benson, Lyman, and Robert A. Darrow, 1954. The Trees and Shrubs of the Southwestern Deserts. 2nd ed. University of Arizona Press, Tucson.

30. Hastings, J.R., R.M. Turner, and D.K. Warren, 1972. "An Atlas of Some Plant Distributions in the Sonoran Desert." The University of Arizona, Institute of Atmospherics Technical Reports on the Meteorology and Climatology of Arid Regions. No. 21.

31. Arizona State Law, 1976. 3 Arizona Revised Statutes 901-906.

32. U.S. Government, 50 CFR 17.11. U.S. Fish and Wildlife Service List of Endangered and Threatened Wildlife.

33. U.S. Department of the Interior, 1973. Threatened Wildlife of the United State, Washington, D.C., Bureau of Sport Fisheries and Wildlife.

34. Phelph, J., 27 April 1977. Arizona Department of Game and Fish. Telephone Communication.

35. Arizona State Law, 17 Arizona Revised Statutes 101, 102.

36. Arizona State Law, 17 Arizona Revised Statutes 236.

37. Weaver, Robert, 27 April 1977. Arizona Department of Game and Fish. Telephone Communication.

38. U.S. Bureau of the Census, 1973.

39. Yuma County Chamber of Commerce, 1976(a). 1976 Economic Guide to Yuma County, Economic Development Department, Yuma, Arizona.

40. Arizona Department of Economic Planning and Development, 1976. "Gila Bend Arizona Community Profile," State of Arizona, Phoenix, Arizona.

41. Bureau of Economic Analysis, 1974. "Local Area Personnel Income," Survey of Current Business - Vol. 54, No. 5, SESA, U.S. Department of Commerce, Washington GPO.

42. Arizona Department of Economic Security, 1976a. "Nonagricultural Wage and Salary Employment in Maricopa County, January - December 1975 and January - August 1976." Bureau of Statistical Information, Phoenix, Arizona.

43. Arizona Department of Economic Security, 1976b. "Nonagricultural Wage and Salary Employment in Yuma County, January - December 1975 and January - July 1976." Bureau of Statistical Information, Phoenix, Arizona.

44. Arizona Department of Transportation, no date. Arizona Traffic, 1975.

45. Southern Pacific, 27 October 1976a. Trainmaster, telephone communication.

46. Southern Pacific, 27 October 1976b. McKissie, Trainmaster, telephone communication.

47. Gila Bend Airport, 27 October 1976. Airport Manager, telephone communication.

48. Sky Harbor International, 27 October 1976. D. Anderson, Airport Manager, personal communication.

49. Yuma International Airport, 27 October 1976. Airport Manager, telephone communication.

50. Fontana, Bernard L., 1965. "An Archaeological Survey of the Cabeza Prieta Game Range, Arizona," MS, on file Arizona State Museum, University of Arizona, Tucson.

51. Harner, M.J., 1958. "Lowland Patayan Phases in the Lower Colorado River Valley and Colorado Desert." Reports of the University of California Archaeological Survey, No. 42, pp. 93-97. Berkeley.

52. Johnston, Francis J., and Patricia H. Johnston, 1957. "An Indian Trail Complex of the Central Colorado Desert: A Preliminary Survey," Reports of the University of California Archaeological Site Survey, No. 37, pp. 22-39, University of California, Berkeley.

53. Rogers, Malcolm J., 1966. Ancient Hunters of the Far West. Union-Tribune Publishing Company, San Diego.

54. Goodyear, Albert C., 1975. "Hecla II and III: An Interpretive Study of Archaeological Remains from the Lakeshore Project, Papago Reservation, South Central Arizona." Anthropological Research Paper No. 9. Arizona State University, Tempe, Arizona.

55. U.S. Air Force, 1976. Environmental Assessment, Kirkland Air Force Base, New Mexico, Air Systems Command, HAVE HOST Test Program.

56. U.S. Government, 1964. Public Law 88-577. Federal Wilderness Act.

57. Arizona State Law, 45 Arizona Revised Statutes 141, 142.

58. Wilshire, H.G., and Nakata, J.K., 1976. "Off-road Vehicle Effects on California's Mojave Desert," California Geology, Vol. 29, No. 6, pp 123-132.

