



2007 On Site Review Report

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Wadi Hanifa Wetlands

Riyadh, Saudi Arabia



Architect

Arriyadh Development Authority

Client

Arriyadh Development Authority

Design

2001

Completed

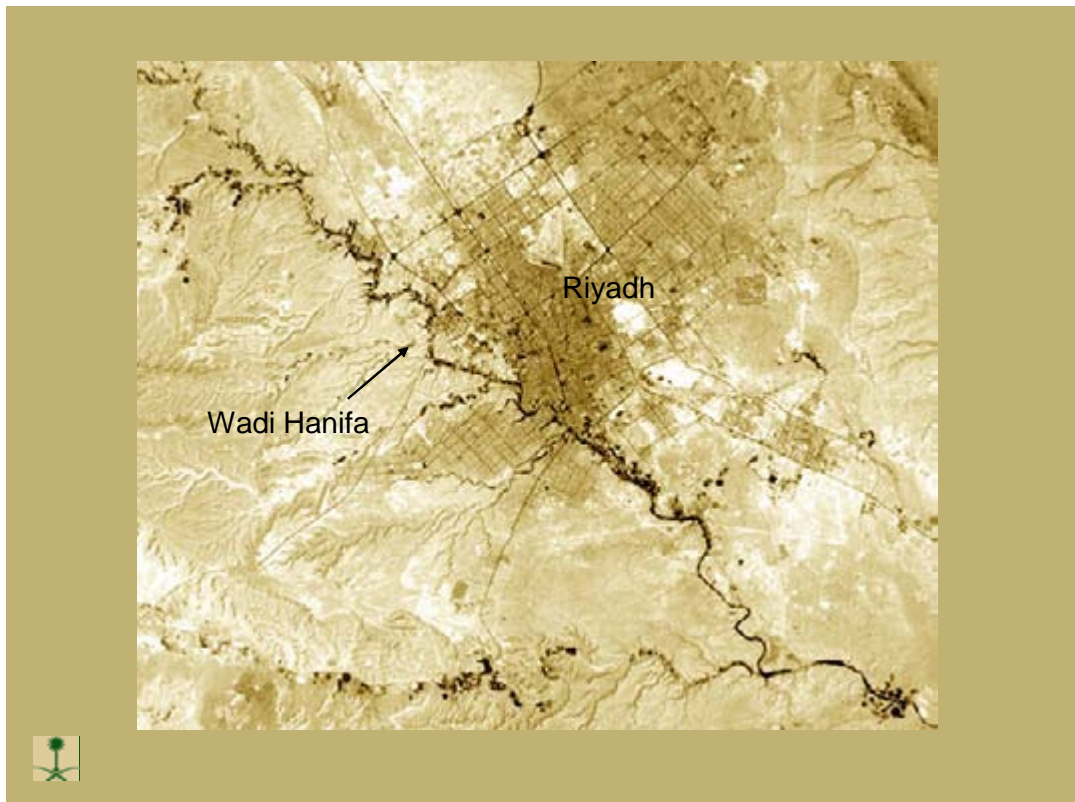
2004 - 2007

Wadi Hanifa Wetlands

Riyadh, Saudi Arabia

I. Introduction

Located in the middle of the Najd Plateau of the Kingdom of Saudi Arabia, the Wadi Hanifa watershed is the most significant natural landmark in the region. Its basin and many tributaries form a unique 120 kilometre-long ecological zone that descends from the Tuwaiq escarpment in the northwest to open desert southeast of Riyadh. The development of the wadi (referring henceforth to the wetlands) is inextricably tied to the history of Riyadh.



An oasis at the heart of the Arabian peninsula, the Wadi Hanifa watershed system has long provided sustenance for communities along its length. For centuries a balance prevailed between the water, land and resources of the wadi and the people living around it, between natural processes and human interventions. This stability existed because the inhabitants of the wadi were completely dependent on it for their survival and prosperity.

The first Saudi state strategically located its capital at Addiriyyah on the west bank of Wadi Hanifa, taking advantage of water, stone, and arable lands. Subsequently, Riyadh or Arriyadh, the new capital of the modern Saudi state, developed to the east of Wadi Hanifa. Until the rapid expansion of Riyadh that started in the mid-1970s, the city and the wadi existed in harmony with each other, with the wadi used as a sustainable resource for water and food.

