MASTER PLAN FOR THE PROTECTION & USE OF

PETRA NATIONAL PARK
OFF-SITE

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PROTECTION & USE OF

PETRA NATIONAL PARK
Cover: Bonded sandstone ceiling of the Triclinium (Festive Hall) in Wadi Farasa, Petra
Cover design suggested by John Funari
Photo by Paul F. Spangle.
CONTENTS

Foreword 1
Index of Major Proposals 2
Park Resources and Basic Information 4
Human History 8
Access To Park 10
Terrain 10
Climate 11
Tribal & Other Uses 12
Land Status 12
Village Relationship 13
Park Resources 20
Park Development and Management 21
Park Establishment 21
Park Boundaries 22
Land Management 22
Bedouin Resettlement 25
Watershed Protection 26
Protection of Historical - Archeological Resources 36
Visitor Introduction to the Park 40
Concessions 43
General Development 58
Petra Entrance Area Development 72
Petra Basin Development 78
Secondary Developments 78
Park Administration 80
Staff Organization 84
Management Schedule 89
Visitor Projections & Economic Implications 97
Public Relations 98
Glossary 98
Appendix 102
A. Points of Interest Enroute 103
B. Regional Climate 104
C. Flora of Petra 111
D. Fauna of Petra 112
E. Consolidation & Conservation Projects 115
F. Pencapsula 118
G. Audio-Visual Programs 119
H. Exhibits 121
I. Publications 121
122 J. Trails & Roads System
125 K. Watershed Control Cost Estimates
126 L. Development Costs - Public Use & Staff Facilities
132 M. Phase I Staffing Costs
133 N. Land & Boundary Survey Costs
134 O. Mapping of Petra
138 P. Bibliography

MAPS AND DRAWINGS

PET - 1 Geographical Location
PET - 2 Location
PET - 3 Regional Location
PET - 4 Historical - Archeological Base Map
PET - 5 Historical Chronology
PET - 6 Geological Base Map
PET - 7 General Development (sheet 1 of 2)
PET - 7 General Development (sheet 2 of 2)
PET - 8 Land Ownership
PET - 9 General Utilities
PET - 10 Watershed Control
PET - 11 Petra Entrance Development
PET - 12 Petra Entrance Development Visitor Flow Analysis
PET - 13 Petra Entrance Development Utilities
PET - 14 Petra Basin Development
PET - 15 Index of Mapping
As used today, the English word Park is based on the Latin word Parcere, a piece of land spared from materialistic use and reserved for pleasure and enjoyment. Generally, National Parks are established to preserve outstanding examples of national heritage. They are, in a sense, great outdoor museums requiring only such developments as are needed for the areas' protection and administration and as required for the comfort, understanding and convenience of those who visit them for the recreation and inspiration they offer. Commercial uses such as farming, livestock grazing, hunting and mining are inconsistent with this concept.

This plan has been prepared as a management document to be used as a guide for the use, development, interpretation, protection and general administration of Petra National Park. As such it cannot be considered the final, unchangeable, long-range plan. Instead, because man's requirements change, it should be used as a control document to guide the future development and use of the park in ways that will assure its protection and continuing use as a viable national resource.

Imaginative and rapid action within the framework of sound fiscal planning by the Government of Jordan is required to bring the concepts embodied in this plan into being.
INDEX OF MAJOR PROPOSALS

Page: 21  Creation of national park.
      21  Park boundaries.
      22, 31  Resettlement of Bedouin.
      25, 55  Watershed protection.
      26  Protection of Historical - Archeological resources.
      40  Concessions reorganization.
      41  Village economic benefits and need for village zoning.
      58  Visitor and administrative facility development - Petra Entrance.
      72  Visitor and administrative facility development - Petra Basin.
      48  Restriction on use of motor vehicles.
      39, 44  Removal of overnight accommodations from Petra Basin.

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An integral part of the planning included the participation of a staff of counterparts drawn from various ministries. The assistance of these technicians was invaluable and hopefully, this staff will continue the work when the U.S. team completes its assignment. These counterparts are considered a part of:

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Amman, Jordan
June, 1968
PARK RESOURCES AND BASIC INFORMATION
1. A Neolithic site at Rekîma

2. An Iron Age village at Wadi Musa

3. El Tier is a classical representation of the carved stone architecture of the Nabataeans.

4. The colonnaded paved street identifies Roman influence at Petra.

5. El Wali'la was probably a Crusader outpost of nearby Rabbah.
Petra is to most visitors, a place of great beauty and mystery. Its remoteness, the magnificence of the rockcut tombs and temples, and the ruggedness of the surroundings, combine to overshadow its historical significance; a city that played a long, and sometimes important role in the history of Arabia and the Near East.

The relative abundance of water at the upper reaches of Wadi Musa and its tributaries has been a magnet attracting men for many thousands of years. Tools of palaeolithic men have been found in the vicinity and there are several Neolithic villages, notably the pre-pottery site at Beida which has been partially excavated by Diana Kirkbride of the British Academy. At Beida is "the largest uninterrupted exposure of early Neolithic habitation (ca. 6800 B.C.) yet excavated".

At the present time no sites of either the Chalcolithic or Bronze Ages have been found in the immediate vicinity of Petra. In such a favorable location, however, it seems probable that such sites exist and, in time, will be found.

It was during the Iron Age that Petra began to assume importance. By the 14th century B.C. the Edomite Kingdom was established with its capital at Sela (Rock). Sela was, as was normal in those days, both the secular and religious capital of the Edomites. Their principal shrine, the Great High Place, was probably on Umm al Biyarra which also seems to have served as a place of refuge in times of danger.

In the 7th century B.C. there appeared on the scene a semitic tribe from southern Arabia—the Nabataeans. Probably leading a nomadic life in the region east of the northern portion of the Red Sea, the Nabataeans apparently raided caravans plying the main routes between southern Arabia and the Mediterranean time after time. Over a period of two or three hundred years however, they gradually became more sedentary in their habits.
1. Most small wadis were dammed

2. Entire hillsides were terraced to slow runoff and trap soil

3. Large cisterns (Masonry wall on the right) stored water for the long dry summers

4. Channels were carved in the wadi walls to transport water

5. Elaborate aqueducts spanned gorges and open places
Much of southern Palestine was unoccupied during the 4th century B.C. because of the Jewish captivity in Babylon. The Edomites either moved or were pushed into the void and their former home of Sela was quickly occupied by Nabataeans.

Now well established in northern Arabia the Nabataeans, rather than raiding caravans, derived their principal income from protecting the caravans from other raiders, exacting tribute for this work.

It is not known just when the Nabataeans began to construct the rock-cut tombs and temples and the great water conservation projects for which they are now famous. Quite likely some work of the sort had been going on from the time they moved into the former Edomite stronghold but it seems it was only after the beginning of the Hellenistic period (late 4th century B.C.) that much construction was done. The sudden Greek influence in the eastern Mediterranean affected many different peoples in a similar manner. It was at this time also that the name Sela was changed to its Greek equivalent Petra.

Early rock-cut structures at Petra show stylistic influences from both Assyria and Egypt modified into something which is recognizably Nabataean.

Even though Petra is famous for its rock-cut monuments, the great Nabataean contribution to life in this arid land was in the field of water conservation. Throughout the areas in which they lived, the Nabataeans terraced the hillsides, built water catchment and distribution devices and constructed reservoirs and cisterns. Their engineering skills were remarkable and the works they completed enabled the Nabataeans to maintain a rather large agricultural population in a land which now supports only scattered nomadic tribal groups.
The ancient city of Petra was located at a considerable distance from any large spring. Water was brought to the city by the Nabataeans and Romans via aqueducts from springs at the site of the present village of Wadi Musa. This supply was supplemented by rainwater collected and stored in cisterns and by diverting the seasonal wadi flows.

The effectiveness of Nabataean engineering has been demonstrated in the Negev where Nabataean terracing and water catchment devices have been repaired and put to modern use. There, agriculturalists now live on lands which had reverted to desert.

The power of the Nabataean Kingdom increased and at times they controlled lands which extended from the Red Sea to Damascus; they also occupied the entire Sinai Peninsula and much of the lands east of the Rift Valley in southern Jordan.

At the height of Nabataean power they met head on another nation which also was at the height of its power—Rome.

Rome gradually checked many Nabataean activities and finally, in A.D. 106, absorbed Nabataea into the Roman Empire. During the 2nd century A.D. there was a flurry of building activity at Petra and several tombs and temples in a classical style of Roman architecture were built as well as the paved road and Qasr el Bint.

New trade routes, through Palmyra, began to replace the older routes about this time and Petra declined in importance. By the 5th century it was an unimportant Byzantine provincial town, but the seat of a bishopric. Apparently Petra was abandoned by the time of the Islamic occupation in the 7th century. Crusader forts were built and occupied at Petra for a short period during the 12th century and then the ancient city was lost to the western world until it was visited by Burckhardt in 1812.
For almost a hundred years after Burckhardt's visit few foreigners had either the means or the endurance necessary to visit secluded Petra. A number of explorers found their way to the ancient city and published written and pictorial descriptions. The ancient city gradually became famous as a place of great beauty but one extremely difficult of access. It was not until about 1900 that serious studies were first made and even later, after 1920, that scientific excavations began to provide evidence of the historic development of the site. Publicity based on scientific expeditions led to touristic promotion of Petra as one of the major sights for Middle East tourists.

Access To The Park

The proposed Petra National Park, located in southern Jordan, is about two-hundred and sixty kilometers (about 161 miles) south of the capital city of Amman and 138 km (about 85 miles) from Aqaba, Jordan's outlet to the Red Sea.

The major access route is by way of Amman southward along the Desert Highway to the road junction eighteen kilometers beyond the town of Ma'an. Here a secondary paved highway, a single lane two-way road, leaves the Desert Highway and heading northwest goes through the villages of Ail, Basta, and Wadi Musa (El Ji) to the park entrance at the Petra rest-house. An alternate road to the park entrance via Ail, Taiyiba, and Wadi Musa, provides a spectacular view of Petra's sandstone massifs and Wadi Araba beyond.

The other access route from Amman parallels the ancient Kings' Highway by way of Madaba, Karak, Tafila, and Shaubak to Wadi Musa and the park entrance. This route provides opportunities to visit several areas of historical interest and provides spectacular vistas of the major wadis that dissect the Jordan Plateau as well as magnificent views of Wadi Araba. The road is paved from Amman to a point shortly beyond Tafila. While the highway is two-way, the narrow pavement width over much of its length requires passing vehicles to drive onto the
PROPOSED PETRA NATIONAL PARK

LOCATION
NATIONAL PARK

REGIONAL LOCATION
PETRA NATIONAL PARK

Scale 1:250,000

AQABA

DRAWN NO. PETA PAGE

SHAUBAK

MA'AN

RAS EN NAOB

QUWEIRA

DRAWN NO. PETA PAGE

SAPI 38 KM

KABAK 71 KM

AMMAN 155 KM

DARAWISH
shoulders of the road. Much of it southward from the end of the pavement to Wadi Musa is good quality, graded road. There are, however, some very rough sections between Tafila and Shaubak which are hazardous for automobile travel. This access route requires considerably more driving time than the Desert Highway. Improvements on this road are under way but no completion date has been scheduled by the Ministry of Public Works.

Places of significant historical or archaeological interest that may be visited along the Desert Highway or the Kings' Highway as part of a journey to Petra are listed in Appendix - A-.

A road from Aqaba to Safi is now under construction along the eastern side of Wadi Araba. It will pass about 10 kilometers beyond the park's western boundary.

<table>
<thead>
<tr>
<th>Table Of Distances</th>
<th>From</th>
<th>To</th>
<th>Kilometers</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amman</td>
<td>Petra</td>
<td>via the Desert Highway</td>
<td>262</td>
<td>161</td>
</tr>
<tr>
<td></td>
<td></td>
<td>via the Kings' Highway</td>
<td>303</td>
<td>190</td>
</tr>
<tr>
<td>Jerusalem</td>
<td>Petra</td>
<td>via the Desert Highway</td>
<td>350</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td></td>
<td>via the Kings' Highway</td>
<td>391</td>
<td>245</td>
</tr>
<tr>
<td>Petra</td>
<td>Wadi Rum</td>
<td></td>
<td>85</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>Aqaba</td>
<td></td>
<td>138</td>
<td>85</td>
</tr>
</tbody>
</table>

Travel to the Park is usually by taxi, rented car, private car, or tour bus. A daily commercial bus runs between the village of Wadi Musa and Ma'an where taxis or commercial busses may be taken to the north or to the south.
Access Within The Park

Access into the Park from the resthouse for most visitors is by foot or on horseback. There has been increasing use of helicopters to transport important persons to and from the Park. Vehicle traffic into the main ruins area in the basin by way of the world famous Siq has unjustifiably increased at a alarming rate and has mocked Lankaster Harding's perceptive statement that "The whirr of engines and shriek of klaxons is not for Petra" and that "The gaunt red mountains and vast mausoleums of a departed race have nothing in common with modern civilizations, and ask nothing of it except to be appreciated at their true value - as one of the greatest wonders ever wrought by Nature and Man".

Terrain

The terrain of the park and its immediate vicinity is divided from east to west into three zones. To the east is the high limestone escarpment of the Jordan Plateau; in the center are the rugged, severely eroded, varied colored sandstone massifs so characteristic of Petra, and to the west are the massive alluvial fans which form the sides of Wadi Araba. The drainage pattern of the area is from the escarpment of the Jordan Plateau westwardly to Wadi Araba and is characterized by systems of wadis that within the park are major torrent channels. To the immediate north and south of the park the terrain features have similar characteristics.

Climate

The climate of the park and its immediate environs is a Mediterranean type characterized by hot, dry summers; and cold, wet winters. Rainfall, which varies as the elevation changes along the escarpment, ranges from less than 50 millimeters mean annual in Wadi Araba, to 100-200 millimeters along the escarpment of the Jordan Plateau. Major wet periods in descending order of maximum rainfall are winter (December - February), spring (March - May), and fall (September - November); virtually no rain falls during the summer (June - August). Snows and frosts are characteristic of the higher elevations of the
escarpment and the plateau, and major winter storms cut telephone lines and wash out sections of road or block them with snow. While the Desert Highway is usually back in service within from 24 to 48 hours after such a storm, repairs and snow removal of lesser roads including the park entrance road may take up to a week. Westerly to southwesterly winds predominate throughout the year. Weather records available for Ma'an and Aqaba appear in Appendix -B-. 

Tribal Use

The approximately 200 members of the Bdul Bedouin tribe occupy land within the park boundary from Wadi Sabra to Jebel Beida including the Petra Basin area. Their uses of the land include wheat and barley dry-farming, irrigation from wells of small plots of potatoes and tomatoes, hunting and trapping of what little wildlife remains in the park, and herding sizeable numbers of black goats and a few sheep. They keep donkeys and a few camels, but have no horses. The men are employed from time to time as laborers on archeological projects within the tribal territory. They also dig in the antiquity sites of the park, particularly in the Petra Basin, seeking artifacts to sell to the tourists. The Bdul have established a number of soft drink shacks in areas of tourist concentration.

Various trails pass through the park, providing traditional routes of travel for Bedouins from Wadi Araba to the Jordan Plateau. The intensity of use of these trails is not known but it is believed they are not major access routes.

Other Uses

In the Petra Basin is a school which has about thirty pupils, a hotel and restaurant (Nazzal's Camp), and a Department of Antiquities' Museum. Parts of the hotel, the museum, living quarters for employees, and storage areas utilize antiquity caves. Even the Khazna, the most famous temple of Petra, has not escaped this disgraceful fate; one of its chambers has been boarded up for storage.
The park is within the boundaries of the Ma'an Governorate. All of the land area within the park boundaries is in government ownership except 831 dunums along the Wadi Musa - Taiyiba Road and 183 dunums at the park headquarters. The Bdul tribe has traditional rights of use of park lands.

The village of Wadi Musa adjacent to the park is a small agrarian community producing wheat, barley, vegetables, olives, grapes, figs, apples, and apricots. Located here are the offices of the Director of the District (the representative of the Ma'an Governorate), the Police Post, and a school. A small Suq serves the needs of the villagers.

There is no hospital or pharmacy; a doctor usually makes weekly visits from Ma'an. The men of the village provide horses for tourist use and provide labor for projects within the park. It is suspected that some of them, like the Bdul, deal in illegally excavated artifacts and at least one individual makes ceramic reproductions of Nabataean artifacts which are bought by tourists as authentic antiquities.
Throughout the world specific sites have been recognized as primary representatives of civilizations of bygone eras. Persepolis recalls the splendor of ancient Persia; Rome preserves the grandeur that was the western Roman empire; Istanbul memorializes the pages of Byzantine history; and Petra, with its fabulous array of tombs and temples laboriously hewn in multi-colored sandstone, reflects the era of the Nabataeans, a tribe of desert dwellers who burst upon the scene as common brigands, quickly developed an empire stretching from the Red Sea to Damascus, and then fell to the mighty empire of Rome.

In the 150 years since its rediscovery, Petra has become a magnet, attracting visitors from all parts of the world. Even the glittering prose of travel writers cannot adequately describe the grandeur of Petra and the beauty of its setting, for Petra is a resource which must be accorded treatment worthy of its international importance.

To plan effectively for the development and use of Petra as a National Park, it has been necessary to examine the total resources of the area and evaluate the part each resource will play in the development of Petra as a National Park. Some resources are vital to development sections; water soil and rock characteristics, etc. Others, scenery, plant and animal life, are the resources that if properly utilized, will enhance the primary resource, the historical scene.

Three major plant communities, controlled by elevation and soil types, are found within the proposed park. The higher ridges of the eastern boundary contain a southern extension of the Mediterranean Woodland with remnants of a climax forest of oak-juniper. Soils within this community are derived mainly from limestone. Scattered junipers are found throughout the sandstone areas of the park on higher hills or in narrow,
Five distinct plant communities may be seen at Petra.

1. Remnants of juniper woodlands
2. Low shrubs on the higher slopes
3. Nearly barren plains leading to Wadi Araba
4. Lush growths of oleander in the main wadis
5. Hanging gardens in narrow wadis
shaded valleys.

The second community found on the open slopes above the sandstone zone and on higher interior slopes is a typical steppe association dominated by dwarf shrubs, primarily represented by Artemisia. Limestone soils predominate.

The third community, the sandy Hammada Desert, is found throughout the spreading wadis of the western section draining into Wadi Araba.

**Specialized Communities**

Specialized conditions have created two additional plant communities within the heart of the sandstone zone. Available moisture in a number of wadis, usually subsurface, has permitted a luxurious growth of oleanders and other moisture-loving plants to form green strands throughout the relatively barren interior.

Extremely narrow clefts through the sandstone massifs create micro-climatic conditions favoring ferns, mosses, and other typically cool climate vegetation.

**Misuse**

Misuse of the vegetative resources of the park area through overgrazing, removal to allow cultivation, and removal of trees and shrubs for firewood has had far-reaching affects on the region. Destruction of the vegetative cover has allowed accelerated erosion, destructive to the land and to the antiquities. In addition to the erosion factor, the disturbance of the vegetative balance has no doubt affected the native wildlife population.

The centuries of misuse of the vegetation of the region cannot be corrected overnight, but it is clear that the adverse practices mentioned above must be stopped before the park area becomes a biological desert.
Lack of adequate research precludes the preparation of a natural history base map showing vegetation patterns. This base map can be prepared when adequate research data becomes available.

A preliminary check list of plants is attached as Appendix -C-.

Wildlife Misuse

The wide range of habitats within the Park area has, in the past, supported an interesting assortment of fauna, but the destruction of vegetative cover along with unrestricted hunting has eliminated or reduced animal life.

Corrective Measures

Improvement of the vegetative habitat and the prohibition of hunting within the park will allow the natural or artificial repopulation of vanished or scarce wildlife species to add to the enjoyment of park visitors. Of primary importance are the Nubian ibex, fallow deer, and mountain gazelle.

Appendix -D- contains partial checklists of the fauna of the region. As noted in the vegetation section, no wildlife base map is included due to the lack of adequate research.

Geological Features

The most significant geological features in the park are the dissected rounded masses of red and white sandstones of the Paleozoic era. It is in the two major sandstone series, the reddish Quweira series capped by the light colored Ram sandstone, that the Nabataeans carved their spectacular structures.

Of equal interest is the Wadi Araba, the extension of the Jordan Valley south of the Dead Sea. This valley is one segment of the famous Rift Valley extending from southern Lebanon through the length of Jordan and the Gulf of Aqaba into Africa.
Very few, if any, large animals remain in the Petra area. The re-establishment of (1) Ibex and (2) Gazelles will add to the scenic values of the park.
The accompanying geologic map graphically describes the array of geologic layers exposed throughout the park as a result of rejuvenated drainage to the Rift Valley. Exposed, are strata representing Pre-Cambrian, Paleozoic, Mesozoic, and Cenozoic.

**Water Sources**

Springs are the main source of water in the vicinity of the proposed park. For many centuries people lived near the springs and constructed terraced fields irrigated by gravity flow. Today the best springs near the proposed park are being used and little water is available for new users.

Certain alluvial filled valleys within the proposed boundary may contain subsurface stream flow. This resource is known to be used within the proposed Park from the dug wells in the channel of Wadi Musa below Nazzals' Camp, and in Wadi Turkamaniya.

Perennial surface flow occurs at certain points of Wadi Musa in the narrow rocky gorge below Petra. For reasons of distance and possible contamination this is not considered to be a satisfactory water source.