59. Zimmerman, J.R., and R.S. Thompson, 1975. User's Guide for Hiway, a Highway Airpollution Model, U.S. Environmental Protection Agency, 650/4-74-008. Research Triangle Park, North Carolina.

60. U.S. Environmental Protection Agency, 1974. "Development of Emission Factors for Fugitive Dust Sources," EPA 450/3-74-037, Research Triangle Park, North Carolina.

61. Arizona State Department of Health, May 1972, Arizona Rules and Regulations for Air Pollution Control, Article 7, Part 1, amended March 1973.

62. Fryrear, D.W., 1969. "Reducing Wind Erosion in the Southern Great Plains," Texas A&M University, College Station, Texas.

63. Markle, M.S., 1917. "Root Systems of Certain Desert Plants," Bot. Gaz. 64:177-205.

64. Waterman, W.C., 1923. "Development of Root Systems Under Dune Conditions," Bot. Gas., 68, 22-58.

65. Wallace, A., S.A. Bainberg, and J.W. Cha, 1974. "Quantitative Studies of Roots of Perennial Plants in the Mojave Desert." Ecology, 55:1160-1162.

66. Lacey, J.R., P.R. Ogden, and K.G. Foster, 1975. Southern Arizona Riparian Habitat, Spatial Distribution and Habitat, University of Arizona, Tucson, 148 pages.

67. Warren, D., and R. Turner, 1975. "Saltcedar (*Tamarix chinensis*) Seed Production, Seedling Establishment and Response to Inundation." J. Az. Acad. Sci., 10:135-144.

68. Nash, T.H., 1975. "Lichens of Maricopa County, Arizona." J. Az. Acad. Sci. 10:119-125.

69. Cameron, R., 1960. "Communities of Soil Algae Accompanying the Sonoran Desert in Arizona." Arizona Acad. Sci. 1:85-88.

70. Cameron, R., and G. Blank, 1966. "Desert Algae: Soil Crusts and Diaphanous Substrata as Algal Habitats," Jet Propulsion Laboratory Technical Report No. 32971, 41 p.

71. Tomoff, C.S., 1974. "Avian Species Diversity in Desert Scrub," Ecology, 55: pp 396-403.

72. Raitt, R.J., and R.L. Maze, 1968. "Densities and Species Composition of Breeding Birds of a Creosote Bush Community in Southern New Mexico," Condor, 70:193-205.

73. Arizona State Parks Board, 4 and 5 November 1976. Bergthold, P., Trails and Natural Area Coordinator, telephone communication.

74. Wachter, B., Bull, W.B., and Reynolds, S., 1976. The Mojave-Sonoran Natural Region Study, prepared by the University of Arizona Geosciences Department under contract to the National Park Service Science Center.

75. Fugro National, Inc., 1976. Site Evaluation/Selection Report: Multiple Aim-Point Validation (MAV) Program, 16 July 1976. (Unpublished draft), Contract No. F04701-74-D-0013.

76. Fugro National, Inc., 1975. Environmental Assessment, Vol. IV, "Geotechnical Field Investigations," Space and Missile Systems Organization, Department of the Air Force, El Segundo, Calif.

77. U.S. Air Force Regulations, AFR 19-2, Section 3.a(f).

78. Pignatero, L.J., et al., 1973. Traffic Engineering Theory and Practice. Engelwood Cliffs, N.J., Prentice-Hall, Inc.

79. Woodruff, N.P., and F.H. Siddoway, 1965. "A Wind Erosion Equation," Proceedings of the Soil Science Society, Vol. 29.

80. U.S. Environmental Protection Agency, 1975. Compilation of Air Pollutant Emission Factors, Supplement No. 5, Research Triangle Park, North Carolina.

81. U.S. Air Force. March 1977. Draft Formal Environmental Assessment, Continuation of Public Land Withdrawal Sanctioned by Public Law 87-597 for use by the Department of Defense as part of the Luke Air Force Range.

