

# The Marine Environmental Impacts of Artificial Island Construction

Dubai, UAE

By

Bayyinah Salahuddin

Date: \_\_\_\_\_

Approved:

\_\_\_\_\_  
Dr. Michael Orbach, Advisor

Masters project submitted in partial fulfillment of the  
requirements for the Master of Environmental Management degree  
in  
the Nicholas School of the Environment and Earth Sciences of  
Duke University  
2006

## **ACKNOWLEDGEMENTS**

لأجل أهلي

First, I thank Allah for making my research successful and rewarding.

Next, I would like to thank my dear family for their generous, unwavering support and encouragement.

Finally, I would like to thank the Student International Discussion Group and the Environmental Internship Fund at the Nicholas School of the Environment and Earth Sciences at Duke University for funding my research.

## **ABSTRACT**

In the United Arab Emirates, Dubai is building three colossal artificial islands—each in the shape of a palm tree—in the Arabian Gulf. This has prompted several other Gulf countries to construct artificial islands. To determine the impacts of the first of these Palm Islands, The Palm Jumeirah, I traveled to Dubai and interviewed governmental agencies, environmental groups, and the developer's environmental scientists. I analyzed the island's impacts on marine wildlife as well as the developer's mitigation efforts and the developer's compliance with the relevant environmental laws. The Palm Jumeirah has buried and asphyxiated wildlife, increased turbidity, and changed the alongshore sediment transport. It has also created habitat along its rocky breakwater and within its lagoons. The developer has implemented several environmental mitigation measures, and has generally adhered to the Equator Principles. However, the developer missed a few important opportunities to mitigate. Also, due to political pressure and legal loopholes the developer has been allowed to ignore relevant environmental laws. In the future, developers should adhere to local environmental laws, avoid building islands on coral reefs, and adhere to the Equator Principles meticulously.

## **TABLE OF CONTENTS**

Introduction to the Country and the Region	5
Research Methods for Studying Dubai's Palm Island	13
The Relevant Environmental Policies of Dubai and the UAE	24
The Palm Jumeirah's Beginnings	36
The Marine Environmental Impacts of Constructing The Palm Jumeirah	43
A Critical Analysis of The Palm Jumeirah's Impacts and Its EIA	57
Nakheel's Remediation Efforts for The Palm Jumeirah	72
Conclusions and Recommendations	84
Works Cited	89

## INTRODUCTION TO THE COUNTRY AND THE REGION

*Thirty years ago there was almost nothing here in Dubai. Forty-year-olds and Fifty-year-olds remember having to travel from Dubai to Abu Dhabi by camel—a journey that took eight days.*

—Frederic Launay, Director of World Wildlife Fund-UAE

The United Arab Emirates (UAE) is a federation of seven city-states, or emirates on the Arabian Peninsula. To its north lies the Persian Gulf, and to its east lies the Gulf of Oman. The UAE shares its borders with Saudi Arabia, to the west and the south, Oman, to the east and northeast, and Qatar to the northwest. The country was founded in 1971, and the last emirate, Fujairah, joined in 1972. The UAE is a small nation that occupies approximately 83,600 km<sup>2</sup> (UAE Ministry 2004. 29). It is a federalist country, and each emirate enjoys broad general autonomy (“Nation Building”) The UAE ranks as one of the world’s largest exporters of petroleum (UAE Ministry 2004. 129), and revenues from oil and gas constitute 30% of the gross domestic product (GDP) (“United Arab Emirates”).



Figure 1: The United Arab Emirates

Reproduced from media.maps.com/magellan/Images/UAE-W1.gif

The country is fully developed and boasts many features that surpass the western world. In terms of political structure, the UAE has a president, but the nation's highest constitutional authority is the Federal Supreme Council. The Council, composed of the seven emirate rulers, establishes general policies and sanctions federal legislation. Rulers of Abu Dhabi and Dubai enjoy effective veto power. Abu Dhabi was selected as the UAE's capital, but it was Dubai that became the young nation's busiest port and its principal commercial center.

Dubai city, the capital of Dubai emirate, lies upon the Arabian Gulf in the UAE's northeast and contributes 66 km to the UAE coastline (UAE Ministry 2005. 280). Dubai's booming economy was built on revenues from the oil industry after oil was first discovered there in the mid 1960s ("Dubai Overview"). However, Dubai has recently sought to diversify its income and decrease its dependence on oil revenues. To this end, Dubai has expanded its information technology, finance, commerce, and tourism industries and invested heavily in modernization and development.

Dubai's relentless striving has met with great success. Today Dubai enjoys a solid reputation as the Arab world's trading hub. By the year 2000, only 10% of its gross domestic product came from oil revenues (ibid). Its efforts to increase tourism— by building hundreds of hotels, hosting the world's richest horse race, breaking several world records, offering special investment incentives, and welcoming all expatriates— have especially succeeded. The tourism sector is expanding faster than any other sector in the city's economy (ibid), and it accounts for 22% of Dubai's GDP (Samson and Davey). In fact, Dubai now boasts the world's highest revenue generated per available hotel room (at US \$175.47), beating out both New York and Paris (Dept. of Tourism). Famous people from around the world – including Michael Jackson, Donald Trump, Venus and

Serena Williams, Andre Agassi, Boris Beckham, and Indian movie Star Sharukh Khan – visit Dubai to conduct business, shop, and enjoy its sunny weather and beautiful beaches. By 2010, Dubai aims to attract 10 million tourists annually (“Dubai Overview”).

But Dubai has been running out of room for tourist attractions. By as early as the 1990s, hotels and ports had occupied Dubai’s entire coastline (Krane “Arab Island Resorts”). To reach its staggering tourism goal, Dubai needed to find more beaches for more tourists; it began to look for ways to artificially construct beaches.

The Ruler of Dubai, His Highness Sheikh Muhammed Bin Rashid Al Maktoum, decided to build an artificial island in the Arabian Gulf off Dubai’s coast. He needed a shape that would maximize beachfront space; he chose the shape of a palm tree. Government-controlled Nakheel, the developer, was successful in constructing the first Palm Island, and the beachfront real estate sold out to hotels and retailers before the island was even constructed. Three-quarters of the buyers were foreigners (ibid). Soon, the Crown Prince requested a second Palm Island—The Palm Jebel Ali—then a third one—The Palm Deira—each one bigger and more elaborate than its predecessor.



**Figure 2: The Palm Jumeirah**  
Reproduced with permission from Nakheel



**Figure 3: The Palm Jebel Ali**  
Reproduced with permission from Nakheel



**Figure 4: The Palm Deira**  
Reproduced with permission from Nakheel

Nakheel also announced its plans to build The World, an exclusive 300-island archipelago forming a map of the world. This incredible engineering feat is taking shape 4 km off Dubai's coast. When completed, at a cost of \$1.8 billion, The World will stretch across a slice of the Arabian Gulf 9 km long and 6 km wide. An extensive breakwater and several elongated, submerged reefs surround The World, protecting it from high waves ("The World Islands"). The individual islands each span about 23,225 m<sup>2</sup> to 83,612 m<sup>2</sup> and are expected to sell for over \$6.85 billion (ibid). The only mode of transportation between these exclusive islands and the mainland is marine transit.





**Figure 5: The World Archipelago**  
Reproduced with permission from TEN Real Estate

Most recently, Nakheel announced the development of yet another “land reclamation” project—Dubai Waterfront. This colossal development will form a massive circle adjacent to the second Palm Island, engulfing it in the Waterfront’s massive circumference. According to Nakheel, Dubai Waterfront will house 400,000 people and will span an area 2.5 times bigger than Washington D.C. (Krane “Dubai to Build”).



**Figure 6: The Dubai Waterfront Project**  
Reproduced with permission from Nakheel

These elaborate projects and their success have prompted other emirates and countries in the Gulf to develop tourism destinations of their own, in an effort to capture a portion of the booming tourism industry.



**Figure 7: Schematic of all Nakheel's Projects. Note the Plethora of Artificial islands.**  
Reproduced with permission from Nakheel

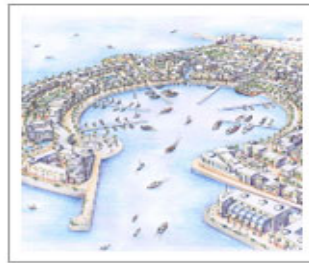
The Emirate east of Dubai, Sharjah, has announced that it will build a \$4.9-billion, artificial-island archipelago, called Nujoom, or Star Islands, comprising 10 islands and covering 5.6 million m<sup>2</sup> along the northeastern coast, 15 km from Sharjah's center ("Nujoom Islands").



**Figure 8: Model of Sharjah's Nujoom Islands Project**  
Reproduced with permission from TEN Real Estate

Farther east, the emirate of Ras Al Khaimah plans to construct islands of its own. It will spend \$500-million to construct Saraya Islands, a project spanning one million square meters in the Arabian Gulf ("RAK Launches").

In 2005 the neighboring Sultanate of Oman began its own dredge-and-fill project set to approach completion in 2008 or 2009 (Samson and Davey). Oman's \$805-million Wave project will occupy 7.3 km of beachfront ("The Wave Oman") and 400,000 m<sup>2</sup> of "reclaimed land" ("Oman Launches 'The Wave'"). It will feature 850 lavish apartments, 700 opulent villas, a marina housing 250 boat slips, and a plethora of luxurious hotels and resorts.



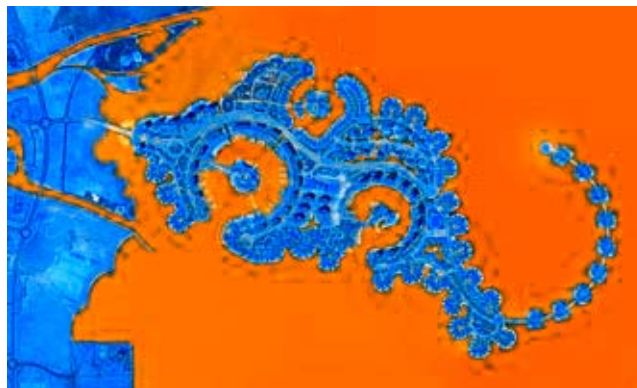
**Figure 9: Oman's Wave**  
Reproduced from <http://www.alaqariyaonline.com>

The small island-nation of Bahrain is also heavily competing for a chunk of the tourism industry. It is developing two artificial archipelagos: Amwaj Islands and Durrat Al Bahrain. The Amwaj Islands, expected to reach completion in 2009 (Samson and Davey), consist of almost 3 km<sup>2</sup> of exclusive manufactured islands (Ossis Property Developers). Durrat Al Bahrain is a \$1.2-billion archipelago, set for completion in 2009 or 2010 ("Durrat Al Bahrain: Ultimate Luxury"). At a size of 20 km<sup>2</sup>, it will consist of 13 islands, and will require 27 million m<sup>3</sup> of sand (MacDonald). Durrat Al Bahrain will include enough villas, hotels, condominiums, and shopping centers to accommodate 30,000 residents along with 2,000 daily visitors ("Durrat Al Bahrain").



**Figure 10: Durrat Al Bahrain**  
Reproduced from [www.3dtotal.com/team/interviews](http://www.3dtotal.com/team/interviews)

Not to be left behind, Qatar is building its own artificial archipelago 350 meters off its shores. The Pearl Qatar will span 4 km<sup>2</sup>, house 30,000 people, and cost \$2.5-billion to construct (MacDonald). It will feature extensive marinas, luxurious hotels, upscale retailers, and opulent residential properties. The project is nearing completion and is expected to open to its first residents in early 2007 (United Development Company).



**Figure 11: The Pearl Qatar**  
Reproduced with permission from TEN Real Estate

Any of these artificial island projects would serve as an enlightening case study for understanding the marine environmental consequences of artificial island construction, but studying Dubai's first Palm Island seems most appropriate since that island catalyzed all the other projects. And one is likely to find more data and information on Dubai's first Palm because it is the oldest. Any environmental lessons learned from The Palms can perhaps be used to prevent repetitions of the same mistakes elsewhere in the Arabian Gulf.

## RESEARCH METHODS FOR STUDYING DUBAI'S PALM ISLAND

*Officially, you'll never get anything from Nakheel. Not their EIA and not their baseline studies. But you can try.*

—Anonymous Biologist, addressing me.

In 2005, I first heard about The Palm Island projects in Dubai. After surfing the web for information, I learned of The Palms Jumeirah and Jebel Ali, their sizes, and their designs. Initially, I was disinterested in studying The Palms and their environmental impacts because I thought their primary impacts would be physical, hydrographical, and meteorological rather than biological. I was wrong.

A marine biologist from the UAE later told me that The Palms were *indeed* affecting marine biota, but no one, not even the government, was monitoring those effects. Dubai Municipality's Coastal Zone Monitoring Programme examines only the topographical and hydrographical aspects of Dubai's coastline, including the areas in which The Palms are being built (Coastal Management Section). That was the extent of the environmental monitoring related to The Palms. I once asked the former Secretary General of the Environmental Research and Wildlife Development Agency, Dr. Saif Al-Ghais, why government authorities were not studying the biological impacts of The Palms. He responded in Arabic, "*Naymeen!*" They're asleep.

I decided to travel to the UAE in the summer of 2005 to study the marine biological and environmental impacts of The Palms, but I knew that I couldn't discover and document all the actual impacts in the space of a few summer months. Instead, I planned to examine the *perceived* marine environmental impacts: what did the developer, Nakheel, think were the marine biological impacts of its projects? And what was Nakheel doing to mitigate the damage? Those were the questions I sought to answer.

The problem was that only Nakheel could accurately answer such questions; thus, I needed to see The Palms' Environmental Impact Assessments (EIAs). Dr. Al-Ghais had warned me that I would not be able to get them from Nakheel. Apparently Nakheel had always said the EIA was public information, available to any member of the public who asked to see it. Yet despite people's requests for copies of the EIA, no one had actually received one. Dr. Al-Ghais told me that I would never be able to convince Nakheel to meet with me and discuss its projects. Consequently, for a long time, I didn't attempt to contact Nakheel.

Instead, I chose the next best course of action—interviewing environmental non governmental organizations (NGOs), governmental agencies, and stakeholders to ascertain The Palms' perceived effects and Nakheel's mitigation efforts. I traveled to Dubai and began interviewing the appropriate people and organizations. Each time I conducted an interview, I asked the interviewee to recommend others who might have valuable information to share.

I also conducted online research, sifting through newspaper articles, trying to find articles addressing the environmental impacts of The Palms. When I had searched the web in the US, I had found only one article that mentioned anything negative about The Palm projects. Even that article ended on a positive note. It seemed difficult to find articles that didn't, at least, end with compliments for The Palms. One environmentalist complained, "Most articles about The Palms read like advertisements" (Holmes). Eventually, I *did* discover two articles that took a critical approach, pointing out the potential for harm to marine fauna and their habitats.

In addition, I reviewed the environmental laws in Dubai and in the UAE to determine if Nakheel was adhering to the relevant environmental regulations. I also

examined the UAE's history to better understand the stage upon which Nakheel's and Dubai's actions were set.

By the time I left Dubai, I had formally interviewed nine people, two of them more than once. (There are 11 interviewees listed below.) I was careful not to tell the interviewees until after the interview had commenced that I was focusing on The Palm Islands. I didn't dare tell them so while trying to setup the interview via phone, because I suspected that many of them would have refused to meet with me. When setting up the interview, I only mentioned that I was researching coastal development in Dubai. Later, at the interview, I explained my focus. Figure 12 lists all the interviewees and the institutions they represent.

**Figure 12: List of My Interviewees, Their Titles, Their Agencies, and the Interview Date**

<b>Interviewee</b>	<b>Title</b>	<b>Agency</b>	<b>Date of Interview</b>	<b>Country</b>
Dr. Eisa M. Abdellatif	Chief Technical Advisor	Zayed International Prize for the Environment	6/13/2005	UAE
Shaun Lenehan	Senior Environmental Scientist	Nakheel	6/15/2005 & 7/5/2005	UAE
Anonymous	Biologist	Ministry of Agriculture and Fisheries	6/21/2005	UAE
Ali Sagar Al Suweidi	Head	Emirates Environmental Marine Group	6/26/2005	
Ibrahim N. Al-Zu'bi	Environment Department Director	Emirates Diving Association	6/26/2005 & 7/5/2005	UAE
Khalid Mohammed Al Zahed	Head	Coastal Management Section, Roads and General Projects Sector, Dubai Municipality	7/2/2005	UAE
Mohammed Abdul Rahman Hassan	Head	Marine Environment & Sanctuaries Unit, Environment Protection & Safety Section Environment Department, Dubai Municipality	7/2/2005	UAE
Dr. Shahid Mustafa	Senior Marine Environmentalist	Nakheel	7/5/2005	UAE
Dr. Frederic Launay	Director	World Wildlife Fund (WWF)--UAE Office	7/13/2005	UAE
Dr. Bernhard Riegl	Associate Director	National Coral Reef Institute	3/10/2006	USA
Dr. Tom Williams	Former Senior Technical Advisor	Nakheel	3/18/2006	USA

Below, I outline the questions I created prior to the first interview. I used all or some of these questions (depending on the interviewee's agency and on whether or not I



had already obtained an answer to a question in a previous interview) in my first four interviews.

- Have any marine wildlife protection zones been setup in Dubai?
- What conservation laws have been enacted in the marine protection areas?
- What marine protection laws have been issued for the Dubai coastal/marine area?
- What enforcement measures have been put into place to protect these areas? To protect all of Dubai's marine wildlife?
- Where can I find the laws written out?
- Who makes the marine environment protection laws?
- Based on what do they make these laws?
- Has marine life been endangered, destroyed, or threatened due to this activity?
- Approximately how much wildlife has been lost?
- What measures have been undertaken to ensure that marine wildlife and the marine environment are protected?
- Are there any NGOs opposing the development of coastal Dubai? The Palm Islands?
- Are there any environmental groups supporting The Palm Island developments? Coastal development in general?
- Can marine wildlife protection occur without hampering economic development and progress?
- How many scientists have been involved in assessing the impacts of The Palms?
- Name some of those scientists.
- How long do you think it will take to attract new coral and establish a new reef?
- What is the probability of successful coral recruitment?
- Are there any coastline laws to protect/limit human activities in the marine environment?
- What is the role of tourism in protecting the environment?
- When was the last EIA of The Palms conducted? May I have a copy?
- Are the EIAs required by the law? Who conducts the EIA?
- What are some of the negative environmental impacts of island-building?

