Special habitats have been created in this Ecotype due the presence of water, associated vegetation cover and somewhat isolated conditions. The action of flowing water has created several pools, both temporary and permanent, waterfalls, and sandy embankments. These features allow for the presence of a wide variety of riparian and aquatic vegetation, and associated fauna. The presence of drinking water is vital for all organisms residing in the study area and mammals and birds passing through it.

(2) Special Protection/Conservation Status

The study area falls within a prohibited hunting zone. A range land managed by the Forestry Department/ Ministry of Agriculture covers most of the plateau land. The Mujib Wildlife Reserve is also adjacent to the study area. Furthermore, Bird Life International in cooperation with RSCN have declared the Dead Sea area, in which the study area falls, as an Important Bird Area for the Middle East region and Jordan.

(3) Ecological Importance & Sensitivity

Based on the surveys' findings and analysis as shown in Figure 2.6, the ecological importance/sensitivity of each Ecotype is:

Ecotype A can be rated, in relation to the other Ecotypes, as having *Low Ecological Sensitivity.*

Ecotype B can be rated, in relation to the other Ecotypes, as having *Medium Ecological Sensitivity* and should be carefully dealt with during both construction and operational phases.

Ecotype C1 can be rated, in relation to the other Ecotypes, as having *Medium Ecological Sensitivity* and should be carefully dealt with during both construction and operational phases.

Ecotype C2 can be rated, in relation to the other Ecotypes, as having *High Ecological Sensitivity* and should be avoided, as much as possible, during both construction and operational phases.

2.6. Archaeology

The Human Environmental Surveys main objectives is to identify archaeological sites and cultural and heritage sites. This was mainly achieved by conducting database searches, literature reviews, and a walking survey conducted by a team of three.