There are no deep wells in the region and no exploratory drill holes are known to the Park study team. It is not likely that ground-water, other than perched aquifers of limited supply, occurs much higher than the level of Wadi Araba to the west of the proposed Park. Even so, this source, deep ground-water, appears to be the only one available for development on the west side of the Park (the Wadi Araba side) and may be the only source, albeit an expensive source, for greatly expanded use at the Petra Entrance or in Petra Basin. Water sources are shown on the General Utilities drawing, and details are discussed in the Developed Area portion of this plan. Because of this situation extensive studies of possible water sources should be conducted by the Natural Resources Authority of the GOJ.
Water Quality

No information is available to the team on the mineral or bacteriological content of the water currently being used in the Petra area. However the conditions of the land surface, with human and animal excrement scattered about indicates that any surface water supplies would be contaminated.

Fault Systems

The Quweira Fault, a major wrench fault, begins twenty-five kilometers southeast of Aqaba, goes northward through the town of Quweira, and ends as a series of northwest-southeast branching tension faults between Petra and Shaubak. The fault movements produce steps leading to Wadi Araba.

Er Risha, a major fault that is still active, begins on the west side of the Gulf of Aqaba, crosses the Wadi Araba diagonally about 8 kilometers from Petra, continues to Wadi Hasa where it heads northerly along the east shore of the Dead Sea.

Data on earthquake frequency and magnitude are not available.
Petra as defined here is an area combining exceptional historical and scenic values which give meaning and substance to Jordan's heritage. Measured with National Parks elsewhere, Petra will stand as one of the great national parks of the world. The GOJ should therefore consider these proposed boundaries and following agreement upon the area to be included, take whatever legislative and administrative action which is required to have the area designated as a National Park.

The area selected for inclusion within the park is believed to be sufficient to protect the archeological and historical features which tell the total Petra story. Additionally, lands have been included which are needed to protect the historic and scenic resource, to demonstrate historic conservation practices, and provide unobtrusive development sites necessary for public use and management facilities.

As shown on the adjoining map, the east boundary is drawn between the village of Wadi Musa and the existing Parks Division development west of the village. In order to protect the park approach road as it leaves the village from undesirable private development, a short segment should be included within the park boundary and limited to agriculture and contiguous property access uses.

The south boundary has been selected to include Wadi Sabra with its remains of historic copper mining and smelting operations. A portion of the Taiyiba road has also been included within this boundary to protect from uncontrolled development this highly scenic road approach to the park.
West Boundary
On the west, the park boundary has been drawn to include the massif that forms the highly scenic, rugged eastern skyline of Wadi Araba. Jebel Harun and its pinnacle shrine marking Aaron's tomb is located within this portion of the park.

North Boundary
On the north, the boundary has been set to include a very scenic and historically interesting portion of lower Wadi Musa as well as the vast neolithic site at Beidha. This portion of the park is also believed to have been the site of a great Nabataean trading center that flourished during the first century.

LAND MANAGEMENT

Land Misuse
Now a despoiled, severely exploited land, long abused by the combined forces of man and the natural forces of wind, water, and gravity, this area comprising approximately 122 square kilometers, is today the range of sedentary Bedouin tribes who with their goats, guns, plows and their endless quest for antiquities are, without malice, quickly converting this area to a wasteland ultimately fit for neither Bedouin nor tourist.

Bedouin
Resettlement
Resettlement of the Bdul tribe is one of the most urgent requirements of this plan if the Government is to preserve and develop Petra as one of the great National Parks of the world. It is recognized that resettlement is not proposed lightly nor should it be taken as a simple exercise in the physical movement of a people from one place to another. Accordingly, it is recommended that the practical and effective way to accomplish the preservation of the resources of Petra from the destructive effects of human habitation is to resettle the approximately 200 members of the Bdul tribe now living within the proposed park boundary and to close all of the park.
The Bdul of Petra lead a precarious existence based on their herds of goats and meager farm plots. Not only are these people caught up in an unending cycle of poverty, but their quest for life here is damaging to the historic remains of Petra.

It would be better for the Bdul to be resettled elsewhere to improve their lot in life as this resettled tribesman now enjoys.
lands to further settlement, livestock grazing, farming, wood and plant gathering, mining, mineral exploration, and shooting.

The Government has projects in the el Jafr, al Hussainye, and al-Qarien areas of the Ma'an Governorate under the supervision of the Department of Research, Ministry of Agriculture and in cooperation with the United Nations in which members of the al Huwaitat tribe have been settled. For each Bedouin family this program provides:

- 50 dunums of land suitable for farming.
- A water supply.
- A house.
- The land and the house are leased to each family.
- Seed, tools, equipment, and training in farming techniques along with food for sustenance are provided.
- A general guarantee is made to the tribesmen that they will be at least as well off as they were before resettlement.
- If the tribesmen farm successfully for five years, they are allowed to purchase the house and land using long-term, low interest loans.

The overall objective of this program is to help the tribesmen to take up successfully a village-farming way of life with such social benefits as basic education and medical help being provided. The effectiveness of this on-going program cannot be evaluated fully for several years due to the inherently slow nature of human reactions to exercises in planned culture change. To date, the program is considered successful, the tribesmen are farming, and they are living in the houses built for them.

To give the proposed resettlement of the Bdul tribe a better chance of success, it is recommended that an adequate Socio-cultural study of the Bdul tribe precede any attempt to move them. The kind of study proposed is within the capabilities of the staff of the Department of Sociology and Philosophy of the University of Jordan and could probably be completed in six months time.
The support of the highest level of leadership of the country should be obtained as to the necessity of the resettlement of the tribe and the closing of the park to non-park uses.

Along with their stone carving skills the Nabataeans developed a phenomenal hydraulic ability, manifested in the remnants of numerous water control systems. Hillside terraces slowed the run-off of rainfall by requiring water to seep from one level to another. Small dams built like stairsteps in the wadis also cut down the force, and loss, of the torrential flows that raced down the wadis during the short rainy season. Sand and soil, trapped behind these small rock dams and barriers retained moisture and was used by the Nabataeans for vineyards and groves, providing fruit and shade.

Just as these historical installations have been reopened or re-established elsewhere in the Kingdom, and neighboring lands, there is urgent need and compelling justification at Petra to do the same in order:-(1) to protect the irreplaceable antiquities within the park. (2) to guard against possible loss of life in case of flash floods and (3) to conserve water which is so vital to the restoration of plant and animal life. The details of the proposed improvements are discussed on pages 55 through 57.

Watershed management is a basic requirement to the prevention of damage to the historic scene as shown here.
Protection of the antiquities of Petra should be a primary function of the Parks Division through properly planned development and visitor control. Interpretation should also play a part in the protection by drawing attention to the loss of irreplaceable antiquities through ignorance. The physical protection of Petra's antiquities from the forces of nature should be provided through the consolidation activities of Department of Antiquities technicians.

Without doubt Petra is one of the great remaining treasures of the ancient world, yet this treasure is so fragile that the forces of nature will take an annual toll of the temples, tombs and dwellings which are the most prominent remains of the old Nabataean city.

The delicate nature of the ruins is such that when the protection and preservation of the ruins is in conflict with desires or convenience of park visitors the ruins should be given precedence. Of primary concern is the fact that it is the existence of these particular structures which is the basis for the creation of the Park.

Almost all the construction of Petra was of, or in, sandstone which is soft, friable and poorly consolidated. When subjected to erosion by water, wind-driven sand, and human use, the sandstone yields readily and there is nothing that can be done to totally stop this action. Efforts, however, will be directed towards slowing this destruction as much as possible.

The most urgent need for Petra at the present time is an inventory of historic structures. This will require a large scale topographic map of the park locating all exposed historic remains. This should be a prerequisite for consolidation of sites, planning future research and for development of long
range visitor facilities within the Park. The detailed maps prepared by Brunnow and Domazzewski are not to scale but are accurate enough that they can be used as a start for the preparation of a proper historic base map. In addition, there will soon be published by Peter Parr of the University of London a map of the city area of Petra. It is not known how much in addition to the city this map will include.

The inventory should be supplemented by a narrative including a summary of all known work at each individual monument, sketches and measurements and, most important, a statement of its present physical condition together with recommendations for protection and consolidation.

The Department of Antiquities in cooperation with the Parks Department, using the above described inventory, should prepare an overall, comprehensive, long-range consolidation plan that would serve as the basis to support budget requests for funds for this extremely critical resource preservation requirement.

The Department of Antiquities approach to consolidation of monumental structures is pointed heavily towards taking a ruin apart and rebuilding it using newly cut stones to replace damaged original masonry. For the reasons discussed on pages 30-35 of this plan, this practice should be stopped and a policy of in situ consolidation adopted.

Further excavations of the ruins at Petra should stop immediately and for several years to come until all exposed ruins are consolidated or proper protective measures are taken. During the past 10 years several small scale excavations have been done by the Department of Antiquities or by archaeologists from foreign countries.

The results have been that an appalling number of walls, stairs, and other architectural features have been exposed without being consolidated. These exposed features, for the most part
built from 1,700 to 1,900 years ago, are constructed of the soft, friable sandstones of the Petra Basin. They are showing already the signs of accelerated destruction caused by wind, water, and human use. The stair case in front of "Qasr el Bint", the steps to the "Lower Market", the "Byzantine Suq" along the "Cardo Maximus", a small house near the "Palace Tomb", and the area south of the gate excavated last Spring are but a few examples of consolidation needed because of excavations of the past. Also, there are many structures exposed by natural erosion, structures free-standing above the present surface of the surrounding ruins, and numerous rock-carved structures that are in dire need of consolidation in order to preserve them as significant tourist attractions. The total consolidation needs of ruins now exposed at Petra could well use the budgeted funds of the Department of Antiquities for the next five to ten years. Yet excavations continue without proper consolidation and preservation efforts.

Criteria For Excavations

Archeological excavations should not be resumed at Petra until the following requirements are met:

First, the Department of Antiquities, in conjunction with the Parks Department should prepare a comprehensive, long-range, problem oriented plan of research for the proposed Petra National Park. This plan should evaluate all prior excavations, assess what is known from these excavations and from historical resources, and identify specific problems for which archeological research could provide the needed answer. A secondary objective of the research plan would be to identify ruins which should be excavated for display to the tourists; and just as important ruins or areas which should be excavated for information and then re-covered with earth.

Second, the Department of Antiquities and the Parks Department should both adopt the policy that no excavations will be undertaken without adequate funding to insure the consolidation or preservation of the site and its artifacts.
Third, all excavations at Petra funded by the GOJ should conform to the requirements of this Master Plan and the research plan proposed above.

Fourth, all excavations of Nabataean and later periods funded by the GOJ should adhere to the highest standard of scientific technique and should be undertaken only under the direct field supervision of a thoroughly experienced Greco-Roman archeologist who has achieved the doctorate level of education. Excavations of sites from earlier periods should meet the same requirements except that the archeologist in charge should be thoroughly experienced and academically trained in the particular period in which he expects to excavate.

Fifth, proposals for excavation of ruins in the Park sponsored by foreign archeological institutions should conform to the standards outlined above. The GOJ, however, should fund and undertake the necessary consolidation or preservation requirements.

If the present practices of the GOJ with respect to excavation, consolidation, and preservation of the ruins of Petra are continued, irreparable damage will be done to the ruins of the Petra Basin and significant archeological findings determined by scientific excavations based upon problem-oriented research plans will be lost forever. Some of the more serious consolidation and preservation needs are discussed on the following pages and in Appendix -E-.

Conservation of the ruins at Petra falls into three categories: (1) conservation of the site as a whole; (2) conservation of structures hewn from sandstone masses, and (3) conservation of free standing structures.
Site Protection

The ancient city of Petra lies in a basin in which three drainage areas meet - those of Wadi Musa, and its two principal tributaries, Wadi Mataha and Wadi Turkumanyah. Each of these has a drainage area sufficiently large that it poses a threat to the city area of Petra each rainy season. After the disastrous flood of 1963 in which 28 tourists lost their lives in the Siq, a diversion dam was built across Wadi Musa at the head of the Siq and this portion of the stream course no longer is as dangerous as before. Waters from the upper reaches of Wadi Musa are now diverted by the Siq dam into Wadi Mataha forcing it to carry more than its share of any general flood. The worst feature of the new arrangement is that Wadi Mataha joins Wadi Musa in the heart of Petra and its lower course points like an arrow at the Nymphaeum and the colonnaded street.

A few hundred meters below the junction of the two streams dirt from recent excavations has been dumped into the bed of Wadi Musa so constricting the channel that an additional hazard has been created. Flood waters could easily choke the channel at this point and cause irreparable damage to ancient remains on either side of the stream.

At about the same time the dam was built across Wadi Musa a long and unsightly retaining wall was constructed on both sides of Wadi Musa from the Nymphaeum to the Monumental Arch near Qasr el Bint. This revetment was intended to protect the Nymphaeum and paved street, but it has been seriously undermined by the stream. This channel should be stabilized. The existing revetment walls should be faced with sandstone of a size and pattern to be in sympathy with the Roman period ruins.

Elsewhere in this plan a proposal is presented to construct a system of check dams and hillside terraces throughout the Wadi Musa drainage as did the Nabataeans. Such a basin-wide system of water controls, regularly maintained, seems the only practical means of preserving both ruins and terrain.
An excess of rainfall runoff carried by Wadi Musa because of overgrazing forced the construction of a revetment to protect the Roman period structures - continued excess water is now undermining this revetment.

The dumping of excavation debris has restricted the flow of Wadi Musa causing further erosion upstream.
In addition, erosion by human activity should be controlled. This also is proposed in another section of the Master Plan but is added here to give additional stress. The Bdul tribe should be resettled out of the area to halt the farming and browsing which damage the site and, above all, to end the illicit and apparently never-ending digging for relics to be sold to visitors.

**Protection Of Carved Structure**

Much of the sandstone of Petra, and particularly the varicolored-red beds, is being eroded at an alarming rate. At the present time the most effective means of slowing such erosion is to spray or paint the sandstone with a penetrating rock hardener. Properly applied these hardeners are remarkably effective and make the stone hard, resistant to wear and do not change the external appearance of the rock. Such a treatment is expensive. A description of one of these chemicals, of American manufacture and their application costs, is in Appendix -F-.

**Protection Of Free-Standing Structures**

There are only a few free-standing structures at Petra; chief among these is Qasr el Bint with some lesser buildings such as the monumental gate, the scena of the theatre and the partially excavated portions of the baths.

Before entering into any discussion of the care and maintenance of masonry walls it will be well to quote Mr. T. A. Bailey of the Department of Public Works, Ancient Buildings, of the United Kingdom. He wrote in: Notes on the Repair and Preservation of ancient monuments and historic Buildings. "No defective masonry which can possibly be secured in situ should be taken down". It is much too easy for a technician to be carried away by his own skill when making necessary repairs to ancient structures and end up with something which may be structurally sound but entirely out of keeping with what it proposes to be.
(A) The Obelisk Tomb,  
(B) Qasr El Bint, and  
(C) The monumental Gate are examples of the effects of wind erosion at Petra. Major structures will require preservative treatment to reduce this erosion.
Some recent work at the monumental gate is a case in point. A number of stones in some of the lower courses of the gate were replaced or reset. The stones were very neatly dressed and mortared with cement. The result is that those courses of stone have all the appearance of fine modern masonry and clash with the appearance of the masonry above, which is in a fairly precarious condition and needs consolidation.

It has been proposed to take down the upper portion of the gate and to rebuild it - using the same stones - plus a few new ones to replace those which are badly cracked. To do this would be to destroy the entire aspect of the gate and create a caricature of a ruin in modern masonry.

The free standing structures are ruins and they should be preserved as ruins. The days when the stones were neatly dressed and the structures presented a solid appearance are long gone and an attempt should not be made to re-create those days.

Where masonry blocks of the gate have separated and rubble has entered the widened joints, additional pressure has been exerted so that much of the upper portion of the structure is becoming unstable. The joints can be raked, some of the rubble core removed, the entire upper portions of the gate can be jacketed, and the masonry jacked back far enough so that with epoxies, pins, and internal braces, the structure will once more be in equilibrium and will still look like a ruin. A delicate job - but not an impossible one.

The other free standing structures of the site, notably Qasr el Bint, should be approached in the same manner. The temple has suffered much damage by earthquakes in the past and a number of stones in the faces of the walls as well as the remaining portion of the arched entrance appear in danger of falling. A comparison of the walls today with photographs published by Brunnow and Domaszewski in 1904, show that little change has taken place during the past 65 years. This
indicates that the walls are not in immediate danger of collapse (unless from some hidden weakness) and that there is probably time to make a detailed survey of the entire structure and then proceed with carefully planned consolidation of the temple which Peter Parr has termed, "one of the most important surviving Hellenistic buildings in the Near East". Here also, it is of the utmost importance to preserve Qasr el Bint as a ruin - a handsome relic of the past.
Introduction Of The Visitor To The Park

Scenic Approach
At present visitors are routed from the Desert Highway past Ain Musa and through the village of Wadi Musa to the rest-house area. To better prepare the visitor for the rugged and scenic expanse of the park, it is proposed that they be routed through Taiyiba. This road offers an extensive over-view of the entire area. Along part of this scenic approach overlooks with orientation exhibits should be developed.

Visitor Center
The focal point of all visitor activities will be the park visitor center. Arriving visitors will be channeled into this facility so that their needs may be taken care of in an orderly fashion. Circulation and facilities within the visitor center will be as follows:

Manned Information Facility
The information station will serve as a filter to provide basic information-orientation and direction to visitors. Here a clerk-cashier would be stationed to collect park entrance fees.

Toilets
Adjacent to the entrance will be conspicuously marked toilets.

Information Orientation Exhibits
A large illustrated map of the park will denote trails and other available activities. Multilingual labels should be provided as well as multilingual map folders.
Accommodations Facility
At this facility all transactions for accommodations, horse rentals, campground fees, or guides may be completed.

Audio - Visual Exhibits
A brief audio-visual program would provide further orientation to the park. Multilingual audio equipment should be available. Appendix -G- outlines the presentation.

Museum Exhibits
Exhibits should be provided in the visitor center. Appendix -H- outlines the exhibit content and treatment.

Publications Center
It is recommended that this be the central sales point for all park publications and authorized souvenirs. Appendix -I- outlines the number of publications and their contents.

From the visitor center visitors have the option of going to their rooms, to the restaurant, lunch terrace, or to the park trails (foot or horse).

The Trail System
The major visitor activity within the park should be a personal exposure to the scenic and historic features of the park on a network of foot and horse trails. The trails should be designed to be used as guided or self-guiding trails. Most of the trails will feature alternate return routes for maximum exposure to park features. Trail route markers and site markers should be color coded for identification. Each trail should be supported by guide booklets available in Arabic, English, French, German and Italian to provide a welcoming and friendly individual approach. Appendix -J- outlines the trails according to a priority of development.
Personal Services  A staffing chart is included in another section of the Master Plan, but it is necessary here to spell out the activities of the uniformed staff in the fields of information and interpretation. The initial visitor contact at the visitor center information desk will have a direct effect on the attitude of the visitor to the park, the park system and even to the country. It is therefore necessary to provide the best trained personnel available for the initial contact duty. To ensure a uniform quality of personal contact, the uniformed staff should rotate their assignments between the following duties:

Visitor center information desk
The contact station in Inner Petra
The contact point near the Roman Theater
Trail roving assignment
Evening program duties
Special tours

Evening Programs  The concentration of overnight accommodations (hotels and a campground) in one general area will facilitate the development of evening programs. Evening programs can be a very useful extension of the information-interpretation activity, utilizing personal services, audio-visual presentations, and demonstrations. Programs may also be developed to encourage tourists to visit other National Parks and points of interest throughout Jordan. Each program should also include entertainment of a type that will feature the folk arts; singing, dancing, and the playing of native instruments such as the rebaba and the shepherd's pipe.

Guide Services  Although trail information - interpretation should be primarily geared to self-guided activities, there will be a demand for personal guides. Many, if not all, of the agency-arranged tour groups will be accompanied by their own guides. In any operation of this type, there will be a need for guide service for
special guests and as mentioned in the personal services section, members of the uniformed staff should be available for this duty. For the independent tourists, guides should be made available through a National Visitor Center which will be proposed for development in Amman. No guide should be permitted to operate in Petra National Park until he has been licensed by the Tourism Authority. It is further recommended that the Parks Department be represented on the guide-licensing board to assure adequate service to park visitors.

Concessions

Lodging And Camping

Development of accommodations at the park entrance to meet a broad range of visitor preferences, satisfying both national and international visitors, will be necessary. One day round-trips to the Petra Basin will probably continue as the most popular activity. However, development of camping and expansion of lodging facilities should be placed in high priority for use of visitors interested in a longer and more complete park visit through trips to El Dier, the Great High Place, Beida, and other outlying points of interest.

Interior Development

Within the fragile core area of the park, one primary site for visitor services, limited to rest, refreshment, and information should be developed. By concentrating intensive use to one carefully selected and well planned site, visitor damage to park values along with concession problems of supply and cleanup will be greatly reduced.

The present overnight facility Nazzals' Camp, located within the Park's most important concentration of Roman period ruins, is a gross intrusion and constitutes an intolerable violation of Petra's historical integrity. Negotiations pointed at the removal of Nazzals' Camp from the Petra Basin are of paramount importance to the future of the Park and should be a high priority item in the park development program.
A well designed and maintained system of foot and horse trails, connecting the park entrance development with outlying interest points, should remove the need for overnight accommodations within the Park by placing these points within day-use distances.