II. Present Condition of Wadi Hanifa

From the early 1970's Riyadh expanded westward towards Wadi Hanifa, eventually spreading along its west bank. The wadi was exploited to satisfy the increasing demand for water and to provide mineral resources to meet the massive construction needs arising from the rapid growth of the capital city. By the 1980's, the water resources in the wadi and indeed the whole region could not cope with demand, and water table levels had dropped to well below sustainable limits.

To meet this new level of demand, water began to be supplied from the desalination plant in the Eastern Province. This brought with it new problems: the rise in groundwater, and the need to control this increase. As the natural drainage system for the region, Wadi Hanifa provided the solution: groundwater control by its discharge into the wadi.

Groundwater is drained from the City through the storm drainage system, and discharged into a surface flow channel in Wadi Hanifa, which drains the flow south of Al Hair. The resulting permanent flows to the lakes south of Al Hair have been a mixed blessing. On the one hand, dry weather flows have created attractive microclimates for diverse plant and wildlife communities, as well as recreational opportunities for people. On the other hand, however, the permanent flow is perceived as a sewer because its water quality is poor, it smells in certain places, and is a health hazard in others. The solution to the problem of rising urban groundwater has been appropriate and positive, but does not fully exploit the potential benefits of the water flows into the wadi because the question of water quality has not been adequately addressed.

Despite regular attempts to improve the condition of Wadi Hanifa, mainly by clearing dumped material, the ongoing condition of the wadi remains poor. The structures of responsibility for its ongoing maintenance remain unclear because the wadi lacks special planning and development status. The lack of a comprehensive plan that addresses ongoing problems has also made it difficult to improve and restore Wadi Hanifa to health and so improve the quality of life for the people of Riyadh.

The following issues continue to go unanswered:

Environmental degradation, loss of natural functioning and ecosystem productivity of the wadi through the un-sustainable use of land, water, energy and other resources

- Illegal dumping of solid and liquid wastes
- Lack of special development controls for Wadi Hanifa and its environs
- Development that has led to encroachments on the flood flow channel, and to changes in the level of the wadi bed. These conditions have negatively affected the wadi's function as a natural drainage system, and its ability to deal with floods
- Inadequate system of surface flow channels, which receive flow resulting from rising groundwater as well as discharge from the Manfouha Sewage Treatment Plant. The measures taken so far have provided an interim response to the problem, but require planning and coordination that address a broader range of issues

- Uncontrolled discharges into the wadi surface flow channel and/or its tributaries – for example from the abattoir, the tannery, as well as unauthorised discharge from sewage tankers
- Health issues related to the quality of water in surface flow channels because of uncontrolled discharges
- The general waste of a potentially valuable water recycling resource
- Visual degradation, resulting from loss of natural environment, dumping, quarrying, lack of co-ordinated infrastructure installation, and lack of development control
- Uncoordinated use of the wadi for trunk utilities, such as sanitary, potable water, irrigation mains, and use of the wadi for overhead electrical distribution.

The degradation of the wadi needs to be reversed if a sustainable future for the City and the Region is to be achieved.

III. Actions Taken by the Arriyadh Development Authority

In the 1980s, investigations began into the consequences for Wadi Hanifa of recent development and expansion of Riyadh which had led to the rise of ground water and dumping among other consequences. Since then, actions have been taken to alleviate the degradation of the wadi's environment and to prepare for a comprehensive development plan.

The Arriyadh Development Authority (ADA) has undertaken technical studies in parallel with the development of a strategy for the wadi. In addition to the groundwater studies and ongoing groundwater monitoring, the ADA has conducted studies on water resource and flooding, as well as historical and archaeological assets in the area.

These studies were used, together with the ongoing water flow and quality monitoring, as the technical basis of the Strategy for Wadi Hanifa, which was adopted in 1994. The core objectives of this plan were as follows:

- Conservation of the wadi's natural environment
- Removal of disorderly activities and uses
- Preparation of the wadi as a natural drainage course for Riyadh
- Use of the wadi as a recreational area
- Enhancing and upgrading agricultural use
- Preservation and utilisation of heritage assets

The 1994 Strategy for Wadi Hanifa has only been partially implemented. Quarrying in Wadi Hanifa has been stopped. Whilst the wadi provided a convenient and substantial source of stone and aggregates for construction, mining and excavation activities severely damaged the landforms of the wadi. Cessation of this activity within the wadi has had a positive effect, although uncontrolled dumping in some quarries has created a potential health hazard. Where inert building or excavation material is dumped, no health risk has been created. However, in areas where industrial, clinical or domestic waste is being dumped, there is a risk of groundwater or surface runoff contamination.