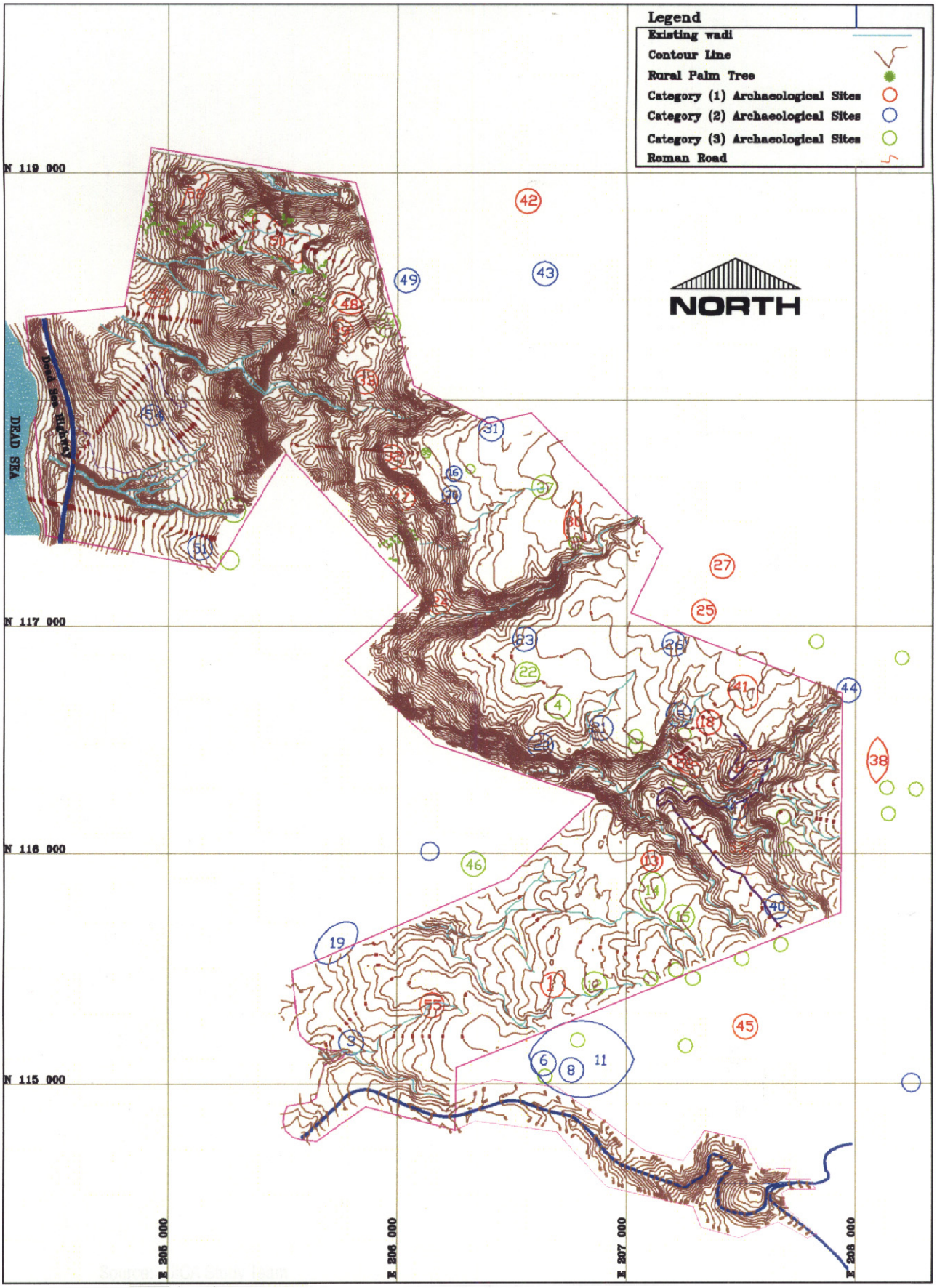
Findings indicate that the hilltops above the project area have always had the concentration of urban development and agriculture because of the favorable soil conditions, climate, availability of water and good trade routes, while the lower Rift Valley margin has traditionally been difficult to access. This fact, coupled with the semi-arid conditions, means that the study area has never been heavily exploited by humans. However, there are permanent and semi-permanent water sources that have provided the means of survival for travelers, nomadic herders, and hunters in the past as they still do today.

The field work conducted under the archaeological survey identified several findings, which are classified under different types(refer to Figure2.7). Under each type, the findings are categorized according to their significance and discussed further.

A surprising number of sites were located during the field survey. They fall into ten basic site types as follows:

- Settlements
- Stone enclosures and circles (some including graves)
- Small stone shelters

Figure 2.7 Archaeological Sites



Source: JICA Study Team

- Walls and fields
- Dams and water harvesting terraces
- Large cairn tombs
- Cemetery
- Single graves
- Flint scatter
- Roman Road

(1) Categorisation of Sites

The located archaeological sites have been divided into three categories as shown in Table 2.3. Their brief explanations are as follows:

Significant sites

The road alignment preferably avoids these sites, or if this is impossible then they must be excavated and documented. The survey findings identified 23 sites, which fall under this category.

Parts of the Roman Road were observed east of site No. 2 at Wadi Himara and dirt road intersection. Based on the observations conducted in 1978, by A. Strobel, this strip of road near Wadi Himara is the furthest west the Roman Road extends. Since 1978, several sections of the Roman Road are likely to have been destroyed by Bulldozer activity

Sites of minor significance

The road alignment should avoid these sites, or if this is impossible then a brief watching must be carried out during construction. The survey findings identified 21 sites, which fall under this category.

Cemeteries and single burials

The road alignment preferably avoids these sites, or if this is impossible then they must be excavated and any bones found should be studied prior to reburial, with the agreement of the Ministry of Awqaf and Islamic Affairs. The survey findings identified 28 sites, which fall under this category.