**Single Concessioner Concept**

Impressions visitors form and keep of travels are often closely related to the means used to make possible their outings. Unpleasant experiences stemming from transport or accommodation can serve to shorten a visitor's stay, or cancel a return. Further, unpleasant vacation experiences recalled at home of badly prepared food or substandard hotel accommodations can often mar otherwise glowing reports of distant and unusual places.

To assure a high standard of visitor supporting services and to effect better coordination of these facilities with government managed elements of the park and with the tourism industry, proposals in this plan are directed at the use of one government regulated operating company for the entire park. This company would be responsible for all revenue producing activities including lodging, food service, and transportation.

**Single Concessioner Advantages**

The advantages of a single company operating under a long term contract are impressive. In addition to the usual advantages associated with large business enterprise, i.e. quantity buying and volume sales, problems at Petra stemming from isolation such as warehousing, food preparation and transportation would be merged, eliminating the costly duplication of specialized facilities and equipment. Additionally, and of importance to park authorities, will be the administrative advantage of dealing with a unified professionally managed organization, capable of providing complete visitor support services on an individual or package basis to meet the growing popularity of prepaid group travel.
Horse Rentals

Traditionally, horse rentals have been an important element to the economy of Wadi Musa. At present approximately 300 horses with almost as many owners are available on an "as needed" basis. No organization of horse rentals now exists with the exception of very loose controls over the individual horse owners exercised by the Parks Division. These controls are primarily concerned with fees and horse rotation.

Safety standards relating to horses and their equipment are either nonexistent or are unenforced. The most important need is to discontinue the practice of leading horses along park trails. Visitors should be given the option of having full control of their mounts. Steps should be taken to improve the quality of the horses and horse trappings.

There is need to organize the Wadi Musa horse owners into an organization which effectively controls the horse rental operation. Such an organization would work both to the administrative advantage of the Park concessioner and to the individual horse owners themselves by giving them the strength of a unified voice in the affairs of their activities.

Village Economic

Benefits And

Zoning

Just as tourism benefits the visitor, it also benefits the visited, provided proper safeguards are implemented. At the present time a drive through the village of Wadi Musa constitutes an important bonus to Petra visitors. A view of this unusually attractive terraced and well watered oasis and its village life is a scene of Jordan which should be kept to satisfy the curiosity international visitors have for other peoples, surroundings, and customs. This does not mean that the village should not enjoy the economic and social benefits resulting from increased tourism at Petra. Certainly every advantage should be taken of the increased job situations and expanded business opportunities, generated by the Park, to raise the living standards of the village. However, without a clear, well conceived plan to control the future growth of Wadi Musa, the values that presently give the village its
touristic appeal will most certainly be destroyed. Without proper zoning control the village approach road to the Park entrance will inescapably fester into a linear proliferation of substandard shops, all vying for the dinar of bewildered visitors who will view the village as more of an obstacle than as an attraction.

Zoning Proposal

To protect these meaningful touristic values, a zoning plan for the village of Wadi Musa should be prepared and implemented by the Ministry of Interior for Municipal and Rural Affairs in cooperation with the Parks Division of the Tourism Authority. The implementation of this plan should precede further major construction at the Park entrance discussed in a later section.
The development areas proposed in this Master Plan are conceived to meet the expected large number of visitors entering Petra via the traditional Siq route. While this route provides the unique entrance to the Petra Basin and the dramatic visual impact of the Khazna, it creates areas of intense concentration of visitor activity with unbalanced distribution of the visitors through the park. In order to protect the fragility of the resource, development is recommended at two compact sites—both removed from visual intrusion on the major resources. The visitor will be placed in visual contact with every aspect of the park but through the location of trails and access points, physical contact with the park features will be kept to a minimum.

The Petra entrance area is planned as the visitor staging and dispersal point. Development elements here can be arranged to relate one to the other thus accomplishing the purpose of orienting the visitor and starting him on his way into the heart of Petra. The primary trail system is directed away from the development and toward Petra. Architectural accents to attract the visitor into the logical sequence of reception and orientation should be developed to accelerate visitor movement through the development area. In this area should be the only park overnight accommodations—a hotel and campground—and the center of park administration and operations.

Only one development is proposed for Petra Basin; a secondary information and park staff station, public toilets, and a snack bar—lunch area. This development should provide visitor comforts in a relaxing atmosphere. Shade, shelter, and informality will complement the serenity of the setting. Architectural and landscape treatment should be designed to permit a free flow from one facility to another without a sense of herding or crowding.
Development Restrictions

All construction and maintenance activities involving ground disturbance should first be concurred in by the Department of Antiquities. In the planning stage, all sites of permanent construction should be investigated by the Department of Antiquities to determine their archeological significance. Such investigations should determine the nature of the site, the need for salvage excavation, or if the site should be restricted rather than used for facility development. In case of disagreement between the Parks Division and the Department of Antiquities regarding these activities the matter should be submitted to the Minister for his decision.

The Park Division construction and maintenance supervisors should be alert to the recognition of artifacts and ruins uncovered in the course of their work. When antiquities are discovered, work in the area should be suspended until the importance of the site can be evaluated by Department of Antiquities representatives.

There should be no construction of facilities on or in conjunction with archeological ruins or historic structures in the Park. Existing uses of caves for habitation, soft drink sales, equipment and storage, and trash disposal (including Nazzals' Camp, the museum offices, and post office) should be discontinued. The recently constructed walls of these caves should be removed and the interiors cleaned and restored to a natural appearance or back filled and graded to a natural slope. Where existing structures, trails, and utilities are designated in this Master Plan “to be obliterated”, these existing facilities should be removed and the site restored to the natural landforms. All construction debris resulting from this operation should be buried as a part of the land restoration project or removed to the sites assigned to refuse disposal and salvage storage areas.
Local Bedouins mar the historic scene by walling up tombs and Nabataean caves for living quarters and through their indiscriminate digging in search of relics to sell.
The Architectural Theme

Stark contrasts are everywhere evident throughout the landscape of Petra. The contrasting shapes, textures, and colors of the landforms create a dominant pattern. The development should be designed to be in sympathy with the landscape and become an organic part of it.

The architectural theme should relate to hot, arid summers, to prolonged periods of bright cloudless skies, and to piercing winter winds. The structures should be functional in design and provide the required shelter in a contemporary manner that in no way mocks or intrudes upon the archeological ruins and their setting.

In the Petra Basin the character of the developments should reflect the contrasts of a change of scale from the gigantic land forms and architectural facades which are Petra to intimate clusters of new facilities; and from the high open areas of the Park to shaded sheltered structures of the development.

The design of the major visitor structures should be assertive - the character should be one of immediate identification as a place to go for orientation and dispersal through the development and to the Park - a friendly and cheeful place that will proclaim the Jordanian Park Division presence without monumentality or "official" character.

The architectural theme in a minor key but with the same standard of design excellence should prevail for the hotel, administrative, housing and maintenance structures.

Design Standards

Structures requiring large spaces should be designed of smaller asymmetrical unit-clusters that avoid monumentality. This should help to create a human scale that will invite the visitor rather than impress him. Small structures should be
designed to conform to the physical features of the landscape and should not call attention to themselves as separate features. All development from trail signs to major structures should utilize design concepts, construction materials, and colors that will maintain a spirit of dignified enjoyment.

By using traditional materials, domestic scale and forms, combined with modern technology, a new regional architectural style can be evolved that is appropriate to the site and designed to produce shelter from the extremes of heat, wind, and light. Design excellence should be the criterion for all development. There should be no attempt to standardize just for the sake of design expediency.

Screening of day-use facilities from the major archeological resources, and supporting facilities from the public use areas, should be accomplished primarily by siting and planting. Architectural elements such as courtyards and compounds should be integrated into the design to provide security and privacy.

Access

A new park entrance is proposed from the Desert Highway- Wadi Musa Road at Ail. Here the existing Taiyiba Road commences and continues to Wadi Musa through the village of Taiyiba. Although it is quite narrow and its alignment is somewhat tortuous, this route offers a spectacular overview of Petra and the dramatic formations to the south.

Before the Park can accommodate peak visitor loads access roads should be upgraded to a minimum of seven meters in width and realigned. The distance from the Desert Highway on the Wadi Musa road is 31 km., and via Taiyiba 38.5 km.

A landing area should be designated for helicopters at the entrance development. Landing of helicopters in other sections of the park should be prohibited.
Circulation within the Park, with the exception of the entrance development, should be accomplished solely by means of an extensive system of pedestrian and horse trails. Pedestrians should have the use of all trails. However, horses should be limited to designated horse trails. Tethering points should be provided where necessary so that equestrians can dismount and traverse spur trails which are limited to pedestrians, i.e. Snake Monument trail, trail to Umm el Biyara. Most of the trails should be designed as loops to allow more visitor exposure to the monuments and natural scenery.

Standards of construction for trails should vary according to type and volume of traffic. Generally trails within the vicinity of the entrance development and within Petra Basin should be built to a high standard to accommodate heavy traffic whereas outlying trails should be simple graded trails with obstructions removed and some construction required to ease grades on steeper sections. Horse trails following wadi bottoms will require removal of obstructions. Where steps are required it is important that the riser-tread relationship be constant in any one run of steps. The maximum dimension for risers should be 15 cm. Whenever possible the relationship should be 15 cm riser to 30 cm tread. If steeper runs are required handrails should be provided and the relationship should be a maximum of 20 cm riser to 25 cm tread.

A list of the individual trails and the types of construction is included in Appendix –J–.

The Petra Entrance development will require a minor road system serving the campground, visitor parking at the visitor center and short spurs to the hotel, staff housing, and maintenance areas. Roads should not penetrate the Petra Basin. However, servicing of the day use development and emergency access can be handled with electric carts operating on the horse trail to
Before this section of Wadi Musa can be used for horse and emergency vehicular travel, runoff must be controlled and the wadi bottom stabilized.
the Petra Basin trailhead. The bottom of Wadi Musa from the Nymphaeum to the Petra Basin trailhead will require stabilization to accommodate these carts and to protect structures along the Roman street from water erosion.

A list of individual roads at the entrance development is included in Appendix -J-.

Roadside Overlook

Parking overlooks should be developed along the Wadi Musa Road - Taiyiba entrance road at points of historical interest or high scenic value.

Utilities

It is proposed that water systems for the Park be designed and managed on the basis of the following criteria.

Water : Design Criteria

1. All overnight facilities and all food serving and toilet facilities should be constructed with piped water systems.

2. There should be no water works in the area of important historical and archeological remains. Further, no water works should be visible or otherwise intrude on areas of outstanding scenic value.

3. Water should be supplied of a quality which meets the bacteriological, chemical, physical and radiological requirements of the World Health Organization.

4. The quantity of water to be provided should be as follows:

<table>
<thead>
<tr>
<th></th>
<th>1975</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel (per person)</td>
<td>120</td>
<td>180</td>
</tr>
<tr>
<td>Campground (per tent camper)</td>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td>Campground - trailers &amp; self-contained camping vehicles (per person)</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Day-use, at Entrance points (per person)</td>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>
Day-use, within Petra Basin
(per person)  
10  
15

Permanent residents, staff
(per person)  
200  
300

The daily rates shown above for 1975 are 50% of the present rates in recreation areas in the United States as published in Environmental Health Practice in Recreational Areas, US Public Health Service. For 1985 it is assumed that the rates will rise to 75% of U.S. experience.

5. Water pressure, at the fixtures, should be not less than 1.0 Kilogram per square centimeter (15 psi) nor more than 4.2 Kilograms per square centimeter (60 psi).

6. Storage reservoirs, with gravity flow to the points of use, should be provided with capacity equal to 12 days demand where there is gravity flow from the source and equal to 20 days demand where the water is pumped from the source.

7. Water quantity and pressure for firefighting should be limited to the requirements for domestic uses.

The general features of proposed water systems meeting these criteria are shown in the Developed Area portion of this plan, pages 65 to 68

Sewerage:
Disposal Methods
The terrain of the proposed Park presents several difficulties with respect to the disposal of sewage. There are no bodies of water to which treated sewage could be discharged. Except for the Wadi Araba side there are few places level enough to permit the use of stabilization ponds. Disposal of effluent underground is made difficult by the scarcity of suitable soils and by the possibility of contaminating spring or well...
supplies. Nevertheless, this latter method, that of underground disposal, offers the best possibilities.

It is proposed that sewer systems for the Park be designed and managed on the basis of the following criteria:

1. Except for certain remote sites, provisions should be made for water-carriage systems of sewage disposal. At remote sites pit toilets should be used, or, if there is a small supply of water and suitable soil available for underground effluent disposal, "Pullman" type toilets could be provided. Chemical or burn out toilets should not be used as the operation and maintenance of these types of units present such problems as would make them unsatisfactory.

2. Treatment should be by septic tank and underground disposal of effluent. No sewage or effluent should be discharged on the surface of the ground.

3. The systems should be designed for a quantity of sewage equal in volume to the water supply.

**Electric Power**

Enjoyment of the Park places two requirements on electric power. One, that adequate electric power be available at buildings providing for the needs of the visitors and the staff and, no less important, that the generating plants and transmission lines not intrude on the sights and sounds of the Park.

The following criteria are proposed for electric power supplied to the Park:

1. The voltage and cycles should conform to the current in general use throughout Jordan, that is, 220 volts, 50 cycles.
A total disregard of the integrity of Petra in the interest of modern development has marred the view of the Khazna and other structures.

This telephone line must be relocated or buried to preserve the scenic values.
2. Where possible and economically feasible, connection should be made to power sources outside the park boundary.

3. Transmission lines within the park boundary should be placed underground to protect scenic values.

4. Generating plants should be located and constructed so as to keep sounds at a minimum.

Details of proposed power systems are shown in the Developed Area Section of this Master Plan.

Communications Systems

Communication systems within the Park are required, to meet the needs of the Park administrative staff, the concession operators, and the visitors for rapid and reliable communication to points within and outside the Park. As with electric power installations, communication facilities should not visually intrude on the Park features.

The following general criteria are proposed for communication systems within the Park:

1. Park headquarters, the major center of public use concentration at the Park entrance, should be connected with both the local Wadi Musa telephone system and with a long distance system either via telephone cable with multiple circuits or microwave.

2. A private branch exchange is necessary between park headquarters and points of visitor concentration within the Park.

3. A local, line-of-sight, low powered radio system (walkie-talki) should be established for use by the Park staff.

4. The existing overhead telephone line should be removed from the Siq and any new telephone lines should be placed underground.
5. Microwave stations, radio repeater stations or other communication equipment should not be located where they will intrude on the scenery within the Park.

6. There should be no Post Office within the Park.

**Refuse Disposal**

The Park Organization should include personnel and equipment for the collection and disposal of garbage and other solid wastes.

Past methods of disposal have included dumping into tombs, wadis, and on nearby land. These methods should be stopped. It is proposed that a sanitary landfill be established in the vicinity of the Park entrance.

**Watershed Protection**

The Nabataeans, in order to maintain a rather large population in what must have been a considerable degree of luxury, made themselves masters of water conservation methods. A network of agricultural terraces and water diversion and collection devices covered the hills and valleys of the Petra area. It seems safe to say that Nabataean water conservation was so efficient that only rarely would flood waters escape the retarding structures and flow down the wadis.

To follow the practices established by the Nabataeans it is recommended that the protection of the watershed of Wadi Musa above the Roman street be included in the first phase development. The scope of the work, shown on sheet PET-10, would include wadi check dams, hillside terraces, and the re-establishment of vegetative cover. In addition to new ground cover, soil and water conservation will improve existing farm land providing new agricultural opportunities for crops, groves, and orchards outside the park. The watershed includes approximately 55,000 dunums of land of which 15 percent is within the Park. Since most of the water-shed is outside the boundary of the park, it will be necessary for this work to
Some erosion control work has been done, but much more will be required to protect Petra for future generations.
be planned, constructed, and maintained by other agencies in cooperation and coordination with the Park program. Wadis and hillsides within the Park would be controlled by works constructed under the Park Division development program.

Maintenance and improvement of this system within the park should be a continuing project in the management of the Park.

In order to be effective, the sequence of check dam construction must start in the extreme upper reaches of each water course. Therefore, no check dams should be constructed in the Petra Basin until the protective works are completed in all the tributeries of Wadi Musa above the area of the Roman-Nabataean occupation. The construction sequence for the hillside terraces is similar in that construction should start from the ridge and proceed downhill. However, hillside terraces and planting can be completed prior to completion of the entire system of check dams.

The procedure for planning and construction of this soil and water protection system will necessitate operating agreements with interested ministries or agencies, completion of a detailed survey of the watershed area, determination of the extent and design of the structures, designation of new land uses and the scope of replanting, and establishment of procedures for improvement and maintenance of the entire system. All decisions should be coordinated with Park objectives.

Nabataean dams and hillside terraces within the Park should be rebuilt improved and expanded. Both rebuilt and new dams should utilize native stone in sizes and methods similar to the Nabataean work. Where possible channels should be constructed to divert water from the wadi check dams onto the terraces. Outside the park, standard engineering construction methods and materials may be used for the protective works.

Standards of design and construction, and estimated construction cost are in appendix -K-.
Petra Entrance

The Petra Entrance development area adjacent to the village of Wadi Musa should be the focal point for park visitors. Overnight facilities and the operating center for park management with the necessary headquarters, maintenance areas, and staff quarters should be located here. The selection of this site is dictated by its proximity to the entrance of the Siq and the existence of present facilities. Since the landscape has been disturbed it is the best use of the resource to construct the new facilities on this site and take advantage of existing structures and utilities as they meet approved design criteria. The total cost of the improvements recommended for the entrance area is estimated at JD 469,000 including contingencies, plans, supervision etc. (See Appendix -L-).

Character Of Site

The site is located in the contact zone between the limestone ridges of the Transjordan plateau and the sandstone massifs that characterize Petra. A buff colored sandstone hill dominates the development scene. Smaller hemispherical domes with Nabataean caves are evident to the west and north. To the east and south the verdant multi-terraced village, fields and orchards of Wadi Musa complete a varied and interesting vista.

Visitor Center

The location of the facilities about the existing resthouse and parking terrace is designed for optimum relationships and circulation: pedestrian, vehicle, and horse. When the visitor leaves his vehicle on the parking terrace, he is greeted visually and actually by the visitor center which is oriented to be the first and only building he can enter from the parking area. Here the visitor is provided with basic information, toilet facilities, and the opportunity to make arrangements for his stay in Petra. Below the entrance level of the visitor center complex will be the park headquarters and maintenance area.
LEGEND

EXISTING

PROPOSED

OBLITERATE

BUILDINGS

ROADS

TRAILS (FOOT)

TRAILS (HORSE)

WALLS

WADIS

BOUNDARY

NOTE:

Phase I: Bus parking will be changed to auto parking during Phase II.

Campground roads will be designated Phase I or II after more detailed studies have been made.
LEGEND

EXISTING BUILDINGS

ROADS

TRAILS (FOOT)

TRAILS (HORSE)

WALLS

WADIS

BOUNDARY

NOTE:
PHASE I BUS PARKING WILL BE CHANGED TO AUTO PARKING DURING PHASE II.
CAMPBARGOUND ROADS WILL BE DESIGNATED PHASE I OR II AFTER MORE DETAILED STUDES HAVE BEEN MADE.
SOLID ARROWS - VISITOR CIRCULATION
HOLLOW ARROWS - SERVICE FLOW

PETRA ENTRANCE DEVELOPMENT
PETRA NATIONAL PARK

Scale 1:1250
The open plaza between the visitor center and resthouse is the pivotal point in the circulation pattern. Shaded terraces will provide an opportunity for rest and reflective thoughts; from here the visitor has the option of beginning his trip into Petra by foot or horse, getting settled in his room in the resthouse, having refreshments in the lunch area, or having a meal in the snack bar or dining room. In this plaza, evening interpretive programs and entertainment may be provided. An outdoor theatre is proposed for phase two to accommodate the evening programs.

The visitor center and park headquarters is the initial contact point. It is also the center for park administration and operations. Here, the visitor receives his first impression of the Jordanian National Park operation. The visitor center lobby is in a sense the entrance to the park - providing visitor information, orientation, public toilets, and other visitor needs. This should be designed as a space to encourage a leisurely flow from one function to another. A continuation of this visitor flow should be to the museum exhibits and audio-visual devices. Light and sound will be controlled by a series of baffles rather than doors.

Since the audio-visual orientation will be shown to large groups of people and for a short duration, the design of the audio-visual space should not be limited to a static presentation in a traditional auditorium. Rather than the standard seating configuration the visitor may sit on continuous benches or lean against a rail. The audio-visual program and the interpretive exhibits should be intergrated into one space. Visitor comfort is of prime consideration in the visitor center. Materials for interior finish should be simple, easy to maintain, and tastefully combined with light and color to complement the architectural character of the building, but not to be merely decorative. The building should be centrally heated. The inclusion of a cooling system in the phase two construction program should be a requirement for all public spaces of the visitor center. A lounge for bus and taxi drivers should be off the public spaces of the visitor center. This should be
Administrative
And
Maintenance
Spaces

The park headquarters portion of this complex should house offices for the park superintendent and his staff, a library-conference room, a communication center, a first aid room, and storage and work rooms. These facilities would be shared with Department of Antiquities representatives on the site in the course of their research and consolidation duties.

