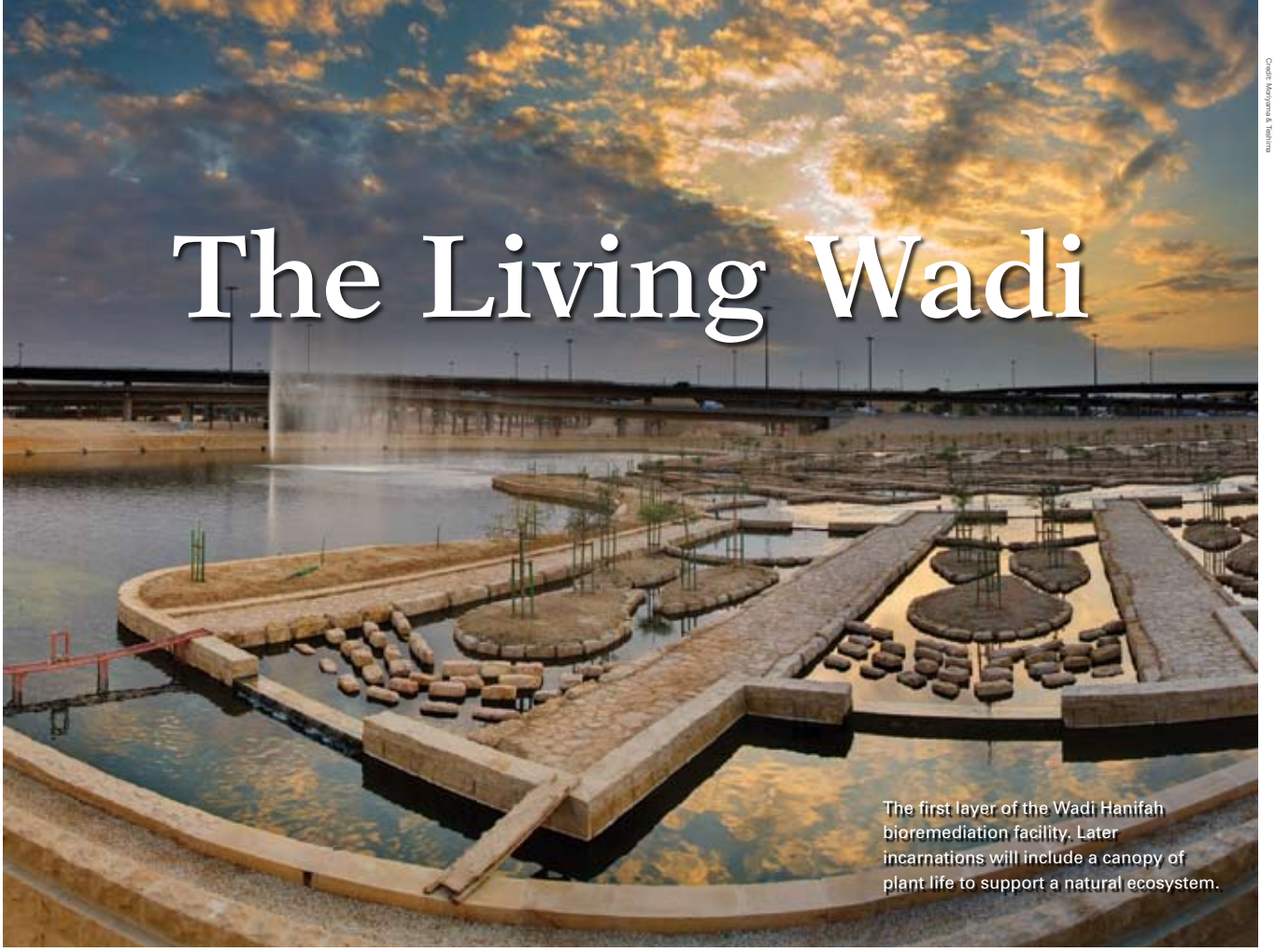
The Living Wadi



Credit: Moriyama & Teshima

The first layer of the Wadi Hanifah bioremediation facility. Later incarnations will include a canopy of plant life to support a natural ecosystem.