Table 2.3 Category of Archaeological Site

Category	Number of sites
Category-1. Significant sites	23
Category-2. Sites of minor significance	21
Category-3. Cemeteries and single burials	28

Source: JICA Study Team

Most of these sites (falling close to the recommended alignment) were additionally investigated and duly recorded by the DOA Mission.

2.7. Infrastructures

(1) Access

Between the Madaba-Ma'in Spa road and the National Highway Route 65 there is an existing road, badly damaged and with steep slopes, and which has been poorly maintained. Except for this road there is no access to the site at the southern end. At the northern end of the Parkway, the National Highway Route 65 would be another access, although the connection is rather hard due to the steep slope of the Parkway site.

(2) Water Supply

A water supply pipe is installed to the city of Ma'in 15 km from the site. No water resources could be found in the vicinity of the site. The nearest is the well at Ma'in Spa around 4km from the site.

(3) Electricity Power Supply

No transmission lines are running in the area, but a transmission line of 3.3 KV is connected to Ma'in Hotel (Ma'in Spa) around 4 km from the site.

(4) Drainage

Stormwater drainage may not pose any particular problems and can be discharged to the existing wadis.

(5) Sewerage

The nearest sewerage system is in the City of Ma'in, but it is not possible to connect to it.

(6) Solid Waste Disposal System

A sanitary landfill system can be employed subject to land availability. As an option an incinerator system could be considered.

(7) Telecommunications

No main telephone cables are running in the area, but there is a connection to Ma'in Hotel (Ma'in Spa) around 4 km from the site.

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Chapter 3 Design Premises

3.1. Selection of an Optimum Corridor

3.1.1. Alternative Corridors in the JICA Master Plan Study

In the JICA Master Plan Study, 4 alternative corridors are proposed for the Parkway, each of which shows a continuous area where the road will be aligned within a certain range, as identified below:

Alternative 1: Improvement of existing Ma'in Spa - Zara Road

The existing road can be improved by resurfacing, protection from landslides and falling rocks, guard rails and bays for emergency, etc., without substantially changing the existing alignment. (Realignment necessitates a disproportionate amount of construction work.) Even after the improvement, however, the road can not handle large vehicles due to the steep slopes and sharp curves.

Alternative 2: Branch route from existing Ma'in Spa - Zara Road

A new alignment is needed on the ridge and on the steep slope. This alternative requires a new alignment with less difficult topographical conditions close to the existing one. The grade is gentler than the first alternative. However, it is thought that large vehicles can operate on the road, although they need special care.

Alternative 3: North of Wadi Abu el Asal Route

This alternative makes use of better topographical conditions to the north of Wadi Abu el Asal. It includes improvement of dirt road sections wherever appropriate from the Main Spa Road to the Wadi Abu el Asal Area, and new road construction down to the Zara Area. The grade is gentler than the alternatives above. It is thought that this route will be able to accommodate large vehicles.

Alternative 4: Wadi Ain Hammad-Ain Ad Theb-Suweimesh Route

This alternative uses a route utilizing existing paved and dirt roads on less steep topography. The road between Wadi Ain Hamma and Suwayma is improved to a standard high enough to accept large vehicles. However, it is far from the Ma'in Spa area and close to the Mt. Nebo - Kafrain Road. Therefore, it will not provide significant additional circulation for tourists and its priority is low.

Figure 4.5.1 “Road to Connect Madaba and the Dead Sea” in the JICA Master Plan Report was referred to for the review study.

The JICA Master Plan Study report finally recommended Alternative 3 "North of Wadi Abu el Asal Route" based on the above comparison.