**Figure 13: Interview Questions for My First Four Interviewees**

The questions served only as drafts; and in the interview, I often worded the questions differently and posed them in a semi-random order. I felt it was important to let



the interviewee speak casually and naturally. If he answered a question before I had a chance to ask it, I recorded his comments, and moved to the next related question.

I have found that the tenor of each interview is almost as important as the interviewee's comments; so, I will describe the interviews and the interviewees.

My first interviewee was Dr. Eisa Abdellatif, from the Zayed International Prize for the Environment. I interviewed him because I had read in a newspaper that the Zayed International Prize had partnered with Nakheel “to install and monitor four units of two artificial reef systems...in the waters of Dubai, just off the breakwaters of The Palm, Jumeirah” (Nakheel Testing Artificial Reefs). I began with the questions, then I let him talk at his own pace, telling me about the reefs he and Nakheel tested. At the end, he gave me copies of business cards to other stakeholders including some environmental scientists at Nakheel.

For the next interview, I called Nakheel and spoke with Mr. Shaun Lenehan. He immediately accepted my proposal to interview him about Nakheel's Palm projects. He showed me The Palm Jumeirah's EIA—the only EIA available—and he took me on a tour of the island. In other words, he did everything I expected that Nakheel's environmental scientists would refuse to do. During our next meeting, he let me choose sections from the EIA that were relevant to my study. (The EIA fills one-and-a-half 5-inch binders and includes details about The Palm's construction; no one outside Nakheel was allowed to have a complete copy of such details. But Mr. Lenehan agreed to let me have a copy of any *purely environmental* sections I selected, if my selection was small enough to photocopy in a reasonable amount of time). Mr. Lenehan was forthcoming and open about The Palms and Nakheel's mitigation efforts. Lenehan answered all of my

questions, and only directed me to Imad al-Haffar, Nakheel's Research and Development Manager, for three or four of my more-detailed questions.

My interview with Nakheel's Dr. Shahid Mustafa was very different. Dr. Mustafa, who had 10 years of experience working on environmental issues for Dubai Municipality, seemed reluctant to share information with me. His response to half of my questions was to refer me to either Shaun Lenehan or Imad Al-Haffar. However, Dr. Mustafa *did* give me a copy of Nakheel's Environmental Management Guidelines, outlining rules of conduct at The Palm Jumeirah for contractors, landscapers, and residential and commercial tenants.

The interview with the biologist at the Ministry of Agriculture and Fisheries went well, but he could not provide much information because he was new to the area and The Ministry (he is originally from another Arab country). He talked about the overall environmental attitudes and challenges in Arabian countries. And he gave me a copy of some of the relevant federal laws of the UAE and his opinions about The Palms.

My interview with Mr. Ali Sagar Al-Suweidi turned out to be a waste of time. For the entire interview, which lasted an hour and a half, he refused to answer any questions about The Palm projects. Instead he talked about Dubai's heritage as a pearling village and the pearls that still remain in Dubai's waters. He took me on a tour of the Jebel Ali Wildlife Sanctuary (JAWS). He was proud of that sanctuary, its terrestrial and marine biodiversity, and its educational programs. But, he never mentioned that Nakheel's Jebel Ali Palm would eliminate the marine portion of the sanctuary, destroying the marine wildlife he was so proud of. When asked about environmental awareness in the UAE, he was very optimistic, often using Abu Dhabi's remarkable environmental laws and programs as examples. Abu Dhabi (the UAE's capital) has a strong environmental

agency and many environmental measures; Dubai has no *purely* environmental government agency and suffers from weak enforcement and implementation. However, Dubai does have some good environmental programs, and Mr. Al Suweidi focused on them. He was an optimist whose patriotic answers reflected well on Dubai and the UAE. I believe that he avoided talking about The Palms because he wanted to prevent any potential trouble. He never answered any of my subsequent phone calls.

Later that day I visited Ibrahim Al-Zu'bi. In contrast to Al Suweidi, Al Zu'bi was a man who was not afraid to talk to me about The Palm Islands. He'd recently been quoted, to his surprise and discomfort, in a widely circulated article. According to the article, he'd described the once-crystal-clear dive sites near The Palms saying, "Visibility is zero" ("Island-Building"). Usually, and quite naturally, he expressed that he liked to stop short of placing his neck *directly* on the chopping block, but somehow he'd been quoted in the newspaper. I think Al-Zu'bi is an optimistic realist; he accepts that The Palms are here to stay, but he is concerned about the construction's biological impacts. As an Arab, he felt proud of the projects; but as an environmentalist he was worried that the Gulf countries were moving too fast, building massive islands before anyone had the opportunity to learn from the first one. Al-Zu'bi taught me a lot about Dubai and his interactions with Nakheel. In our second interview, I learned even more. For instance, I learned that he respects the environmental scientists at Nakheel. He felt that they were educated, qualified, and that they put forth remarkable mitigation efforts.

My next interviewee was Khalid Mohammed Al Zahed at Dubai Municipality. What I gained from that interview was mainly in the form of magazines, articles, and brochures. I took them off his coffee table; all-in-all I took about half of the items he'd stacked there. He was a newlywed, polite young man. He wanted to help me but couldn't

give me the information I needed; he said he was not allowed to comment on The Palm projects and the coastal processes they affected. (If only I'd known that before setting up the meeting! But that is what happens when you don't tell your interviewees that you are seeking information concerning The Palms until after the interview has begun.) At the end of our interview, Mr. Al Zahed asked Mohammed Abdul Rahman Hassan to meet with me and answer my questions about JAWS.

Mohammed Abdul Rahman Hassan told me a great deal about Dubai's wildlife protection laws and JAWS. He even provided diagrams of JAWS and lists of its marine flora and fauna. He pointed out that the marine portion of JAWS was on the brink of destruction because Nakheel was building The Palm Jebel Ali there. He was extremely helpful, explaining the laws and describing Dubai's sanctuaries, but he knew little about Nakheel's projects—almost no one at Dubai Municipality knew any details about The Palms. Nakheel had excluded Dubai Municipality, and there was nothing the latter could do about it. The questions I posed to Mr. Hassan and to Mr. Al Zahed are listed below.

- What enforcement measures (in terms of fines, fees, rangers...etc.) have been put into place to protect Dubai's marine wildlife?
- What sort of marinelife does Dubai have?
- How much of the seafloor off the Dubai coast is barren and dessert-like?
- May I have a copy of the laws pertaining to coastal development and EIAs (in English)?
- Through what processes are development projects approved if they fall along the coast or in the water?
- May I have a copy of the EIAs for The Palms?
- Can marine wildlife protection occur without harming/ impeding economic development?
- Can economic development occur without harming the marine environment and its creatures?
- Which scientific companies have conducted the EIAs of The Palms?
- At what stage of planning and construction is an EIA required? At what stage has it been carried out for Nakheel's Palms?
- Which stakeholder groups were consulted in the planning stage of The Palms?
- Exactly how has the island-building affected the alongshore transport of sand and beach erosion? May I have the supporting data/figures/studies?
- Are there any ecotourism projects planned or underway in Dubai?
- Where is the sand for The Palms dredged from?
- Has Island building affected water clarity and visibility? To what degree?

**Figure 14: Interview Questions for Interviewees at Dubai Municipality**

The last person I interviewed in Dubai was Dr. Frederic Launay of WWF. The questions I asked him are detailed below. He talked about more environmental issues than those prompted directly by the questions, speaking casually and candidly about everything from Dubai's history, to its environmental laws, to Nakheel. His comments were extremely insightful, helping me to put all that I had learned into context.

- What is your general view of the coastal development going on here in Dubai?
- What is your general view of the marine environmental protection laws and their enforcement?
- Have any wildlife been threatened due to all this coastal development (The Palm projects in particular)?
- What measures have been taken to ensure marine organisms are barely harmed by all this development and by island-building specifically?
- Are there any environmental groups opposing coastal development in Dubai?
- What is your relationship with Nakheel? Do they consult you in their environmental decisions?
- How long do you think it will take for chemical and physical recuperation?
- How has the island construction affected Dubai's natural beaches?
- At what stage is environmentalism here in the UAE?
- Are there any environmentally-friendly tourism operations planned for Dubai?

**Figure 15: Interview Questions for the World Wildlife Fund**

The next stakeholder I interviewed was Dr. Bernhard Riegl, in the United States. He is the Associate Director of the National Coral Reef Institute in Florida. Dr. Riegl had been recommended to me by almost all of my interviewees in Dubai. He was well known among them because he'd studied the coral communities along certain sections of Dubai for over a decade. His scientific papers provide detailed information about the coral species that live along Dubai's coast, especially in the Jebel Ali Wildlife Sanctuary. Dr. Riegl shared his most relevant papers with me. He also shared invaluable information about Dubai's coral and the Gulf's benthic habitat.

My next interviewee provided even more invaluable information. Dr. Tom Williams is the last person I interviewed for this study. He'd worked at Nakheel for five years and had served as Nakheel's Senior Technical Advisor until about one and a half years ago. Since he was no longer employed by Nakheel at the time of the interview, he could freely divulge everything he knew about the projects. He knew all the details about

The Palms and how Dubai's benthos had looked before the construction began; and he shared that knowledge with me.

There were others whom I wanted to interview, but who declined to meet with me either because they did not want to discuss the topic, or because they did not think they could help. I could usually discern the two types of people. Those wishing to avoid the topic would say, "Why don't you just speak to the developers." When I explained that I wanted unbiased information they'd say, "Well I cannot speak to you about that." Or if I said, "A scientist at Nakheel sent me to you", they'd ask "which scientist?" After I had answered that question, they'd say, "You spoke to him, so you should have what you need already." I think that some of them had been anticipating a call from me. Once, when I called a potential interviewee and introduced myself, he said, "O, yes, yes. I've heard of you."

Another gentleman requested that my project-advisor send him a letter about my research and that I give him the name of *all* my previous interviewees before he would concede to an interview. I was in the midst of requesting the letter from my advisor when the gentleman recanted his request and refused to meet with me at all. His unusual request had been meant to be so outrageous that I'd be unable to comply. My determination called his bluff, and he declined to meet with me.



## THE RELEVANT ENVIRONMENTAL POLICIES OF DUBAI AND THE UAE

*I don't know if I am a good leader, but I am a leader. And I have vision. I look to the future, 20, 30 years.... I take decisions and I move fast. Full throttle.*

—His Highness Sheikh Muhammed Al Maktoum

The United Arab Emirates is a young nation, and the environmental movement is still in its childhood stages. The World Wildlife Fund's Fred Launay says:

Environmental laws and regulations are new here. Only three Federal laws relevant to coastal developments have been established: Federal Law No.7 of the year 1993 (as amended by Federal Law No. 30 of 2001) on the founding and establishment of the nation's Federal Environmental Agency; Federal Law No. 23 of 1999 on the exploitation, protection, and development of marine resources; and Federal Law No. 24 of 1999 on the protection and development of the environment. (Launay)

Federal Law No.7 establishes The Federal Environmental Agency (FEA), which works with the "competent governmental authority" in each emirate to enforce the federal environmental laws. According to Article 4 of Federal Law No. 7, the FEA is charged with cooperating with the appropriate competent authorities to conduct the following activities *inter alia* (Only points relevant to this discussion are listed; thus the bullet numbers do not begin at zero):

6. Establish the required principles and basis for incorporating environmental considerations into the process of planning and development in the State, by ensuring that environmental considerations become an integral part of policy making, and by ensuring that environmental matters become part of the planning, execution and follow-up of development projects initiated by government or the private sector, applying the measures of environmental impact assessment [sic].

7. Monitor all public and private development activities that might have an adverse effect on the environment and has to firstly give approval to such developmental activities before licensing them. The Cabinet will determine the types of project which might have adverse environmental impacts [sic]. (Fed. Law No. 7 of 1993, Article 4)

This federal law is important because it not only establishes a national environmental agency, but also asserts the need for Environmental Impacts Assessments, ensuring that



both private and governmental developers consider their projects' environmental impacts and that they do so early, during the planning phase.

Federal Law No. 23 primarily concerns fishermen and establishes fishing laws; however, it *does* address coral reef protection:

Article (37)

It is prohibited to establish artificial coral reefs made of any material in any ground of the fishing waters unless after the approval of the fishing regulations committee and obtaining a license from the competent authority as well as from the ministry to achieve any one of the following two purposes:

- a) Conduct Scientific research
  - b) Development and enhancing certain species of the living aquatic wealth (releasing larvae, setting up reserves...etc.)
- (Fed. Law No. 23 of 1999)

As I will explain later, this law applies to The Palm Islands because the developers plan to establish artificial reefs surrounding at least one of the islands.

With regard to Federal Law No. 24 of 1999, it contains several chapters on different environmental topics. Chapter 1 is titled *Development and the Environment*. In the first section of that chapter, the federal law addresses the environmental impacts of developments:

**Article 3 [Relevant sections only]**

The [Federal Environmental] Agency, in consultation, with the competent authorities and concerned parties shall set the standards, specifications, principles and regulations for the assessment of environmental impact of projects [sic] and establishments applying for license and shall specifically undertake the following:

1. Identification of categories of projects, which due to their nature may cause harm to the environment.
  2. Identification of areas and sites of special environmental importance or sensitivity such as...coral reefs, natural reservations, and public parks.
- (Fed. Law No. 24 of 1999)

Article 3 is bolstered by Article 4, which emphasizes the EIA's importance, "No project or establishment shall start the activity before obtaining the license aforementioned in the

previous article including environmental impacts assessment [sic].” Even after a developer submits an EIA and obtains a license, the developer must

Undertake regular analysis of wastes and monitor the properties of discharge and pollutants generated from such projects including degradable materials and keeping monitoring records and sending reports with the results to the Agency and the Competent Authorities. (Fed Law No. 24 Article 7)

Section 2 of Federal Law No. 24, titled *The Environment and Sustainable Development* further addresses environmental protection during development and construction, making environmental impacts necessary components in any development plans,

All Concerned Parties specially parties responsible for...development shall consider aspects of protection of the environment, control of pollution, and rational use of natural resources when developing... plans and when establishing and executing of projects [sic].” (Fed Law No. 24 Section 2 Article 9)

The final provisions of this federal law, addresses pre-existing projects:

**Article 97**

The owners of projects and establishments existing on the date of operation of this law and determined by the Executive Order, shall provide the Agency within a period not exceeding one year from the operation of the Executive Order, with a complete statement of their activities. The statement shall include their suggestions concerning precautions and measures to be taken so that the operations of the projects or establishment meet the required environmental standards.

**Article 98**

Projects and establishments existing on the date of operation of this Law, shall amend their status according to its provisions and the provisions of the Executive Order within a period not exceeding one year from the date of operation of the Executive Order.

The Board of Directors [of the FEA] may extend this period for another year if need so requires or the extension has justification acceptable to the Board. (Fed Law No. 24 Chapter 9 Article 97-98)

This ought to mean that older developments can not be grandfathered in, and that they must adhere to the aforementioned environmental standards.

Dubai Municipality has also issued laws and regulations regarding EIAs. In the Municipality’s Technical Guideline Number 53, it defines an EIA as “a systematic,

holistic, and multidisciplinary process that examines the environmental consequences of development actions in advance” (Dubai Municipality). Clearly, the municipality expects EIAs to be completed and submitted before construction begins on a new development. The municipality provides step by step explanations and detailed guiding principles for conducting EIAs. I outline several of the relevant guidelines below. (Bullet numbers are non-sequential because I have left out all irrelevant bullets):

2. The objectives of Dubai’s EIA process are to predict and determine significant environmental impacts; to identify and incorporate into the project, appropriate abatement and mitigation measures; and to identify and incorporate safety and health plans....

3.3 [The Environment Protection & Safety Section (at Dubai Municipality)] EPSS will review the [Environmental Impacts Summary] EIS and assess whether the environmental considerations have been adequately considered and suitable mitigation measures proposed....

3.5 If the development is permitted, an Environmental Protection and Safety Permit is issued to monitor the development during construction and while it is in operation....

3.7 When the project is implemented, the EPSS is required to monitor the project to ensure compliance with Environmental Protection & Safety permit and legislation. [sic]...  
(Dubai Municipality Env. Dept Env. Protection and Safety Section Technical Guideline No.53)

As for the EIS, it must adequately describe the project, providing, *inter alia*, “An estimate, by type and quantity, of expected residues and emissions (water, air, and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the execution and operation of the proposed project” (Dubai Municipality). It must also include “A description of the likely significant effects, direct and indirect, of the proposed project on the environment.” Additionally, the developer must outline its efforts to *protect* the natural surroundings. Dubai Municipality requires that EISes include “A description of the measures envisaged to prevent, reduce, and where possible offset any significant

adverse effects on the environment” (ibid).