There have also been significant and frequent actions taken to clear dumped material throughout the wadi. These have led to an immediate improvement in appearance, but not to the cessation of dumping as a general practice.

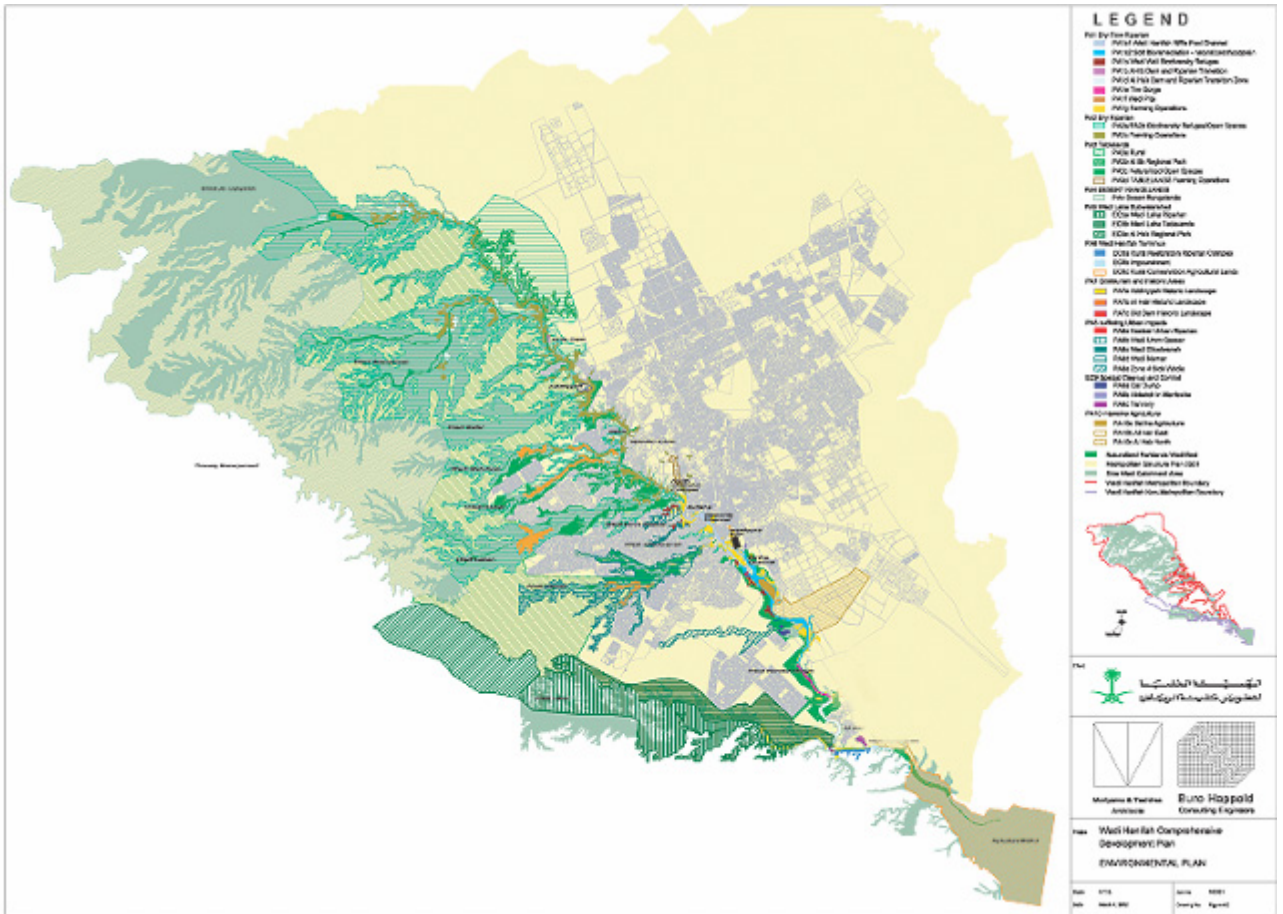
The wadi continues to deteriorate because proper implementation of the 1994 Strategy requires a comprehensive and co-ordinated development plan, as well as a management structure to implement this plan. Adoption of a comprehensive development plan for Wadi Hanifa would provide a framework for action to restore the ecosystem functioning of the wadi, create healthy environments and provide opportunities for water reclamation—in addition to improvements in the quality of life. Without the adoption of a comprehensive development plan, and the actions to implement such a plan, there is a real risk that Wadi Hanifa will continue to decline, keeping opportunities for recreation, tourism and water recycling beyond reach, and preventing future generations from being able to meet their basic needs.