3.1.2. Options of Corridor in SAPROF Study

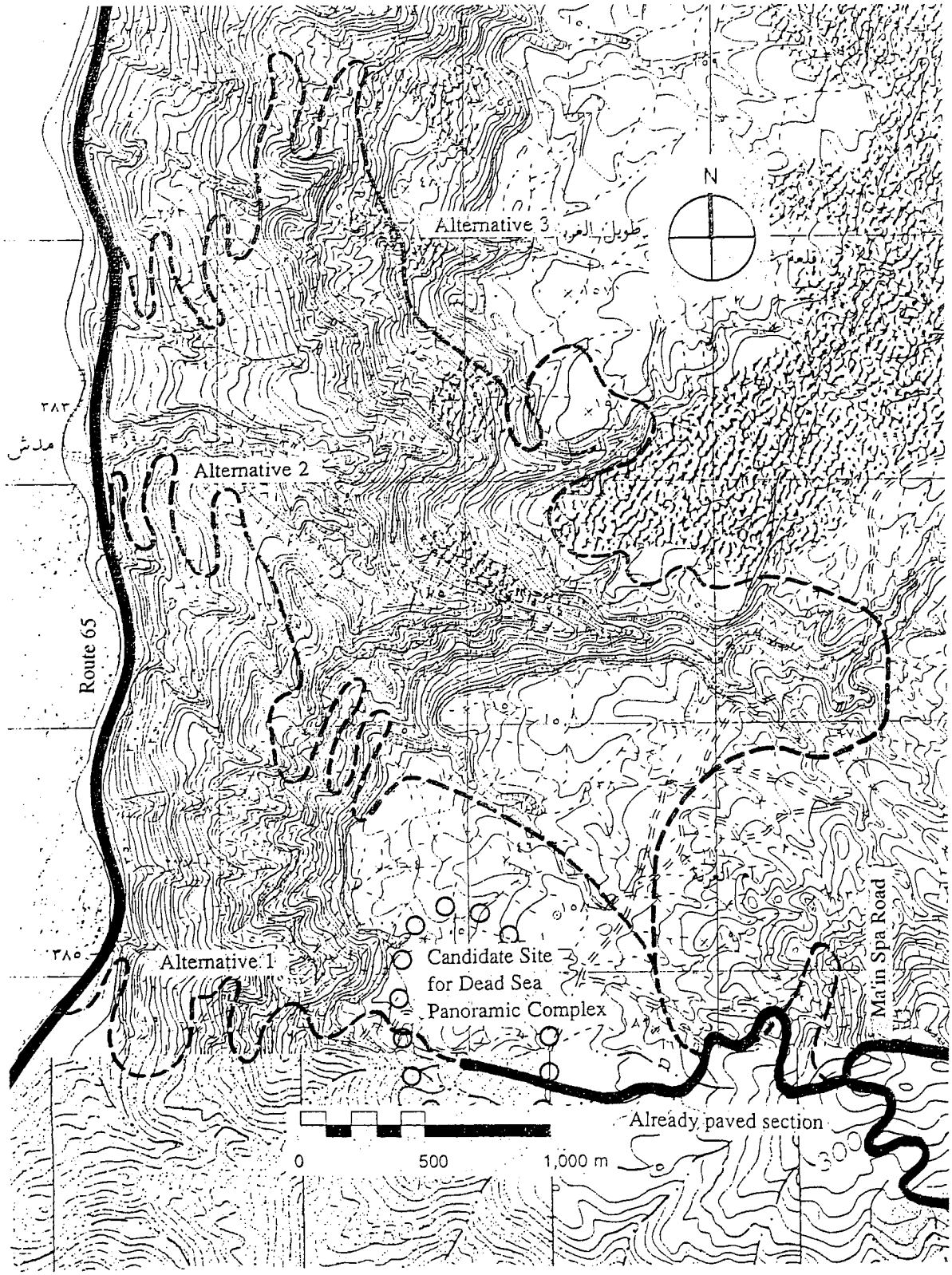
OECF also carried out a Special Assistance for Project Formation (SAPROF) study of the "Tourism Sector Development Project" and prepared a report in March 1997.

The SAPROF report proposed options of the corridor as follows:

- Corridor Option 1: North of Wadi Abu el Asal Corridor
- Corridor Option 2: Branch route from existing Ma'in Spa - Zara Road

The options are shown in Figure 3.1.