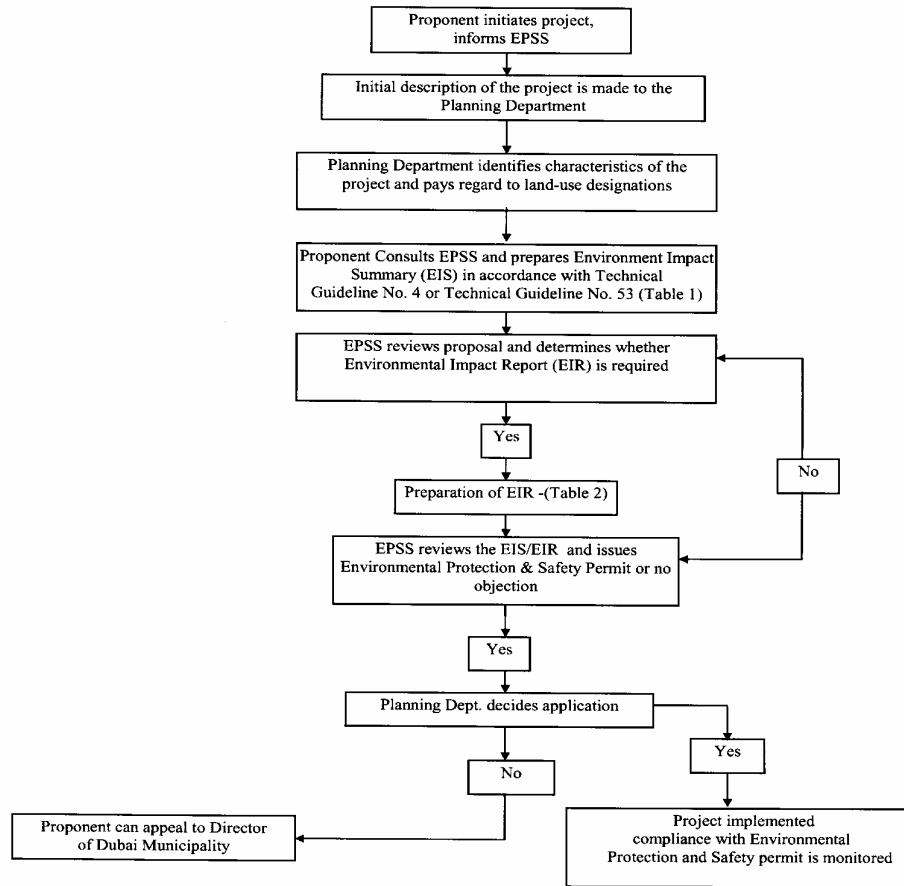
If a project will have significant environmental effects, the project’s founder must also compose an Environmental Impact Report (EIR) describing the physical aspect of the project. The EIR should outline “residues and emissions by type, quantity, composition, and strength” including discharges into the water, emissions into the air, noise, vibrations, light, radiation, heat, and deposits to the land or soil. Dubai Municipality also expects developers to consider alternative sites and methods. Hence, the EIR is to include “Main alternatives sites and processes considered, where appropriate, and reasons for final choice.” (Dubai Municipality). Natural reserves and protected areas must receive special consideration in the EIR: “Where applicable, the information under this section should include all relevant statutory designations such as wildlife sanctuaries.” The EIR must also outline the biological impacts in terms of “Loss of, and damage to, habitats and plant and animal species...other ecological consequences... physical effects of the development, e.g. change in local topography, soil erosion, etc.” The mitigation measures to be included in the EIR are listed in Figure 16. Note that the report must include an analysis of the proposed mitigation’s effectiveness. These EIA regulations, established by Dubai, are further reinforced and supported by the FEA’s own EIA guidelines. This reinforcement establishes and highlights the importance of EIAs in the UAE.

### **Mitigating measures**

- 4.1 Where significant adverse effects are identified, a description of the measures to be taken to avoid, reduce or remedy those effects, eg:
- a. site planning;
  - b. technical measures, eg:
    - i. process selection;
    - ii. recycling;
    - iii. pollution control and treatment;
    - iv. Containment (eg, bunding of storage vessels).
  - c. Aesthetic and ecological measures, eg:
    - i. mounding;
    - ii. design, colour, etc.
    - iii. landscaping;
  - iv. tree plantings;
  - v. measures to preserve particular habitats or create alternative habitats;
  - vi. recording of archaeological sites;
  - vii. measures to safeguard historic building or sites.
- 4.2 Assessment of the likely effectiveness of mitigating measures.

**Figure 16: Environmental Impact Reports Must Include These Mitigation Measures**

Dubai Municipality outlines the process by which its EPSS reviews the EIAs, EISes, and EIRs as indicated in Figure 17. If properly implemented, this process would ensure that all environmentally deleterious projects mitigate or compensate, for any environmental harm caused.



**Figure 17: Dubai's Review Process for Environmental Impact Assessments**

The Palm Island projects are definitely massive enough and nature-altering enough to require the execution of an EIA. In an Arabic document available on its website, The Federal Environmental Agency lists the types of projects that would necessitate EIAs. Based upon my translation of that document, the list specifically includes the following:

Projects for the discovery, extraction, manufacturing, storage, and transportation of sand or rocks, including whatever they contain of establishments and preparations of a related nature; all projects of marine transportation including docks, marinas, and piers without regard to their sizes; all projects for deepening marine channels and marinas and docks; and all marine bridge projects. (*Qaa-imah AlMasharee'*)

If building The Palms did not involve all of the above activities, it would still necessitate an EIA because all projects related to residential development also require EIAs.

Just as the EPSS at Dubai Municipality coordinates EIA implementation and review, The Marine Works Unit supervises and manages the marine and coastal engineering projects in Dubai. Anyone planning a project involving coastal dredging or construction must first obtain a No Objection Certificate (NOC) from the Marine Works Unit. The unit also “anticipates and mitigates against potential environmental impacts of coastal development projects” (Coastal Management Section).

Let’s now return to discussing Federal law No. (24). This federal law not only establishes the legal importance of EIAs but also protects natural reserves and wildlife sanctuaries. In Dubai, these areas are, in fact, protected under both federal and local laws (which are issued by Dubai Municipality). According to Federal Law No. (24) Of the year 1999:

Works, activities and acts prohibited in reserve areas which may lead to damage or deterioration of the natural environment, cause harm to wild or marine life or affect their aesthetic value, shall be determined by a decree issued by the Competent Authorities in coordination with the Agency. The following shall be particularly prohibited; [only the bullet points that were relevant to this discussion are listed; hence bullet numbers are not sequential]

- 1....Harming wild and marine creatures or undertaking activities leading to their eradication.
2. Damaging or destroying geological or geographical formations in areas considered natural habitat to animal and plant species as a result of increase or growth of such species....
4. Polluting the soil, water, or air of the reserve....
8. All that can disturb the natural balance of such reserves.

It is also prohibited to set up establishments, buildings, or construct roads, drive vehicles, or practice any...industrial or commercial activities in reserve areas without the permission of the Competent Authorities. (Fed Law No. 24 Chapter VI Article 64)

Even conducting environmentally damaging activities near a reserve is prohibited. “It is prohibited to practice any activities, acts or works in areas surrounding the reserves if such practices affect the environment of the reserves or their natural phenomena, without permissions from the Competent Authorities in consultation with the Agency” (Fed Law No. 24 Chapter VI Article 66).

Local laws further protect natural reserves which are often referred to as Protected Areas. (See Figure 18.) The law protects the protected area’s wildlife and habitats from almost any imaginable, harmful activity. The only exception is provided, “by a permit from the competent authority [Dubai Municipality].” Without a permit from Dubai Municipality, no one can conduct any potentially harmful activities without violating both local orders and federal laws.



## Rules and Regulations

### The Law

Local Law No. 11 of 2003 on the ESTABLISHMENT of PROTECTED AREAS in the EMIRATE of DUBAI specifies:

“Any work, acts, activities or procedures which may destroy or damage wildlife, marine flora and fauna, and affect the aesthetic standard in protected areas, shall be prohibited; particularly the following:

1. Hunting, transporting, killing or disturbing marine or other wildlife; or undertake any acts which lead to their destruction
2. Hunting, removal or transporting of any creatures or organic materials such as mollusks, coral reefs, rocks or soil for any purpose
3. Destroying or transporting plants from the protected areas
4. Damaging or disfiguring geological or geographical formations of areas considered to be the habitat of animal or plant species or their proliferation
5. Introducing non-indigenous species to the protected areas
6. Polluting the soil, water or air of the protected area by any means
7. Constructing buildings, structures, roads; using motorized vehicles or practicing any agriculture, industrial or commercial activities in the protected areas, or practice any activity, acts or works in areas surrounding the conservation area unless by a permit from the competent authority in accordance with approved conditions and rules”

*Violators of rules and regulations can be prosecuted under the Local Law No. 11 of 2003, and local order No. 61 of 1991*

**Figure 18: Local Laws Protect Preserve Protected Areas**

Thus far we have reviewed the three relevant federal environmental laws that Dr. Launay pointed out and the complimentary local laws issued by Dubai Municipality. Dubai’s local laws, orders, and enforcement measures have a large role to play, because, according to Dr. Launay, the federal laws lack teeth. The laws provide general frameworks but do not dictate methods of implementation, enforcement, or bylaws. Bylaw establishment is left up to the competent authority in each emirate. Hence

environmental bylaws, their implementation, and their enforcement differ from emirate to emirate with the result that industries and firms establish themselves wherever the environmental laws seem weakest. Even fishing regulations differ among the emirates (Launay). According to a scientist at the Environmental Resource and Wildlife and Development Agency, this disunity represents the biggest environmental challenge currently facing the UAE (Anonymous scientist).

The Non-Emraatees I Interviewed thought the federal laws were too weak. But the Emiratees thought their laws were strong enough. In their opinions, what their laws lacked was enforcement. Dubai Municipality, for example, does not have the capacity to adequately enforce local and federal environmental regulations, no matter the strength of those laws.

Dubai's political structure further complicates matters. Dr. Tom Williams, Former Senior Technical Advisor to Nakheel explained the political structure to me as follows.

Dubai's previous Ruler, Sheikh Maktoum Bin Rashid Al Maktoum, passed away on January 4<sup>th</sup>, 2006. Before his death, his brother, Dubai's current ruler, Sheikh Mohammed Bin Rashid Al Maktoum, served as Dubai's Crown Prince, and their other brother, Sheikh Hamdan Bin Rashid Al Maktoum, served as Dubai's Deputy Ruler. Sheikh Mohammed and Sheikh Hamdan designed development projects to push Dubai forward as a major hub for tourism, shopping, international commerce, and real estate. Their projects were often jaw-dropping and outrageous, but they worked.

So environmentalists were often unwilling to call attention to the environmental ramifications of such large development projects. If anyone complained about the environmental issues associated with these large-scale development projects, he might

appear to be opposing developments that were critical to Dubai's future, or even worse, criticizing the Sheikhs.

Dr. Williams also says that Sheikh Mohammed was misled. Sheikh Mohammed was under the impression that The Palm projects are environmentally sound and pose *no* risk to sensitive marine wildlife like corals and mangroves. Why would he think that? Because Sultan Bin Sulayem, Chairman of Nakheel, has assured him (and all of Dubai) that "Methodical planning and exhaustive feasibility studies...ensure that the islands can be built without disrupting the environment. The area's natural resources remain unharmed: not a single head of live coral has been touched in the process" (O'Flynn). Imad al-Haffar, Director of Research and Development at Nakheel, went even further, claiming that The Palms would enhance the natural marine environment because Nakheel plans to artificially attract and transplant coral to the areas surrounding The Palm Jumeirah. Sheikh Mohammed has no reason to disbelieve them, especially since he specifically instructed Nakheel's Senior Technical Advisor, Dr. Tom Williams, (in the presence of Sultan Bin Sulayem—CEO, and Saeed Ahmed Saeed—Managing Director) to protect the mangroves and coral reefs.



## THE PALM JUMEIRAH'S BEGINNINGS

*Development is happening too fast in Dubai; too fast for the social structure, too fast for the infrastructure; too fast for the people; too fast for the environment; and too fast for us to learn from our mistakes.*

—Dr. Eisa Abdellatif

By the mid-1990s Dubai had discovered that it desperately needed more beachfront so that it could build hotels, villas, condos, marinas, and a slew of other tourist attractions that couldn't fit on Dubai's 66 kilometers of already-crowded, natural beaches. The present ruler of Dubai, His Highness Sheikh Mohammed Bin Rashid Al Maktoum, who was at that time Dubai's Crown Prince, conceived a bold plan to create more beaches—he would build a massive artificial island in the waters of the Arabian Gulf in front of Dubai. To boost Dubai as the tourism capital of the world, the island had to be irresistibly attractive. It had to have a multifunctional shape—one that would maximize beachfront space, reflect the emirate's rich Arabian culture, and draw tourists in like ants at a picnic. The crown prince mulled over several different shapes—circles, spirals...et cetera.

In the end, he chose one of his own designs because it was unique and functional. He chose the date palm tree. This design would represent the importance of dates and date palm trees to the economy and culture of the region. And it would present dozens of developable beaches, with the trunk and each frond providing beaches on both of their sides. Furthermore, who could resist a palm-shaped island? It was perfect.



**Figure 19: The Concept for Palm Jumeirah**  
Reproduced from [www.thepalmdubai.com](http://www.thepalmdubai.com)

To build the perfect island, the developer conducted three or four years of detailed planning and feasibility studies (O'Flynn). Wahid Attalla, an Executive Director at Nakheel, said, "From the very beginning of the project we have worked with the world's leading authorities to ensure that we are employing the most up-to-date technology and are benefiting from the latest experience and data on the construction of man-made islands" (Dubai Review). He added, "Only when the results of all of the studies had been fully analyzed and our team was satisfied that work could begin did we enter the first phase of infrastructure development." Next Nakheel hired the best firms in environmental monitoring, marine engineering, and dredging and reclamation. Nakheel awarded most of the reclamation work to Van Oord, a Dutch company. The Dutch have immense experience in developing artificial land; they have done so extensively in their homeland for decades. "The people who built The Palm islands are world-class experts in marine construction, engineering and reclamation. They come from a sea-affected nation such as Holland, which has overcome the battle against the sea and they know exactly what they are doing," said Wahid Attalla. All in all, several dozen contracted companies helped conduct the research necessary to design and build The Palm Jumeirah.

Construction began on the island in June of 2001. The Palm was named Jumeirah, in honor of the section of Dubai it would lie in front of. The eponymous Palm Jumeirah

lies at about the center of Dubai's coast. It is currently the world's largest, manmade island (although the third Palm will be the largest when it is complete). The Palm Jumeirah spreads out in Dubai's waters in an image so grandiose it is visible from space. It spans over 5 km in width and 5 km in length and consists of 17 fronds atop a massive trunk 450 meters wide and 2.4 km long (AAA freehold).

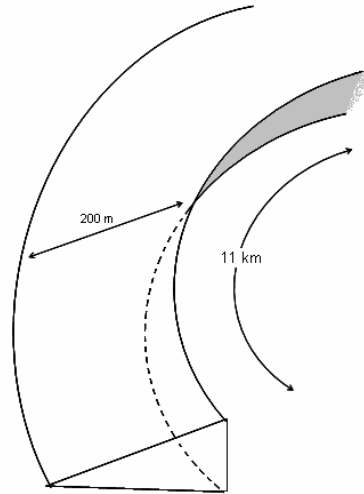
Construction firms worked around the clock configuring over 110 million m<sup>3</sup> of sand and 7 million tons of rocks (Van Oord). The rocks were brought over land and sea from over 16 different quarries around the country. The sand was dredged from the bottom of the Arabian Gulf in an area about 25 kilometers offshore of one of Dubai's ports. Placed end to end, the construction material could have formed a wall 2 m high and 0.5 m thick, circling the earth three times (Nakheel).

Nakheel also constructed a rocky, crescent-shaped breakwater surrounding the island.

The outermost component is a crescent...whose outer faces are heavily protected with an engineered rock wall comprised of a layer of smaller rocks covering the outer sand slope, geotextile to provide initial coherence to the structure, and outer layers of rocks averaging about 1m<sup>3</sup> in size that are individually placed and locked together. (Sale et al. 17)

The breakwater is 11 kilometers long and 200 meters across and can withstand waves up to 5.2 meters high. Its triangular shape allows it to slow waves and force them to break at a distance 15-20 meters away from the main structure. ("Dubai: AlJuzzur Al-Istinaa'iyah"). At 5.2 meters above mean sea level, the breakwater extends 1.7 meters above the height of the highest waves ever recoded in the area. Atop the breakwater is a 1.2-meter-high wall to further protect the development. Next to the wall lies a road that is 36 meters wide, providing a buffer against any unpredictably violent storms that might

occur hundreds of years hence. This breakwater is just one of the many things Nakheel has implemented to protect the island's inhabitants.



**Figure 20: Palm Jumeirah's Breakwater**

Nakheel has also compacted the sand and rocks used to build The Palm. The sand and rocks were compacted to such a degree that The Palm Jumeirah can withstand earthquakes that register six on the Richter's scale. Earthquakes are rare, yet the island can withstand very strong ones.

And as global climate transforms, causing sea levels to rise, the breakwater will be able to accommodate a one-meter rise in sea level. All these measures should prove sufficient for protecting the developments sprouting up on the breakwater (on the other side of the aforementioned road) and on The Palm itself as well as all its residents and visitors.

Nakheel has invested heavily in protecting its future residents. But has it invested heavily in protecting the marine environment into which it is placing all this rock and sand, these buildings, boats, and people? To answer this question we must first look at the Arabian Gulf and its condition pre-Palm Jumeirah.

The Arabian Gulf is an evaporative sea surrounded almost completely by dry, dessert land masses. In the summers of this hot and arid region, the water temperatures of the Arabian Gulf climb up to 50° Celsius. Such high temperatures lead to evaporative losses of between 0.2g/m<sup>3</sup> and 0.6g/m<sup>3</sup> of water daily (“*Juhood Himaayat Albiy-ah*” 14-15.) These high evaporation rates coupled with almost non-existent rainfall have increased the Gulf’s salt content over the millennia. Desalinization plants are also rapidly increasing the Gulf’s salt content. Hence, the Arabian Gulf is now known for its extreme saltiness. On average, its saltiness ratio is 39-41.5 grams of salt to 1 kilogram of water. In addition to high salinity, the Arabian Gulf is also characterized by shallow waters. Its depth ranges from about 35 meters on the Arabian side to about 81 meters on the Persian side. Also, the slopes leading into the basin are low and shallow; hence the waters of Dubai are shallow enough to allow land reclamation.

The Gulf continually experiences strong winds, known as Shamals, that rush from the North, gusting over the water, generating high waves and strong currents, and scattering the yellow sands of Iran and Iraq over everything in their paths. (See Figure 21.) The Shamals are so strong that the subsequent currents (called Shamal currents) have pushed sunken barges and planes around, on the bottom of the Gulf near Dubai (Al Zu’bi interview, Abdellatif Interview).





**Figure 21: The Shamals of The Arabian Gulf**  
Reproduced with permission from NASA

All these characteristics make the Arabian Gulf both unique and fragile. The creatures that live in the fragile marine environment must adapt to high temperatures, high salinity, and strong winds and currents. They must also contend with anthropogenic stresses from oil exploration, maritime transport, and coastal development.