A committee of people from the concerned agencies was formed to define the flood boundaries of the wadi and identify the encroachments thereof. The outcomes of this search, which was approved by the High Commission in 2001, formed the base for the works laid out in the Wadi Hanifa Comprehensive Development Plan.

IV. The Wadi Hanifa Comprehensive Development Plan

In 2001 ADA commissioned the British consultants Buro Happold along with their Canadian Landscape Architect partners Moriyama & Teshima to develop the Wadi Hanifa Comprehensive Development Plan (WHCDP), to draw together all the completed studies and contain a plan to meet the future needs of the City. The terms of reference also required that designs be prepared for a first contract of works for the restoration of the wadi from the Al-Ilb Dam in the north to Al Hair in the south.

The WHCDP forms part of a 10-year programme of works that aims to restore and develop Wadi Hanifa as an environmental, recreational and tourism resource – not only to restore its natural beauty, but also harness and rehabilitate its water. In addition, the consultants were also asked to develop guidelines for the use as a planning policy document. The ADA recognised that the lack of such planning controls would seriously undermine the restoration project, and an area known as the Wadi Hanifa Reserve was defined as the place where the planning policies would be applied.



The pollution caused by decades of illegal and unrestricted dumping of untreated waste, rubbish and development has resulted in an environment that is injurious to the local environment and the people of Riyadh.



The ADA's vision to restore the wadi back to its original state is well on its way to being realised.

The capital construction works to implement the master plan have been divided into two parts: The 'Wadi Hanifa Restoration Project' involves those construction works necessary to restore flood performance and water quality, and to complete the restoration of the wadi bed; and the 'Wadi Hanifa Development Programme' is formulated around those public infrastructure and public landscape capital construction works which, together with private sector investment projects, will build on the platform provided by the Wadi Hanifa Restoration Project to complete the implementation of the Wadi Hanifa Comprehensive Development Plan.

V. The Wadi Hanifa Restoration Project

The project begins the overall implementation process by first meeting existing demands along Wadi Hanifa before addressing future needs. The key steps involve restoring and protecting the environmental values of the wadi and upgrading its functionality, including:

- Cleaning the wadi bed of dumped material
- Improving the flood performance of the channel by reprofiling and regrading
- Improving the wadi's road network in relation to the proposed water restoration works, to better accommodate local access needs, improve connections to the Riyadh road network, and provide better performing and safer local roads
- Improving and relocating the utilities network in the wadi (required by the proposed water restoration works and proposed road works)
- Introducing landscaping to re-establish natural vegetation in the wadi bed
- Improving the surface flow channels and introducing discharge, bio-remediation and monitoring practices to clean the water flowing through Wadi Hanifa
- Developing a major part of the wadi Bed Naturalized Parkland and Recreational and Interpretative Trail, to get early public participation and use of the wadi environment and to encourage public "buy-in" and "ownership" of the Wadi Hanifa project
- Establishing a platform of a clean environment, accessibility, environmental quality, public landscape and cultural resources to attract private investment for additional private-sector projects. This is critical to attract private sector tourism investment.

The construction in the wadi has been split into 5 zones; work has been ongoing for almost four years in an area that stretches from the Al Amariyah road to Al Hair dam, a distance of some 71 kilometres.

The construction works have involved the removal of almost 1.25 million cubic metres of construction waste as well as other inert and non-inert waste that has been dumped in the wadi over many years. There has also been a restoration of the wadi channel to cope with a one in twenty-year storm, in order to contain the water in times of flood. Prior to this work, there was widespread flooding when it rained due to the rubble and illegal building within the wadi which impeded the flow of water into the channels.



Before



After



Before



After

In conjunction with this, the original network of un-coordinated roads, utilities and dry weather flow channels has been reorganised and co-ordinated as much as possible. A majority of the overhead power lines have been relocated underground, and other utilities have been placed in dedicated corridors beside the reconstructed road system that has been designed to withstand flooding.