Figure 3.1 Study Area and Alternative Corridors proposed by SAPROF Study



Source: JICA Study Team

The SAPROF Study recommended Corridor Option 1 due to its lower gradient than available to the other option and it can accommodate larger vehicles. However, the study also proposed that Corridor Option 2 should be studied comparatively before determining the final route alignment for the detailed design.

3.1.3. Selection of a Corridor in the Study

Finally, Corridor Option 1 was selected as the optimum corridor according to the following considerations made through the various site visits and the results of detailed topographical survey:

1) The length of Corridor Option 2 is approximately 8.5km which is shorter than Corridor Option 1 (13km). The first two kilometers of Corridor Option 2 passes through almost flat plateau. However, the rest of the Corridor passes through the area where the difference in elevation between the plateau and Dead Sea is 500m in 1km distance (1:2).

   It means the alignment of Corridor Option 2 requires a very steeply sloped road. In addition, an almost vertical cliff is shown approximately 100m from the plateau.

2) Considering the topographical conditions in the area of Corridor Option 2, it is very difficult for road construction. If these steep and long slopes are improved and excavated on a large scale, there is a possibility to de-stabilize the slope which may lead to a landslide. Finally, additional budget may be required in order to mitigate such landslide problems.

3) From the environmental aspects, initially, it is judged that the area which covers the 4 alternative Corridors has no significant differences in the natural environment according to the site inspection and the information from the environmental specialists of the Royal Society for Conservation of Nature (RSCN) and Professor Disi, University of Jordan, who are familiar with the natural environment of this area.

4) Corridor Option 1 has better topographic conditions than Corridor Option 2 because this Corridor avoids the steep grade near Wadi Himara and Abu el Asal, and also the Corridor from the plateau to Route 65 has gentler grades for road construction.

5) It is considered that Corridor Option 1 also has the following advantages in comparison with Corridor Option 2.

   The alignment can be designed with gentle slopes since the length of the Corridor is longer.

   - It is simpler in terms of construction method and operation and maintenance in the future.
   - The plateau through Corridor Option 1 has been afforested on a small scale. Therefore, it might contribute to future plantation campaign.

Based upon the above studies and also results of the site inspection, Corridor Option 1 is selected as the final corridor for further study, with minor modifications considering the access of the Dead Sea Panoramic Complex confirmed by MPWH and MOTA.

3.2. Scope of Work

In the SAPROF Study, it is specified that this sub-project consists of the following two (2) work-components.

1) Construction of a new road: Two lanes with 3.6m width and 3.0m wide shoulders shoulder on both sides

2) Construction of a tourist road facility: Asphalt pavement area with landscaping including signing for parking area and signing for vehicles and tourists.

Based on the scope of this sub-project required in the SAPROF Study, the contents of the above work-components are reviewed and confirmed as follows.

3.2.1. Comparison of Scope

Based on a series of discussions with the Technical Committee representing MPWH and PMU, MOTA, as well as various site investigations, the scope of the Dead Sea Parkway Development work-component was reviewed and confirmed with the Jordan side.

The comparison of the proposed facility component and scope with the SAPROF Study is shown below:

Table 3.1 Comparison of Scope of Work

SAPROF	JICA D/D Study
1) Length of Parkway - approximately 13km by JICA Master Plan Report in case of adopting Alternative 3	1) For length of Parkway - reduced to 9.1km according to the topographic conditions as well as environmental conditions
2) End alignment of Parkway - According to the OECF SAPROF report, the end alignment of Parkway to Dead Sea Panoramic Complex site was not clearly identified, but not including road already paved	2) End alignment of Parkway - According to the discussion with MOTA and MPWH, the end alignment of Parkway was decided considering the exact location of Dead Sea Panoramic Complex site
3) Tourist Road Facilities - At least one parking area with shelters, trash bins, etc. along the Parkway	3) Tourist Road Facilities - a Parking area with asphalt pavement of 1000m2 and Landscaping area of 500m2 with trash bins, benches, etc. on both roadsides.
	4) Adding 2.25 km of connecting road from Madaba-Ma'in Section

Source: JICA Study Team

3.2.2. Major Change of Scope

As shown in Table 3.1, the major changes in the scope of the work-component are as follows:

(1) Length of Parkway

Originally, the length of Parkway was estimated as approximately 13km in the JICA Master Plan Report. However, as a result of the topographic survey and the alternative study of alignment of Parkway, it was found out that the length of the recommended alignment of Parkway is estimated as approximately 9.1km.