The maintenance area of this complex should be the operating base for all park and concession maintenance and antiquity projects - buildings, utilities, roads and trails, vehicles and equipment, and consolidation of ruins. This area would house shop offices, work shops, vehicle work bays, tool and parts storage, bulk storage, and oil and fuel storage. This facility should be located where it will not be visible from the visitor use area. The structures should close upon themselves to form working compounds and storage courtyards. Here should be the only maintenance, warehousing, and outdoor storage facility in the park. The existing storage room, warehouses, equipment rooms, reservoir, etc. should be obliterated as part of this development program.

Staff Quarters

Rental of adequate housing for staff personnel in the village of Wadi Musa is not feasible. Quarters for the park staff, permanent and seasonal, Department of Antiquities and key concession personnel should be constructed adjacent to the Petra Entrance Development. There should be no quarters constructed within other areas of the park.

The residential area is proposed as a unit of structures clustered against the hillside to be visually in context with the village of Wadi Musa although within the park boundary. They are oriented for surveillance of the entrance facilities. The architectural scale, forms, and materials should be in
Architectural elements of the Resthouse as shown in this interior photograph overwhelm and even partially conceal the forecourt columns and side rooms of this Nabatean tomb.

Enlargement of the Resthouse will introduce strong horizontal architectural elements to break the excessive vertical appearance of this structure.
character with the local domestic buildings. Housing should provide all modern facilities and optimum floor areas with varying arrangements of one to three bedroom units. Seasonal quarters providing semi-private dormitory rooms and efficiency type (one room) apartments should also be part of this development. Fourteen house units and eight seasonal units are proposed for phase one. This should be expanded to twenty houses and fourteen seasonal units by 1985.

The proposed overnight accommodations should be constructed adjacent to the existing resthouse which would then become an integral part of the new hotel facility. This hotel should be designed to operate as a model high standard touristic hotel, offering one class accommodations - with or without bath at moderate prices. This hotel should set the standard for privately operated overnight accommodations outside the park. To meet the immediate needs, resulting from the closing of Nazzals' Camp, additions to the existing resthouse should include; 50 double rooms with baths, an enlarged dining room and lobby, and the necessary ancillary services. This addition would meet the projected requirement for hotel accommodations in 1975. The extent of further expansion of this facility should be determined by an evaluation of actual travel patterns in the next five years.

The existing resthouse, occupying the site of the major Nabataean tomb, Al Khan, was designed to be superimposed on the architectural elements of this edifice. Unfortunately the capitals of the columns and rooms of the forecourt were hidden by changes in design of the resthouse lobby that took place during construction. As a result, the facade of the tomb is overwhelmed by the structures of the resthouse. The design resulted in an unnecessary massing of the building into a multi-story plan with resulting aesthetic and functional problems.
The plan is not efficient and facilities are not sufficient for a good hotel operation. There are two floors with a total of only eight guest rooms, sharing common toilets and showers. One of these rooms is used by the resident staff. The remaining rooms are crowded with a third bed and often accommodate a family of five in the peak season. Use of space in the lobby is poorly managed. There is inadequate space for food and beverage storage, no space for a hotel office, and no provision for janitor supplies and equipment storage on the main or the guest floors. Although the rest house operates all year around there is no heating of the building and no domestic hot water in the showers and wash rooms.

Proposed Alterations And Additions

The proposal of this plan would effect minimum alterations to the existing resthouse. The guest rooms should be refurbished to easily accommodate a third bed. Domestic hot water should be supplied to all toilet rooms and showers. A new kitchen with all necessary supporting functions should be constructed. The present lobby would then become a snack bar and the existing kitchen would become a mechanical room for the central heating plant. Air conditioning should be provided only in the dining room and snack bar by a package unit installed in the existing space.

The new portions of the hotel should include a lobby and lounge, administrative offices, storage and laundry, and guest rooms with baths. These new structures should be designed as one story buildings clustered on the hillside above and beside the existing resthouse in order to mitigate the excessive vertical proportions of this three story mass. These units should be designed to be shaded during the day by structures or planting, and can be easily ventilated to take advantage of the cooling effect of the evening breezes. Dining terraces would extend from the building and near by would be an open lunch area serving refreshments from a kiosk.
Camping in Petra National Park should be limited to the Petra entrance area campground and should be operated by the concessioner. The site of the campground is physically and visually removed from the concentration of visitor activities at the visitor center and hotel. However, this site is located in the circulation pattern so the camper will receive the same information and orientation as the non-camping visitor. The campground can be serviced by the utility distribution system constructed for the entire development area. Camp sites will be developed adjacent to parking pull-outs constructed along the campground loop roads. These parking pull-outs can be expanded into trailer spurs when trailer camping becomes popular. "Rotel" units - buses with sleeping trailers - can be accommodated at a widened section of the campground entrance road. The alignment of the loop road follows the natural landforms with the camp sites being leveled and terraced in sympathy with the existing landscape. Each camp site should be provided with a table.

Buildings housing toilets, showers, and storage rooms should be located to accommodate the maximum number of camp sites within a walking distance of 50 meters. There should be no fixed structures for cooking, eating, or sleeping in the campground. Water points and trash receptacles should be provided at key points. It is anticipated that campers will purchase their necessary provisions in Wadi Musa village or elsewhere.

Trees and shrubs should be planted to provide shade and a sense of privacy at the camp sites and between areas of the loop. There should be no attempt to plant ground cover at the camp sites.

The first phase development should provide facilities for 50 camp sites. The area designated for camping can be expanded to 150 sites, which is maximum capacity for camping at this development area. When visitors fill this campground to capacity there will be a need for limiting the duration of each camper's stay as well as considering construction of new
The existing stables and taxi-bus drivers lounge should be obliterated. The stables should be relocated on the flat across Wadi Musa below the maintenance area. This work should be accomplished when the parking lot is enlarged in the second phase of development. These new facilities should include stables for fifty horses and horsemen's toilets and shelter. This complex should provide minimum facilities with electricity, water, and sewage.

**Utilities**

**Water: Sources And Existing System**

The only sources of water within the proposed boundary in the vicinity of the Park Entrance are Ein Ibraikh and Ein Amoun located near the Taiyiba road. This water is being used for irrigation of fields and for domestic purposes by a few nearby inhabitants. The combined flows of these springs at times of minimum flow is about 4.7 cubic meters per day.

The village of Wadi Musa is located below the relatively large spring of Ein Musa and around several smaller springs. The location and discharge of these springs is shown on drawing PET-13. The combined flow of these 30 springs, all outside the proposed park, is about 300 cubic meters per day maximum, 100 m³/day minimum and 160 m³/day mean. This water is used for domestic purposes by the 4000 inhabitants of Wadi Musa and for irrigation. The crops irrigated are grains, fruits, and olives, the three often combined on the small terraced plots of the village.

The municipal water system consists of a concrete enclosure over Ein Musa supplying water by gravity through a two inch galvanized steel pipeline 2.5 km. long to a 50 cubic meter concrete reservoir located at the main road inter-section in the village. Several canals lead from Ein Musa and provisions have been made for the filling of containers at the spring. Smaller springs at various
points in or near the village have facilities for filling containers which the villagers carry to their homes. Water is piped to 32 individual houses and is metered. The connection charge is 7 dinar. Monthly charges for metered connections are 50 fils per cubic meter for the first 10 m$^3$, 80 fils per m$^3$ thereafter. The average daily consumption is 6 cubic meters for all 32 connections or 187 liters per day per house.

The water of Ein Musa contains about 390 parts per million total dissolved solids which indicates an acceptable mineral quality. Other than this, the chemical and bacteriological qualities of the Ein Musa water were not ascertained, but a brief examination of the village system showed the piped water to be reasonably well protected from contamination. The future domestic water needs of the village are estimated as follows:

<table>
<thead>
<tr>
<th></th>
<th>1975</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>4700</td>
<td>7000</td>
</tr>
<tr>
<td>Per capita consumption, liters per day</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>Daily consumption, cubic meters</td>
<td>165</td>
<td>343</td>
</tr>
</tbody>
</table>

It is apparent that if the population of the village increases, or if a majority of the houses are connected to the water system even without an increase in population, there will be a shortage of domestic water before 1975.

A one-inch diameter steel pipeline connected to the village system leads 2200 meters to the present entrance development. Water is stored in a 54 cubic meter concrete reservoir. From this point it is distributed to public toilets, the resthouse, stables and drivers toilets. The system is gravity flow. The static water pressure at the ground floor of the rest house is 1.3 kg/cm$^2$ (20 psi). This portion of the system is owned and operated by the Tourism Authority.

General features of the village system and of the park entrance system are shown on drawing PET-13.
The future water needs of park visitors and administrative operations are estimated as follows: (calculations are based on average daily visits during the peak month of April).

<table>
<thead>
<tr>
<th>Year</th>
<th>Daily Demand</th>
<th>Liters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>Hotel guests @ 120 liters</td>
<td>14,520</td>
</tr>
<tr>
<td>121</td>
<td>Tent campers @ 70 liters</td>
<td>5,670</td>
</tr>
<tr>
<td>81</td>
<td>Trailer &amp; self contained campers @ 100 liters</td>
<td>8,100</td>
</tr>
<tr>
<td>527</td>
<td>Day visitors @ 30 liters</td>
<td>15,810</td>
</tr>
<tr>
<td>86</td>
<td>Permanent residents, staff families @ 200 liters</td>
<td>17,200</td>
</tr>
<tr>
<td></td>
<td>Total 1975 demand</td>
<td>61,300 (61.3m³)</td>
</tr>
<tr>
<td></td>
<td>1975 reservoir capacity needed = 12 days @ 61m³ = 732 m³</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Daily Demand</th>
<th>Liters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>Hotel guests @ 180 liters</td>
<td>40,500</td>
</tr>
<tr>
<td>225</td>
<td>Tent campers @ 100 liters</td>
<td>34,000</td>
</tr>
<tr>
<td>510</td>
<td>Trailer and self-contained units @ 150 liters</td>
<td>76,500</td>
</tr>
<tr>
<td>2040</td>
<td>Day visitors @ 40 liters</td>
<td>81,600</td>
</tr>
<tr>
<td>110</td>
<td>Permanent residents, staff families 300 liters</td>
<td>33,000</td>
</tr>
<tr>
<td></td>
<td>Total 1985 demand</td>
<td>265,600 (265.6 m³)</td>
</tr>
<tr>
<td></td>
<td>1985 reservoir capacity needed = 12 days @ 265.6 m³ = 3187 m³</td>
<td></td>
</tr>
</tbody>
</table>

It appears unlikely that even the 1975 demand could be met by drawing from the village system, let alone the 1985 demand. As a first priority, a new water source must be found if the Park is to be developed and visitation approaches the predictions of this master plan.

It is proposed that a hydro-geologic study be undertaken under the Jordan National Resources Authority to determine the availability of ground-water or of an alternate water source.
Even with the limitation of the Wadi Musa village supply it is proposed to continue to draw from that source to the extent water is available.

To meet the 1975 demand it is proposed that the water system be improved as follows:

Replace 1-inch portions of the present line from the village with 2-inch steel pipe.

Install a water meter on the supply line to provide data for estimating future needs.

Install a hypochlorinator on the supply line. Perhaps this could be a gas chlorinator if chlorine cylinders and trained operators become available.

Construct a new concrete reservoir, sited so as not to be visible, with a capacity of 750 cubic meters at an elevation of 1057 meters so as to provide a static pressure varying from 1.3 k/cm² (20 PSI) to 2.8 k/cm² (43 PSI) at the points of use.

Construct new distribution lines to the places of use making use of existing lines wherever possible.

**Existing Sewerage**

The existing resthouse is served by a sewage disposal system consisting of 4-inch diameter sewers leading to a makeshift septic tank (a rock-cut tomb). Effluent from the "septic tank" is carried by a 4-inch sewer to a concrete box located in the gravel bed of Wadi Musa. The box is intended to act as a dry well discharging the effluent underground. The separate public toilets have a sewer leading to a septic tank with an effluent line connected to the resthouse system. A separate system with a septic tank serves the toilets in the drivers building. The system was constructed by the Tourism Authority in various stages between 1962 and 1967.
The resthouse portion of the system was operating satisfac-
torily during the winter of 1967-1968. The public toilet
system shows signs of inadequate grade of the sewer lines,
there being accumulations of sludge in the manholes. The
rest rooms were locked during most of 1967 and continued to
be locked during the course of the study for this Master Plan
so there was no opportunity to determine if this portion of
the sewage system was working.

It is judged that the present system will be inadequate for
the facilities proposed in this plan and a complete new system
will have to be constructed.

Since some of the campground facilities are to be located
northwest of the dividing ridge above the resthouse, a
separate system will be required for that area. Furthermore,
the proposed staff housing area is at such a distance from
the main development that a second separate disposal system
will be required.

The main development will produce about 60 cubic meters of
sewage per day during the peak season in 1975. It is proposed
that a new septic tank be constructed with a capacity of 60
cubic meters allowing 24 hours retention. An effluent line
will lead across Wadi Musa to an absorption field designed
to dispose of the waste fluid underground.

Separate septic tank and absorption trench systems should be
constructed for the campground and for the staff housing.

The systems are shown on drawing PET-13.

The resthouse is presently served by a power plant owned and
operated by the Tourism Authority. The plant consists of two
diesel-electric sets located in an ancient rock-cut tomb near
the resthouse. Electricity is generated and distributed at
220 volts, 50 cycle, the transmission line being an underground cable. The plant is presently (1968) being operated from about 11 am to 10:30 pm each day.

The village of Wadi Musa has a power plant constructed in 1967, consisting of two 35 KVA, three phase, 230/400 volt 50 cycle diesel-electric sets with control equipment for parallel operation. Power at 400 volts for street lighting and 230 volts for house connection is distributed by this system. The present village load has not been determined but it is expected that the load will soon grow to the capacity of the plant.

Sixty houses (of the 800 in the village) and two mosques were connected to the system in early 1968 and the occupants of an additional 140 houses have asked to be connected. The house connection charge is 7 dinar and the monthly energy charge is 65 fils per KW/Hr for the first 10 KW/Hr, 50 fils per KW/Hr for the next 10, and 25 fils per KW/Hr thereafter.

To provide for electricity at Petra Entrance in 1975 it is proposed that, in cooperation with the Ministry of the Interior for Municipal and Rural Affairs and the Ministry of Public Works, the capacity of the village power plant be enlarged and that the park entrance development be connected to the village system by means of an underground transmission line.

The cave housing the existing plant should be restored and made available for public display. The generating sets should be retained for emergency use but housed in a suitable building.

The resthouse is presently connected with the village of Wadi Musa by a single telephone line. There is an overhead telephone line from the village to Ma'an and thence to other points in Jordan. However, the line was out of service much of the time during the winter of 1967-68 because of storm damage.
LEGEND

EXISTING PROPOSED OBLITERATE

BUILDINGS  
ROADS  
TRAITS (FOOT)  
TRAITS (HORSE)  
WALLS  
WADIS  
BOUNDARY

NOTE:
PHASE I BUS PARKING WILL BE CHANGED TO AUTO PARKING DURING PHASE II.
CAMPGROUND ROADS WILL BE DESIGNATED PHASE I OR II AFTER MORE DETAILED STUDIES HAVE BEEN MADE.

WADI

EXISTING RESERVOIR

PROPOSED RESERVOIR

GUEST ROOMS

FOOT TRAIL FROM PETRA BASIN

HORSE TRAIL TO PETRA BASIN

PETRA NATIONAL PARK

Scale 1:1,500
Operation of the Park and the hotel will require that there be adequate and reliable telephone communication including long distance lines with population centers in Jordan and elsewhere.

**Refuse Disposal**

At present there is no systematic collection and disposal of garbage and other solid wastes at the resthouse. Trash at times has been dumped in several of the tombs in the vicinity and cans and broken glass are strewn on the rock slopes near the resthouse.

It is proposed that a sanitary landfill be established at a nearby site outside the Park and that a program of regular collection and disposal be started.

Tombs now containing trash should be cleaned out and made available for display to visitors.

Tombs and other structures have suffered the ignominious fate of garbage pits. A sanitary landfill will solve this problem.
The Petra Basin development area located in Wadi Musa beyond the Roman street is the only proposed visitor use facility inside Petra. Here would be located a secondary visitor information station, public toilets, lunch service and eating terraces, a Ranger station and ancillary storage and equipment rooms. The total cost of this development is estimated at JD 110,000 including contingencies, supervision etc. (See Appendix L).

The site selected is physically and visually removed from remnants of the Roman period and the panorama of tomb facades and caves of the Petra Basin. This site near the hub of interpretive trail heads and termini will be the focal point of intense day-use, particularly during the lunch hours.

The day-use site is in a magnificent canyon dominated by the massive heights of Al Habis, Umm Al Biyarra, and Al Siyagh honey-combed with nondescript cave openings so typical of the Petra landscape. Scale and form are so immense, color and light so bold that the development facilities must be designed to provide the visitor with a human frame of reference for vertical and horizontal scale as well as shade and shelter from the intensities of light, heat, and wind.

This site is located on the alluvial bench in Wadi Musa below the confluence of wadis Al Deir and Turkamaniya and the sandstone benches beyond. The design of public use facilities here must recognize the possibility of infrequent high water and the need to minimize the intrusion of this development on the historic setting.

The narrow limited size of the site dictates a linear character of structures connected by terraces and wide foot paths.
Site Development

The development of the site is dictated by two visitor needs: information and accommodations; toilets and food. Free circulation is planned with a logical flow sequence controlled by the location of the various buildings. The Ranger station will incorporate space for visitor information, first-aid, staff toilets, lockers, and a bunk room. The public toilets should be designed to accommodate the anticipated operating use of this area by more than 300 people an hour. Pre-packaged food should be dispensed from a self-service counter with a back bar for preparation of hot beverages. Shelters from sun, rain, and wind should be provided on the lunch terraces. Storage and equipment rooms should be provided within this complex to meet the needs of the operation.
Utilities

Water Sources

And

Existing System

Water sources are limited in the Petra Basin area. The Nabataean and Roman inhabitants brought water from springs in the vicinity of the present village of Wadi Musa supplemented by collection and storage of rain water. There also may have been works to divert, settle, and store the occasional flow of the wadis.

There is one small spring in the basin located 300 meters north of Qasr El Bint and surface flow appears in Wadi Musa about 700 meters below Qasr El Bint. The present Bedouin inhabitants make use of these sources, and the Wadi Musa source is diverted to irrigate crops on small plots in the lower Siq. The Jordan Natural Resources Authority has installed many stream gauging stations in Petra. The location of one of these stations is on Wadi Musa in the Siq below the Basin. The site and flow data of this station is shown on drawing PET-14.

Nazzal's Camp is supplied with water from a well, owned and operated by the Government, located at the edge of the channel of Wadi Musa at the point shown on drawing PET-14.

The well is equipped with a pump delivering water through a 1-inch pipe exposed on the face of the cliff piped to four galvanized steel tanks located in a cave on the cliff face above the well. Water is delivered by pipeline to Nazzal's Camp. The water is not treated. Its chemical and bacteriological qualities are not known to the study team.

Future Demand

And

Proposed System

The water needs of the facilities proposed for Petra Basin based on the criteria shown on page 50 are estimated to be as follows:
### 1975

<table>
<thead>
<tr>
<th>Visitors per day (average during peak month)</th>
<th>730 persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily use per visitor</td>
<td>10 liters</td>
</tr>
<tr>
<td>Water demand</td>
<td>7 m³ per day</td>
</tr>
</tbody>
</table>

### 1985

<table>
<thead>
<tr>
<th>Visitors per day (average during peak month)</th>
<th>3100 persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily use per visitor</td>
<td>15 liters</td>
</tr>
<tr>
<td>Water demand</td>
<td>46 m³ per day</td>
</tr>
</tbody>
</table>

It is expected that the existing well will supply the demand of 1975 but that a new source will have to be developed before 1985.

It is proposed that the existing water system be improved with the following features:

- The well enclosure should be reconstructed to fit the development plan.
- A new pump should be installed.
- A new concealed pipeline should be constructed from the pump to the reservoir.
- A hypochlorinator should be installed on the line between the pump and the reservoir.
- Storage tanks with capacity expanded to 84 cubic meters should be moved to a site not intruding on antiquities and at an elevation of about 30 meters above the development site so as to provide a static pressure of 3 kilograms per square centimeter (45 psi) at the place of use.

**Sewerage**

At present sewage from Nazzal's Camp is discharged into four cesspools.

Sewage from the toilets rest rooms and other buildings would be disposed of in a septic tank located approximately 30 meters downstream from the well. Effluent would be carried approximate
50 meters farther downstream where it will be disposed of underground by an absorption trench.

**Electric Power**

The existing facilities in Petra Basin are supplied with electricity by an electric generator located in a cave near Nazzal's Camp. The system is owned and operated by the Camp's owner.

The day-use development proposed by this Master Plan requires electric power. It is expected that the power demand of 1975 can be met by a plant with two 5kw diesel-electric sets. It is proposed that 50 cycle single phase current be generated and distributed at 220 volts.

**Communications**

The existing Nazzal's camp in Petra Basin is served by a two-wire telephone line connected with the village of Wadi Musa via the Siq.

A post office is located in one of the ancient caves in the cliff west of Qasr El Bint.

The overhead telephone line is not compatible with the region of ancient rock carved monuments and scenic splendor. It is proposed that the overhead line be removed. The post office should be closed and the site restored when the Bedouin have been settled elsewhere.