Pollution caused by decades of illegal and unrestricted dumping of untreated waste, rubbish and development has resulted in an environment that is injurious to the local environment and the people of Riyadh.

Approximately 450,000 cubic metres of water (dry weather flow) continually flows out of the city each day into the Wadi Hanifa from various side wadis and channels. The main sources of flow into the wadi are:

- The North Diversion Channel – 24,000m³/day
- Wadi Gudwannah – 3,600m³/day
- Wadi Umm Qassar – 9,000m³/day
- West Ship – 19,300m³/day
- Batha Channel (Manfouha STP outfall) – 250,000m³/day (average) 450,000m³/day (peak)

These flows are expected to increase two-fold by the year 2021.

At the moment this water cannot be reused for irrigation, agriculture and non-potable water uses, because of water quality concerns.

Riyadh currently consumes 1.3 million cubic metres of water and this is expected to rise to 3 million cubic metres by the year 2021. Because of the continual draw-down of the water table to cope with the city's ever increasing population, Riyadh has had to find alternative sources of water. Now most of the city's (desalinated) water supply is piped in from the coast 350km away, a very expensive and unsustainable option.

ADA's plan is to try and recycle one million cubic metres of water per day by 2021 to meet a third of the city's total water demand; to achieve this, it is necessary to clean up the water entering the wadi.

The system that has been set up to clean the water makes use of natural processes. Introducing oxygen in to the water results in the coliform bacteria present in the water being killed off and allows micro organisms to grow, further adding to the natural cleaning of the water. Various methods have been used to achieve this, including the construction of a new stone-lined channel that allows micro organisms to grow, which in turn act as a part of a food chain for various other predators such as fish that feed on the various life forms in the water and rocks. A series of natural stone weirs have been built in order to introduce oxygen into the water as it passes over and through them.



Fig. Typical Natural Stone Weir in the Dry Weather Flow Channel

Just down stream of the weirs, pools have been constructed which will have a series Artificial Periphyton Benthic Substrate Devices (APBS) placed in them. The units resemble upside-down mops and have a very large surface area to allow the various organisms that will feed on the pollution to grow. There will also be fish in the pools.

Although the features described above will help reduce the amount of pollution in the wadi, the major part of the water-cleaning process comes out of the bio-remediation plant:



Bioremediation Facility Under construction

The water enters the system on the far left of the picture and works its way down through a series of cells (see below) to the final area where a fountain again adds more oxygen to the system. The fountain will achieve at least a 20m column of water.



Original Design Layout of Bio-remediation Facility

There are now three compartments to the bio-remediation system, although in the original concept, there were four. The reduction in size was due to the high cost of rerouting some of the larger services buried within the wadi bed. To overcome this 'loss', however, the cells from the compartment that was unrealised have been redistributed in the third compartment, so there has been no loss in the function of the facility.

There are 134 individual cells in the bio-remediation system, configured in a herring-bone arrangement. The cells are designed to have the same amount of water flowing at the same time and to keep the water within the cells as long as possible, in order for the various parts of the cell to act on the water to reduce the amount of pollution.

To help reduce the coliform bacteria and other pollutants in the water, oxygen will be introduced into each of the inlet channels (running down the spine of each compartment) by a series of perforated pipes (similar to the ones used in the bases of fish tanks, only much larger).

Within the cells, natural organisms will create a food chain which will act on the bacterial organisms and in doing so clean up the water. Fish will be the top predator and these will be introduced to the bioremediation facility where they will be harvested on a regular basis. It is anticipated that in excess of one tonne of fish per day will be taken from the facility.

VI. Wadi Hanifa Development Programme:

The cleaning up of Wadi Hanifa is of course a critical part of the project however just as important are the other measures designed to bring the wadi back to the people of Riyadh. The Wadi Hanifa Development Programme builds on the work of the Restoration Project, with strategic public and private sector projects aimed at developing the environmental, cultural, recreational and water resources of the Wadi Hanifa. The programme's methods include:

- Providing open spaces and parklands along the wadi and extending them into surrounding residential areas.
- Developing the magnificent cultural resources of Wadi Hanifa, particularly at Addiriyyah, Hay Al Masani, the Old Dam and Old Al Hair.
- Re-establishing the natural landscape in the desert tablelands and rangelands of the desert catchment area above the wadi bed, including construction of check dams.
- Providing private sector investments to renew the Seyah mixed use development area.
- Providing private sector investment opportunities for recreational and leisure facilities.
- Providing private sector investment opportunities for tourism development.
- Providing private sector investment for innovative agricultural development.
- Constructing the impoundment downstream of Al Hair, to meet the future reserve capacity needs for water recycling in Riyadh.
- Constructing water recycling and treatment facilities, to meet the future water recycling needs of Riyadh.