82. Sehmel, G.A., 1975, "Initial Correlation of Particle Resuspension Rates as a Function of Surface Roughness Height" Pacific Northwest Laboratory Report for 1974 to the USERDA Division of Biochemical and Environmental Research, Part 3, Atmospheric Sciences, Richland, Washington.

83. Sehmel, G.A., 1975. "Airborne Dust Size Distributions as a Function of Wind Speed" Pacific Northwest.

84. Charlson, R.J., 1969. "Atmospheric Visibility Related to Aerosol Mass Concentration." Env. Sci. and Tech., Vol. 3, No. 10.

85. Chepil, W.S., F.H. Siddoway, and D.V. Armbrust, "Climatic Index of Wind Erosion Conditions in the Great Plains," Soil Science Society of America Proceedings, 27 (4) 449-452. July-August 1963.

86. Cowherd C. Jr., K. Axtell, C.M. Guenther, G.A. Jutzc, "Development of Emission Factors for Fugitive Dust Sources," EPA-45013-74-037, June 1974.

87. Woodruff, N.P., and F.H. Siddoway, "A Wind Erosion Equation," Soil Science Society of America Proceedings, 29 (5) 602-608, September-October 1965.

88. U.S. Air Force, 1977. Baseline environmental studies conducted in support of the MX: Buried Trench Construction and Test Project.

SECTION 11
GLOSSARY

Air Quality Monitoring Stations	Stations set up at scattered and strategic locations in an area, which continually sample for and measure pollutants which may be present in the atmosphere.
Alluvial Fan	A fan shaped deposit of alluvium (fill) made by a stream where it issues from the mountains unto the lowland. The abrupt decrease of slope reduces the streams energy and the stream loses its velocity and drops its burden of silt or gravel, which spreads out in an ever widening arc. Over time this deposition builds up and an alluvial fan is formed.
Ambient Air (Meteorology)	Refers to surrounding external or unconfined conditions, i.e., outdoor air.
Arroyo	A watercourse or water-carved gulley (as a creek or a stream) in an arid region.
Bajada	An alluvial plain formed at the base of a range of mountains by the coalescing of several alluvial fans.
Boring Log	A written record of the properties of the materials encountered by boring into the ground.
Borrow Areas	Areas where soil/rock/sand/gravel, etc. is excavated and transported to a construction site where it is used for filler for making concrete, roadbed material, etc.
Caliche (Geology)	A calcium carbonate deposit formed in surficial rocks of arid regions.

Deflocculation	The change from an aggregated mass to a more loosely organized state.
Dendritic Riparian Pattern	A pattern of watercourses joining together at acute angles, e.g., as branches on a tree.
Desert Pavement	A relatively thin, fragile surface deposit on alluvial fans in desert regions, consisting of pebble to cobble sized rocks from which all fine interstitial material has been removed by wind erosion.
Desert Varnish	A dark, lustrous coating or crust, usually of manganese and iron oxides, that forms on rocks, pebbles, etc. in the desert.
Desert Riparian Associations	Plants or animals which live in groups along the dry desert washes.
Detritus	Loose material resulting from disintegration or wearing away of rock.
Environmental Impacts	Resultant changes in the quality of the environment due to specific and summary changes in measurable environmental parameters which are used to describe the existing condition of the biological, physical, and socioeconomic sectors.
Ephemeral Plants	Plants that germinate, produce seed, and die during a period of a few months or less. Identical to annuals except that the complete cycle can occur more or less frequently than annually.
Fossorial	Adapted for digging or burrowing as gophers, moles, etc.
Fugitive Dust	Temporary, transient dust as from construction activities.
Gallery Forest	A forest growing along a watercourse in a region otherwise devoid of trees.

Granivorous	Feeding or subsisting on grain, as granivorous rodents or birds.
Habitat	The natural environment of a plant or animal or communities of these species.
Interim Control (Land)	A zoning classification used in the City of Yuma for land annexed by the City for which final zoning has not been established by the City Council.
Lithic Scatter	Archaeologist's term for chips of rock thought to have resulted from human tool making.
Lithology	The study of rocks; the character of a rock formation.
Man Year	Amount of labor effort from one person during one year. A desirable quantity so that one man year may be one person working for a full year or two people working for a half year each.
Multiplier	An economic term used in the estimation of the total amount of economic stimulation in an area resulting from direct expenditures on a project.
Neotropic	The area of the New World Extending from the Tropic of Cancer southward.
Overburden	Material overlying a deposit of useful geological materials.
Pediment	A broad gently sloping bedrock surface with low relief that is situated at the base of a steeper slope and is usually thinly covered with gravel and sand.
Pedogenic Carbonate	Carbonate formed in the soil.
Plant or Animal Communities or Associations	The assemblage of plants and animals inhabiting a specific area.