Management of the Park and safety of the visitor require that there be some method of rapid communication between Park Headquarters and the point of visitor concentration in Petra Basin. It is proposed that this be by means of a private branch exchange with an underground telephone cable between headquarters and Petra Basin.
At present garbage and other solid wastes from Nazzal's Camp are dumped on the hillside behind and in a cave within Petra Basin. It is proposed in the future that refuse from the day-use area be collected and hauled out of the basin for disposal in a sanitary landfill near the Park entrance.
Secondary development areas as proposed in this Master Plan are planned to be part of the phase two development schedule. No part of this proposal should be started until the recommendations for phase one development are substantially completed.

It is anticipated that secondary entrance facilities with park contact - information centers, minimal staff facilities, and limited overnight and food accommodations may be warranted in Seil Wadi Musa and Beida. The feasibility of developing these areas will become apparent following the completion of the Aqaba-Safi road and the Kings Highway when there may be pressure for more direct road access to the park from these new routes. The scheduling of development as outlined in this Master Plan should be rigidly adhered to. No approach roads for use of the general public should be constructed to the outlying parts of the park until the need for these developments has been carefully evaluated.

As new archeological sites are discovered and the flora and fauna of the area become re-established there may be interest in additional loop trails to the remote points in the park. Along these trails there could be primitive camps at existing water points to provide for lunch and overnight stops. The major use of these loop trails and camps would be by guided parties.

Park Administration

At present the management of Petra as an antiquity site falls between two arms of the Ministry of Tourism and Antiquities. The Department of Antiquities has overall land management responsibility for the site and the Parks Division of the Tourism Authority has responsibility for the development and operation of Petra's limited visitor amenities. In a broad sense, the Parks Division, through its operation of specific tourist facilities and services, functions as a permittee to the Department of Antiquities.
Role Of Parks Division

Once national park status has been given to this area there will be need within the Ministry to realign Antiquities-Parks responsibilities which will recognize and support the justifiably dominant role to be taken by the Parks Division in the future administration of this area. Moreover, such realignment of G.O.J. public administration should give the National Parks Division primary responsibility for all future planning, implementation, and control of Petra as a land management entity. It is anticipated that legislation now in preparation will clarify and strengthen the responsibilities of the departments involved.

The continuing important role of the Department of Antiquities should be to furnish scientific support to the Parks Division in the fields of research, and consolidation.

Role Of Antiquities Department

To insure protection of Petra's archeological and historical values all future construction and other land-disturbing activities should be implemented only in accordance with the Petra Master Plan and with the mutual concurrence of the heads of both the Parks Division of the Tourism Authority and the Department of Antiquities.

Park Staff

The designation of Petra as a National Park will present an opportunity to create Jordan's first national park staff. Properly organized, this staff can serve as a model for other national parks within the Kingdom.

As a training area, it can also serve as a park personnel recruitment reservoir for future national parks.
Staff Organization

Superintendent
As field representative of the Director of the National Parks Division of the Jordan Tourism Authority, the superintendent would be the chief administrative official of the Park. He would provide interpretation of policy and general direction and guidance on all activities concerned with the management of the Park and service to its visitors. As head of the Park, he would program park activities and be responsible for the Park's public relations by cooperating and actively participating with national organizations, both public and private, sharing common or related interests in conservation, the promotion of tourism, and recreation.

Administrative Officer
This employee would be responsible for all administrative services and would supervise and direct the activities of park personnel concerned with fiscal accounting, procurement and property, personnel, records management, and administrative reports.

Chief Of Visitor Services
Supervision, direction, and training of the uniformed Park Ranger force would be the primary responsibility of this employee who would function as the Chief Ranger. Programs relating to visitor information, interpretation, protection of park resources and the protection of park visitors would be the broad areas of his responsibility.

Specific activities of his staff should include:

Protection Of Park Property
Continued routine and random surveillance of all park property to deter vandalism, domestic livestock grazing, loss of antiquities through illicit digging, and shooting and trapping of park wildlife.
Law Enforcement

Enforcement of park regulations. These regulations should be brought to the attention of visitors through information and interpretive media. Should there be need for additional law enforcement personnel, assistance will be requested from the Wadi Musa Police Post.

Fire Protection

All permanent structures should be built, in so far as possible, with fire resisting materials. Buildings and ranger vehicles should be equipped with fire extinguishers. Routine inspections should be made pointed at the identification of fire hazards.

Search And Rescue

Aided by mobile, narrow band, two way radios, search and rescue would be a responsibility of the ranger force who will be taught, in the course of their training, rescue techniques.

First Aid

Training of rangers in first aid should be mandatory in order to provide assistance to visitors and employees who suffer physical injury. An electric cart, fitted with a litter, would be maintained on a standby basis to move the badly injured over horse trails to park headquarters for subsequent movement to an appropriate hospital.

Chief Of Maintenance

This employee, qualified in a broad field of construction activities, would have supervisory responsibility for the maintenance and repair of all modern structures and utilities within the park. These responsibilities should be separated into the following major activities, each headed by foremen:

Roads, Trails, Parking Areas, And Grounds

Maintenance activities would be concerned with preventive and corrective measures necessary to keep roads, trails, parking areas, and grounds in safe, clean, and as-built
condition taking into consideration normal wear and age. Maintenance and repair work requiring heavy or specialized equipment should be performed under a standing agreement between the Ministry of Tourism and Antiquities and the Ministry of Public Works. The collection of litter in areas and along trails of high visitor concentration would be carried on as a day-to-day maintenance operation. Through interpretive media, visitors would be encouraged to use litter and garbage receptacles. The collection of roadside litter would also be done on a routine basis.

Buildings And Utilities

As with road, trail and grounds maintenance, rigid standards designed to assure a high degree of upkeep and cleanliness of buildings and other public use facilities should never be relaxed. Over the world these factors contribute heavily to the impressions people keep of their travels. Activities concerned with keeping buildings, fixed mechanical equipment, and utilities in efficient, clean, and safe operating condition should be done on a routine basis. Repair and preventative maintenance of concession leased buildings and facilities should be done under agreement by park maintenance personnel on a reimbursable time and materials basis.

Signs And Markers

A comprehensive informational and interpretive sign and wayside exhibit program, designed and controlled by the Visitor Services Division to assist the visitor in the use and understanding of the park, should be maintained by the buildings and utilities personnel.
Staff Organization

SUPERINTENDENT

- Supervisor of Visitor Service
- Administrative Officer
- Supervisor of Maintenance

Protection and Interpretation
Clerical; Property Management, Personnel, Fiscal & Accounting
Roads, Trails, Grounds, Buildings and Utilities

See Appendix M for Staffing detail and cost estimate.
## MANAGEMENT SCHEDULE

### PARK, GENERAL

**Protection of Historical and Archeological features**

1. Identification and Assessment  
2. Consolidation  
3. Elimination of Adverse uses  
   a. Removal of intrusive features from historical structures*  
   b. Removal of recent buildings from historical sites (Basin)*  
   c. Removal of Telephone line from Siq and Petra Basin  

### Watershed Protection

1. Construction of check dams and hillside terraces  
2. Re-establishment of trees and shrubs.

### Land Acquisition

**Bedouin Resettlement***

### Boundary Identification

**Trail signs and Interpretive Markers**

**Foot Trails:**

1. Visitor Center to Siq Entrance  
2. Siq Entrance to Visitor Center  
3. Siq Trail to Highplace stairs  
4. High place stairs to Roman Street  
5. Qasr El Bint - Wadi trail to visitor contact and day use area.  
6. Qasr El Bint to Wadi Sabra trail head  
7. Qasr El Bint to Roman Soldier tomb  
8. Roman Soldier tomb to Highplace  
9. Qasr El Bint to El Deir trail head  
10. El Deir trail

---

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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</tbody>
</table>

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* Indicates priority or focus.
11. El Deir to Siq Barid and Baida trail junction

12. Theatre - Wadi Mataha - Sidd al Ma'ajiin - Visitor Center trail
   a. Theatre to Florentinus tomb
   b. Florentinus tomb to Crusader Castle trail junction
   c. Crusader Castle junction to visitor center.

13. Spur to Roman Reservoir

14. Theatre to Highplace

15. Umm El Biyara Spur

16. Snake Monument Spur

**Horse Trails**

1. Visitor Center to Siq Entrance
2. Siq Trail to Highplace stairs
3. Highplace stairs to Nymphaeum
4. Nymphaeum to Petra Basin trail head
5. Petra Basin trail head - Wadi Araba trail.
7. Jebel Haroun Spur
8. Petra Basin trail head - Baida (via Wadi) el Nu'eisra & esh Shariqiya
9. Petra Basin trail head, via Turkamaniya tomb to Visitor Center via Baida trail.
10. Wadi Sabra - Siq entrance
11. Visitor Center - Baida trail

**ENTRANCE DEVELOPMENT**

**Buildings:**

Hotel alterations & additions
Visitor Center and Administrative Offices
Employees Housing
<table>
<thead>
<tr>
<th>Warehouse and Maintenance Shops</th>
<th>Toilet Buildings (campground)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Utilities:</strong></td>
<td></td>
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<tr>
<td>Water system reconstruction</td>
<td></td>
</tr>
<tr>
<td>Electrical system</td>
<td></td>
</tr>
<tr>
<td>Sewage system</td>
<td></td>
</tr>
<tr>
<td>Telephone system</td>
<td></td>
</tr>
<tr>
<td>Radio system (two-way)</td>
<td></td>
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<tr>
<td><strong>Roads and Trails</strong></td>
<td></td>
</tr>
<tr>
<td>Entrance Road-Parking Terrace Redevelopment</td>
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</tr>
<tr>
<td>Campground Roads</td>
<td></td>
</tr>
<tr>
<td>Staff housing service road</td>
<td></td>
</tr>
<tr>
<td>Visitor Center - Staff housing trail</td>
<td></td>
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<tr>
<td>Visitor Center to Campground trail</td>
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</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
<td></td>
</tr>
<tr>
<td>Campground Development</td>
<td></td>
</tr>
<tr>
<td>Lunch Terrace Development</td>
<td></td>
</tr>
</tbody>
</table>

### Basin Development

### Buildings:

- Visitor contact station
- Refreshment bar

### Utilities:

- Water system redevelopment
- Electrical system
- Sewage system

### Miscellaneous

- Lunch Terrace Development
- Planting
### Staffing *

<table>
<thead>
<tr>
<th>Position</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
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</thead>
<tbody>
<tr>
<td>Superintendent</td>
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<tr>
<td>Administrative Officer</td>
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</tr>
<tr>
<td>Personnel Clerk</td>
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<tr>
<td>Property Clerk</td>
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<tr>
<td>Fiscal Accounting Clerk</td>
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<tr>
<td>Supervisor of Visitor Services</td>
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<tr>
<td>Supervisor of Maintenance</td>
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<tr>
<td>Storekeeper</td>
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</tbody>
</table>

### Cost Estimates and Yearly Expenditures

In thousands, JD, 1968 price indices

<table>
<thead>
<tr>
<th>Category</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
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<tbody>
<tr>
<td>Land Acquisition &amp; Boundary Identification</td>
<td>44</td>
<td>85</td>
<td></td>
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<tr>
<td>Identification &amp; Protection of the Archeological Resource now exposed</td>
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<td>45</td>
<td>60</td>
<td>50</td>
<td>30</td>
<td>30</td>
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<tr>
<td>Capital Costs &amp; Watershed Protection</td>
<td>235</td>
<td>260</td>
<td>174</td>
<td>118</td>
<td>111</td>
<td>85</td>
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</table>

* items not included in cost estimates.
VISITOR PROJECTIONS AND ECONOMIC IMPLICATIONS
Visitor Projections

Any projections of the number of future visitors to Petra which are made at this time are, at best, tenuous. This is attributable to two major factors: (1) the uncertain political situation and (2) the inadequate statistics which are available. With regard to the second point, virtually no records were kept prior to 1964 on visitors to individual sites in Jordan. In addition, the statistics since 1964 do not break down the visitors into categories such as peak-hour, peak-day, group arrivals, average length of stay, nationality etc.

The available statistics show that April is the peak month of visitation with August as the second busiest month. This corresponds to the Easter and European holiday seasons. The next busiest months, March, May and September, all have visitor counts of approximately the same magnitude. As shown in Figure 2B, over 31,000 tourists visited Petra in 1966 and the average of the years 1964-66 was over 25,700.

Because of the problems associated with the lack of either detailed or historical statistics, the best method of developing projections seemed to be to make some correlations with the most recent projections of tourist arrivals. In this case, projections made by the Battelle Memorial Institute under AID sponsorship on airport development and the Annual Reports of the Ministry of Tourism and Antiquities have been used. It should be pointed out that both sources do not consider Jordanian nationals as tourists. It is anticipated that a substantial number of visitors at Petra will be Jordanians so the projections ultimately developed are, if anything, on the conservative side. For example, statistics for the years 1964-66 show that about 15% of all visitors to Petra during those years were Jordanians. This could easily be 20-25% of the total following the establishment of a national park.

Using the Ministry statistics for 1964-66, it was found that slightly more than 5% of all tourists visiting Jordan went to Petra (see Figure 1B). The same 5% figure was applied to Battelle's medium projections for the years 1970 through 1985.
(see Figure IA) in order to estimate visitors at Petra. As shown in Figure, IB, average annual visits to Petra could reach 610,000 by 1985.

It should be pointed out that the Battelle projections were made prior to the June war when Jordan had the benefit of Jerusalem as a touristic attraction. Therefore, one is tempted to immediately conclude that the projections developed by correlation with the Battelle study must be overestimated. Several factors mitigate against such a conclusion. First of all, as mentioned above, the Battelle figures exclude Jordanian nationals and therefore could reasonably be increased by 15-25%. Secondly, several possible future developments will undoubtedly increase Petra's percentage of the total visitors to the country, which conservatively has been kept at 5% throughout the study period. They are: (1) the development of Aqaba as an internationally known resort, (2) the possible development of a ferry service between Aqaba and Suez, (3) the active promotion of Petra as an overnight stop as part of a package tour and (4) the existence of better facilities which by themselves induce more visitors to the Park.

The latter point is almost a truism whenever good facilities are constructed and properly maintained. An example is construction of the access road into Petra which undoubtedly has a profound influence upon the decisions made by individual tourists to visit Petra. By the same token, the existence of the facilities proposed in this plan will have a similar effect upon future tourists by either encouraging them to visit Petra, remain there longer or even stay overnight.

In attempting to develop visitor projections, the importance of political stability cannot be overestimated. In the absence of any sort of political settlement, the estimates are probably high. If a political settlement is reached which results in a return to conditions roughly similar to those existing at the time of the Battelle study (return of the West Bank and Arab Jerusalem but only one way crossing of borders), the projections are probably low. If, on the other hand, a settlement is reached which would also allow unrestricted crossings, the
The economic implications of the points mentioned above are far-reaching for Jordan. While recognizing that the future of tourism in Jordan is linked to a great measure to the political stability of the area, certain facts become apparent when investment in tourism is considered. For example, one could take the total investment made in tourism by the GOJ from its own budget as well as foreign donor sources since 1958 (estimated at $5.5 million), add to it estimated private investment in tourism over the same 10 year period (estimated at approximately $20 - 25 million) and compare that total with the revenue realized in 1966 alone of over $33 million. The economic importance of tourism is also shown in the large number of people employed in related industries prior to the hostilities.

Tourism in Jordan made impressive gains prior to last June and was virtually Jordan's "leading sector". This is emphasized by the fact that during the first half of 1967, it replaced remittances as the country's leading foreign exchange earner. The importance of tourism is shown by the following statistics:

<table>
<thead>
<tr>
<th>Tourist Arrivals</th>
<th>% Increase over Previous Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962</td>
<td>210,000</td>
</tr>
<tr>
<td>1963</td>
<td>320,000</td>
</tr>
<tr>
<td>1964</td>
<td>390,000</td>
</tr>
<tr>
<td>1965</td>
<td>500,000</td>
</tr>
<tr>
<td>1966</td>
<td>617,000</td>
</tr>
<tr>
<td>1967</td>
<td>253,800 (up to the end of April)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Tourism Income in Dollars</th>
<th>% Increase over Previous Year</th>
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</thead>
<tbody>
<tr>
<td>1962</td>
<td>14,140,000</td>
</tr>
<tr>
<td>1963</td>
<td>19,750,000</td>
</tr>
<tr>
<td>1964</td>
<td>22,500,000</td>
</tr>
<tr>
<td>1965</td>
<td>26,800,000</td>
</tr>
<tr>
<td>1966</td>
<td>33,800,000</td>
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<tr>
<td>1967</td>
<td>Not Available</td>
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</table>
Employment in Tourism Related Ind. % Increased over Previous Year

<table>
<thead>
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<th>Year</th>
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<th>Increase</th>
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<td>1963</td>
<td>3,800</td>
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<tr>
<td>1964</td>
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<td>18.5</td>
</tr>
<tr>
<td>1967</td>
<td>7,500</td>
<td>66</td>
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</table>

It is difficult to make a detailed economic analysis of the specific investments proposed herein. The most valid approach is to make a sensitivity analysis. The sensitivity analysis is a means of estimating in approximate terms the various factors which come to play in an economic evaluation. If by making a sensitivity analysis, it can be shown that the returns required to make the project economic are clearly within the realm of future possibility, there is no need to undertake a detailed and exact economic evaluation.

The question then is whether or not the total estimated expenditures of JD 976,200 proposed can be expected to be recovered in benefits to the economy over a reasonable period of time.

Figure 4A has projected the costs and benefits over a 6 year period only. The future benefits and costs have been expressed in terms of their present values by having been discounted at 15%. The figure 15% has been arbitrarily selected as the opportunity cost of capital, which is the annual return investors in Jordan would expect to receive from alternative investments. The calculations show that if the benefits derived at Petra are of the magnitude of $8.75 (JD. 3.125) per tourist visit all of the costs will be recovered within six years, an extremely short pay-back period. Clearly, this is within reason and the realm of future possibility especially since the total cost of the proposed watershed development has been included and no attempt has been made to estimate additional benefits derived from this development. In addition, the analysis does not take into account the multiplier effect which means that each dollar spent in the economy generates a certain number of additional expenditures. Addition of these factors would, of course, make the proposal more attractive. Therefore, the proposals contained in the report are considered to be economically desirable.
<table>
<thead>
<tr>
<th>Year</th>
<th>Capital Costs and Watershed Protection</th>
<th>Land Acquisition Identification of Ruins</th>
<th>Identification &amp; Protection of Ruins</th>
<th>Operation and Maintenance</th>
<th>Present Worth Total @ 15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>658</td>
<td>123</td>
<td>84</td>
<td>-</td>
<td>865</td>
</tr>
<tr>
<td>1</td>
<td>686</td>
<td>238</td>
<td>126</td>
<td>-</td>
<td>1050</td>
</tr>
<tr>
<td>2</td>
<td>487</td>
<td>-</td>
<td>168</td>
<td>42</td>
<td>697</td>
</tr>
<tr>
<td>3</td>
<td>230</td>
<td>-</td>
<td>140</td>
<td>42</td>
<td>412</td>
</tr>
<tr>
<td>4</td>
<td>311</td>
<td>-</td>
<td>84</td>
<td>42</td>
<td>437</td>
</tr>
<tr>
<td>5</td>
<td>238</td>
<td>-</td>
<td>84</td>
<td>42</td>
<td>364</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>42</td>
<td>18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Tourists x $5.00</th>
<th>Present Worth @ 15%</th>
<th>Number of Tourists x $10.00</th>
<th>Present Worth @ 15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>64,000</td>
<td>320.0</td>
<td>64,000</td>
<td>640.0</td>
</tr>
<tr>
<td>1</td>
<td>74,200</td>
<td>371.1</td>
<td>74,200</td>
<td>742.2</td>
</tr>
<tr>
<td>2</td>
<td>86,100</td>
<td>430.5</td>
<td>86,100</td>
<td>861.0</td>
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<tr>
<td>3</td>
<td>99,900</td>
<td>500.0</td>
<td>99,900</td>
<td>999.0</td>
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<tr>
<td>4</td>
<td>115,000</td>
<td>575.0</td>
<td>115,000</td>
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<td>5</td>
<td>145,000</td>
<td>725.0</td>
<td>145,000</td>
<td>1450.0</td>
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1,724.7  
3,453.0

$3,025 = \text{approximately } 75\% \text{ of the difference between } $1,724.7 \text{ & } $3,453.0 
175\% \text{ of } $5.00 = $8.75 \text{ which is approximate "break-even" expenditure required.}
ANNUAL VISITS

<table>
<thead>
<tr>
<th>YEAR</th>
<th>VISITS TO JORDAN</th>
<th>VISITS TO PETRA</th>
<th>PERCENT OF TOTAL</th>
<th>ANNUAL PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>397,343</td>
<td>10,713</td>
<td>4.65</td>
<td>20</td>
</tr>
<tr>
<td>1966</td>
<td>501,346</td>
<td>26,805</td>
<td>5.34</td>
<td>40</td>
</tr>
<tr>
<td>1967</td>
<td>616,875</td>
<td>31,843</td>
<td>6.16</td>
<td>19</td>
</tr>
<tr>
<td>AVE 64-66</td>
<td>501,835</td>
<td>26,787</td>
<td>5.11</td>
<td>27</td>
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FIGURE IA