(2) Alignment in southern end part of Parkway

Originally, according to the SAPROF Study, the south-end alignment of the Parkway to the Dead Sea Panoramic Complex site was not clearly identified. Therefore, it was proposed that the alignment in the area at the southern end of the Dead Sea Parkway should be closer to the Dead Sea Panoramic Complex site for the convenience of visitors to the Complex. On the other hand, it was also requested by MOTA to make a study to determine the alignment of the Parkway keeping a certain distance for the deduction of traffic noise from the Parkway. Such space should be beneficial to the hotel site, which will be developed in the future and also should function as a buffer zone to avoid illegal settlements around the Panoramic Complex and the hotel sites.

According to the study of traffic noise, 300m between the Parkway and the Panoramic Complex area is formulated as an adequate distance to decrease traffic noise level to 50 dB

which is commonly understood as the noise level in the morning time of residential area. The result of the study was agreed by MOTA.

According to the above, the topographic survey area of the Dead Sea Parkway is proposed to be shifted to the west from the original survey area by approximately 400m.

It was finally confirmed with the Jordan side that the end alignment of the Parkway is as follows;

- To set the alignment at 300m from the Panoramic Complex site, and
- To shift the topographic survey area to the west by approximately 400m.

(3) Addition of a connecting road

It was assumed that the SAPROF Study judged that the existing road of approximately 2.25 km between the south-end of the Parkway and the existing road section of Mdaba-Ma'in Spa could be a connecting road to the Parkway. However, through the site investigations made during the D/D stage it was raised that the connecting road could not be used because it is badly damaged and has too steep slopes,and is unsuitable for large tourist buses. MOTA as well as MPWH requested and the steering committee and JICA agreed to add the improvement of the connecting road as a part of the Parkway. By this regard the total road length of the Parkway has become 11.5 km in total.

3.3. Design Standard and Design Criteria

The Parkway is sub-divided into the following sections in general according to topographic conditions and process formulating the sub-project:

Part-A (Sta. 0+000 ~ Sta. 5 + 540);	Construction of a new road section starting from the intersection of Dead Sea Highway Route 65 with the very steep gradient of 500m height and 1,500m length.
Part-B (Sta. 5+300 ~ Sta. 10+200);	Construction of a new road section running on the rather flat plateau of the Dead Sea, with two large wadis, which require some crossing structures such as a bridge.
Part-C (Sta. 10+200 ~ Sta. 11+635.75);	Improvement of the badly damaged existing road, running in the steep slope area.

The general design criteria for the Dead Sea Parkway sub-project is as follows;

3.3.1. Traffic Volume

The traffic volume of the Dead Sea Parkway on an average day and the peak day (Friday) estimated by the JICA Master Plan Study Team is as shown in Table 3.2. The traffic volume includes vehicles of tourists, passing tourists, and non-tourists and is the basis of the detailed design.

Table 3.2 Traffic Demand Estimation

	2000		2010	
	Average day	Peak day	Average day	Peak day
Total traffic volume (vehicle/day-v/d)	1,690	2,480	3,340	4,480

Source: JICA Master Plan Study Team

3.3.2. Road and Pavement Design

All geometric Design Standards are based on the following standards:

- AASHTO " A Policy in Geometric Design of Highways and Streets ", 1994 edition,
- Japanese Standards: Ministry of Construction
- Jordanian Codes of Practice (MPWH), and
- Specification for Highway and Bridge Construction (MPWH-1991).