To achieve this, a series of landscaping and other features have been introduced:

- Rock features to introduce an interesting natural feel to the wadi.
- Planting of palm trees at some of the gateways to Riyadh.
- Landscaping cells of indigenous species of flora that occur naturally in the wadi and are proven to be hardy in the harsh environment. Through natural regeneration these will spread throughout the wadi.
- Interpretative trails that wind their way throughout the wadi allowing the public to access the area easily and to direct them to places of interest.
- The interpretative trails and wadi roads will be lit to allow safe access through the area during the cooler night period
- Lighting to provide an interesting ambience to the wadi by lighting up certain features, such as rock escarpments, to bring an interesting look.
- Using existing features to create interesting landscapes.
- Creation of lakes and parks for recreational purposes. At the moment five large parks are under construction.
- Prayer areas.
- Toilet blocks.
- Interpretative signage has been introduced.



Fig. Palm Trees at Algeria Maidan



Old Stone Dam will form an integral part of a park area



New Lakes off AL Jezah



Massana Lakes before Clean-up

Future enhancement features include:

- An educational and interpretative visitor centre will be constructed within the wadi's boundary. This centre will focus on the educational and social aspect of the wadi by using videos and interactive features to show how important the wadi is and has been to the city of Riyadh
- Development of the side wadis to link them into the main wadi
- Kiosks and food/ drink outlets will be added
- Establishment of prayer areas throughout the wadi
- Iconic bridges will be introduced into areas of public interest
- Establishment of play and recreation areas

- Cable car access being introduced into some areas
- Reintroduction of animals indigenous to Saudi Arabia into some areas of the wadi
- Establishment of a wadi plant nursery that will be used as a resource to further enhance the wadi and to supply trees and plants to other ADA projects throughout Riyadh

The Wadi construction has been split into 5 zones and currently the construction for the completion of 2 sections - Lower Zone 2 and Zone 3 - within the city boundaries are due to be completed by the end of the year (see Appendix A for details of completion dates and costs for other parts of the project).

Currently the ADA is looking at further ways of enhancing the main wadi and to develop and restore many of the sub-wadis to bring these into what is becoming the “Great Park of Riyadh”.

The ADA is currently in the process of setting up the Wadi Hanifa Directorate, which will be ultimately responsible for the continued maintenance and development of the wadi.

With water at a premium in many developing countries, this scheme is a cost effective method of achieving cleaner water to help create a healthy environment and to allow people to achieve a more healthy and productive life.

The scheme has won international recognition with the awarding of the prestigious Waterfront Prize in Montreal in 2003, and the project was presented to the United Nations in New York in April 2004. It also received in 2006 a “Highly Commended” award by British Expertise, an association representing consulting and construction firms operating internationally.

Appendix A

Wadi Hanifa Facts and Figures as at End of April 2007

<u>Zone 1 and Upper Zone 2</u> Ch 0 to Ch 28+700	Est. Completion Date July 2008
<u>Lower Zone 2</u> Ch 28+700 to Ch 36+487	Est. Completion Date July 2007
<u>Zone 3</u> Ch 36+487 + Ch 52+900	Est. Completion Date Jan 2008
<u>Zone 4</u> Ch 52+900 to Ch 74+780	Est. Completion Date Jan 2008
<u>Zone 5</u> Ch 74+780 to Ch 78+830	<u>(Not out to Tender)</u>
<u>Lighting</u>	Est. Completion Date Jan 2008
<u>Toilet Blocks</u>	Est. Completion Date Dec 2007
<u>Parks</u>	Est. Completion Date Dec 2007
<u>Signage</u>	Est. Completion Date Dec 2007
<u>Additional Roads</u>	<u>(Not out to Tender)</u>
<u>Additional Parks to be Constructed</u> Wadi Laban Dam DQ Sub Wadi Al Hair Park	<u>(Not out to Tender)</u>