FIGURE IB
MONTHLY VISITS

FIGURE 2A

TABULATION OF MONTHLY VISITS

<table>
<thead>
<tr>
<th>MONTH</th>
<th>ACTUAL MONTHLY VISITS</th>
<th>PROJECTION, VISITORS PER MONTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAN</td>
<td>879</td>
<td>3.0</td>
</tr>
<tr>
<td>FEB</td>
<td>984</td>
<td>3.8</td>
</tr>
<tr>
<td>MAR</td>
<td>2577</td>
<td>10.6</td>
</tr>
<tr>
<td>APR</td>
<td>4469</td>
<td>16.8</td>
</tr>
<tr>
<td>MAY</td>
<td>2833</td>
<td>10.4</td>
</tr>
<tr>
<td>JUN</td>
<td>1544</td>
<td>5.8</td>
</tr>
<tr>
<td>JUL</td>
<td>1891</td>
<td>7.3</td>
</tr>
<tr>
<td>AUG</td>
<td>2866</td>
<td>11.1</td>
</tr>
<tr>
<td>SEP</td>
<td>2419</td>
<td>9.3</td>
</tr>
<tr>
<td>OCT</td>
<td>2490</td>
<td>9.8</td>
</tr>
<tr>
<td>NOV</td>
<td>1664</td>
<td>6.7</td>
</tr>
<tr>
<td>DEC</td>
<td>1382</td>
<td>5.4</td>
</tr>
<tr>
<td>YEAR</td>
<td>25787</td>
<td>1.00</td>
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</table>

FIGURE 2B
### DAILY VISITS—PROJECTIONS

<table>
<thead>
<tr>
<th>YEAR</th>
<th>AVERAGE DAILY PEAK MONTH OF APRIL</th>
<th>PEAK DAY 200 PERCENT OF APRIL AVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966 ACTUAL</td>
<td>210</td>
<td>420</td>
</tr>
<tr>
<td>1970</td>
<td>360</td>
<td>720</td>
</tr>
<tr>
<td>1975</td>
<td>610</td>
<td>1620</td>
</tr>
<tr>
<td>1980</td>
<td>1680</td>
<td>3370</td>
</tr>
<tr>
<td>1985</td>
<td>3400</td>
<td>6800</td>
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</table>

**Figure 3A**

#### DESIGN LOADS

---

### TABULATION OF PREDICTED DAILY VISITS BY TYPE OF ACCOMODATION

<table>
<thead>
<tr>
<th>ACCOMODATION</th>
<th>AVERAGE DAILY VISITS PEAK MONTH OF APRIL EQUIVALENT TO 20TH HIGHEST DAY OF THE YEAR (PERCENT OF TOTAL DAILY VISITS IN PARENTHESES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOTEL GUESTS</td>
<td>54(15)</td>
</tr>
<tr>
<td>TENT CAMPERS</td>
<td>18(5)</td>
</tr>
<tr>
<td>CAMPERS WITH TRAILERS OR OTHER SELF CONTAINED UNITS</td>
<td>18(5)</td>
</tr>
<tr>
<td>DAY VISITORS ENTRANCE AREA</td>
<td>252(65)</td>
</tr>
<tr>
<td>TOTAL DAILY VISITS</td>
<td>360</td>
</tr>
<tr>
<td>DAY VISITORS TO PETRA BASIN</td>
<td>320(90)</td>
</tr>
<tr>
<td>PERMANENT RESIDENTS STAFF FAMILIES</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 3B**
PUBLIC RELATIONS

An effective and dynamic national parks program will require the full understanding and backing of the people of Jordan and their government. To best obtain this support, it is recommended that a Kingdom-wide public relations campaign be initiated by the Ministry of Culture and Information directed at the promotion of National Parks - What are they? What can they do for Jordan and her people? Why are they important? Because of the long-range social and economic implications of the development of a National Park System, there should be heavy emphasis placed at all levels on a school-oriented program.

Jordan's ongoing international tourist promotion program should take full advantage of the added quality both real and implied which will be given to Petra with national park status.
GLOSSARY

Audio-visual: Using electronic devices, a presentation in sound or pictures, or both. Examples: A tape-recorded message, a motion picture.

Campground: An area with an organized plan; having defined roads, parking spaces, places to camp, sanitary facilities & water supply.

Campground loop road: A road through a campground that returns to meet its own starting point.

Campsite: A clearly marked area of ground within a campground for use of an individual person, a family, or a group of persons.

Concessioner: The individual or group that holds a contract to operate within a park facilities and services needed by park visitors. Examples: Rental of horses; providing accommodations, food service, sale of souvenirs, etc.

Contact station: Any designated place where Park employees meet the visitor to provide informational and interpretive services.

Day-use: Visitor activity in a park that does not involve staying overnight.

Development areas: A place in a park where facilities for visitor use or park use are concentrated.

Diorama: An interpretive exhibit consisting of modeled figures usually in miniature in a three dimensional setting which merges into a carved painted background.
Hypochlorinator: A mechanical device to inject liquid chlorine into a water line.

Information: General factual, directional, and regulatory information not primarily directed toward interpretation.

Interpretation: An activity which presents the inspirational, educational, and recreational values of a park in such ways that visitors may obtain understanding, appreciation, and enjoyment from a park visit. It does not mean translation from one language to another.

Interpretive shelters: A type of structure used at an outside exhibit for the protection of the visitor or the exhibit from the weather and which marks a location for interpretation.

Kiosk: A small booth or building.

Lunch area: An area provided with tables at a place convenient for visitors to stop for lunch.

Microclimate: Climatic conditions in a relatively small area that are markedly different from those of the surrounding area; due mainly to drastic differences in exposure and temperatures as between the two areas.

Overlook: A place provided with parking or standing space and other facilities as needed for the use of visitors in viewing a scenic feature.

Park headquarters: The location of the main administrative facilities of the park.

Peak day: A term used to describe the 24-hour day in which the greatest number of visitors arrive at a park.
Peak hour: A term used to describe the hour during the day in which the greatest number of visitors arrive at a park.

Peak month: A term used to describe the month in which the greatest number of visitors arrive at a park.

Plant community: All of the plants characteristically associated together in a particular kind of an environment.

Salvage Excavation: Excavation of an archaeological site in accordance with accepted standards of research before the construction of roads, buildings, or other kinds of construction that would destroy or disturb archaeological remains.

Sanitary landfill: A method of disposal of garbage and other solid refuse. In a sanitary landfill operation, the refuse is spread, compacted, and then covered with a layer of earth.

Seasonal quarters: A place to live for employees who work only part of the year in a park.

Self-guided trail: A trail system, or part of a trail system, that has devices (such as guide booklets, signs, exhibits) which, without the services of a guide present to the visitor a significant story of the area through which the trail passes.

Snack bar: A small shop that serves a limited variety of foods to the public.

Stabilization A method of disposal of liquid organic wastes ponds (sewage): (raw or settled sewage) by containing the sewage in a small, shallow, artificial lake. The process depends mainly on sunlight and the presence of micro-organisms (algae) to convert organic wastes to stable, inoffensive residue. Other names used are: Sewage, Lagoon, Oxidation, Pond.
Visitation: A term used to express the volume of park visits or public use of parks.

Visitor center: A facility consisting of a building or a combination of buildings which serves as the main information, orientation, reception, visitor service, and interpretive center for visitors to a park.

Visitor use, public use, park use: The presence and activities of visitors within a park.

Toilet, burn-out: A W.C. that disposes of wastes by burning at high temperatures inside of the toilet unit.

Toilet, chemical: A W.C. that holds wastes in a tank of chemicals. The tank must be emptied periodically and new chemicals added.

Toilet, pullman: W.C. that uses small amounts of water.

Trailer spur: A paved space for parking a trailer off a loop road.

Trail head: The beginning of a trail.
Appendix A  Points of Interest to and from Petra

Jordan is a vast outdoor museum of archeological and historical sites. Inaccessability, lack of excavation, or present day towns built upon the ruins of the previous ancient towns limit the number of sites that tourists will visit on a trip to Petra via the Kings' Highway. A visitor might want to stop at one or more of the following places:

b. Dhiba, location of the finding of the Moabite Stone (8th Century B.C.)
c. Karak, Crusader castle of 12th Century A.D. with later Arab period use.
d. Mauta, site of the first battle fought between the Arabs and the Byzantines in 632 A.D.
e. Mazar, mosque that is the burial place of two martyrs of the Battle of Mauta.
f. Dhat Has, one of the largest Nabataean sites in Jordan.
g. Khirbet et Tannur, Nabataean temple of Atargatis and Hadad.
h. Shoubak, crusader castle of Mons Realis, later an Arab castle of Chaldaean Shoubak.

A tourist taking the Desert Highway will find few sites along the way. Qatrana Station and Qal'at Hasa have pilgrim forts.

Most of the sites along both highways while interesting are not interpreted which is a discouraging fact to visitors and simply serves to hurry them on their way to their destination at Petra.

Visitors staying overnight at Petra can continue southward along the Desert Highway to Wadi Rum (spectacular scenery) or to Aqaba (port city and resort area)
Appendix B  Regional Climatic Conditions

Weather records available for Ma'an and Aqaba are charted below and give indication of the range, variation, and extremes of climate in the park and its vicinity. There are several stream-flow guaging stations located in Petra. These stations, now under the control of the Natural Resources Authority, were installed at various times by foreign experts for different water studies. There is no consistent data from these stations because the recording units have not been kept in continuous operation. There are rain gauges at the Petra school and Wadi Musa school; data, however, from these stations have not been available for use in this plan.

<table>
<thead>
<tr>
<th>Climate</th>
<th>Location</th>
<th>Temperature</th>
<th>Rain (mm)</th>
<th>Humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Maximum</td>
<td>Mean</td>
</tr>
<tr>
<td>WINTER</td>
<td>Aqaba</td>
<td>23.2</td>
<td>10.5</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>(Dec. Feb.) MA'an</td>
<td>19.0</td>
<td>3.1</td>
<td>6.3</td>
</tr>
<tr>
<td>SPRING</td>
<td>Aqaba</td>
<td>31.4</td>
<td>16.7</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>(Mar. May) MA'an</td>
<td>24.3</td>
<td>9.3</td>
<td>2.5</td>
</tr>
<tr>
<td>SUMMER</td>
<td>Aqaba</td>
<td>40.0</td>
<td>24.8</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>(June Aug.) MA'an</td>
<td>34.3</td>
<td>17.0</td>
<td>0.0</td>
</tr>
<tr>
<td>FALL</td>
<td>Aqaba</td>
<td>46.9</td>
<td>19.5</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>(Sept. Nov.) MA'an</td>
<td>27.5</td>
<td>11.3</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Appendix C  Flora of Petra

The following list of plants has been gleaned from Post's *Flora of Syria, Palestine, and Sinai*. The list is not meant to be a complete catalog of the flora of Petra, but it may be useful as a basis for a future catalog to be prepared after a botanical survey has been made and a park herbarium is established.

<table>
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<tr>
<th>Family</th>
<th>Genus and Species</th>
<th>Common Name</th>
</tr>
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<tbody>
<tr>
<td>RANUNCULACEAE</td>
<td>Adonis Dentata</td>
<td>Toothed Pheasant's-eye</td>
</tr>
<tr>
<td>(Crowfoot Family)</td>
<td>Delphinium Pygmaea</td>
<td>Dwarf Larkspur</td>
</tr>
<tr>
<td>PAPAVERACEAE</td>
<td>Resedaria Dodecandra</td>
<td>Oriental Horned Poppy</td>
</tr>
<tr>
<td>(Poppy Family)</td>
<td>Glaucesium Arabicum</td>
<td>Arabian</td>
</tr>
<tr>
<td></td>
<td>&quot; Dimidiatum</td>
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</tr>
<tr>
<td></td>
<td>Hypaeicum Procumbens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; Dimidiatum</td>
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<tr>
<td>FUMARIACEAE</td>
<td>Fumaria Parviflora</td>
<td>Small-Flowered Fumitory</td>
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<td>(Fumitory Family)</td>
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<td>CRUCIFERAE</td>
<td>Moretia Canescens</td>
<td>Small Rocket</td>
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<td>(Mustard Family)</td>
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<td>Ereobium Lineare</td>
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<td>Arabidopsis Pumila</td>
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<td>Sisymbrium Schimperi</td>
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<td></td>
<td>&quot; Septulatum</td>
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<tr>
<td></td>
<td>&quot; Regidulum</td>
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</tr>
<tr>
<td></td>
<td>Malcomia Africana</td>
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<td></td>
<td>&quot; Torulosa</td>
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</tr>
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<td></td>
<td>Lobularia Lybica</td>
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<td>Erucaaria Hispanica</td>
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<tr>
<td></td>
<td>Schimpera Arabica</td>
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</tr>
<tr>
<td></td>
<td>Diplotaxis Harra</td>
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<td>F. Hispida</td>
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<td>CAPPARIDACEAE</td>
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<td>&quot; Ellipticum</td>
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<td>Family</td>
<td>Genus</td>
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<td>--------------------------------------------</td>
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<td>Polygalaceae (Milkwort Family)</td>
<td>Polygala Scoparia</td>
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<td>Caryophyllaceae (Pink Family)</td>
<td>Dianthus Multipunctatus</td>
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<td>&quot; Judaicus</td>
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</tr>
<tr>
<td></td>
<td>Gypsophila Rokejka</td>
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</tr>
<tr>
<td></td>
<td>Silene Coniflora</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; Linearis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; Libanotica</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alsine Meyeri</td>
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</tr>
<tr>
<td></td>
<td>Spergularia Media</td>
<td>Sandwort</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Downy Spurry</td>
</tr>
<tr>
<td>Paronychiaceae (Whitlow-Wort</td>
<td>Paronychia Flavescens</td>
<td>Whitlow-Wort</td>
</tr>
<tr>
<td>Family)</td>
<td>Paronychia Argentea</td>
<td>Mtn. Knotgrass</td>
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<tr>
<td></td>
<td>&quot; Lenticulata</td>
<td>Desert Whitlow-Wort</td>
</tr>
<tr>
<td></td>
<td>Gymnocarpos Decandrum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pteranthus Dichotomus</td>
<td></td>
</tr>
<tr>
<td>Portulacaceae (Purslane Family)</td>
<td>Portulaca Oleracea</td>
<td>Common Purslane</td>
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<td>Tamaricaceae (Tamarisk Family)</td>
<td>Reaumuria Hirtella</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; Alternifolia</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tamarix Mannifera</td>
<td>Manna Tamarisk</td>
</tr>
<tr>
<td></td>
<td>&quot; Articulata</td>
<td>Jointed &quot;</td>
</tr>
<tr>
<td>Frankeniacae (Sea Heath Family)</td>
<td>Frankenia Revoluta</td>
<td>Sea Heath</td>
</tr>
<tr>
<td>Malvaceae (Mallow Family)</td>
<td>Malva Sylvestris</td>
<td>Common Mallow</td>
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<td></td>
<td>Oxyloba</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; Rotundifolia</td>
<td>Dwarf Mallow</td>
</tr>
<tr>
<td></td>
<td>&quot; Parviflora</td>
<td>Cheese-Weed</td>
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<td>Microcarpa</td>
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<td></td>
<td>&quot; Hirtum</td>
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<tr>
<td>Zygophyllaceae (Caltrop Family)</td>
<td>Fagonia Bruguieri</td>
<td>Fagonia</td>
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<tr>
<td></td>
<td>&quot; Myriacantha</td>
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<td></td>
<td>Fagonia Grandiflora</td>
<td>Sparse-Glandulosa</td>
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<td></td>
<td>Xyophyllum Simplex</td>
<td>Simple-Leaved Bean Caper</td>
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<td>Rutaceae (Rue Family)</td>
<td>Haplophyllum Blanchei</td>
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<tr>
<td></td>
<td>&quot; Tuberculatum</td>
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<tr>
<td>Anagardiaceae (Terbinth Family)</td>
<td>Rhus Tripartita</td>
<td>Sumach</td>
</tr>
<tr>
<td></td>
<td>Cashew or Terebinth</td>
<td></td>
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<tr>
<td></td>
<td>&quot; Mutica</td>
<td></td>
</tr>
<tr>
<td>Rhamnaceae (Suckthorn Family)</td>
<td>Ziziphus Spina-Christi</td>
<td>Syrian Christ-Thorn</td>
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</table>
PAPILIONACEAE (Fabaceae Pea Family)

Retama Raetam
Ononis Matrix
" Vaginalis
Trigonella Stellata
Medicago Sativa
" Litoralis Tribuloides Coast Medick
" Hispida Denticulata Bur Clover
Trifolium Dicroanthum
" Xerocephalum
Trifolium Nigrescens
Lotus Palustris
" Pisillus Major
Tetragonolotus Palaestinus Pal, Winged-Pea
Hippocrepis Bisiliqua
" Constricta
Psoralea Bituminosa
Psoralea Flaccida
Colutea Istris
Astragalus Fatmensis
" Eremophilus
" Corrugatus
" Tenuirugis
" Annularis
" Cretaceus
" Alexandrinus
" Sieberi Racemosus
" Gruntiflorus
" Spinosus
Onobrychis Crista-Galli
" Wettsteinii
Alhagi Maurorum

CAESALPINIACEAE (Senna Family)

Ceratonia Siliqua
St. John's Bread, Carob

MIMOSACEAE (Mimosa Family)

Prosopis Stephaniana

ROSACEAE (Rose Family)

Crataegus Azarole
Common Hawthorn

FICOIDACEAE (MESEMBRYACEAE)

Mesembryanthemum
Egyptian Fig Marigold

Fig Marifold Family Mesembryanthemum Forskahlei Forskal Fig Marigold
Aizoon Hispanicum
" Canariens

UMBELLIFERAE (Parsley, Carrot Family)

Dupleurum Heterophyllum
" Gerardi Patens
Apium Graveolens
" Nodiflorum
Ridolfia Segatum
Pituranthos Tortuosa
" Triradiata
Pimpinella Cretica
Arabica
Pimpinella Petraea

White Broom
Shrubby Rest-Harrow
Sheathed " "
Alfalfa, Lucerne
Horseshoe Vetch
" "
Scurf Pea
Scurf Pea
Aleppo Colutea
Milk Vetch
Alexandrian Milk Vetch
Cock's-Comb
Sinai Manna

Spanish Aizoon
Purslane-Leaved Aizoon
Hare's-Ear
Hare's-Ear
Smallage, Celery
Procumbent Marshwort or Water Parsnip
Ridolfia
Cretan Burnet Saxifrage
Foeniculum Vulgare
Common Fennel
Ferula Communis
Common Giant Fennel
Chaetosciadium
Hairy-Seeded Chervil
Trichospherum
Syrian Hemlock Chervil
Toralis Neglecta
Fine-Leaved Bur Parsley
Cauanis Leptophylla

ARALIACEAE
Hedera Helix
English Ivy

CAPRIFOLIACEAE
Lonicera Etrusca
Italian Honeysuckle

(Rivy or Ginseng Family)

CAPRIFOLIACEAE
Honeysuckle Family

RUBIACEAE
Rubia Tintorum
Madder
" Peregrina
Madder
" Temufolia Eburnea Madder
Asperula Humifusa Pycnantha Woodroof
Gaflum Canum Musciforme Bedstraw
" Petrae

(Radder Family)

VALEMINACEAE
Valerianella Szovitsiana Cornsalad

(Valerian Family)

DIPSACACEAE
Scabiosa Olivieri Scabious
" Aucneri Scabious
Pterocephalus Sanctus Sinai Scabious

(Teasel Family)

COMPOSITAE
Erigeron Trilobus Fleabane
Asteriscus Graveolens Stinkwort
Anvillea Garcini Arabian Oxeye
Inula Viscosa Clammy Inula
Pulicaria Arabica Arabian Fleabane
Iphiona Macronata Spiny Goldy-Locks
Vartemia Montana Mtn.
Hochstetteria Schimperi
Leyssera Capillifolia
Gymnarrhena Micrantha
Filago Spathulate Prostrate Broad-Leaved Cudweed
Ifloga Spicata
Achillea Santolina Santolina Milfoil
Achillea Fragrantissima Sweet-Smelling
Pyrethrum Santolinodes Lavender Cotton
Cotula Cinerea Sinai Feverfew
Artemisia Herba-Alba Ashy-Cotula
Laxiflora Herba-Alba
Calendula Aegyptica Egyptian Marigold
Suberostris
Tripteris Vaillanti Smooth Globe Thistle
Echinops Glaberrimus Lebanon Carline Thistle
Chardinia Orientalis
Carlina Libanotica Plumeless Thistle
Microcephala Cotton Thistle
Cardus Pyrrocephalus Dwarf Centaury
Sonoporon Ambiguum Egyptian Centaury
Jurinea Steachelinae
Rhaponticum Pusillum
Amberboa Lippid

107
Centauræa Ammocyanus
" Damascena
" Eryngiioides
" Iberica
Carthamus Lanatus
" Glauces
" Syriacum
Scolymus Hispanicus
Tolpis Virgata
 Schrogonera Intricata
Petraea
Taraxacum Megalorrhizon
Sonchus Maritimus
Launaea Cassiniana
" Nudicaulis
" Fallax
" Massuensis

PRIMULACEÆ
(Primrose Family)
Anagallis Latifolia

APOCYNACEÆ
(Dogbane Family)
Nerium Oleander

ASCLEPIADACEÆ
(Milkweed Family)
Pentatropis Spiralis
Daemia Tomentosa.
 Cynanchum Acatum
Gomphocarpus Sinaicus
 Bouqerosia Aaronis

BORAGINACEÆ
(ASPERIFOLACEÆ)
Borage Family
Heliotroplum Rotundifolium
Round-Leaved Heliotrope

Anchusa Strigosa
Onosma Syriacum
" Stellulatum
Pellidum
Echichilon Fruiticosum
Alhanna Orientalis
 Angustifolia