The proposed Dead Sea Parkway is aimed at serving tourists and some local traffic. The proposed parkway will connect the Dead Sea Highway (Route 65) with the Ma'in Spa Main Roadway. The Parkway is being considered as a secondary road, which passes through a rural area.

The alignment of the road is refined in order to comply with specific conditions of the site taking into consideration that several alternatives were studied.

Several design speeds are considered giving flexibility for the designer during the design of both the horizontal and vertical alignments, taking into consideration the mountainous and rough terrain the Parkway passes through.

The flat to hilly parts of the alignment are designed for 50kph while the mountainous and steep parts are designed for 30kph.

The Starting Point of the Project (00+000) shall be at the intersection point with the Dead Sea Highway Route 65 while the end of the road shall be at the intersection point with Ma'in Spa Main Road.

The cross-section of the proposed road is designed to accommodate one lane of traffic in each direction having a width of 3.7m/lane, together with shoulders for both sides of the road. According to AASHTO, shoulder width can vary from 1.8 m to 2.4 m, hence, it is proposed to use 1.8 m shoulders in steep areas and 2.4 m in flat to hilly terrain.

Geometric Design Criteria

Table 3.3 is the summary list of the General Geometric Design Criteria, which have been approved earlier by MPWH with minor modifications presented regarding the lane width, guardrail spacing and the maximum super-elevation (6% instead of 8%).

3.3.3. Structural Design

(1) Codes and Standards

The design standards and codes adopted for bridges and other highway structures are:

1) AASHTO Specification for Highways and Bridges
2) Jordanian Codes of Practice (MPWH)
3) Specification for Highway and Bridge Construction (MPWH-1991)
4) Japanese Standards and Codes; Ministry of Construction

(2) Design Criteria

The main design criteria for bridge design can be summarized as follows:

Loading for bridges

- Permanent loading:
  - Reinforced concrete density = 2.5 t/m^3
  - Wearing surface density = 1.8 t/m^3
  - Additional 5cm of future wearing surface shall be considered

Table 3.3 General Geometric Design Criteria for Parkway

Design Element	DESIGN SPEED		
	30 km/hr	40 km/hr	50 km/hr
Lane Width (m)	3.7	3.7	3.7
No. of Lanes	2	2	2
Shoulder Width (m)	1.8m/Steep Slope Sections	1.8m/Steep Slope Sections	1.8m/Steep Slope Sections
(w.o. clearance for G. Rail)	2.4m/Flat & Hilly Sections	2.4m/Flat & Hilly Sections	2.4m/Flat & Hilly Sections
Cross Slope	2.0% Lane	2.0% Lane	2.0% Lane
	4.0% Shoulder	4.0% Shoulder	4.0% Shoulder
Stopping Site Distance (m)	29.6	44.4	57.4 - 62.8
Passing Site Distance (m)	217	285	345
HORIZONTAL ALIGNMENT			
Minimum Radius (m)	30	50	80
Maximum Super-elevation	6.00%	6.00%	6.00%
Sharpest Curve w.o. (S.E)	400	700	1000
Minimum Runoff (m)	40	45	45
Equivalent. Relative Slope	1 / 133	1 / 143	1 / 150
Super-elevation Method	Around C.L	Around C.L	Around C.L
Widening (m)	3.4, R=30	2.2, R=50	1.5, R=80
	2.5, R=40	1.8, R=60	1.4, R=90
	2.0, R=50	1.6, R=70	1.2, R=100
	1.7, R=60	1.4, R=80	1.1, R=110-120
	1.4, R=70-80	1.2, R=90-100	1.0, R=121-130
	1.2, R=81-90	1.0, R=101-130	0.9, R=131-140
	1.0, R=91-110	0.8, R=131-170	0.8, R=141-170
	0.8, R=111-140	0.6, R=171-180	0. 7, R=171-180
	0.6, R=141-160		0.6, R=181-200
VERTICAL ALIGNMENT			
Minimum Grade	0.30%	0.30%	0.30%
Maximum Grade**	12%	12%	12%
Vertical Curvature (K)			
- Crest	3	5	9-10
- Sag	4	8	11-12
CUT SLOPES***			
Talus Deposit	1 V : 1 H	1 V : 1 H	1 V : 1 H
Lisan Sand, Marl	1 V : 1.3 H	1V : 1.3 H	1 V : 1.3 H
Weathered Sandstone	1 V : 1 H	1 V : 1 H	1 V : 1 H
Sandstone	1 V : 0.5 H	1 V : 0.5 H	1 V : 0.5 H
FILL SLOPES***			
H < 2.0m	4 H : 1 V	4 H : 1 V	4 H : 1 V
H < 3.0m	3 H : 1 V	3 H : 1 V	3 H : 1 V
3.0m < H < 6.0m	3 H : 2 V	3 H : 2 V	3 H : 2 V
H > 6.0m	2 H : 1 V	2 H : 1 V	2 H : 1 V