Local and federal laws were recently instituted to protect these creatures and their habitat from anthropogenic stress. For instance, any project with a magnitude similar to that of The Palm Jumeirah would fall under every local and federal law that requires EIAs prior to construction. In fact, according to Dubai Municipality laws, a developer cannot even receive a permit to begin construction until it submits an approved EIA and EIS. Yet when I visited Dubai Municipality in July of 2005, the Municipality explained that the Environment Protection and Safety Section (EPSS) had not received an EIA from Nakheel, nor had it received an EIS, nor an EIR. Nor had the Marine Works Unit issued a No Objection Certificate (NOC) for the coastal dredging and construction. In short, every applicable environmental assessment regulation seemed to have been tossed aside.

How could Nakheel get away with this? According to Frederic Launay, Director of WWF, the applicable environmental laws, both local and federal, are all relatively new, having only been passed after 1999. The conception and planning for The Palm

Jumeirah is older, so the laws don't apply to it. The Palm Jumeirah does not fall under the jurisdiction of Federal Law No. 24 of 1999 which requires EIAs. Similarly, it does not fall under any of Dubai's local EIA orders. Nakheel was under no obligation to submit an EIA for The Palm Jumeirah. Furthermore, Dubai Municipality lacks the authority and jurisdiction to oversee The Palm Jumeirah project or ensure that the proper mitigation measures are taken.

Surprisingly, Nakheel *has* developed an EIA for The Palm Jumeirah; it just never gave the EIA to Dubai Municipality or any other government authority. Until now, no one outside of Nakheel has ever reviewed The Palm Jumeirah EIA for compliance with local standards. Nor has anyone evaluated the potential environmental damage from the project or Nakheel's mitigation plans.

(Nakheel says the EIA is technically "available to the public, upon request." Yet, the Emirates Diving Association requested the EIA, and never received it.)

Even so, Nakheel's Mr. Lenehan acquiesced to my requests for copies of the portions of the EIA that I felt were relevant to this research. In the upcoming sections, I will analyze The Palm Jumeirah's environmental impacts. To do so, I rely heavily upon data from Jumeirah's EIA and information from the interview with Dr. Tom Williams, who holds degrees in geology, paleontology, and zoology and was formerly employed with Nakheel as its Senior Technical Advisor. Dr. Williams's accounts are both valid and vital because in his former capacity at Nakheel, he oversaw every aspect of The Palm projects. Thus he was able to provide otherwise-unobtainable information.



## THE MARINE ENVIRONMENTAL IMPACTS OF CONSTRUCTING THE PALM JUMEIRAH

*Coastal erosion in Dubai is causing worries, however, with more than 50 per cent of the 66-kilometer-long mainland coastline of the emirate eroding....Large-scale engineering projects offshore, of island construction in particular, are believed to be having a particularly adverse impact.*

—UAE Ministry of Information and Culture

Appendix D in Palm Jumeirah's EIA consists of a "Bathymetric, Geophysical, Marine Ecological, Topographic, And Geotechnical Investigation" conducted by a consulting firm called Martin Mid-East. Martin Mid-East (MME) is a 13-year-old company that specializes in bathymetric, ecological, and geophysical surveys and assessments. The MME team conducted this particular assessment in the year 2000, one year before construction began on Jumeirah. In the assessment's executive summary, MME says the following about the area where Nakheel planned to build The Palm Jumeirah: (I have included only those bullets relevant to this discussion.)

- The bottom types in the planned construction area consist primarily of consolidated and unconsolidated sands.
- The areas of highest biological (macrofaunal and macrofloral) productivity are oysterbeds.
- Three distinct oyster beds occur in the investigated area. One of which will be lost during the construction process.
- Fish fauna and biomass is relatively poor....
- No significant fishery exists in the area.
- No critical habitats, like coral reefs or dense seagrass meadows, exist in the investigated area.
- No endangered species that could not relocate exist in the investigated areas....
- By creating artificial hard grounds, the construction of the Date Palm Island could in some areas enhance biological diversity.
- It is suggested to develop the breakwater as an artificial reef (transplant corals into the area)...
- Most of the study area is characterized by caprock (lithified sand) overlain by a variable amount of unconsolidated sand....

Let us examine how MME came to these conclusions.

First, MME evaluated The Palm Jumeirah project based upon Nakheel's plans for its construction. By reviewing the construction plans, MME determined that The Palm Jumeirah would affect the alongshore sediment transport and other physical environmental processes.

This is a major project that will interfere with natural processes on several levels. Water transport, in particular longshore currents, will be diverted with possible resultant scour and accretion....[And] significant changes to local oceanography can be expected"(2).

Martin Mid-East's staff also determined that siltation would occur, increasing turbidity, in the areas adjacent to the construction zone. In addition, the breakwater had the potential to "increase habitat complexity" because it could provide a hard, rocky substratum for marine life. "Careful planning can generate an area of high natural and recreational value. (2)" Martin Mid-East's approach seems pragmatic rather than conservationist. It is concerned with both environmental and economical value.

While the beaches of Palm Jumeirah will attract tourists and provide economic value, they come at the expense of some of Dubai's natural beaches. The Palm disrupts the alongshore sediment transport, starving the beaches:

Some sediment starvation can be expected downstream... The longshore current will be forced to flow around the structure, which could lead to some increased current velocity and thus increased scour in some areas. Mathematical modeling would be necessary to confirm this. (27)

Indeed the beaches near Jumeirah have suffered greatly from a loss of sand, especially the beaches to the east of The Palm, since the primary direction of sediment transport is eastward.

Van Oord, the primary dredging contractor for Nakheel, indicated on its website that it replenished seven beaches along eight km of coastline just east of The Palm Jumeirah. The replenishment required over 3,500,000 m<sup>3</sup> of sand and extended the

beaches by approximately 30 meters. Van Oord then used 540 tons of rock to construct three offshore breakwaters and extend one existing breakwater so that the beaches would not erode so quickly in the future. Even so, Van Oord says the beaches will require periodic maintenance in the future. Van Oord used to display a map of Dubai, with a circle around the affected area on one of its webpages. (See Figure 22.) But Van Oord recently changed that webpage and exchanged the map. The site no longer implicates The Palm Jumeirah for preventing alongshore sediment transport; it now mainly blames nature, alluding to The Palm's effects in a manner that makes them appear secondary to nature's ravages "Dubai's beaches have always been prone to erosion from wind and the rough waters of the Arabian Gulf. The large offshore developments in Dubai also influence sediment transport along the beaches" (Van Oord).



**Figure 22: Old Van Oord Map Showing Eroded, Natural Beaches East Of The Jumeirah Palm**

Reproduced from [www.vanoord.com](http://www.vanoord.com)

Indeed, Dubai's beaches lose large quantities of sand naturally. According to Khalid Al Zahed, Head of the Coastal Management Section of Dubai Municipality, the beaches used to lose 10,000-15,000 m<sup>3</sup> of sand annually. (Dubai now uses dozens of hard structures to armor its beaches). "Dubai's beaches are so small that they could not afford to lose any more sand," said Al Zahed. Those beaches also couldn't afford to lose the sediments that normally come to them via alongshore transport. I think that is why Nakheel had to replenish the beaches its Palm affected.

Dr. Tom Williams confirms that The Palm Islands severely disrupt the alongshore sediment transport, starving Dubai's natural beaches of much-needed sand. He estimates that the three Palm Islands' combined alongshore sediment transport disruption has starved over 40 kilometers—that's over 60%—of Dubai's 65 km of natural shoreline.

The natural beaches are not the only ones that require continual renourishment. Tides and waves have been reworking The Palm's fronds. Nakheel will have to nourish these beaches periodically as it tries to achieve an ideal, balanced state somewhere between a natural, steady-state equilibrium (in which waves completely rework the fronds) and a controlled state (in which engineers keep the fronds perfectly in place). To be sustainable, the renourishment periodicity must balance anthropogenic control and natural erosion.



Let us now look at The Palms impacts on the underwater environment. In the MME team's analysis of the topography, and geomorphology of the area, they state that it is a shallow sloping seabed without any major features. The area contains low rocky ridges, some of which represent broken-down, former coral areas. But MME asserts that those ridges never formed more than one meter of positive relief (3). The rest of the seabed MME characterizes as mainly sand or mud, with small wave and current ripples visible in the sand. These tide-generated ripples usually did not exceed 10 cm in height. The Martin Mid-East team also explains that the Gulf's sands tend to solidify into hard substratum that later gets covered in layers of loose sand.

Submarine lithification of sediments in the area appears to be rapid. Consequently, a layer of calcarenite underlies wide areas of sand. This formation is locally known as caprock and consists of sand grains held together by early marine aragonitic cements. The caprock can be covered by variable thickness

layers of sand and frequent probing is necessary to positively confirm the presence of caprock. (3)

The figure below, taken from Jumeirah's EIA, shows some of the sand-covered caprock that MME encountered while surveying the area.



**Figure 23: Martin Mid-East Show This Caprock Ledge and Black Sea-Squirt, *Phallusia nigra***  
Reproduced from The Palm Jumeirah's EIA

After examining the geophysical aspects of the construction site, MME discusses the ecological characteristics of the area and the organisms and habitat that would be destroyed in the process of constructing The Palm. Martin Mid-East evaluated the ecological characteristics of the overall area by sampling 246 points within a 500 m by 500m sampling grid. "Sample points were evaluated...at the intersection of Northing and Easting lines at 500m spacing" (7). The MME team did *not* examine the entire construction area (which measures 25,000,000 m<sup>2</sup>); they only examined a sample area measuring 250,000m<sup>2</sup>—which equals 1% of the construction zone and .33% of the total marine area to affected by the island's construction. But their sampling method appears adequate; for it involved sampling sediment, counting fish, and photographing the benthic ecology:

At each second sampling point a sediment sample was taken, while at every other sampling point a photograph was taken. At each point, an additional sample was evaluated approximately 1m from the original sample. This additional sample was only photographed, when significantly different to the original sample at the intercept of the Northing and Easting lines. Thus a total of 492 samples and spot observations covered the area of investigation in a dense net. (7)

As for the results of the investigation, the MME team found little biodiversity; Over 95% of the sampling points fell on bare substratum. Martin Mid-East found some sea grasses (*Halophila ovalis* and *Halodule uninervis*), but these formed only sparse patches and did not form dense seagrass meadows. The only other flora they found were algae, especially *Acanthophora spicifera* forming long tufts on oyster beds and other hard substrata (23). They also found several different species of marine fauna. The most biologically diverse areas encountered consisted of rocky ridges and artificial reefs.

Some of the rocky reefs formed drop-offs 20-50 centimeters high that harbored populations of reef fishes. Other rocky reefs were composed of piles of rock rubble. While the MME investigators did not know the origins of those rocky rubble piles, they hypothesized that the piles used to be coral before the coral framework broke down from anthropogenic thermal stress.

These [rock pile] areas were found in the distance to shore that coral growths normally occur in Dubai. If these were indeed former coral areas, they would have been killed over a decade ago by thermal outflow from the nearby industrial installations. Since the thermal outflows still remain, regeneration is impossible. (8)

Since, the Arabian Gulf is already an ecosystem of extreme stress due to high temperatures, high salinity, sharp temperature fluctuations, and low nutrient content, any additional thermal stress from industrial processes could have easily killed nearby coral. If the area was indeed continuously thermally stressed, the coral would not be able to reestablish themselves.



The other type of diverse habitat MME found consisted of artificial reefs. One such reef had been constructed using tires and rocks. The EIA's Figure 6 shows the reef teeming with fish and marine life. The tire reef will be buried under one of The Palm's upper fronds, but MME notes that the breakwater could provide much more habitat than this tire reef did.



**Figure 24: An Artificial Reef of Old Tires Attracts Snappers and An Arabian Angelfish**  
Reproduced with Permission from Nakheel

The Palm Jumeirah would also negatively affect marine wildlife. All mobile biota would flee the area, and the benthic organisms in or near the construction zone would be buried or asphyxiated. What organisms lived here pre-Palm Jumeirah?

In its analysis of the local fish population and the potential for local fishing, MME states that fish counts yielded low numbers of benthic and demersal fish. According to the fish counts, 35 species of fish inhabited the study area. The tiny, benthic Prawn-Goby *Cryptocentrus lutheri* exhibited the most dominance and abundance. Other species that MME frequently encountered were Mojarras (*Gerres oyena* and related species) and banded Terapons (*Terapon puta*) (20). Some members of these species would die during Palm Jumeirah's construction, especially the benthic Gobies; but according to MME,

“The species affected are very common. The fish species frequenting sandy and muddy areas are highly mobile and could move away from the construction site.” MME also asserts that the pelagic fish, such as Carangidae and Scombridae, would flee the area, and would not experience significant impacts.

But would this fish displacement affect local fishermen? The MME team observed some fishing in the area but concluded that it was not important for subsistence because the fish populations exhibited too low density to sufficiently sustain the fishermen. Therefore, MME concluded that The Palm Jumeirah would not negatively impact any local fisheries. (Interestingly, one of the local NGOs complained that Nakheel was not giving back to the community of locals and fishermen.)

Martin Mid-East’s researchers also found many different kinds of invertebrates. “The fauna consisted primarily of bivalve shells... burrowing sea-urchins, and surface-feeding snails” (8). In addition, they observed sponges, sea cucumbers, snails, sea urchins, starfish, sea pens, corals, and dense pearl oyster (*Pinctada radiata*) beds. Still, they commented “Total biomass is usually low.” Sometimes the oyster beds also contained coral and sponges, in cohabitation. Martin Mid-East pointed out that these oyster beds would die if Nakheel built The Palm Jumeirah. “The construction process will without doubt kill large areas of oysters, this will, however, not endanger the species.” A complete list of all the observed taxa follows.

Figure 25: List of Fauna (Besides Fish) Observed by Martin Mid-East at The Palm Jumeirah  
Reproduced with permission from Nakheel

### 3.7 Observed fauna (other than fish):

#### 3.7.01 CNIDARIA

*Siderastrea savignyana*, *Pseudosiderastrea tayamai*, *Favia pallida*, *Favia favius*, *Platygyra daedalea*, *Cyphastrea microphthalma*, *Porites lutea*, *Turbinaria peltata*, *Heteropsammia sp.*, *Heterocyathus sp.*

#### 3.7.02 MOLLUSCA BIVALVIA

*Siliqua polita*, *Circenita callipyga*, *Ervilia scaliola*, *Dosinia erythraea*, *Marcia marmorata*, *Gari amethystus*, *Cardites bicolor*, *Pinctada radiata*, *Bellucina semperiana*, *Pillucina sp.*, *Acar plicata*, *Barbatia parva*, *Diplodonta gnethila*, *Modiolus ligneus*, *Amiantis umbonella*, *Pandora ceylanica*, *Circe rugifera*, *Chama aspera*, *Malfundulus normalis*, *Atys cylindrica*, *Circe sp.*, *Circe intermedia*, *Lopha cristagalli*, *Diplodonta sp.*, *Tellina sp.*, *Fulvia australis*, *Pteria tortirostris*, *Ostrea*, *Pterelectroma zebra*, *Tellinides emarginatus*, *Wallucina erythraea*, *Lioconcha ornata*, *Corbula taitensis*, *Serratina sulcata*

#### 3.7.03 GASTROPODA

*Ancilla djiboutina*, *Tonna luteostoma*, *Nassarius albescentis*, *Potamides conicus*, *Rissoina sp.*, *Strombus persicus*, *Pupa affinis*, *Heliacus cerdaleus*, *Terebra sp.*, *Cerithium sp.*, *Rhinoclavis sp.*, *Eunaticina papilla*, *Clanculus genesi*, *Mitrella blanda*, *Ancilla farsiana*, *Nassarius sp.*, *Nassarius deshayensis*, *Calliostoma fragrum*, *Granulina oodes*, *Pseudominolia sp.*, *Thais lacera*, *Trochus firmus*, *Muricopsis sp.*, *Costellaria sp.*, *Cronia konkanensis*, *Conus sp.*, *Umbonium vestiarium*, *Neocancilla sp.*, *Oliva bulbosa*, *Cymatium sp.*, *Duplicaria duplicata*, *Domiporta granatina*, *Vacaecheilus angulatus*, *Epitonium aculeatum*

#### 3.7.04 SCAPHOPODA

*Dentalium octangulum*

#### 3.7.05 POLYPLACOPHORA

*Chiton peregrinus*

- 3.7.06 NUDIBRANCHIA  
**Dendrodoris nigra**
- 3.7.08 ECHINODERMATA  
*Astropecten polyacanthus, Ophionereis dubia, Ophiotrix sp., Holothuria atra, Clypeaster humilis, Echinodiscus auritus*  
**Lovenia elongata**  
*Metalia persica*
- 3.7.09 CRUSTACEA – DECAPODA  
*Leucosia sp., Thalamita sp., Alpheus sp., Alpheus djeddensis, Gonodactylus sp., Diogenes avarus*
- 3.7.10 CRUSTACEA – AMPHIPODA  
*Cymodoce sp., Sphaeroma annandalei*
- 3.7.11 CRUSTACEA – CIRRIPIEDIA  
*Balanus amphitrite, Chthamalus sp.*
- 3.7.12 CHORDATA  
*Branchiostoma spp., Phallusia nigra, Didemnum candidum, Polyclinum constellatum, Polyandrocarpa sp., Styelia*

The construction process would kill not only oysters, but also coral; although according to MME, coral were rare in the sampled area. Martin Mid-East states that sparse colonies of *Siderastrea siderea*, *Pseudosiderastrea tayamai*, and faviids often colonized Gulf caprock. The Martin Mid-East team expected some members of these species to suffer mortality from The Palm’s construction. Although MME believed that The Palm Jumeirah’s construction would especially kill some coral, it also believed that “This will not have deleterious effects on local populations” (9). In fact, MME expected corals to recruit strongly to the newly-created, hard substratum on The Palm Jumeirah’s

breakwater, “Therefore, the construction of Date Palm Island will likely enhance, rather than disadvantage, local coral populations.”

In sum, MME believed that impacts from Palm Jumeirah’s construction would be negligible and would not harm any critical or vital species.