SOLANACEÆ
(Potato or Nightshade Family)
Lycium Arabicum

SCROPHULARIACEÆ
(Figwort Family)
Hyoscyamus Aurens

Verbascum Sinaicum
" Rotundifolium
" Schimperianum
Celsia Parviflora
Anarphium Orientalis
Linaria Floribunda
" Lenigera
Linaria Macilenta
Scrophularia Heterophylla
Veronica Macrostachya

Sand Centaury
Damascus Centaury
Distaff Thistle
Smooth Safflower
Syrian
Spanish Oyster-Plant
Tall Tolpis
Viper's Grass
Fall Dandelion
Sea Sow Thistle
Naked Launaea
Broad-Leaved Pimpernel
Oleander

Prickly Alkanet
Syrian Golden-Drop
Yellow or Bugloss
Alkanet
Arabian Boxthorn
Golden-Flowered Henbane
Sinai Mullein
Round-Leaved Mullein
Small-Flowered Celsia
Toadflax
Woolly Toadflax
Toadflax
Speedwell

108
LABIATAE  
(Mint Family)

Lavandula Coronopifolia  
Mentha Rotundifolia  
" Longifolia  
Origanum Maru  
Aegyptiacum  
Thymus Serphyllum  
Angustifolius  
Ziziphora Tenuior  
Salvia Pinardi  
" Palaestina  
" Lanigera  
" Aegyptiaca  
" Deserti  
Scutellaria Fruticosa  
" Sibthorpii  
Ballota Undulata  
" Rugosa  
Otostegia Moluccoides  
Phlomis Aurea  
" Platystegia  
Ajuga Tridactylites  
Teucrium Polium  
" Album  
" Pilosum  

PLANTAGINACEAE  
(Plantain Family)

Plantago Major  
" Albidans  
" Bellardi  
" Psyllium  

CHENOPODIACEAE  
(SALSOIACEAE)  
(Goosefoot Family)

Atriplex Palaestina  
Salsola Inermis  
Salsola Rigida Tenuifolia  
Nosea Mucronata  
Anabasis Setifera  

POLYGONACEAE  
(Knotweed or Buckwheat Family)

Calligonum Comosum  

NYCTAGINACEAE  
(Four-O-Clock Family)

Boerhavia Verticillata  

THYMELAEACEAE  
(Daphne or Mezerdeum Family)

Dapne Linearifolia  
Thymelaea Hirsuta  

LORANTHACEAE  
(Mistletoes Family)

Viscum Cruciatum  

EUPHORBIACEAE  
(Spurge Family)

Chrozophora Tinctoria  

MORACEAE  
(Mulberry Family)

Ficus Carica Genuina  
" Pseudo Sycomorus  

FAGACEAE  
(Mulberry Family)

Quercus Coccifera  
Calliprinos  

109
<table>
<thead>
<tr>
<th>IRIDACEAE</th>
<th>Iris Petranana</th>
<th>Petra Iris</th>
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<tbody>
<tr>
<td>(Iris Family)</td>
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<tr>
<td>AMARYLLIDACEAE</td>
<td>Sternbergia Macrantha</td>
<td>Large-Flowered Sternbergia</td>
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<td>(Amaryllis Family)</td>
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<tr>
<td>LILIACEAE</td>
<td>Colchicum Bulbocodioides</td>
<td>Meadow Saffron</td>
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<tr>
<td>(Lily-Family)</td>
<td>&quot; Steveni</td>
<td>Steven's M. &quot;</td>
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<tr>
<td></td>
<td>Urginea Maritima</td>
<td>Sea Squill</td>
</tr>
<tr>
<td></td>
<td>Asphodelus Aestivus &quot;</td>
<td>Tall Asphodel</td>
</tr>
<tr>
<td></td>
<td>Fistulosus</td>
<td>Onion-Leafed Asphodel</td>
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<tr>
<td></td>
<td>Asparagus Acutifolius &quot;</td>
<td>Acute-Leafed Asparagus</td>
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<td></td>
<td>Aphyllus</td>
<td>Prickly</td>
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<tr>
<td>JUNCACEAE</td>
<td>Juncus Maritimus Arabicus</td>
<td>Sea Hard Rush</td>
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<td>(Rush Family)</td>
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<td>CYPERACEAE</td>
<td>Fimbristylis Dichotoma</td>
<td>Annual Clubrush</td>
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<td>(Sedge Family)</td>
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<tr>
<td>GRAMINEAE</td>
<td>Pennisetum Ciliare</td>
<td>Ciliated Cenchrus</td>
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<tr>
<td>(Grass Family)</td>
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<tr>
<td></td>
<td>Andropogon Hirtus</td>
<td>Hairy Beargrass</td>
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<td></td>
<td>Aristida Ciliata &quot;</td>
<td>Triple-Awned Grass</td>
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<td>Caloptila</td>
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<td></td>
<td>Stipa Parviflora</td>
<td>Small-Flowered Feather Grass</td>
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<td></td>
<td>Agrostis Verticillata</td>
<td>Creeping Bent Grass</td>
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<tr>
<td></td>
<td>Tetrapogon Villosus</td>
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</tr>
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<td></td>
<td>Phragmites Communis Stenophylla</td>
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<td>Melica Minuta Parviflora</td>
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<tr>
<td></td>
<td>Festuca Elatior Pratensis</td>
<td>Small Melic Grass</td>
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<td>Bromus Squarrosus</td>
<td>Corn Brome</td>
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<tr>
<td></td>
<td>Lanuginosus</td>
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<td>Gynomonosperms</td>
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<tr>
<td>PINACEAE</td>
<td>Cypresus Sempervirens</td>
<td>Evergreen Cypress</td>
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<td>Horizontalis</td>
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<td>Juniperus Phoenicia</td>
<td>Phoenician Juniper</td>
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<td>GNETACEAE</td>
<td>Ephedra Camplopopoda</td>
<td>Leafless Shrubby Horsetail Leafy</td>
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<tr>
<td>(Gnetum Family)</td>
<td>&quot; Alte</td>
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</tr>
<tr>
<td>CRYPTOGRAMS-FLOWERLESS PLANTS</td>
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<tr>
<td>POLYPODIACEAE</td>
<td>Ceterach Officinarum</td>
<td>Miltwaste, Rustyback Fern</td>
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<td>(Common Fern Family)</td>
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<td></td>
<td>Notholaena Lanuginosa</td>
<td>Fleecy Fern</td>
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<td></td>
<td>Cheilanthes Fragrans</td>
<td>Sweet Lip Fern</td>
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<tr>
<td></td>
<td>Adiantum Capillus- Veneris</td>
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</tr>
<tr>
<td></td>
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<td>True Maidenhair Fern</td>
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Appendix D Fauna of Petra

MAMMALS:

<table>
<thead>
<tr>
<th>Name</th>
<th>Habitat</th>
<th>Remarks</th>
</tr>
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<tbody>
<tr>
<td>Nubian Ibex (Capra Ibex Nubiana)</td>
<td>Sandstone Mtn. Areas</td>
<td>Probably Extinct in Park Area, But Found to North</td>
</tr>
<tr>
<td>Mountain Gazelle (Gazella Gazella)</td>
<td>Above Sandstone Zone</td>
<td>Probably Extinct in Park Area</td>
</tr>
<tr>
<td>Fallow Deer (Dama Dama)</td>
<td>Desert Wadis Below Sandstone Mtns.</td>
<td>Probably Extinct In Park But May Drift In From W. Araba</td>
</tr>
<tr>
<td>Cheetah (Acinonyx Jubatus)</td>
<td>Sandstone Mtn. Areas</td>
<td>Questionable, But Known To Be Associated With Ibex</td>
</tr>
<tr>
<td>Wolf (Canis Lupus)</td>
<td>Interior</td>
<td>Small Pack Recorded In Naqb Valley Several Years Ago, But Poisoned Out</td>
</tr>
<tr>
<td>Striped Hyena (Hyaena Hyaena)</td>
<td>Throughout</td>
<td>Reported Occasionally</td>
</tr>
<tr>
<td>Sand Fox (Vulpes Rueppelli)</td>
<td></td>
<td>Commonly Seen Along Approach Highway</td>
</tr>
</tbody>
</table>

Many Smaller Mammals are no doubt in area, but no accurate reports available.

BIRDS:

The following partial list represents those birds actually observed and reported.

Fan-Tailed Raven (Corvus Rhipidurus)
Tristan's Grackle (Onychogonthus Tristami)
Sinai Rose-Finch (Erythrina Sinica)
Cretzschmar's Bunting (Emberiza Caesia)
Rock Sparrow (Petroina Petroina)
Pale Rock Sparrow (Petroina.Brachydactyla)
Blue Rock Thrush (Monticola Solitarius)
Bonelli's Eagle (Hieraetus Fasciatus)
White Stork (Ciconia Ciconia)
Rock Dove (Columbia Livia)
Rock Partridge (Alectoris Graeca)
Sand Partridge (Ammoperdix Heyi)

REPTILES:

Very little is known of the reptilian fauna of the region and even a partial checklist cannot be included here.
Appendix E: Consolidation and Conservation Projects

Restriction of Traffic

All vehicle traffic on the paved street should be prohibited. The Roman street will not bear the weight of vehicles and it already shows signs of breaking. Horse traffic should also be kept off this high-crowned roadway.

Roman Theater

Recent wall consolidation of the scaena and stage of the Roman period theatre should be undone. It is recommended that the new stonework and the poorly erected columns be removed and the rubble-cored walls stabilized as they were when excavated.

The Siq

It is proposed in this plan to make a firm roadway through the Siq. The gradient of the Wadi floor will be made constant. At the same time flood-deposited fill in the gorge should be removed. Remnants of the ancient roadway through the Siq are visible at several spots and there are places where a considerable amount of fill has covered what remains of the road. Work in the Siq should be proceeded by careful archaeological investigations to expose whatever remains of the historic road. All existing portions of the roadway should be consolidated.

The Khazna

The area immediately in front of the Khazna should be cleared of debris and any structures consolidated. This work would be protected by the rebuilding of two ancient check dams located south of the structure. The rebuilt column should be plastered, so that its appearance will not be so completely out of keeping with the original structure.

Other Sandstone Structures

Sandstone steps. On the south side of the paved street are steps that probably had a fairly long life when the inhabitants of Petra were shod with soft sandals or went barefoot. Today's visitors to the city, however, wear heavier shoes with leather soles and the steps are disintegrating rapidly. They should
be sprayed with a rock-hardener to reduce the speed of erosion. If this cannot be done immediately it might be desirable to cover the steps with earth in order to preserve them.

The Nabataean trails to High places, reservoirs or other destinations were frequently cut into sandstone and, where this was done on steep grades, steps were cut into the stone. Today it becomes necessary to use these same trails for they frequently were laid in the only feasible means of access to some of the sites.

Wherever possible new trails should be made to parallel the old ones but there will be instances where that will be impossible. In such cases the old steps should be sprayed with a rock-hardener if the steps are still usable. If the steps have become severely damaged and eroded, then new steps should be cut into the stones and these sprayed with a hardener.

**Monumental Gateway And Qasr El Bint**

The important work needed at these related ruins is:

a. Rake joints around displaced masonry, clear rubble core where it has forced stones out of position, jacket the sections of the arch or wall and force stones back towards their original positions. It will probably be impossible to re-set each stone in its original position, and this is not necessarily desirable. Broken stones should be welded with an epoxy. The structure requires strengthening by internal pins, tension rods, or braces and new structural core. The top of each remaining portion of the arch or wall should be capped with a water repellent material to prevent continued damage to the structure by per-colating waters. Care must be taken to protect ornamental stone work and applied plaster ornament.

b. The missing horizontal tension beams on Qasr El Bint should be replaced with structural concrete and new wooden faces, applied and sprayed with a wood preservative-pentachlorophenol-which will cause no change in their appearance.
c. The arch over the entrance to the temple should be carefully grouted with mortar or epoxy. The arch voussoirs and haunch requires careful checking for incipient failure. If structural reinforcement is necessary a new reinforcing beam should be hidden and the extrados of the arch and the members of the arch hung from the new beam.
Appendix F  Pencapsula - A Preservative Agent for Sandstone and Other Materials

Pencapsula, a synthetic resin, was developed for use in the National Park Service ruins stabilization program by the Texas Refinery Corporation of Fort Worth. Extensive applications and tests of it have been made since 1962 and this is a summary of the results achieved.

Pencapsula is a non-toxic viscid petrochemical which, for use, must be diluted with one of the petroleum-derived solvents. Excellent results are to be had with either mineral spirits or kerosene in the proportions of 1 part Pencapsula to 5 parts solvent. Application is best made as a spray at very low pressure (not more than 10-12 psi); we used both 3 gallon garden sprayers and 20 gallon orchard sprayers with excellent results.

It is imperative, to insure a successful treatment, that the Pencapsula be allowed to penetrate the surface of whatever material is being sprayed. Pencapsula does not form a film or membrane on the surface but is carried into the material by the solvent and then encapsulates the constituent members of the mass. This leaves open the normal tiny interstices which exist between the particles of any material and permits the normal "breathing" made necessary by changes in atmospheric and hydrostatic pressure and thus reduces any tendency for the treated portion of the material to spall.

Penetration into the sandstone should be at least 2 centimeters. Any additional penetration adds to the efficiency of the treatment. In order to achieve penetration it is necessary to spray and re-spray an area several times until capillary action carries Pencapsula into the material. In applying the Pencapsula it is usually necessary to cut or drill into the wall to determine the amount of penetration.

Once a relationship between the quantity of spray and an area of surface has been determined then it is simple enough to apply
1 gallon of dilute Pencapsula to, for instance, 100 square feet of wall surface.

"Penetration" is the important word in this instance, not, "coverage".

For purposes of estimating costs one can treat about 100-150 square feet of adobe wall surface with 1 gallon of the diluted Pencapsula; on other materials the coverage is about twice as much. A single application, well applied, is sufficient. Pencapsula is inert and one application should last for 18-20 years.

Depending on the material a treated surface will look damp for as long as six months, while the solvent is evaporating from the wall. After that there is no color change or glaze. Even though the solvent remains in the wall for a comparatively long time Pencapsula hardens and becomes effective within 24 hours.

The equipment needed to apply Pencapsula is simple, and inexpensive. The actual application can best be done with common hand operated garden sprayers with tank capacities of 3 or 4 gallons. Access to the monument for spraying the stone would be by tubular steel scaffolding - of which the Department of Antiquities has an adequate supply. Two or three men, each with a sprayer, plus one other man to mix the Pencapsula and help move the scaffolding should be able to spray all surfaces of a monument such as El Khazna in four days and much of the time would be spent in erecting or dismantling the scaffolding.

One gallon of diluted Pencapsula (1 part Pencapsula to 5 parts solvent) should successfully stabilize between 3 and 4 square meters of the Petra sandstone. Again the Khazna may be used as an example to estimate the cost of treating one monument. There are approximately 2,700 square meters of rock surface at the Khazna and it is advocated that the entire structure be sprayed.
It will cost approximately 1,500 JD to spray 4 square meters of sandstone. Counting only the cost of the Pencapsula, the solvent, and labor it can be estimated that to spray the entire structure will cost about 1013 JDs.
Appendix G  Audio Visual Programs

1. **Orientation:**

The A-V program recommended as a part of the introduction to the park consists of a brief automatic slide-tape program. This program would be designed to enhance the introductory personal contact, exhibits, and publications available to assist the visitors in planning their activities. It is highly recommended that the audio components be capable of transmitting in the 5 languages mentioned in the trail guide section of the plan.

2. **Evening Programs:**

A number of A-V programs, both movies and slides, should be assembled for use of the evening programs. These programs would include orientation of other points of interest in Jordan as well as specialized programs concerning various aspects of Petra.
Appendix H Exhibits

1. Visitor Center Orientation:

Exhibits in the lobby of the visitor center should be designed to assist the visitors in planning their activities while at Petra. The primary exhibit would be a large scale map of the park with an accent on the trail system. Trails should be color coded to match the color coded trail markers and guide books. Specific points of interest would be keyed to illustrations. Identification would be keyed to a pocket map printed in the 5 languages proposed for use.

Other exhibits would assist visitors in planning trips to other points of interest within the country.

2. Interpretive Exhibits:

These exhibits would display two major themes; the people of Petra and the artifacts of Petra. To describe the people it would be necessary to graphically compare them with other cultures of the world on a time scale. The time span will range from the Neolithic to the present. Each major occupational period would refer to a specific site within the park to stimulate trail usage.

The artifact display would allow the use of those artifacts too small or fragile to be displayed on-site. Each display would contain in-depth interpretation of the manufacture, use, or significance of the object. Dioramas or original artwork concerning the in-depth treatment would enhance the subject matter.

Wherever possible it should be the policy to let the exhibits speak for themselves, thus obviating the need for multilingual labels. Where labelling is necessary, it might be accomplished by small multilingual printed guides.
3. **On-Site Exhibits:**

Wherever possible, it should be the policy to utilize the principle of exhibiting objects in place, taking into consideration protection of the object. On-site exhibits would be a part of the trail tours.
Appendix I  Publications

It is our recommendation that the principle of self-guiding activities be emphasized at Petra. The primary reason for this concept is the use of the area by a large number of foreign tourists. The mechanics of multilingual labelling are a formidable task and it would be much easier to depend on multilingual publications. Another reason for the use of self-guiding activities is to reduce the dependence on guides. At best, personal guides are mediocre in their knowledge of the history of Petra and they are prone to apply their own individual interpretations that vary widely from guide to guide.

The scope of the publications should be as follows:

1. The general park folder containing a brief description of Petra and a park map. This and the following publications might be available in Arabic, English, French, German and Italian. As travel increases, it may be necessary to expand the language coverage.

2. A guide to the exhibit room.

3. A series of trail guides, color-coded to match the park trails and the lobby trail map.

4. A historical handbook to describe the antiquities in more depth.

5. A natural history guide to the plants, animals, and geology of the park.

6. As travel increases there will no doubt be an increasing demand for publications, particularly for semi-scientific reports on archeological projects in progress.
Appendix J  Trail & Roads System

Foot Trails:

1. Visitor Center to Siq Entrance via the campground area. 825 m.*, 2.5 m wide.
   Section, type A., some steps required, some rock carving required, some portions of trail where it crosses rock outcrops will be narrowed to 1m. in width.

2. Siq Entrance to Visitor Center via Wadi Musa 825 m, 2.5 m wide.

3. Siq Trail.
   1.35 km., wall to wall, Section, type B. large accumulations of water deposited rock to be cleared out or crushed on site for base material.

4. Exit of Siq to Roman Street 875 m, 3m wide, Section type A.

5. Qasr El Bint/Wadi trail to Visitor Contact and Day Use Area 50 m., Section type C.

6. Qasr El Bint to Wadi Sabra trail head 650 m., 2.5 m. wide, Section type A.

7. Qasr El Bint to Roman Soldier tomb 1.05 km., 2.5 m. wide, Section type A.

8. Roman Soldier tomb to Highplace 950 m., present standards, however some reconstruction necessary to ease steep runs of steps and some hand rails are required.

9. Qasr El Bint to El Deir trail head 650 m., 2.5 m. wide, Section type A.

10. To El Deir
    1.85 km., present standards
11. El Deir to Siq Barid and Baidha trail junction
1.75 km., 1.5-2 m wide, graded trail.

12. Theatre - Wadi Mataha - Sidd El Ma'ajiin - Visitor Center trail.
   a. Theatre to Florentinus Tomb
      550 m., 2.5 m. wide, Section type A.
   b. Florentinus Tomb to Crusader Castle trail junction
      2.5 km., 2-2.5m. wide, graded trail
   c. Crusader Castle junction to Visitor Center
      600 m., 2.5 m. wide, Section type A.

13. Spur to Roman reservoir
150 m., 2.5 m. wide, Section type A.

14. Theatre to Highplace
700 m., present standards. See note under No. 7 for additional construction.

15. Umm Al Biyarra Spur
850 m., 2 m. wide, graded trail

16. Snake Monument Spur
250 m. 2 m. wide graded trail

**Horse Trails:**
1. Visitor Center to Siq Entrance.
   1 km., 3m. wide, graded trail

2. Siq Trail
   See note No. 3 under foot trails

3. Siq exit to Nymphaeum
   875 m., 3 m. wide, graded trail

4. Nymphaeum to Petra Basin trailhead
   700 m., wadi bottom to be stabilized to prevent erosion of monuments and will also provide access for electric supply vehicles.
5. Petra Basin trailhead - Wadi Araba trail
   12 km., 3 m. wide graded trail

6. Petra Basin trailhead - Wadi Sabra trail
   8.75 km., 3 m. wide, graded trail

7. Jebel Haroun Spur
   2.8 km., 3 m. wide, graded trail

8. Petra Basin trailhead - Beida trail (via Wadi El Nu'eisra Esh Sharqiye)
   4.5 km., 3 m. wide, graded trail

9. Petra Basin trailhead, via Turkamaniya tomb to Beida trail
   3.2 km., 3 m. wide, graded trail

10. Wadi Sabra - Siq entrance
    6.5 km., 3 m. wide, graded trail

11. Visitor Center - Beida trail
    6.75 km., 3 m. wide, graded trail

* All distances are approximate and were arrived at by map measure. They do not reflect switchbacks and vertical distance. These distances will be measured in the field.

Type A Section - crushed stone with asphalt binder.
Type B Section - crushed stone without asphalt binder.
Type C Section - concrete construction.