Note: * Criteria for Design Speed of 20 kph were mainly derived from Japanese Design Code
**The maximum slope reached 14% for a stretch of 600m near Mai'n Main Road
*** Refer to design cross sections and available soil investigation report that covers Part B. Soil investigation of Part-A shall be performed by the contractor during construction.

Source: JICA Study Team

- Live load:
  - Design load shall be based on AASHTO-HS20-44 (MS18) + 50% as per MPWH.
  - Recommendations due to the variety of axle loads and the lack of systematic control on trucking and truck loads.
- Earthquake load:
  - To be based on an effective peak ground acceleration (A) = 0.2g [with 90% probability of not being exceeded in a lifetime of 50 years for the area under study].
- Wind load:
  - To be based on a basic wind speed of 126Km/Hr as per the Jordanian loading code
- Thermal forces:
  - To be computed based on a temperature rise of 22^{o}C and temperature fall of 20^{o}C.

Materials

1) Concrete
   - Concrete Class C15 shall be used in all plain concrete, such as mass concrete, blinding, etc. It should have compressive strength of 15 N/mm^2 for cube or 11.55 N/mm^2 for cylinder.
   - Concrete Class C25 or C30 shall be used in all reinforced concrete as specified on drawings for the relevant reinforced concrete structures. It should have compressive strength of 25 N/mm^2 (cube) or 21.75 N/mm^2 for cylinder for C25 and 30 N/mm^2 (cube), 26.1 N/mm^2 for cylinder.
   - Concrete class C40 shall be used in pre-stressed concrete. It should have strength of 40 N/mm^2 (cube) or 34.8 N/mm^2 for cylinder.
2) Steel
   - Reinforcing steel bars shall be deformed bars of high strength, grade 60 conforming to JSS/441/1986 or AASHTO M31M (ASTM A615 M). Stirrups shall be Grade 40
3) Soil
   - The bearing capacity shall be calculated based on AASHTO methodology.
4) Cover around the reinforcement bars

   The location is close to the Dead Sea and reinforced concrete can easily be damaged by a lack of cover. The minimum cover around reinforcing bars, adopted in this project, shall be as follows;

   Bridge
   - Deck slab, Girder diaphragm and parapet: 5.0cm
   - Abutment; wall, wing walls and pier: 7.0cm
   - Abutment; Base of wing, walls and pier: 7.5cm

   Retaining wall
   - Walls: 7.0cm
   - Bases: 7.5cm

Box culvert

- All outside faces: 5.0cm
- Top and bottom slabs, and inside faces: 7.5cm

3.3.4. Rainfall Conditions

The average annual rainfall for the station is about 360mm, with approximately 46 rainy days per year and the maximum depth of rainfall in 24 hours is 85mm according to the available record which was started in 1937.

There is no stream flow data available for the basins inside the project area.