In the area of immediate impact, i.e. the area that is to be filled, the result is obvious. The local fauna and flora will be completely and irrevocably lost. The area under question consists mainly of bare sand, one oysterbed and some areas of rocky ledge and artificial reef. While the sessile benthos and infauna will remain in the area and be killed, the mobile fauna elements will move away from the area of direct impact and most likely survive. Mobile fauna (fishes, other vertebrates, urchins) are not very site specific or territorial and will therefore not have problems resettling. The sessile benthos that will be killed does not consist of any rare or endangered species. Sufficient resources exist in the study area and in other areas of the Gulf. (24)

Of course, organisms can move away from a construction site only if the site is small enough to allow them to exit it before they suffer too much damage. The smaller a construction site is, the lesser its ecological harm. Hence, Nakheel needed to minimize Palm Jumeirah’s construction site.

To minimize the area affected and to prevent fine sediments from spreading to areas surrounding the immediate construction site, MME suggested that Nakheel suspend large silt screens (cloth screens that confine silt and minimize the chances for silt-plume development) around the construction site. Martin Mid East was concerned that if silt screens were not used, sediments would extend to areas surrounding The Palm. Those suspended sediments could clog marine organisms’ gills and nutritive openings. Any particularly fine sediments would remain suspended for long periods of time, afflicting the resident biota. Eventually, the fine sediments would settle on the bottom but would become re-suspended during storms, and thus, would resume afflicting the local marine biota—in an unending cycle. MME prepared a flow chart to demonstrate the

environmental impacts it anticipates from The Palm's construction including sediment plumes. (See Figure 26, copied from the EIA.)

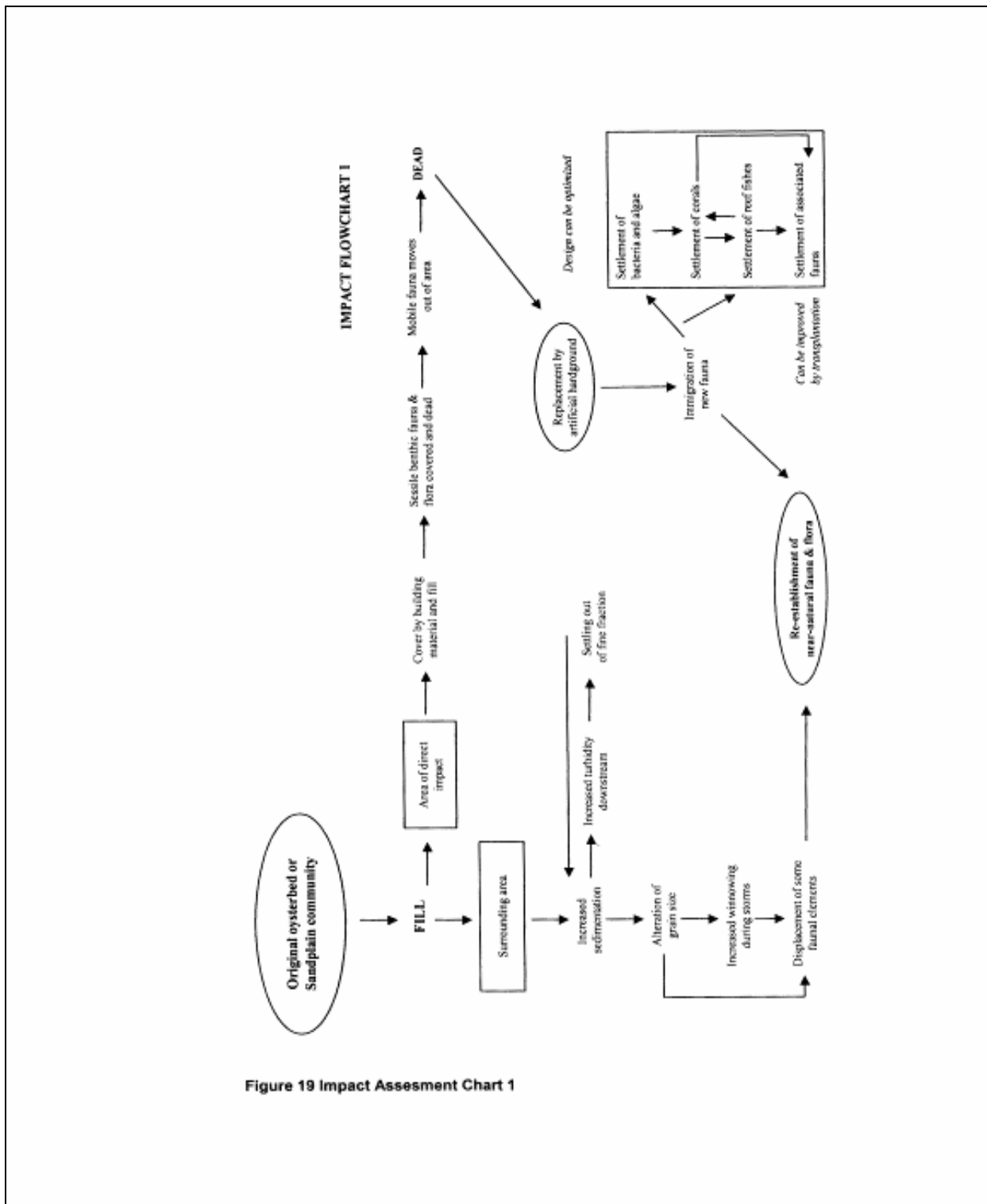


Figure 26: Palm Jumeirah's Impact Assessment Flowchart  
Reproduced with permission from Nakheel

Unfortunately, as Dr. Williams explains, Nakheel did not take MME's advice Nakheel did not use silt screens. Instead Nakheel allowed the plumes to extend many kilometers beyond the construction site. Subsequently, says Dr. Williams, Palm Jumeirah's construction affects an area three times its own size (according to estimates by Nakheel). The Palm itself, being 5 km long and 5 km wide, directly impacts a 25-km<sup>2</sup> area. Plumes of suspended sediments extend more than 25km<sup>2</sup> to the left and 25 km<sup>2</sup> to the right of The Jumeirah Palm. Hence construction affects at least 75 km<sup>2</sup> of the marine environment.

An organism in the middle of the construction site would have to travel as far as 5 km out into the Gulf or as much as 35 km along the coast before it could escape direct burial or asphyxiation by suspended sediments; therefore, I believe that most of the marine organisms never escaped from that large area.

The findings of the United Nations University-International Network on Water, Environment, and Health team support this theory. Nakheel had invited them to visit The Palm projects and develop an ecological monitoring plan. In their 2004 report to Nakheel, they state,

The construction of the islands has required massive dredging operations that have necessarily resulted in substantial resuspension of finer sediments, and the consequent siltation of benthic communities in the general region of each development. Continuous siltation over several months will have profound impacts on many benthic organisms, including smothering and death. (13)

However, the siltation lasted for much longer than "several months" because the construction lasted longer than several months. Even in Mid-2004, three years after construction began, siltation levels were still substantial at The Palm Jumeirah. "At present, waters outside the crescent contain a relatively high sediment load and visibility

along the bottom third of the breakwall is very limited (1m)” (16). This siltation profoundly affected benthic organisms for several years.





## A CRITICAL ANALYSIS OF THE PALM JUMEIRAH'S IMPACTS AND ITS EIA

*It has been detrimental for the natural environment of the Dubai coast, especially at the place and location of the first Palm Island.... There were very good habitats there. There were possibilities of recovery and protection, and there were possibilities of using that natural asset to make something.*

—Frederic Launay, Director of WWF-UAE

Now let us analyze MME's assessment. In this section I compare what MME has reported in their "Bathymetric, Geophysical, Marine Ecological, Topographic, and Geotechnical Investigation" to the information I gathered in the interviews.

You will recall that Martin Mid-East used findings from their survey of a 250,000 m<sup>2</sup> area to estimate the ecological conditions in the entire 75km<sup>2</sup> zone of impact. The area observed for the EIA comprised only 1% of the 25km<sup>2</sup> that The Palm will directly impact and only .33% of the total zone of direct and indirect impact. Hence MME's surveyors would not have seen enough of the benthos to determine the pre-existing ecological structure with statistical accuracy. Dr. Tom Williams argues that Martin Mid-East's study site does not accurately represent the predominant benthic environment. In the interview, when I asked him "Is the Martin Mid-East assessment reliable in your opinion?" he answered "No." He went on to call the assessment "inadequate."

Dr. Williams explained that the MME investigation served only as a *preliminary* study. After reading the MME report, Nakheel decided to investigate further. In 2001, Dr. Williams teamed up with Ali Sagar Al Suweidi, the Head of the Emirates Environmental Marine Group, to ascertain the amount of coral cover in the area where The Palm Jumeirah was to be built. (Of course, the tightlipped Ali Sagar Al Suweidi did not tell me any of this when I interviewed him). They used over 3000 meters of transect and over 3 hours of handheld video during dives to study the benthic environment. The area they

studied was not necessarily larger than the area MME studied. Yet, their results differed markedly from those of MME.

Dr. Williams says that he and the Emirates Environmental Marine Group found that coral patches *alone* covered an estimated 10%-15% of the substratum. Compare this to MME's finding of 5% of the substratum covered with anything living, including corals, sponges, oysters, and other invertebrates. So whereas MME estimated that little or no coral would die in the reclamation process, Ali Sagar and Dr. Williams estimate much more coral death.

The following are Dr. Williams's calculations of the coral cover that The Palm Jumeirah will destroy. The Palm's immediate impact zone spans 25km<sup>2</sup>. But The Palm will not cover every square meter within that zone. In fact, only one third (about 8.33 km<sup>2</sup>) of this direct impact zone would lie directly beneath The Palm, after its construction. Based on Dr. Williams estimates that 10%-15% of this area hosts corals, The Palm would bury approximately 0.83km<sup>2</sup> to 1.25km<sup>2</sup> of coral. This amounts to between 832,500m<sup>2</sup> and 1,248,750m<sup>2</sup>—roughly a million square meters of coral that have become a part of Palm Jumeirah's foundation.

Any other corals within that 25km<sup>2</sup> construction zone would also perish under sand leaking from dredgers and transporters and cascading off The Palm structure, suffocating the coral in construction debris. This debris would kill an additional 1,666,667m<sup>2</sup> to 2,500,000m<sup>2</sup> of coral.

If the areas surrounding the construction site have the same percentage of coral cover as the construction site, then even more coral will perish. Using Nakheel's estimates that sediment plumes would extend 25km<sup>2</sup> to either side of the immediate

construction site, Dr. Williams estimates that an additional 5km<sup>2</sup> to 7.5 km<sup>2</sup> of coral would suffocate on the plumes of kicked-up sediments.

Therefore, Palm Jumeirah's construction may have eliminated 7.5km<sup>2</sup> to 11.25 km<sup>2</sup> of coral. Placed end to end, this dead coral could form a line extending longer than The Palm Jumeirah itself.

Compare that figure to Sultan Bin Sulayem's public statement: "The islands can be built without disrupting the environment. The area's natural resources remain unharmed: not a single head of live coral has been touched in the process" (O'Flynn). Obviously his statement is grossly inaccurate. Whether Sultan Bin Sulayem believes Dr. Williams estimates or MME's estimates, Sultan Bin Sulayem can not honestly contend that The Palms will not harm one single head of coral.

Which study provides a more accurate representation of the area affected by Palm Island construction? Perhaps MME's estimates and Dr. Williams's estimates represent the lower and upper bounds (respectively) on the amount of coral that lived in the area. No one knows with complete certainty. The United Nations University-INWEH team concurs,

Construction has eliminated some unknown amount of benthic, low-relief oyster, rocky or coral reef, has created extensive siltation, and has permanently modified wave patterns and coastal currents, and therefore patterns of sediment transport in the vicinity. (2)

These changes to the natural marine environment are impossible to quantify. We do not know how many corals The Palm destroyed or how many organisms it killed. The total number of corals and other biota that suffered from The Palm construction eludes us, like a black ant on a black stone on a moonless night.



Martin Mid East and Nakheel have both asserted that the breakwater would serve as habitat for coral because it provides a rocky substratum for coral larvae to settle upon. Many others agree, including a biologist from the Ministry of Agriculture and Fisheries, Ibrahim Al-Zu'bi of the Emirates Diving Association, and Dr. Abdellatif of the Zayed International Prize for the Environment. Dr. Bernhard Riegl of the National Coral Reef Institute agrees too, though only partly:

The Gulf Bottom near Dubai is mostly  $\text{CaCO}_3$  covered in sand and loose sediments. Marine larvae can't settle on this loose sediment that is covering up all the hard bottom. So the breakwater could very well attract lots of coral and fish. The question is 'Do these Palm structures so change the currents and the turbidity envelope that coral won't come?' No one knows. There is no *scientific proof* either way.

The breakwater is closer to the water's surface than is the bottom of the Gulf. So, the water column is shallower over the breakwater. When the water temperature rises in the summer or drops in the winter, the corals closest to the surface (and closest to the sun's hot rays or the cold atmosphere) may find themselves more susceptible to temperature anomalies and to temperature-induced mortality than corals at lower depths.

Different types of coral will probably settle on the breakwater at different depths, each in the depth that suits it best. But we really don't know how and where different coral and algae will settle on the breakwater. We have to wait and see.

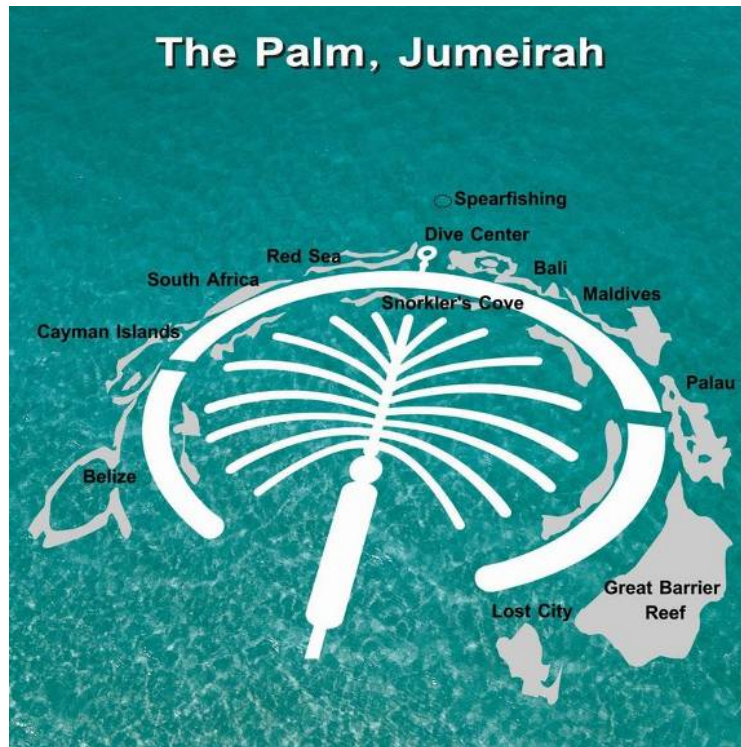
Assertions that the breakwater will provide habitat for coral are not based upon rigorous scientific testing. Nakheel estimates that the breakwater will provide habitat for coral based only upon the coral cover on other breakwaters in the area. Some old breakwaters have become habitat for coral; some old breakwaters have no coral at all. But even on the breakwaters that have become coral habitat, the coral communities differ from natural coral communities. So coral cover and community structure are difficult to predict at this stage, and no one knows what will happen with certainty. (Interview Bernhard Riegl)

Dr. Riegl is correct. The coral may or may not colonize the breakwater in a manner that would resemble natural coral assemblages. There is simply no scientific evidence to indicate what will happen on the breakwater.

Appendix C of Palm Jumeirah's EIA confirms Riegl's statements. Appendix C was prepared by the team from the United Nations University International Network on Water, Environment and Health (UNU-INWEH). In December of 2003 and again in January of 2004, the team visited The Palms Jumeirah and Jebel Ali to assess The Palms' environmental sustainability, identify potential environmental impacts and make recommendation to Nakheel. The United Nations University International Network on Water, Environment and Health states in its report, "The Palm projects are each novel, newly-formed ecosystems...it is impossible to predict, with certainty, how they will evolve over time" (2).

Realizing this, Nakheel opted to forgo the If-we-build-it-they-will-come route in its attempts to re-establish corals. Instead Nakheel plans to establish corals near The Palm Jumeirah's breakwater. Nakheel's plans call for 11 dive sites surrounding the breakwater. To attract tourists, Nakheel plans for the dive sites to resemble coral reefs from all over the world, including Bali, Belize, The Great Barrier Reef, The Cayman islands, and the Red Sea. Of course, Nakheel will have to resort to artificial means to generate this much coral and make each reef resemble those famous reefs from around the globe. The company plans to transplant coral and build artificial structures for coral to colonize in a grand effort to construct an artificial, underwater paradise.

To construct this paradise, Nakheel needed an artificial reef system that would provide suitable substrate for coral larvae to settle upon and for larger corals to be grafted onto. Most importantly, the artificial structure had to be capable of withstanding the strong Shamal currents, otherwise the Shamals would topple or displace the structures. Trying to find the right one, Nakheel tested 5 types of artificial reef structures (Lenehan interview).



**Figure 27: Palm Jumeirah's Artificial Reefs**  
Reproduced with permission from Nakheel

One of the reef structures that Nakheel tested was called “Runde Reef.” Nakheel tested the Runde Reef in collaboration with Kyodo international, The Zayed International Prize for the Environment, and the Emirate Diving Association—which provided volunteer divers to help monitor the Runde Reef’s efficacy.



**Figure 28: The Runde Reef** Reproduced  
with permission from Dr. Abdellatif

Runde Reefs consist of a concrete core measuring 2.5 meters in height. From the core sprout scores of recycled, polyethylene tubes that radiate in all directions expanding

the structure's diameter to 5 meters (Abdellatif). This 8-ton reef generates 250 m<sup>2</sup> of outer surface area and 340 m<sup>2</sup> of cavity space for marine flora and fauna to colonize (Smailley).

Kyodo International considers the Runde Reef a tool for environmental enhancement—a tool that aims to attract not only coral, but also algae, fish and shellfish. Mr. Nordie, Vice President of shipping at Kyodo International, says, “The idea is to cultivate the sea to see how we can improve the number of species of fish and other living things” (Smailley). Kyodo installed three Runde Reefs about 400 meters beyond the center of The Palm Jumeirah's breakwater (Abdellatif). A red “X” marks the location in the figure below.