Roads:

1. Entrance Road
   175 m. 6 m. wide, cross section A.

2. Campground Roads
   1.375 km., 5 m. wide, cross section B.

3. Staff housing service road
   175 m. 5 m. wide, cross section B.
Appendix K

Preliminary Estimated Cost of Watershed Control on 1968 price indices.

Cost Per Hectare

Work proposed includes terracing hillsides with Gradoni terraces with an average distance of 15 meters between terraces, Seedling trees planted at 3 meter intervals along terraces and check dams constructed in torrent channels to reduce sediment transport and to turn water onto terraces. Cost includes 75 waterings of each tree over the first season.

WALLS: Gradoni terraces and check dams 667 meters of walls per hectare at 0.420 JD per m.

TREES: 222 Seedlings per hectare at 0.050 JD

WATER: 222 trees per hectare @ 0.060 each

TOTAL Cost Per Hectare 304 JD

Cost Per Acre $ 345

Cost of Control of Watershed of Wadi Musa & Tributaries

Assuming 10% to 25% of Gross Area, less areas already under control, will be terraced and planted.

<table>
<thead>
<tr>
<th>Gross Area Hectares</th>
<th>Percent Control</th>
<th>Existing Control Hectares Needed</th>
<th>Additional Control Hectares Needed</th>
<th>Cost Hectares Dinars</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSIDE PARK</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wadi Musa above Roman Street</td>
<td>943</td>
<td>25%</td>
<td>138</td>
<td>98</td>
</tr>
<tr>
<td>Wadi Turkamaniya-2nd Priority</td>
<td>693</td>
<td>10%</td>
<td>none</td>
<td>69</td>
</tr>
<tr>
<td>Wadi Thughra - 3rd Priority</td>
<td>665</td>
<td>10%</td>
<td>none</td>
<td>67</td>
</tr>
<tr>
<td>Subtotal</td>
<td>2301</td>
<td></td>
<td>138</td>
<td>234</td>
</tr>
</tbody>
</table>

| OUTSIDE PARK | | | | |
|--------------|----------------|---------------------------------|----------------------|
| Wadi Musa | | | |
| Total | 4585 | 25% | 360 | 786 | 239,000 |
| 10% Contingencies | | | | |
| 10% Plans & Surveys | | | | |
| TOTAL | 6886 | | 498 | 1020 | 310,200 |

10% Contingencies 31,020

10% Plans & Surveys 31,020

TOTAL JD 372,200
Appendix L

Preliminary Estimated Development costs of Public and Staff Use Facilities* required for year 1975 (Phase I) based on 1968 price indices.

SUMMARY

**Building and Utilities**
- Roads and Trails

Subtotal

20% for Plans, Surveys and Supervision

Subtotal

Total Construction Cost (Rounded)

* Exclusive of Land Costs, Purchase of Nazzal's Camp, Watershed Protection, highway improvements, consolidation (inventory of structures, Penscapsula etc.,), publications, and carry-on studies, etc.

Preliminary Cost Estimates for Buildings Construction thru 1975 - Phase I.

**Petra Entrance Development**

<table>
<thead>
<tr>
<th>Area</th>
<th>Cost, Dinars</th>
</tr>
</thead>
<tbody>
<tr>
<td>825 m² Visitor Center and Headquarters Building @ JD 30/m²</td>
<td>24,750</td>
</tr>
<tr>
<td>Lobby</td>
<td>250 m²</td>
</tr>
<tr>
<td>Information</td>
<td></td>
</tr>
<tr>
<td>Concessions - reservations and sales</td>
<td></td>
</tr>
<tr>
<td>Circulation</td>
<td></td>
</tr>
<tr>
<td>Public Toilets from Lobby</td>
<td>50 m²</td>
</tr>
<tr>
<td>Exhibits &amp; Audio-Visual</td>
<td>200 m²</td>
</tr>
<tr>
<td>Administration Offices</td>
<td>160 m²</td>
</tr>
<tr>
<td>Conference - Library</td>
<td>35 m²</td>
</tr>
<tr>
<td>Work Room &amp; Storage</td>
<td>65 m²</td>
</tr>
<tr>
<td>Space</td>
<td>Area (m²)</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>First Aid Room</td>
<td>10</td>
</tr>
<tr>
<td>Communications Center</td>
<td>10</td>
</tr>
<tr>
<td>Drivers' Lounge &amp; Toilets</td>
<td>15</td>
</tr>
<tr>
<td>Staff Toilets</td>
<td>10</td>
</tr>
<tr>
<td>Circulation</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>825</td>
</tr>
<tr>
<td><strong>2300 m² Hotel @ JD 40/m²</strong></td>
<td></td>
</tr>
<tr>
<td>Lobby and Office</td>
<td>100</td>
</tr>
<tr>
<td>Lounge with Bar</td>
<td>150</td>
</tr>
<tr>
<td>Public Toilets</td>
<td>30</td>
</tr>
<tr>
<td>Guest Rooms with Bath, 50 each</td>
<td>1500</td>
</tr>
<tr>
<td>Guest Rooms without Baths, 8 each existing</td>
<td></td>
</tr>
<tr>
<td>Guest Toilets</td>
<td></td>
</tr>
<tr>
<td>Dining Room and Snack Bar</td>
<td></td>
</tr>
<tr>
<td>Public Toilets from Dining Room</td>
<td></td>
</tr>
<tr>
<td>Kitchen</td>
<td>100</td>
</tr>
<tr>
<td>Food Storage receiving and Trash</td>
<td>75</td>
</tr>
<tr>
<td>Employees Dining Room</td>
<td>15</td>
</tr>
<tr>
<td>Employees Lockers &amp; Toilets</td>
<td>30</td>
</tr>
<tr>
<td>Laundry</td>
<td>100</td>
</tr>
<tr>
<td>Storage</td>
<td>50</td>
</tr>
<tr>
<td>Circulation</td>
<td>140</td>
</tr>
<tr>
<td>Mechanical Equipment Room</td>
<td></td>
</tr>
<tr>
<td>Lunch Area Service</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2300</td>
</tr>
<tr>
<td><strong>400 m² Maintenance Building @ JD 20/m²</strong></td>
<td></td>
</tr>
<tr>
<td>Office and Shops</td>
<td>40</td>
</tr>
<tr>
<td>Vehicle Bays</td>
<td>100</td>
</tr>
<tr>
<td>Warehouse</td>
<td>60</td>
</tr>
<tr>
<td>Outdoor Storage Shelters</td>
<td>120</td>
</tr>
<tr>
<td>Mechanical Equipment and generator room</td>
<td>80</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>400</td>
</tr>
</tbody>
</table>
Cost, Dinars

2,240 m² Staff Quarters @ JD 30/m²
  House with 1 Bed Room -
    115 m² 4 units
  House with 2 Bed Rooms -
    130 m² 6 units
  House with 3 Bed Rooms -
    150 m² 4 units
  Seasonal Quarters -
    8-One Room Apts.

Campground Building

2 units Toilets, Showers, & Storage JD 40/m² @ 35 m²

Movable Furniture, Fixtures and Equipment

Subtotal Cost Petra Entrance Development 245,750

Petra Basin Development

120 m² Contact Station @ JD 30/m²

Public Toilets and Equipment Room

Information & Office 16 m²

First Aid Room 4 m²

Staff Lockers, Toilets and Bunk Room 20 m²

Total 120 m²

40 m² Lunch Service @ JD 30/m²

Serving Counter & Back Bar 8 m²

Food and Beverage Storage 12 m²

Furniture Storage 20 m²

Total 40 m²

500 m² Shelters

Rain & Wind 100 m²

Sun 400 m²

Total 500 m²

Movable Furniture, Fixtures and Equipment 5,000

128.
Cost, Dinars

- Subtotal Cost Petra Basin Development: 14,800
- Total Cost for Building 10% Contingencies: 265,550
- Total Cost for Buildings (rounded): 292,000

Preliminary Cost Estimate for Utilities Construction for year 1975 (Phase I)

**Petra Entrance Development**

- 1 each Well, 500 meters deep, with pump: 15,000
- 1 each Reinforced Concrete Reservoir, 750 m³: 11,000
- 200 m. Steel pipe water lines, 3", @ 2.0 JD/m.: 400
- 1600 m. Steel pipe water lines, 2", @ 1.50 JD/m.: 2,400
- 200 m. Steel pipe water lines, 3/4", @ 1.00 JD/m.: 200
- 1 lot Miscellaneous control equipment: 2,000

**Subtotal Water System**: 31,000

- 1000 m. Clay Sewer, 6", @ 3.00 JD/m.: 3,000
- 1 each Septic Tank, concrete, 30 m³: 250
- 1 each Septic Tank, concrete, 17 m³: 150
- 3 each Septic Tank, concrete, 14 m³ @ 100 JD.: 300
- 320 m. Absorption Trench @ 2.50 JD/m.: 800

**Subtotal Sewer System**: 4,500

- 1200 m. Electric Power Line, Underground @ 3 JD/m.: 3,600
- 1000 m. Telephone Line, Underground @ 2 JD/m.: 2,000

**Subtotal Petra Entrance**: 41,100

**Petra Basin**

- 1 each Reinforced Concrete Reservoir, 140 m³: 5,000
- 200 m. Steel pipe water line, 3/4",-2" @ 1.50.: 300
- 1 each Well improvement, incl. pump, hypochlorinator: 2,700

**Water System Subtotal**: 8,000

- 100 m. Clay Sewer pipe, 6" @ 3.0 JD/m.: 300
- 1 each Septic Tank, concrete 7 m³: 100
- 40 m. Absorption Trench @ 2.50 JD/m.: 100

**Sewer System Subtotal**: 500
1 sum Electric Generating Plant,  
building w/2-5kw sets including distribution lines  
3700m. Telephone Line, underground @ 2 JD/m.  
Subtotal Petra Basin  
Total  
10% Contingencies  
Total for Utilities  

Preliminary Cost Estimate for Roads and Trails construction 
for year 1975 (Phase I)  

**Petra Entrance Development**  

<table>
<thead>
<tr>
<th>Item</th>
<th>Costs (JD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 m. Entrance Road 6 m. wide @ JD 3/m²</td>
<td>2,700</td>
</tr>
<tr>
<td>3219 m² Parking @ JD 2/m²</td>
<td>6,438</td>
</tr>
<tr>
<td>1200 m Campground Roads 5m. @ JD 2/m²</td>
<td>12,000</td>
</tr>
<tr>
<td>237 m Service Roads 5m. wide @ JD 2/m²</td>
<td>2,370</td>
</tr>
<tr>
<td>3000 m² Walks &amp; Terraces @ JD 1,500/m²</td>
<td>4,500</td>
</tr>
</tbody>
</table>

Subtotal: 28,008

**Petra Basin Development**  

<table>
<thead>
<tr>
<th>Item</th>
<th>Costs (JD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500 m² Walks &amp; Terraces @ JD 1,500/m²</td>
<td>2,250</td>
</tr>
</tbody>
</table>

Subtotal: 2,250

**Park Trails**  

<table>
<thead>
<tr>
<th>Item</th>
<th>Costs (JD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 km Trails - horse 2m. wide @ JD 1,200/m²</td>
<td>24,000</td>
</tr>
<tr>
<td>40 km Trails - foot 2m. wide @ JD 1,400/m²</td>
<td>32,000</td>
</tr>
<tr>
<td>1 each Misc. Improvements</td>
<td>5,000</td>
</tr>
</tbody>
</table>

Subtotal: 61,000

Total: 91,258

10% Contingencies: 9,125

Total for roads and trails (rounded): 100,400
Preliminary Estimated Foreign Exchange Cost for Capital Development and Operation thru Year 1975 (Phase I) based on 1968 Prices.*

<table>
<thead>
<tr>
<th>Item</th>
<th>Net Cost</th>
<th>Percentage and Cost Attributed to Foreign Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Buildings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- general construction</td>
<td>JD 120,550</td>
<td>15% JD 18,082</td>
</tr>
<tr>
<td>- mechanical contracts</td>
<td>JD 80,000</td>
<td>50% JD 40,000</td>
</tr>
<tr>
<td>- movable furniture, fixtures, &amp; equipment</td>
<td>JD 65,000</td>
<td>80% JD 52,000</td>
</tr>
<tr>
<td>Subtotal</td>
<td>JD 91,258</td>
<td>JD 110,082</td>
</tr>
<tr>
<td><strong>Utilities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- sewage</td>
<td>JD 5,000</td>
<td>30% JD 1,500</td>
</tr>
<tr>
<td>- water</td>
<td>JD 39,000</td>
<td>40% JD 15,600</td>
</tr>
<tr>
<td>- electricity</td>
<td>JD 6,600</td>
<td>60% JD 3,960</td>
</tr>
<tr>
<td>- communications</td>
<td>JD 9,400</td>
<td>70% JD 6,580</td>
</tr>
<tr>
<td>subtotal</td>
<td>JD 25,000</td>
<td>JD 27,640</td>
</tr>
<tr>
<td><strong>Roads &amp; Trails</strong></td>
<td>JD 100,600</td>
<td></td>
</tr>
<tr>
<td><strong>Plans &amp; Surveys</strong></td>
<td>JD 25,000</td>
<td></td>
</tr>
<tr>
<td><strong>Watershed Protection</strong></td>
<td>JD 25,000</td>
<td></td>
</tr>
<tr>
<td>TOTAL (rounded)</td>
<td>JD 180,000 or ($507,600)</td>
<td></td>
</tr>
</tbody>
</table>

* Estimates are broadly based and total may vary ± 25%.
### Appendix M

**Preliminary Phase I Staffing and Costs**

<table>
<thead>
<tr>
<th>No.</th>
<th>Position</th>
<th>Annual Salary</th>
<th>Total Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Park Superintendent</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>1</td>
<td>Administrative Officer</td>
<td>420</td>
<td>420</td>
</tr>
<tr>
<td>1</td>
<td>Personnel Clerk</td>
<td>216</td>
<td>216</td>
</tr>
<tr>
<td>1</td>
<td>Property Clerk</td>
<td>216</td>
<td>216</td>
</tr>
<tr>
<td>1</td>
<td>Fiscal Accounting Clerk</td>
<td>240</td>
<td>240</td>
</tr>
<tr>
<td>1</td>
<td>Stenographer</td>
<td>288</td>
<td>288</td>
</tr>
<tr>
<td>1</td>
<td>Supervisor of Visitor Services</td>
<td>480</td>
<td>480</td>
</tr>
<tr>
<td>6</td>
<td>Park Rangers, Permanent</td>
<td>360</td>
<td>2160</td>
</tr>
<tr>
<td>8</td>
<td>Park Rangers, Seasonal</td>
<td>80*</td>
<td>640</td>
</tr>
<tr>
<td>1</td>
<td>Supervisor of Maintenance</td>
<td>420</td>
<td>420</td>
</tr>
<tr>
<td>2</td>
<td>Foremen</td>
<td>360</td>
<td>720</td>
</tr>
<tr>
<td>4</td>
<td>Equipment Operators</td>
<td>216</td>
<td>864</td>
</tr>
<tr>
<td>2</td>
<td>Storekeepers</td>
<td>180</td>
<td>360</td>
</tr>
<tr>
<td>2</td>
<td>Mechanics</td>
<td>240</td>
<td>480</td>
</tr>
<tr>
<td>8</td>
<td>Laborers, Permanent</td>
<td>144</td>
<td>1152</td>
</tr>
<tr>
<td>8</td>
<td>Laborers, Seasonal</td>
<td>48*</td>
<td>384</td>
</tr>
</tbody>
</table>

**Annual Payroll (rounded)**

JD 10,000

**Estimated Operation, and maintenance materials, supplies and equipment rental:** (Rule of thumb ratio:)

(50% of personal services)

JD 5,000

**Total Annual Operation and Maintenance**

JD 15,000

* 4 months
Appendix N  Land & Boundary Survey Costs

The purchase price of all private lands including improvements within the proposed park as shown on drawing No. PET-15, sheet 1 & 2, is estimated at 127,500 dinar.

Figure 5 below gives a breakdown of the estimated costs. Land and building values are based on the sale price of 4 lots (Block 12, Quarter 7, Lots 87-90 incl.) to the Government in 1967. Adjustments have been made for the relative value of the lands.

**Figure 5 Land Costs**

**Block 12, Quarter 6, Village of Wadi Musa**
- Land 64.9 dunums @ avg. 213 JD.  
  13,780 JD
- Buildings (4) 200 sq. meters @ 5 JD.  
  1,000

**Block 12, Quarter 7, Village of Wadi Musa**
- Land 117.6 dunums @ avg. 245 JD.  
  28,790 JD
- Buildings (2) 50 sq. meters @ 5 JD.  
  250

**Block 17, Tayiba Road**
- Land 831 dunums @ avg. 100 JD.  
  83,100 JD
- Buildings (est) 100 sq. meters @ 5 JD.  
  500

Total 1013.5 dunums, 350 m² buildings  
127,410 JD

**Total Land Costs (Rounded)**  
127,500 JD

**Cost of Boundary Survey**

Cost based on making a traverse of the boundary with transit and tape and making permanent markers (SCRIBED ANGLE IRON) every 100 meters.

**Cost Estimate**  
700 JD
Appendix O Mapping of Petra

Existing Published Maps

The maps listed below were used in the preparation of this Master Plan. Most of the maps are at too small a scale to show details of the antiquity sites. Those maps which were prepared in the past specifically to show the antiquities are more in the nature of sketches rather than accurate maps.

1. UK War Office and Air Ministry and US Army Map Service, Topographic Map NH 36 (Cairo) of Series 1301, scale 1: 1,000,000, 1960. This map, together with three others of the series was used to produce the overall map of Jordan showing the location of the Park.


4. US Army Map Service, Topographic maps 3050 I, 3050 II, 3050 III, 3050 IV, 3150 III and 3150 IV of Series K737, scale 1:50,000, Editions 1-AMS 1959 or provisional printing (undated). This series of maps covers the entire Kingdom of Jordan in 183 sheets. The two sheets of this series covering the area within the proposed park boundary were compiled from aerial photographs taken in 1961 and from other data furnished by the Jordan Department of Lands and Surveys. These maps are the most detailed produced to date of the area of concentration of antiquity sites of Petra and environs. However the scale is too small (1 centimeter = ¼ kilometer) to serve as a base for locating individual sites.

6. Jordan Ministry of the Interior for Municipal and Rural Affairs, Topographic Map of Wadi Musa, scale 1:1250, 1967. This map, in 5 sheets, was produced from aerial photography by Aero-Precisa, Beirut for town planning purposes. Mapping extends to the west only as far as the Petra Entrance Rest House. Coverage is shown on drawing PET-15 Index of Mapping, attached to this report.

7. Brunnow, R.E. and Domaszewski, A.V.; Die Provincia Arabia, Vol. I, verlaq Von Karl J. Trubner, Strassburg 1905. This publication contains detailed sketch maps of Petra including an overall map of Petra Basin and the Siq carrying a scale indication of 1:10,000. The map is useful in showing general locations of archeological features but scale distortion and stylized relief make the map inadequate as an accurate archeological base map. The overall scale of the sketch has been found to be about 1:6850.

8. Kennedy, A.B.W., Petra, Its History and Monuments, Country Life Press, London, 1925. This publication contains mosaics of aerial photographs taken in 1923 and a sketch map of the Petra area extending to the north to include Beida. These were the only aerial photos available to the Park planning team and the Petra Basin drawings of this Master Plan were based partly on the Kennedy mosaics.
9. Wiegand, Theodor (editor); Wissenschaftliche Veröffentlichungen des Deutschen - Türkischen Denkmalschutz - Commandos; Heft III - Petra Berlin. 1921. This publication contains a map of the ruins along the Roman Street. This map was the most detailed available to the study team.

Proposed Mapping

In the course of this Master Plan study mapping by plane table of the entrance development site was undertaken by members of the American team and Jordanian counterparts. Control traverses were run by transit and tape and palestine grid coordinates were calculated for permanent control points. Mapping was done at a scale of 1:500 with a contour interval of 1 meter. Completed mapping is shown by the shaded area on the Index of Mapping, Drawing No. PET-15.

In addition to the above work a layout for topographic sheets of Petra Basin at the same scale (1:500) was prepared as shown on drawing PET-15. A control traverse was run by transit and tape through the Siq to Nazzal's Camp and returned to the entrance area by another route via Wadi Mataha. Palestine grid coordinates for these points were calculated but no actual mapping was done. It is estimated that it would cost $400 JD to complete the survey of Petra Basin by the Plane table method.

As an alternate to mapping the basin by plane table an estimate was received from Aero Precisa, Beirut of the cost of mapping by aerial photography. In addition to mapping of the basin the estimate includes mapping a larger area extending from Es Sabra to Beida of a scale of 1:2500.

The estimate is as follows:
Aerial Photographs

- 500 hectares 1:4000 scale: $5,000
- 7200 hectares 1:15000 scale

Topographic Maps

- 1:500 scale: 9,150
- 1:2500 scale: 14,250

Total: $28,400

Approximately 10,000 JD

Recommendation

It is recommended that mapping by aerial photography of the entire Park be done at a scale of 1:5000 (rather than 1:2500) with a 10 meter contour interval and that the areas of concentration of antiquities (Petra Basin, Beida, Siq Barid) be mapped at a scale of 1:500 by aerial photography with extensive supplemental plane table work to map all features of antiquity. This recommendation extends the area for which the Aeco Precisa estimate was prepared but reduces the scale of the overall mapping. It is estimated that the work recommended here would cost approximately 12,000 dinars.
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