A low-tech, high-thought application brings a river back from the dead.

BY DREW WENSLEY AND GEORGE STOCKTON

IMAGINE AN URBAN RIVER flowing in the heart of a desert nation. Riyadh, Saudi Arabia is home to such a river—the Wadi Hanifah. As the city developed at a rapid pace, the river grew sick, threatening the lifeblood of the city, its residents, and its economy. By 2001, the river was polluted from direct dumping of industrial and municipal wastewater, leaving it so damaged that the entire ecosystem along its shores and within a 4,500-square-kilometre catchment area was close to extinction.

But, over ten years, a groundbreaking natural process of naturalization and bioremediation has put the Wadi Hanifah on the road to recovery. The Arriyadh Development Authority (ADA), working closely with Canadian architecture and planning firm Moriyama & Teshima, in partnership with UK engineering firm Buro Happold, has restored the ecosystem, and the Wadi continues to be a sustainable source of life for this already huge and still growing city.

Naturalization of the watershed

One of the first steps in the naturalization process was to clear the entire Wadi riverbed of 500,000 cubic metres (m^3) of dumping and debris, followed by extensive flood-profiling measures, including the relocation and installation of utilities and roadways. Next, the team revegatated Wadi Hanifah with the same indigenous species of plants that once inhabited it. The ADA and its contractors collected cuttings and seeds from some of the least damaged portions of the Wadi, and began growing thousands of trees, shrubs and grasses in their greenhouses.

The new plants were installed in over 150 different designs of planting cells, designed for the climate's unique conditions, and constructed by the thousands within the Wadi bed along 70 kilometres. Within three years, these planting cells have proven very effective—they're transforming the bare earth of the Wadi bed into attractive greenery and a viable habitat that suits the arid desert setting and ecology.

The bioremediation facility

One of the project's main goals was to remediate urban wastewater, recycle it for reuse, and do it all naturally and without a lot of power. Bioremediation fit the bill.

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The plan kick-started the Wadi's natural remedation system by establishing an ecologically efficient food web consisting of not only primary producers (algae and higher plants) and consumer organisms (fish, birds, insects, et cetera).

Within the dry weather flow channels

One of four on-site water quality experts takes a sample to monitor the facility's success. Each sample site tests for 22 quality parameters, grouped under four categories: general variables, organics, nutrients and microbiology.

Credit: Moriyama & Teshima

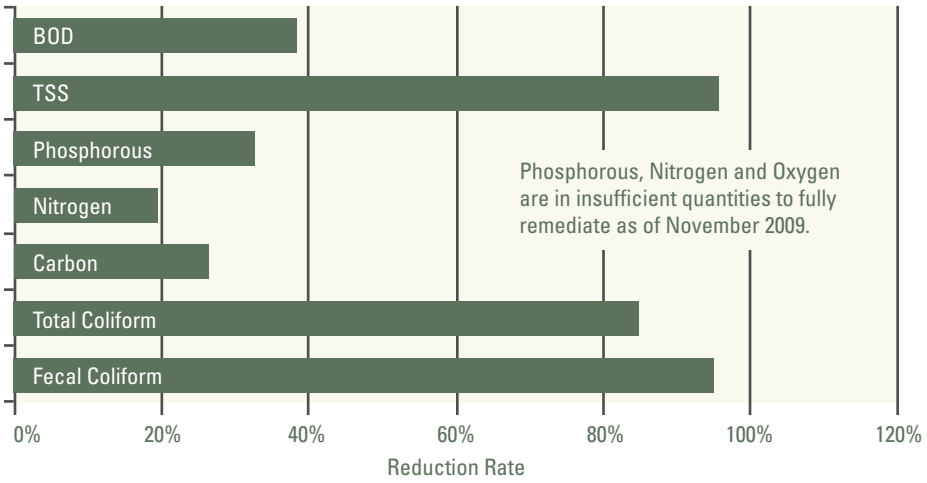
The Site

RIYADH (ar-Riyadh: meaning "the gardens") is the capital and largest city of Saudi Arabia. It's also the capital of Riyadh province, and belongs to the historical regions of Nejd and Al-Yamama. Situated in the centre of the Arabian Peninsula on a large plateau, it is home to 4,854,000 people and it's the urban centre of a region with a population close to six million.