**Figure 29: Testing location for the Runde Reef**  
Reproduced with permission from Dr. Abdellatif

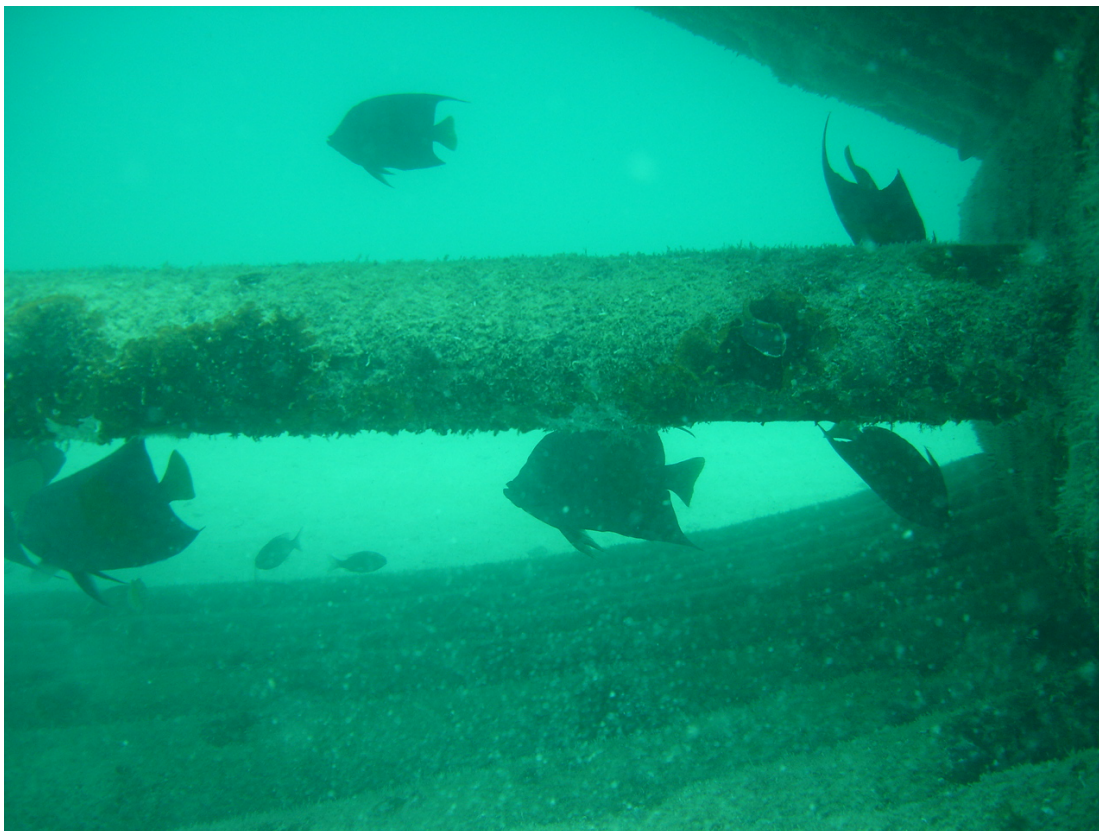
According to Dr. Abdellatif, the Runde reefs performed well. They did not move much under the onslaught of the Shamal currents, and only one of the structures was tilted slightly by the Shamals. He says, “Encrusting organisms, soft corals and even fishes started to appear very early; in spite of the continuous noise and disturbance in the area.” After 2 months, divers observed algae and one fish at the Runde Reefs. (See Figure 30.)



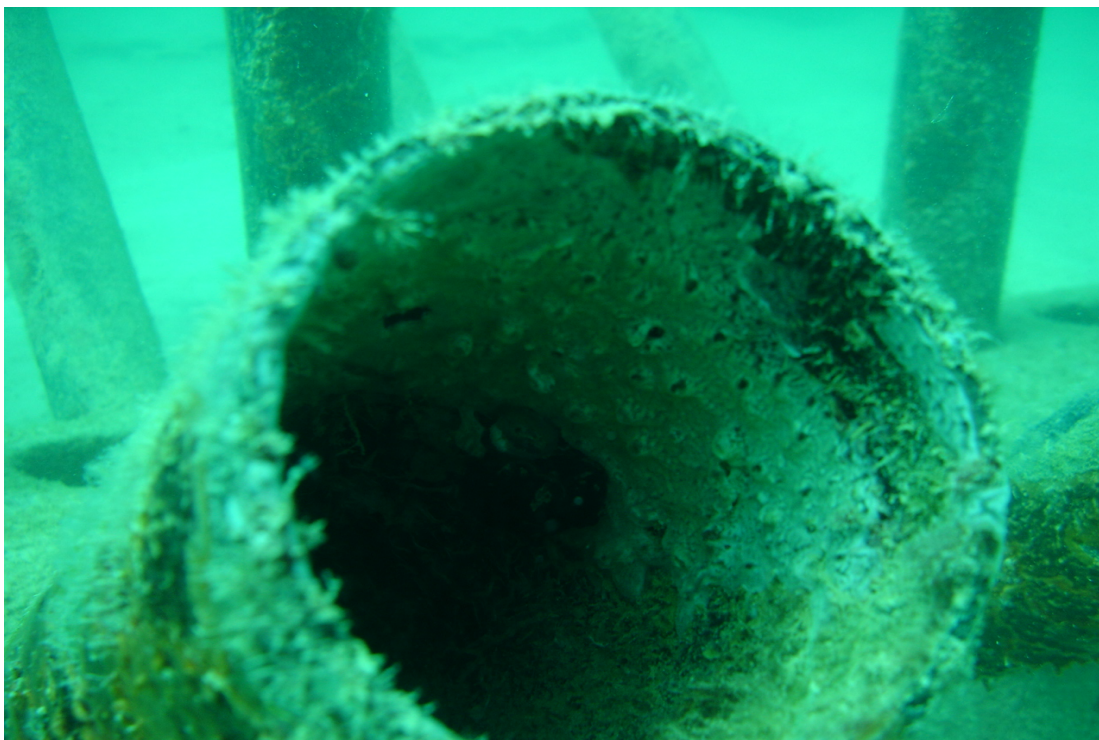
**Figure 30: The Runde Reef After Two Months**  
Reproduced with permission from Dr. Abdellatif

After 4 months, divers observed soft coral polyps, mollusks, and 8 species of fish at the Runde Reefs (Abdellatif). (Perhaps these were all in the larval stages, because I have not seen any large mollusks or corals structures in the photographs.) Dr. Abdellatif concluded that the “Runde Reef proved to be more efficient than concrete blocks or old cars/ships/planes.” Therefore, the Zayed International Prize for the Environment highly recommended large-scale testing for the Runde Reef model





**Figure 31: The Runde Reef After Four Months**  
 Reproduced with permission from Dr. Abdellatif



**Figure 32: Coral Larvae Settle on the Runde Reef after Four Months**  
 Reproduced with permission from Dr. Abdellatif

However, Shaun Lenehan says the three Runde Reef systems did not perform well. “All three fell over under the Shamals,” he said. So Nakheel plans to test a new Runde Reef design that resembles an evergreen tree, having shorter spokes near the top and longer ones near the bottom.

Another reef system that Nakheel planned to test was a hollow, pyramid-shaped model. When I spoke to Mr. Lenehan in June of 2005, he said that Nakheel was planning to test that model soon.

Lenehan says that Nakheel also tested a tripod-looking model that “Got blown all over the place by the Shamals.”

Other artificial structures that Nakheel tested consisted of sunken planes and a barge. Nakheel sank 4 planes, 2 Sabre Jets, and an upside-down barge that were all steam-cleaned to remove hydrocarbons and any other harmful materials. These structures became habitat for corals, nudibranchs, and other marine life. Lenehan said fifteen species of coral colonized the barge.

The final artificial reef model that Nakheel tested was Biorock. Biorock consists of a mesh or grid frame that can be formed into any shape. The Biorock frame must be connected to an electrical current, which causes calcium carbonate to leach out of the sea water and deposit on the frame. The calcium carbonate around the Biorock frame provides a perfect substrate onto which coral can be grafted. When Nakheel tested this model, they found that a layer of calcium carbonate over 4 cm thick accumulated onto the frame within 6 months. The Biorock artificial reef model proved to be the most effective of the five that Nakheel tested.

But Shaun Lenehan says none of these artificial reef systems outperformed the breakwater. He explains that the breakwater attracts corals, fish, and algae naturally and

more effectively. Nakheel expects that the breakwater will provide many kilometers of new habitat with the possible result of enhancing fisheries or at least enhancing nature.

INWEH explains:

[Palm Jumeirah's breakwater] is already being colonized by a broad range of fish and invertebrate species. This can promote biodiversity and provide opportunities for dive tourism, especially when combined with the planned network of artificial reefs. The breakwall might also enhance local fisheries. (17)

Perhaps this is why Imad Al-Haffar has been saying that The Palm Islands will "enhance" nature.

Still, the breakwaters may not enhance coral habitat. The United Nations INWEH expects the breakwater to serve as habitat for several invertebrate species but not for coral. After the team observed The Palm Jumeirah's breakwater in January 2003, they reported the following:

Fauna already present [on the breakwall] included corals, as a few very young recruits. They were not common, and we do not expect that they will become common. Corals typically require very specific chemical cues to induce settlement. These cues are often produced by crustose coralline algae, which do not appear to be common along the breakwall. Therefore, we predict that, in the absence of artificial transplantation of corals, the breakwall reef will continue to develop as rocky reef, perhaps with considerable benthic invertebrate coverage but without substantial structural enhancement of the habitat by scleractinian corals....

...Barnacles and oysters were the most common invertebrates covering rocks at Palm Jumeirah, and coral recruits were rare. We also observed a common species of a large tunicate ('sea squirt') and several small sponges living on the rocks.

...The majority of the benthic coverage on the shallower half of the breakwall was dead shells of barnacles and bivalves, with fewer living organisms. The prevalence of dead invertebrates at present might be due to siltation and/or algal overgrowth or to active predation by carnivorous gastropods or starfish (both of which are present)...Algal growth did not appear extreme except at some locations within the top 50cm of the water column and should be controlled as herbivorous invertebrates and fishes become more abundant.... (18)

...At present, the sessile fauna includes corals, sponges, ascidians, mussels, and oysters, but it is unlikely that corals will grow prolifically. The largely granitic

substratum and potentially frequent high wave action or other factors are more likely to favor sponges, ascidians, and the molluscs. (22)

The breakwater served as a viable host for algae, sea squirts, mollusks, and starfish, but not for corals. I do not know if the breakwater has become more amenable to corals since January of 2003, when the INWEH team observed it or if it has remained primarily suited to invertebrates besides coral.

The breakwater attracts fish though, and may provide new habitat for them. United Nations University-INWEH found 25 species of fish inhabiting the rocky reef formed by the breakwater. Different fish species seemed to prefer different parts of the breakwater; so it is biologically heterogeneous across its extent and depth. The team said the adult fish observed were probably just visitors borrowed from other habitats. But some of the juveniles had probably recruited from plankton directly to the breakwater. If these fish were recruiting to the breakwater directly, then the breakwater would, in fact, increase overall fish recruitment (provided that fish recruitment in nearby habitats was not reduced due to fish's choosing to now settle on the breakwater.

The United Nations University-INWEH analyzed the breakwater while it was still young; some parts of the breakwater were only 3 months old, while other parts were about 1 year old. (This age difference reflects the length of the construction process.) In the two years since UNU-INWEH's analysis, the species diversity at the breakwater has probably increased, especially since the end of the dredge-and-fill portion of construction. The INWEH team asserted that the communities of fish and invertebrates on the breakwater would likely exceed any former communities in The Palm's vicinity in species abundance and perhaps in species richness as well (16).

The breakwater is not the only portion of The Palm that may become new habitat to marine biota. The lagoons of Palm Jumeirah may attract wildlife such as seagrass and the species that colonize seagrass beds.

We have recently found extensive beds of sea grasses colonizing the sea floor within Palm Jumeirah. The fine sediments that are nutrient rich have proven to be an excellent habitat for sea grasses. The shape of the islands provides them with the shelter they need from shamals. (Lenehan personal email)

Lenehan also said,

The vigour of the existing sea grass beds we have found at The Palm Jumeirah is a strong statement as to the health of the water. We have recently found three species which are effectively carpeting the seabed between the fronds - these sea grass meadows are the most extensive in Dubai waters. ("Nakheel to Launch").

The Palm has attracted seagulls and other seabirds as well; although the INWEH scientists do not think the birds will build nest on The Palm because of the high levels of human activity. The scientists also observed three or four Indo-Pacific humpback dolphins in the lagoons between The Palm's fronds. They were not sure if this sighting was a rare occurrence or if dolphins would become regular visitors. They did not observe any other megafauna.



Earlier we discussed the impacts of increased turbidity from island construction on corals and other marine fauna especially. But, the marine fauna are not the only ones who have suffered from the increased turbidity. Divers have temporarily lost popular dive sites in the vicinity of The Palms. By 2004, the Emirates Diving Association was complaining that nine popular diving spots had suffered from The Jumeirah and Jebel Ali Palms' construction. The nine dive sites lie at the following coordinates:

<b>Non-Diveable sites</b>	<b>GPS Coordinates</b>
Jumeirah Artificial Reef	N 25 09' 37" E 55 09' 30"
MV Sarraf 3	N 25 16' 07" E 55 08' 55"
Car Barge & Tug Boat	N 25 16' 16" E 55 08' 02"
<b>Other Sites Becoming Seriously Affected</b>	<b>GPS Coordinates</b>
Cement Barge	N 25 10' 20" E 55 12' 17"
Zeinab	N 25 14' 93" E 54 51' 54"
DB1/SMB	N 25 16' 48" E 55 03' 43"
Neptune 6	N 25 30' 20" E 55 03' 50"
Anchor Barge	N 25 30' 20" E 55 03' 50"
Hopper Barge	N 25 30' 20" E 55 03' 50"

Figure 33's: Emirates Diving Association's List of Affected Dive sites

Eight of those diving sites are located in the vicinity of Palm Jumeirah; the ninth site—Zeinab—is located nearer to The Palm Jebel Ali. Therefore, it appears that Palm Jumeirah's construction has rendered three dive sites non-diveable and has seriously affected five other dive sites. According to EDA's Ibrahim Al-Zu'bi, the three non-diveable sites are unsafe for divers due to lack visibility and the presence of dredgers and other dangerous equipment. Sites that EDA classified as seriously affected suffer from low visibility, and low fish numbers (because nearby construction has scared them away)...et cetera. All nine sites should become suitable for diving again once land reclamation operations for The Palms cease.

The Emirates Diving Association also complains that construction of Palm Jumeirah has polluted nearby beaches with a grey, slimy, cement-like substance. According to EDA intern, Aimee Holmes, "This is likely due to deep underwater dredging that leaves churned up sediment [sic] to settle on the seabed close to the shore." Ibrahim Al-Zu'bi also attested that the grey substance came from The Palm Jumeirah. He says that the substance isn't dangerous or harmful, but it isn't attractive either. I asked Dr. Tom Williams about it, but he said he had never heard anything about the slime before

and he doubted that it came from The Palm Jumeirah rather than some other coastal development project.

Development is taking place up and down the Dubai coast which makes it hard to pinpoint the sources of certain environmental impacts. Even when people suspect a particular development, it is often difficult to prove that that development is the culprit. For instance, Dubai's beaches are littered with dead coral, crunching underfoot ("Island-Building"). Who is the culprit? Current mega-developments, like the Nakheel projects? Other developments, such as hotels, ports, and marinas? Older projects, such as desalinization plants and factories? There is no scientifically accurate answer.



## NAKHEEL'S REMEDIATION EFFORTS FOR THE PALM JUMEIRAH

*Planting a tree doesn't bring back a whole forest. If you plant a native Sable tree outside your home in Florida, does this replace the trees that were cut down to build your house? Nakheel cannot replace or mitigate for the coral they've killed.*

—Dr. Bernhard Riegl, on Nakheel's destruction of coral, particularly at The Palm Jebel Ali

In the previous section, we examined the marine biological and environmental impacts of The Palm Jumeirah and its construction. In this section, we address part two of my research question: How does Nakheel plan to mitigate the environment damage? In the case of The Palm Jumeirah, Nakheel sought several methods of ascertaining and remedying the damage:

- Following The Equator Principles (in compliance with the requirements of overseas investors).
  - Compiling an EIA before beginning construction (though not submitting it to Dubai Municipality).
  - Developing an effective Environmental Management Plan (EMP) that promotes green practices and places restrictions on commercial and residential entities at The Palm.
  - Consulting with stakeholders.
  - Developing a partnership with United Nations University to create an Ecological Monitoring Plan.
- Monitoring eleven types of pollution.
- Attempting to create artificial reefs.



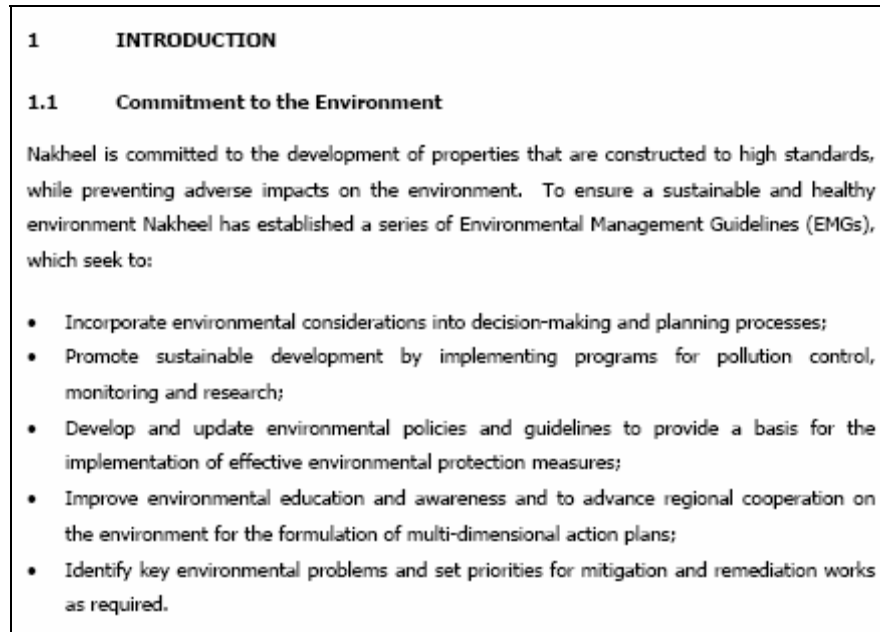
Nakheel's investors include international banks, so Nakheel has to follow The Equator Principles (Lenehan personal interview). The Equator Principles are a set of guidelines that allow lenders to ensure that the projects they finance "Are developed in a manner that is socially responsible and reflect sound environmental management practices" ("The Equator Principles"<sup>1</sup>). In adopting The Equator Principles, Banks agree that "We undertake to review carefully all proposals for which our customers request financing. We will not provide loans directly to projects where the borrower will not or is unable to comply with our environmental and social policies and processes" (2).