Playa	The flat-floored bottom of an undrained desert basin that becomes at times a shallow lake (after a rain when water may stand and where its evaporation characteristically leads to alkali deposits).
Raptor	An order of predatory birds which are adapted for seizing prey, i.e., bills or claws.
Riverine	Referring to rivers.
Seismic Refraction Studies	A technique for inferring the configuration and properties of subsurface geologic formations by measuring and interpreting the arrival times at a subsurface location of pressure pulses (e.g., generated by an impact or explosion) produced at another location.
Sheet Flow (of runoff)	The rain storm or snow melt runoff water which flows over the ground surface as a thin layer - as opposed to the channelized (concentrated) runoff which occurs in rills and gulleys.
Slip Forms	Reusable forms (usually metal) for shaping concrete. The forms are put in place, then loosened and moved after the concrete is poured and set. Used especially for towers, tunnels and like configurations.
Spoil Areas	Storage areas where the soil overburden which is removed as a result of construction or excavation operations is disposed of.
Sympatric	Originating in or occupying the same geographical area.
Terrestrial Ecology	The interrelationships of organisms that live on the earth's surface to one another and their environment.
Transect	A sample area (as of vegetation) usually in the form of a long continuous strip.

ACRONYMS

AMB	Air Mobile Basing
ARS	Arizona Revised Statutes
BEA	Bureau of Economic Analysis
BLM	Bureau of Land Management
BTU	British Thermal Unit
CEQ	Council on Environmental Quality
CL	Sandy Clay
dBA	Decibel values for sound measured using the A-weighting framework of a standardized sound level meter
EIS	Environmental Impact Statement
FEA	Formal Environmental Assessment
LAFR	Luke Air Force Range
MAP	Multiple Aim Point
MAV	Multiple Aim Point Validation
MCAS	Marine Corps Air Station
ML	Clay Silt
MLCC	Mobile Launch Control Center
MSL	Mean Sea Level
NAFR	Nellis Air Force Range
NOAN	National Weather Service
PIP	Project Impact Potential

RFP	Request for Proposal
RIMS	Regional Industrial Multiplier System
SAMSO	Space & Missile Systems Organization
SC	Clayey Sand
SIC	Standard Industrial Classification System
SIOH	Supervision, Inspection and Overhead
SN	Silty Sand
SSTL	State Surface Trust Lands
TL	Missile Transporter/Launcher
WSMR/FBMR	White Sands Missile Range/Fort Bliss Military Range
YPG/LAFR	Yuma Proving Grounds/Luke Air Force Range

METRIC SYSTEM

ABBREVIATION	NAME OF UNIT	EQUIVALENT	UNITS	APPROXIMATE U.S. EQUIVALENT
		LENGTH		
km	Kilometer	1,000	Meter	0.62 mile
m	Meter	1	Meter	39.37 inches
cm	Centimeter	0.01	Meter	0.39 inch
mm	Millimeter	0.001	Meter	0.04 inch
		AREA		
ha	Hectare	10,000	Square Meters	2.47 acres
		MASS AND WEIGHT		
MT or t	Metric Ton	1,000,000	Gram	1.1 ton
g or gm	Gram	1	Gram	0.035 ounce
mg	Milligram	0.001	Gram	

ADDITIONAL UNITS USED

nm	Nautical Mile - Measure of distance - 6076 feet, 1.151 statute mile, 1.852 km
fps	Feet per second - Measure of velocity - 0.348 meter/sec
K	Knot - Measure of velocity - 1 Nautical mile/hour
BTU	British Thermal Unit - Measure of heat energy, 1055 watts
Kph	Kilometers per hour

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