The study area is a 120-kilometre stretch of Wadi Hanifah running through Riyadh, with a catchment area of 4,500 square kilometres.

From 2001-2004, the team developed the Master Plan, restoration designs, and enhancement designs. The construction and implementation period began in 2004. WC

Bioremediation Performance Ave. data (July - November 2009)



of the Wadi Hanifah watershed, the naturalized channel design now provides continual bioremediation of toxicants, harmful bacteria, and excess nutrients from urban and rural discharge in its year-round flow.

The main facility, located north of the main highway interchange, incorporates a series of weirs, riffles, pools, aerating pumps, bioremediation cells, artificial periphyton and benthic substrates, and riparian planting. Together, the elements of this design have developed the appropriate aquatic and riparian conditions to assimilate contaminants and further remediate the water through a community of natural organisms that aggregate to form a food web.

Today, Riyadh's new large-scale bioremediation facility, consisting of 134 cells, cleans more than 350,000 m^3 of urban wastewater per day. By 2025, it's expected to handle 1,200,000 m^3 per day. It already performs beyond expectations, and at a capital cost that is one-third of a mechanical wastewater treatment plant. It links to the city's greywater recycling system (already in place) and integrates a hybrid of natural ecological principles and is the first of its kind in the world.

Credit: Moriyama & Teshima

An aerial view of the three biocell groups.

Objectives

The three main goals are reduce fecal and total coliform bacteria to safe levels, eliminate odour, and prevent cumulative negative impacts of nutrient load through the Wadi.

To address these concerns and enhance the natural treatment process, the facility has four main components:

1. **Biocells** These are the basic units of the facility, responsible for the bulk of nutrient assimilation. The whole facility consists of three biocell groups: Group 2 (20 biocells), Group 3 (34 biocells) and Group 4 (80 biocells).
2. **Aeration system** This provides sufficient levels of dissolved oxygen to the system, killing coliform bacteria and creating favourable conditions for microbes, fish and other aquatic organisms.
3. **Artificial periphyton benthic substrates** These substrates are essential for bio-accumulating nutrients through the food chain.
4. **Fish (tilapia)** These serve as the top of the food chain and control the growth of filamentous algae.

Performance

The Bioremediation Sampling Monitoring Program is designed to allow for water sample collection at strategic locations. The data collected is used to determine the treatment efficiency of individual biocells, groups of cells, and of the entire facility. There are 22 water quality parameters being analyzed in each location and grouped under four principal categories: general variables, organics, nutrients, and microbiology.

The long-term purpose of collecting and analyzing data is to compare system performance to the Master Plan design objectives, in addition to developing long-term bioremediation operation and maintenance protocols.

Based upon early testing and analyses—only five months of data sets from August 2009 to February 2010—Nelson Environmental reported conclusive data in several key areas that show marked improvement in all targeted areas, such as total suspended solids removal and odour control. In addition to third party testing, four on-site water quality experts are responsible for collecting data and monitoring outcomes.

A work in progress

The Wadi Hanifah Restoration Project is showing remarkable progress, but it's a work in progress. A river is a living thing, and the ADA understands that the project will continue to evolve. Future development includes establishing a directorate to oversee the ongoing protection, management and enhancement of the Wadi Hanifah; building an educational centre focusing on environmental and cultural stewardship; restoration and enhancement of the 10 main bodies of water that link to Wadi Hanifah in a total watershed management program; and continued water cleaning, recycling and reuse.

The project has transformed the city's relationship with its most significant natural feature, creating opportunities and benefits for its people. If this river and its ecosystem can be restored and successfully greened, imagine the potential of this approach in other threatened locations, on any scale, around the world. WC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