According to The Equator Principles, a developer must compile an Environmental Impact Assessment that compares the project's potential environmental impacts with the alternatives, including not undertaking the project at all. The EIA must also recommend measures to prevent, minimize, or mitigate adverse environmental impacts and enhance environmental performance. Additionally, the EIA must address compliance with the host country's applicable laws, regulations, and permits. Developers of projects having a considerable impact on the natural environment must also prepare Environmental Management Plans (EMPs)—based upon the conclusions of their EIAs—and regular reports on their compliance with the EMPs. The developer must also consult "In a structurally and culturally appropriate way, with project affected groups, including indigenous peoples and local NGOs" (3) and provide them with a copy of the EIA. Lastly, the developer must appoint an independent environmental expert to help monitor the project and develop reports.

As I previously explained, Nakheel prepared an EIA for The Palm Jumeirah, but did not turn it in to the local authorities. Nakheel has not complied with local regulations and permits. And, while the EIA is technically available to the public in

that anyone who visits Nakheel's environmental office can peruse it, it has not actually been given to the public.

However, Nakheel *has* developed extensive EMPs for The Palms. Nakheel refers to them as EMGs (Environmental Management Guidelines). The EMGs begin with a statement about Nakheel's attitudes toward the environment.



**Figure 34: Nakheel's Environmental Commitment.**  
Reproduced with permission from Nakheel

As the EMGs indicate, Nakheel considers itself a green company that is committed to mitigation and remediation. The EMGs outline environmental rules and regulations for contractors, commercial tenants and individual residents. Contractors working for Nakheel must comply with the following goals:

### **1.2 Guideline EMG 01 Objective and Goals**

The objective of Guideline 01 (EMG 01) is to ensure that all contractors performing work on Nakheel projects, particularly marine projects, do so in accordance with regulatory environmental protection guidelines to:

- formulate comprehensive work instructions to be adopted by contract personnel for the protection of the quality of the environment,
- take action to eliminate or minimize risks of harm to local ecosystems,
- assure the protection of the environment based on sustainable development principles,
- provide a better quality of life for tenants and visitors to the completed development,
- develop a system for implementing the guidelines.

**Figure 35: Environmental Guidelines for Contractors As Outlined in Nakheel's EMG.**  
Reproduced with permission from Nakheel

The contractors must also comply with any applicable guidelines from Dubai Municipality and all other safety, health, and environmental regulators affiliated with Nakheel. In the EMG, Nakheel requires its contractors to use environmentally safe products and to proactively seek more environmentally friendly alternatives to any products already in use. Environmental scientists at Nakheel have also insisted upon sanitary conditions for all contractor personnel. (Unfortunately, UAE contractors don't usually provide their workers with decent sanitary facilities). Nakheel also prohibits dumping wastes and discharging effluents. Furthermore, contractors must use noise attenuation screens to cover heavy, loud equipment; and use silt curtains and floating booms to confine silt generated by construction. They must also prevent scum generated through reclamation from migrating to nearby waters.

In addition, the EMGs require each contractor to appoint an Environmental Protection Officer who acts as its facilitator for all environmental matters and who liaises directly with Nakheel's Environmental Compliance Officer. Nakheel monitors the contractors for environmental performance and awards future contracts based on each contractor's previous performance.

Contractors are required to make reasonable efforts to conform to the environmental management guidelines...Contractors who continue not to comply with the requirements of the EMGs shall incur **negative performance points (NPPs)**....

Contractors who demonstrate good environmental management practices by following the requirements... will be rewarded with **positive performance points (PPPs)**. Contractors with a significant number of PPS shall be preferred during future tender assessments.

Contractors can incur NPPS by failing to properly dispose of wastes, allowing oil or fuel to leak onto the ground, allowing fine particles to enter the marine environment...et cetera.

Landscapers must adhere to especially strict guidelines covering the type and amount of fertilizers, pesticides, and irrigation water that they can use. They must install a unidirectional geotextile layer around the roots of trees and plants to prevent the roots from drawing water through the soil and causing sea water intrusion. Nakheel's landscaping unit reviews landscaping contractors for compliance, issues warnings to violators, and fines unresponsive violators by up to 1000 dirhams per day or 1500 dirhams per incident.

As for commercial tenants such as hotels, restaurants, and tourist attractions, they too must adhere to Nakheel's environmental guidelines. Each commercial tenant must develop its own EIA. Tenants must ensure that their lighting does not cause light pollution to the surrounding environment, must develop strategies to reduce and recycle wastes—including a Waste Prevention Program—and must follow all other environmental health and safety measures. Nakheel even includes an appendix that offers tips on how to reduce wastes and encourage an atmosphere of environmental stewardship among hotel staff.

Environmental Management Guidelines for residents will help protect the environment once residents arrive. These guidelines control when and how a resident disposes of his pool water, and what plants he can place on his property. The Environmental Management Guidelines also prohibit residents from anchoring or mooring their watercrafts near sensitive marine habitats. Most importantly, the EMGs establish a group that will routinely carry out environmental compliance monitoring and will notify non-compliant residents, advising them to change their behavior within seven days. Residents who fail to comply within seven days must pay fines of up to 5000 dirhams per day. These rules make for an effective EMG that protects the environment from unnecessary harm

In keeping with The Equator Principles, Nakheel has also consulted stakeholders. Lenehan says Nakheel consults with approximately 12 stakeholder groups to get ideas, input, constructive criticism, and feedback. For example, on September 8<sup>th</sup> of 2004, Nakheel held an hour-long meeting with the diving community, environmentalists, and members of the public (Holmes). Approximately 80 people attended this meeting.

I asked Al Zu'bi of the EDA about Nakheel's stakeholder consultations. He answered that Nakheel's list of consultants includes the EDA, WWF, The Emirates Environmental Group, The Ministry of Agriculture and Fisheries, The Federal Environmental Agency, Dubai's Department of Tourism and Commerce Marketing, Dubai Ports Authority, Dubai Municipality, Jebel Ali Free Zone and others. This consultation mainly consisted of Nakheel telling the stakeholders what it intended to do and asking for any input, feedback, or objections. Stakeholders like WWF felt frustrated with the process because they felt that their suggestions did not carry enough weight. Stakeholders were usually asked for their opinions after a project had already been

approved. For example, Dr. Launay says Nakheel asked the stakeholders for input about its plans to bring a killer whale to The Palm Jebel Ali, but by then it was too late; for years, newspaper articles had been bragging that The Palm Jebel Ali's aquatic theme park would feature killer whales and dolphins, and Nakheel was already in the process of acquiring the animal.

Still, at least Nakheel did notify these stakeholders of its actions. Nakheel's Imad al-Haffar has met with stakeholders and concerned scientists to explain Nakheel's perception of The Palms' impacts on the marine ecosystem. And Mr. Lenehan has been forthcoming with me—a member of the public—about The Palms' environmental impacts, and Nakheel's mitigation efforts. It seems that, for the most part, Nakheel has adhered to the public consultation component of The Equator Principles.

In keeping with The Equator Principles, Nakheel has appointed an independent environmental expert—The United Nations University's International Network on Water, Environment and Health that will have an independent governance role in providing feedback and advice to Nakheel on its ecological monitoring (Lenehan Interview). Who is UNU-INWEH?

UNU-INWEH is a member of the U.N. University family of organisations. It was created by the UNU Governing Council in 1996 to strengthen water management capacity, particularly of developing countries, and to provide on-the-ground project support. (UNU-INWEH "Homepage")

The United Nations University's INWEH conducts projects on several subjects, including river basin ecosystems, dry-land ecosystems, health and water, and coastal zone ecosystems. Nakheel has partnered with UNU-INWEH via the latter's Coastal Programme which addresses "coastal zone ecosystems" projects.

UNU-INWEH's coastal programme focuses on improvement of scientific understanding to foster sound decision-making. This is directly linked to capacity development efforts to address critical gaps, achieved through diffusion of scientific research and promotion of human and institutional capacity. These initiatives are all directed to the long-term goal of Integrated Coastal Zone Management (ICZM), linked to the integrated management of adjacent inland watersheds. (UNU-INWEH "Threatened Coastal Zone Ecosystems")

The United Nations University's International Network on Water, Environment and Health describes its work with Nakheel on its website. The description is as follows (UNU-INWEH "Coastal Zone Mgmt"):

This project is a multiphase research and monitoring program to assess long-term sustainable coastal management program related to a large, off-shore commercial development projects in Dubai, UAE.

**Project Objectives:**

- Evaluate the current status of coastal ecosystems in Dubai
- Develop a framework for sustainable coastal management in the face of major off-shore construction projects
- Share the experience of near-shore coastal developments, through dissemination of knowledge at the local, regional and international levels

**Project Activities:**

A feasibility study for this program was completed and submitted in May 2004. This report identified long-term management actions to ensure the development and sustained maintenance of the marine environment.

UNU-INWEH has now been invited to undertake a five-year program of activities that will facilitate Nakheel to better manage its coastal marine properties. Activities will include training of staff, equipping and certification of environmental laboratory, and basic research studies to document the ecology of the ecosystems being developed, and to provide predictive management tools. Work is anticipated to begin by early 2006.

**Figure 36: UNU-INWEH Describes Its Work With Nakheel**  
Reproduced from [www.inweh.unu.edu](http://www.inweh.unu.edu)

In their report to Nakheel, UNU-INWEH recommended several immediate actions along with a few long-term goals. The relevant immediate recommendations encourage Nakheel to develop environmental regulations for The Palm's occupants and a system for enforcing those regulations. The report also encourages Nakheel to develop an

environmental laboratory on or near The Palm to support monitoring, assessment, and remediation there. Nakheel has established environmental regulations and enforcement mechanisms (outlined in its EMP), but has not yet established a laboratory on The Palm. However, Nakheel monitors, assesses, and researches various environmental aspects of its projects without the benefit of its own nearby lab. For example, every month scientists sample water from a dozen different sites around The Palm Jumeirah (Mustafa). The scientists analyze the water samples for 30 different parameters. This allows Nakheel to monitor for possible nutrient leakage from the fronds into the water. Nakheel will probably develop an environmental laboratory on or near the Palm Jumeirah in the near future.

The long-term goals that UNU-INWEH recommended to Nakheel are as follows:

- Establish a long-term, multidisciplinary, environmental monitoring program...to increase understanding of how these systems function, and how they respond to particular impacts or management actions....
- Develop models to guide management decisions.... Models of sediment transport, water movement, and water quality within The Palm Jumeirah lagoon....
- Conduct specific targeted research projects to answer critical questions or solve problems in environmental management....to derive new knowledge about the unique ecosystems that have been created....(4)
- With UNU-INWEH, establish The Palm Conferences, a series of international conferences on the marine environment....The new knowledge gained through the construction, development, and sustainable management of each of these projects needs to be presented to the world as a way of building global capacity for successful management of coastal marine environments....(5)

According to Shaun Lenehan, Nakheel is taking all of these recommendations seriously and plans to implement them. Imad Al-Haffar and Shahid Mustafa presented on



this matter at The State of The Gulf Ecosystem Conference, Future and Threats, which was held in March of 2006.

It has become recognized that ecosystem monitoring through well-established protocols is the major key driving ecosystem sustainability and environmental resource conservation and enhancement. Monitoring programs of ecological characteristics have commenced in the marine and inland projects of Nakheel to advise management how to enhance different ecosystems. Phytoplankton, zooplankton, and macrobenthos studies at 14 stations along The Palm Jumeirah indicate high diversity and healthy environmental conditions. Preliminary observation reveals that the fronds between The Palm Jumeirah uphold sea grass species. (Haffar& Mustafa)

Further reports on Nakheel's research efforts have appeared in newspaper articles. The articles report that Nakheel is studying some seagrass beds that have appeared in Palm Jumeirah's lagoons because it wants to transplant some of the seagrass to The Palm Jebel Ali.

Nakheel also monitors its projects for eleven types of pollution including noise, and light and has installed sophisticated technology for waste disposal and recycling (Holmes). I believe that Nakheel will maintain this degree of vigilance in monitoring pollution to ensure that The Palm attracts tourists.

Recently, Nakheel setup a task force that rescued about 1,869 marine organisms from death at The Palm Jumeirah. These fish were about to be caught in a dam that Nakheel was building at The Palm. Nakheel needed the dam in order to expose dry land so that it could build a tunnel. Nakheel realized that fish would die once the dam was closed and draining commenced. So Nakheel setup a task force that saved members of 35 marine species from death ("Nakheel Conducts").

Still, some scientists like Dr. Williams argue that this does not make up for the coral buried at Jumeirah. Even if the coral were dead (as MME believed), it might still deserve protection. Corals of the Arabian Gulf suffer from recurring mass mortalities

caused by temperature anomalies in which temperatures increase or decrease drastically, causing widespread bleaching and eventual death (Riegl, 1999). But coral larvae recolonize the skeletons of their predecessors and the coral community re-establishes itself within about 15 years (Riegl, 1999). If the coral mortality was caused by a temperature anomaly, the coral community would rebound. If the mortality was caused by a continuous stream of hot industrial effluents (as MME indicates), the coral would never have the chance to recover. In any event, the coral Dr. Williams describes was alive, not dead.

He says that Nakheel had the opportunity to save the coral at Jumeirah, but elected not to do so. He and Ali Sagar surveyed the area in which The Palm Jumeirah would be built to see if any coral should be transported away from the construction zone. Dr. Williams presented the results of the survey to Saeed Ahmed Saeed, the Managing Director of Engineering at Nakheel. But Saeed wasn't convinced. Coral transportation and transplantation would be too expensive, especially if conducted by the EDA (Their rates were reasonable but unaffordable in Saeed's eyes). The Emirates Environmental Marine Group, chaired by Ali Sagar, offered to transplant the coral for a reduced fee, but Saeed said Nakheel couldn't afford that fee either. The following day, construction began on The Palm Jumeirah, and the coral was soon lost. Thus Nakheel missed an important opportunity to mitigate by protecting the natural coral.

Several scientists and environmentalists argue that failure to protect natural corals cannot be remedied by creating artificial reefs. Dr. Riegl, Director of the National Coral Reef Institute, compares Nakheel's plans to construct artificial reefs after destroying natural ones (particularly those at The Palm Jebel Ali) to a developer who chops down a

rainforest to build an apartment block, plants three trees out front, and announces that he has not only replaced the rainforest, but has *enhanced* the local environment.

Nakheel's other missed opportunity to mitigate was its failure to use the silt screens that MME recommended. Failure to use silt screens led to widespread turbidity increases and the suffocation of several species of marine fauna.

## CONCLUSIONS AND RECOMMENDATIONS

*This initiative is basically filling a need because there are not enough beaches....Tourism means beaches and this project will create more.*

—Sultan Bin Sulayem

You will recall that the World Wildlife Fund's UAE-Office Director, Dr. Frederic Launay, said that Nakheel did not have to abide by federal and local environmental laws when constructing The Palm Jumeirah because the environmental laws were passed after planning for The Palm Jumeirah had commenced. But what about Federal Law No.24? It states.

### **Article 97**

The owners of projects and establishments existing on the date of operation of this law and determined by the Executive Order, shall provide the Agency within a period not exceeding one year from the operation of the Executive Order, with a complete statement of their activities. The statement shall include their suggestions concerning precautions and measures to be taken so that the operations of the projects or establishment meet the required environmental standards.

### **Article 98**

Projects and establishments existing on the date of operation of this Law, shall amend their status according to its provisions and the provisions of the Executive Order within a period not exceeding one year from the date of operation of the Executive Order.

These Articles seems to eliminate loopholes for older projects. The Palm Jumeirah should not have slipped through any loopholes. So it seems Nakheel outright disobeyed Articles 97 and 98 of Federal No.24. If that is the case, then there is no excuse for Nakheel's failure to provide Dubai Municipality with the aforementioned statement of activities and the EIA for the Jumeirah Palm. Nakheel has also failed to submit EIAs for its other Palm projects, which were planned and designed well after the relevant federal environmental laws had been established.

But there is one federal law that actually supports Nakheel since Nakheel is building The Palm Islands on Dubai's behalf. Federal Law No. (19) Of the Year 1993 gives The State the sole authority to construct and develop artificial islands. Nakheel, as a government-controlled company, falls within the bounds of that law. Still, Nakheel should have to abide by environmental laws too, including Federal Laws No. 23 and 24. But it does not.

Nakheel (along with such government entities as Dubai Ports) is a subsidiary of the Ports, Customs, and Free Zone Corporation, a government owned corporation. The Ports, Customs, and Free Zone Corporation (called PCFC) provides Nakheel with strong government support and allows Nakheel to enjoy the same level of legislative freedom that PCFC enjoys.

Nakheel's position within the PCFC along with other government industrial sectors indicates its importance to the rulers of Dubai. Nakheel is exempted from local and federal environmental laws just as foreign companies that setup in the Jebel Ali Free Zone (another subsidiary of PCFC) are exempted from local taxation laws. Dubai sees this as the way to increase trade and tourism and decrease the reliance upon oil revenue (Williams). Who can blame Dubai for trying to free itself from economic dependence on oil—a non-renewable resource? No one. As Dubai develops itself, it must seek the delicate balance between construction and conservation and must mitigate whenever possible.

Nakheel has undertaken some remarkable mitigation measures in constructing The Palm Jumeirah, especially when one considers that Nakheel could have simply done nothing. Lenehan opined that while the Western populace would probably never have allowed a project like The Palm Islands to be built in their countries, if such a project

were allowed, the developer would have never undertaken all the environmental protection and mitigation measures that Nakheel has undertaken. Here is a company—Nakheel—that essentially resides above the law, yet has still (generally) adhered to The Equator Principles in constructing The Palm Jumeirah (albeit not while constructing their other Palms). Of course, it has mainly done so for public relations and at the request of its investors. Still, I am glad Nakheel undertook any environmental measures at all. Most developers would not have created extensive EMGs, consulted so many environmental firms, highly encouraged their tenants to reduce wastes, or engaged in any of Nakheel’s other mitigation efforts.

My only recommendations to Nakheel (if I limit my recommendations to The Palm Jumeirah), would be that it develop more honesty in its public statements and that it provide copies of the EIA—or at least its environmental sections—to all stakeholders. Several of my interviewees were under the impression that the breakwater would serve as ideal habitat for coral, but UNU-INWEH predicted little coral settlement onto the breakwater. Nakheel should divulge this information by sharing its EIA and by refraining from implying that its projects will enhance the environment by creating coral habitat.

If I don’t limit my recommendations to The Palm Jumeirah, but expand it to all of The Palm Island projects, the list of recommendations would grow much longer; however, the other Palm Projects lie beyond the scope of this investigation. I *will* point out that Nakheel should have compiled EIAs for The Palms Jebel Ali and Deira prior to construction and that all construction should cease until those EIAs are compiled. Nakheel should also not construct The Palm Jebel Ali (Palm II) because the construction zone overlaps JAWS, and could wipe out the second richest biostrome in the Gulf, killing 91 species of fish, 52 species of marine mollusks, and 34 species of coral.

At this late stage, there is nothing Nakheel can do for the coral it has already buried at Jumeirah. Saving the coral would have constituted a very important mitigation measure. Of course transplanting coral is a risky enterprise and only a portion of the transplanted coral would survive. (Ali Sagar estimates a 50-60% survival rate, while Dr. Williams estimates 10-20%. Dr. Riegl estimates very low survival rates.) The best thing for the coral would have been to not have The Palm built at all. Unfortunately, There is no where along Dubai's small coastline that can accommodate a colossal artificial island without causing death to marine vertebrates and invertebrates—corals and others.

My recommendation to Dubai and its authorities is that Dubai Municipality be allowed to do its job fully and completely without having to contend with legal loopholes. Environmental laws should apply to all companies, not just those established outside of PCFC. Dubai Municipality, as the competent, authority should oversee all large development projects for compliance with environmental standards. I support Dubai's decision to not build any more artificial islands (Al Suweidi). We are still learning from The Palms.

Developers in other emirates and other countries can learn from Nakheel and The Palms too. I look forward to Nakheel's conferences in which it plans to share the lessons it has learned. Some of the main lessons are that coral must be preserved and silt screens used. EIAs must be conducted before construction begins. Developers should also create a detailed EMG to regulate tenant behavior. Developers must consult with stakeholders as much as possible, and in the planning stages. In short, Developers should adhere to The Equator Principles and abide by all applicable local environmental laws. If developers fail to undertake these measures, the marine environment surrounding each

artificial island will deteriorate until numerous fauna and flora in Bahrain, Qatar, Oman, and the UAE are lost.





## WORKS CITED

- AAA Freehold. <<http://www.aaafreehold.com>> (4 Dec. 2005).
- Abdellatif, Eisa. Personal Interview. 13 June 2005.
- “AlBayaanaat AlWajib Tawafurihaa Fee Dirasat Taqyeem AtTa-theer Al Bee-ey Lil Munsha-aat.” The Federal Environmental Agency.  
<<http://feaapp.fea.gov.ae:7777/pls/portal/docs/PAGE/FEAPAGEGROUP/ENVIRONMENTALSERVICES/IMPACTASSESSMENTOFPROJECTS/INFORMATION%20REQUIRED-EIA.PDF>> (18 Mar. 2006).
- Al Suweidi, Ali Sagar. Personal Interview. 26 June 2005.
- Anonymous Biologist at the Ministry of Agriculture and Fisheries. Personal Interview. 21 June 2005.
- Anonymous Scientist at the Environmental Resources and Wildlife Development Agency. Personal Email. (15 Feb. 2005)
- Al Zahed, Khalid Mohammed. Personal Interview. 2 July 2005.
- Al-Zu'bi, Ibrahim. Personal Interview. 26 June 2005 & 5 July 2005.
- . Telephone Interview. 18 July 2005.
- “Biography.” The Crown Prince of Dubai. Adapted from a biography written by Graeme Wilson. <<http://www.sheikhmohammed.co.ae/english/biography/crown.asp>> (16 Mar. 2006).
- Coastal Management Section, General Projects Department, Dubai Municipality. Coastal Management Section Capabilities and Services Nov. 2004.
- Department of Tourism and Commerce Marketing “Dubai Hotels Maintain Vibrant Growth.” Press Releases. 4 Mar. 2006. Dubai  
<<http://www.dubaitourism.ae/news/default.asp?ID=1007>> (19 Feb, 2006).

*“Dubai: Al Juzzur Al-Istinaa’iyyah Ghair Qabilah Lilgharq Wa Tathammal Zilzal Mudammarah Biquwwat 6 Darajaat Wa Tsunami Bi-Irtifaa 4 Amtar.” Asharq-Alawsat. 22 Jan. 2005 <<http://faculty.uaeu.ac.ae/fhowari/asharq.htm>> (8 June 2005).*

Dubai Municipality Environment Department Environment Protection and Safety Section. “Technical Guideline No.53 Environmental Impact Assessment Procedures.”

“Dubai Overview” Marketplace International Business Index. 2006. Global Business Media Index. [www.usatoday.com/marketplace/ibi/dubai.htm](http://www.usatoday.com/marketplace/ibi/dubai.htm) (16 Feb. 2006).

“Dubai Review. Panning Out Nicely.” Gulf Construction Online. 25.4. Apr. 2004 <<http://gulfconstructionworldwide.com/bkArticlesF.asp?IssueID=234&Section=1098&Article=5665>> (26 Mar. 2006).

Durrat Al Bahrain. 2005.

<<http://www.durratbahrain.com/Main.aspx?ID=25&MID=53&t=1>> (15 July 2005).

“Durrat Al Bahrain: Ultimate Luxury” Bahrain—Gateway to the Gulf. 16 Dec. 2004. Office of the Economic Representative of Bahrain.

<<http://www.bahraingateway.org/index.cfm?fuseaction=document.home&id=87>> (10 Aug. 2005).

Federal Law No. 7 of 1993 for the Establishment of the Federal Environmental Agency As Amended By Federal Law No. 30 of 2001.

<[http://feaapp.fea.gov.ae:7777/pls/portal/docs/PAGE/FEAPAGEGROUP/ABOUTUS/LAWSOFESTABLISHMENT/FEDERAL%20LAW%20NO%20\(7\)%20OF](http://feaapp.fea.gov.ae:7777/pls/portal/docs/PAGE/FEAPAGEGROUP/ABOUTUS/LAWSOFESTABLISHMENT/FEDERAL%20LAW%20NO%20(7)%20OF)

%201993%20AND%20ITS%20AMENDMENTS%20-%20ENGLISH.PDF> (15 Mar. 2005).

Federal Law No. 23 of the Year 1999 Regarding the Exploitation, Protection and Development of the Living Aquatic Resources in the Waters of the State of the United Arab Emirates. Trans. Ahmed Salim Essa.

Federal Law No. (24) Of 1999 for the Protection and Development of the Environment.

<[http://feaapp.fea.gov.ae:7777/pls/portal/docs/PAGE/FEAPAGEGROUP/LAWSANDLEGISLATIONS/ENVIRONMENTALLAW/FEDERAL%20LAW%20NO.%20\(24\)%20OF%201999-ENGLISH.PDF](http://feaapp.fea.gov.ae:7777/pls/portal/docs/PAGE/FEAPAGEGROUP/LAWSANDLEGISLATIONS/ENVIRONMENTALLAW/FEDERAL%20LAW%20NO.%20(24)%20OF%201999-ENGLISH.PDF)> (15 Mar. 2005). Trans.

“Genesis of a Leader.” HH Sheikh Zayed bin Sultan Al Nahyan: President of the UAE.

19 Apr. 2005. Media Prima. <<http://www.sheikh-zayed.info/natcon.htm>> (5 Mar. 2006).

Haffar, Imad and Shahid Mustafa. Abstract. “Establishment of Long Term Ecosystem Assessment Protocols for Nakheel Projects, Dubai, United Arab Emirates.” The First International Conference On The State of the Gulf Ecosystem Conference: Future and Threats. UAE University. Al Ain, United Arab Emirates, 5 Mar. 2006. <[http://www.uaeu.ac.ae/news/docs/20060305\\_1stGulfCon1stCircular\\_2\\_updated.pdf](http://www.uaeu.ac.ae/news/docs/20060305_1stGulfCon1stCircular_2_updated.pdf)> (27 Apr. 2006).

Hammond, Andrew and Hala Salman. “Dubai’s Man-Made Islands Anger

Environmentalists.” 27 Oct. 2005. Planet Ark.

<<http://www.planetark.com/dailynewsstory.cfm/newsid/33190/story.htm>> (5 Mar. 2006).

Hassan, Mohammed Abdul Rahman. Personal Interview. 2 July 2005.

---. Telephone Interview. 24 July 2005.

Holmes, Aimee. "Pearls of Wisdom: A Three-Part Series of Interviews with Key Individuals in Dubai's Development." EDA Divers for the Environment. 3.1. Dec. 2004:19.

"Island-Building Alters Gulf Ecology." Hindustan Times 27 Feb. 2005.  
 <[http://www.hindustantimes.com/news/5922\\_12060490,001500230005.htm](http://www.hindustantimes.com/news/5922_12060490,001500230005.htm)> (28 Feb. 2005).

"*Juhood Himaayat Albiy-ah Albahriyyah Fi Dawlat Al-Emiraaraat Al-Arabiyyah Al-Mutahidah.*" Al-Emiraaraat Wa Albiy-ah Magazine 10 (2004):13-27.

Krane, Jim. "Arab Island Resorts Are Reshaping Geography." 8 Mar. 2005. MSNBC.  
 <<http://msnbc.msn.com/id/7051051/>> (16 Feb. 2006).

---. "Dubai to Build Mega Project." 4 Feb. 2005.  
 <<http://news.enquirer.com/apps/pbcs.dll/article?AID=/20050204/BIZ/502040340/1001>> (16 Feb. 2006).

Launay, Frederic. Personal Interview. 13 July 2005.

Lenehan, Shaun. <Shaun.Lenehan@nakheel.ae> "RE: Nakheel pictures and images." 25 Apr. 2006. Personal email.

Lenehan, Shaun. Personal interview. 15 June 2005 & 5 June 2005.

MacDonald, Fiona. "Dubai's Tourism, Real Estate Drive Shake Gulf" Middle East Online. 4 Apr. 2005. <<http://www.middle-east-online.com/english/oman/?id=13119>> (16 July 2005).

Martin Mid-East Ltd. "Bathymetric, Geophysical, Marine Ecological, Topographic, And Geotechnical Investigation." 2000. Appendix D. Integrated Environmental Impact Assessment. By Nakheel.

Mustafa, Shahid. Personal Interview. 5 June 2005.

Nakheel. <<http://www.thepalm.ae>> (15 Feb. 2005).

“Nakheel Conducts A Major Fish Rescue Operation at The Palm, Jumeirah” 25 Nov.

2005. Arab Wide Web

<[http://www.arabwideweb.com/english/Environment\\_News.asp?id=20](http://www.arabwideweb.com/english/Environment_News.asp?id=20)> (12 Mar. 2006).

“Nakheel Testing Artificial Reefs at the Breakwaters of The Palm, Jumeirah.” Feb. 2005.

Asia Travel Tips <<http://www.asiatraveltips.com/news05/72-Reefs.shtml> 7> (2 Mar. 2005).

“Nakheel To Launch A Research Project On Sea Grasses In The Palm Jebel Ali With

Taisei Corporation.” 4 Mar 2005. <<http://www.ameinfo.com/cgi-bin/page.cgi?page=print;link=79358>> (27 Apr. 2006).

“Nation Building.” HH Sheikh Zayed bin Sultan Al Nahyan: President of the UAE. 2003.

Media Prima. <<http://www.sheikh-zayed.info/natcon.htm>> (5 Mar. 2006).

“Nujoom Islands.” Property Developments: Sharjah. TEN Real Estate [UAE].

<[http://realestate.theemiratesnetwork.com/developments/sharjah/nujoom\\_islands.php](http://realestate.theemiratesnetwork.com/developments/sharjah/nujoom_islands.php)> (5 Mar. 2006).

O'Flynn, Michael. “Island Oasis.” 1 Feb. 2004. Find a Property

<<http://server.findaproperty.com/region.aspx?regionid=150&opt=story&storyid=2707>> (18 Mar. 2006).

“Oman launches 'The Wave' - A Premium Resort Development.” Aqariya Online.

<[http://www.alaqariyaonline.com/GCC\\_003.htm](http://www.alaqariyaonline.com/GCC_003.htm)> (9 Aug. 2005).

Ossis Property Developers. Amwaj islands Bahrain. 2005. <<http://www.ossisonline.com>> (15 July 2005).

“Palm Island the World’s Largest.” Al Shindagah. 41. July—Aug. 2001.

<[http://www.alshindagah.com/july2001/palm\\_island.html](http://www.alshindagah.com/july2001/palm_island.html)> (26 Apr. 2006).

Qaa-imah AlMasharee’ Allaty Yastalzim AlQiyam Lahaa Bidiraasah Taqyeem Alathar

Al Bee-iy Qabl Albad- Fee Tanfeethihaa Aw Ta’deel Aw Tawsi’ah AlQiyam

Minha” <[www.fea.gov.ae](http://www.fea.gov.ae)> (16 Mar. 2006).

Qanoon Ittihaady Raqam (19) Lisannah 1993 Fee Sha-n Ta’yeen Almanatiq AlBahriyyah

Lidawlah Al-emaaraat Al’arabiyyah Almuttahidah.

“RAK Launches Dh1.8b Saraya Island Project.” Khaleej Times Online. 15 Sept. 2005 <

[http://www.khaleejtimes.com/DisplayArticle.asp?xfile=data/business/2005/September/business\\_September317.xml&section=business&col=>](http://www.khaleejtimes.com/DisplayArticle.asp?xfile=data/business/2005/September/business_September317.xml&section=business&col=>) (1 May 2006).

Riegl, Bernhard. “Corals in a Non-Reef Setting In the Southeastern Arabian Gulf (Dubai,

UAE): Fauna and Community structure In Response to Recurring Mass

Mortality.” Coral Reefs 18 (1999): 63-73.

Riegl, Bernhard. Personal Interview. 10 Mar. 2006.

Sale, Peter et al.—International Network on Water Environment and health (UNU-

INWEH). “Building a Management Program for an Effective and Sustainable

Environment for The Palm Island Project – Dubai: Phase 1 – Pilot Study: Final

report to Nakheel.” 2004. Appendix C. Integrated Environmental Impact

Assessment. By Nakheel.

Samson, Gavin and Emma Davey. “Mixing It Up.” Real Estate. TRI Middle East.

<http://www.trimideast.com/images/dynamic/Info%20Centre/pdf/ef67f7c2d86352c2c42e19d20f881f53417cbab31bb7f.pdf> (16 Feb. 2006).

Smailley, Ben. "Artificial Reefs to Protect Marine Life at The Palm Islands."

AlShindagah. 61. Nov.—Dec. 2004.

<<http://www.alshindagah.com/novdec2004/reefs.html>> (2 Apr. 2006).

"The 'Equator Principles' An industry Approach for Financial Institutions in Determining, Assessing And Managing Environmental & Social Risk In Project Financing." 4 June 2003. <[http://www.equator-principles.com/documents/Equator\\_Principles.pdf](http://www.equator-principles.com/documents/Equator_Principles.pdf)> (20 June 2005).

"The Wave Oman Press Release." The Wave Oman.

<[http://www.thewaveoman.com/wave\\_cone.pdf](http://www.thewaveoman.com/wave_cone.pdf)> (10 Aug. 2005).

"The World Islands." TEN Guide.

<[http://realestate.theemiratesnetwork.com/developments/dubai/world\\_islands.php](http://realestate.theemiratesnetwork.com/developments/dubai/world_islands.php)>

(2 Feb. 2005).

United Arab Emirates Ministry of Information and Culture, 2004 Al-Kitab As Sanawy li-Dawlat Al-Emaaraat. London, UK: Trident Press, 2004.

United Arab Emirates Ministry of Information and Culture. UAE Yearbook 2005.

London, UK: Trident Press, 2005.

<[http://www.uaeinteract.com/uaeint\\_misc/pdf\\_2005/English\\_2005/eyb11.pdf](http://www.uaeinteract.com/uaeint_misc/pdf_2005/English_2005/eyb11.pdf)>

(16 Feb. 2006).

"United Arab Emirates" The World Factbook. 20 Apr. 2006. Central Intelligence

Agency. <<http://www.cia.gov/cia/publications/factbook/geos/ae.html>> (16 Feb. 2006).

United Development Company. "Quick Facts" The Pearl. 2006. The Pearl Qatar.

<<http://www.thepearlqatar.com/SubTemplate1.aspx?ID=165&MID=115>> (21 July 2005).

United Nations University—International Network on Water, Environment, and Health.

“Coastal Zone Management in the Arabian Gulf.” 2005.

<<http://www.inweh.unu.edu/inweh/Coastal/Palm/Palm.htm>> (26 Mar. 2006).

United Nations University—International Network on Water, Environment, and Health.

“Threatened Coastal Zone Ecosystems.” 2005.

<<http://www.inweh.unu.edu/inweh/Coastal/index.htm>> (27 Apr. 2006).

United Nations University—International Network on Water, Environment, and Health.

“UNU-INWEH Homepage” <<http://www.inweh.unu.edu/inweh/>> (27 Apr. 2006).

Van Oord “Project: Beach Replenishment and Shore Protection Dubai.”

<<http://www.vanoord.com>> (3 Dec. 2005).

Williams, Tom. Personal Interview. 18 Mar. 2006.