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## EXECUTIVE SUMMARY

The commercial developments lining the coasts of the Arabian Peninsula that have emerged within the past decade have various implications for the environment, economy, and society as a whole. In particular, this paper is interested in the relationship between residents' perceptions of the coastal landscapes that are being created and the effects of such extensive developments, including their demands on water. Less than 50 years ago, this arid region consisted of a few tribes who collected water from nearby wells and springs. After the rise of the oil industry in the 1970s, however, the United Arab Emirates' growing population and burgeoning economy introduced desalination plants to sustain the people and irrigate lush landscapes, which require significant amounts of energy and infrastructure.

Located in Ras Al Khaimah, Al Jazeera Al Hamra is one of the only full standing abandoned villages in the Gulf region and carries a rich history and once critical coastal location. This paper will profile the village as a prototype for coastal developments in arid environments. Inspired by the traditional practices of the region's inhabitants, this paper introduces a design model that integrates several factors. These include the types of visual references represented in the Gulf region, people's contemporary lifestyles, water saving techniques, and the effects of these proposals on the surrounding environment.

# Sustainable Desert Development: A Case Study of Al Jazeera Al Hamra

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## Background

### Consequences of Contemporary Development Trends

Historically, the Gulf region's population was scattered, with most people living along the coasts of the Arabian Gulf and the Red Sea, depending on the sea as a source of fish and other resources. For many years, the Gulf was a prominent trading route for the pearl industry, which largely sustained the economies of local villages along the coast (Carter, 2005). Districts such as Abu Dhabi, Dubai, Ras Al Khaimah, Bahrain, and Qatar were engaged in pearling; the pearls were then exported to neighboring countries, and, subsequently, to various parts of the world (Carter, 2005).

The discovery of oil changed the course of the Gulf economy and eventually gave way to vast construction projects across the Arabian Peninsula. Desert cities that once were sparsely inhabited have now become largely metropolitan, with people relying on the importation of many goods and resources. In accordance with the region's prosperity, the latest technologies and innovative architectural designs from around the globe have influenced the planning and aesthetics of the cities in the United Arab Emirates (UAE).

On one hand, many modern designs reference the region's history. On the other hand, however, such references frequently lack substantive connections to either the region's historic cultures or existing ecosystems. For example, development projects retain references to characteristic natural forms while displacing native species. Prominent examples include the "Palm Jumeirah" and "Falcon City of Wonders" in Dubai and "The Pearl" in Doha, Qatar. Additionally, much recent architecture incorporates non-functioning wind-towers. Although wind-towers traditionally circulated cooled air in desert structures, these new wind-towers provide no circulation and so are equipped with air conditioners. These inventions give an appearance of a traditional context, yet bear little relation to the natural environment in which they are located.

Even though these types of developments have received positive responses from the general public, the developments remain disconnected from the traditional desert environment in which they are located. Furthermore, they require significant amounts of energy and resources to maintain their ambiance. The result is that these design elements stand in stark contrast to, and sometimes obscure the reality of, the Gulf region and its environment (Koolhaas, Khoubrou, & Bouman, 2007). The paper will explain the potential of future development projects to be connected to their surroundings in a way that does not diminish but instead augments people's experiences. Consequently, this will create a setting that is integrated with its surroundings, and requires less energy, maintenance, and reliance on external resources from distant regions of the world.

One of the consequences of developments that prioritize form over sustainability involves the misuse of one of the region's scarcest resources: water. New coastal building projects have repeatedly resulted in poor seawater circulation along the coast, which has caused algal blooms along the shorelines that face luxury home sites (Van Lavieren et al., 2011). In some areas, obstructions of the current have made water clouded and silty. The result is the unexpected and unending maintenance of beachfronts, which proves to be costly in the long run.

Therefore, the net flow of water current needs to be considered on a larger scale. Coastlines are typically formed based on the interaction of the flow of water currents, wave direction, and tidal flux. Any physical obstruction to this process will subsequently change the coastline formation. This can be seen in the areas directly adjacent to the Palm Jumeirah. On one side of the palm, the existing coastline of Dubai has slowly been carved inwards. On the other end, however, the decrease in water movement due to the construction of the Palm has resulted in shoreline buildup (Van Lavieren et al., 2011). These rapid changes have also damaged existing populations of native wildlife species.

This is not to argue that future coastal developments should not be constructed. The research conducted on existing developments demonstrates some positive outcomes. Research conducted by Burt et al. (2010) showed that despite unfavorable impacts these developments have had, there has been an emergence of a few new species that can adapt to these changes and an increase in diversity of coral reefs on the breakwaters of the man-made coastal developments, such as the Palm Jumeirah. Therefore, at the planning and design stage of a project, it is vital to study the potential impacts a project will have post-construction in order to ensure a positive outcome not only economically, but also environmentally.

## Integrating Historic Practices into Modern Design and Planning

A guiding principle of this paper is that the UAE's fast-paced growth should be accompanied by reflection on the region's historical context in order to learn from former settlements in which people relied on the few local resources that were readily available to them. Through such investigation, modern technology and traditional practices may be combined in order to minimize the negative impacts of contemporary building and landscaping practices.

In light of the environmental and financial costs associated with recent development trends, the need to establish a new design prototype that takes economic, social, and environmental factors into consideration has become essential, especially after the ramifications noticed among recent commercial developments only a few years after their construction. Aesthetic building and landscape elements represent a legitimate dimension of sustainable and functional development proposals, but other dimensions should not be overlooked. There is an urgency to shift from such static depictions of design and to begin considering each prospective site with its unique characteristics, which the design can incorporate. Throughout the design process, important considerations include the purpose of the proposed design, the ways in which designs reflect and respond to natural surroundings, and the potential for new growth to have positive impacts on the environment, which could ameliorate consequences that pre-existing adjacent developments may have.

# Case Study: Al Jazeera Al Hamra

Al Jazeera Al Hamra was chosen as a case study of how economic, social, and environmental factors might inform future design proposals and commercial developments. An abandoned, historic village in Ras Al Khaimah, Al Jazeera has a rich history tied to its once strategic location.[1] It is also one of the only full standing villages that remains in the Gulf region, which increases its potential to function as a prototype for evaluating current development practices through a historic lens.

## Background of Al Jazeera Al Hamra

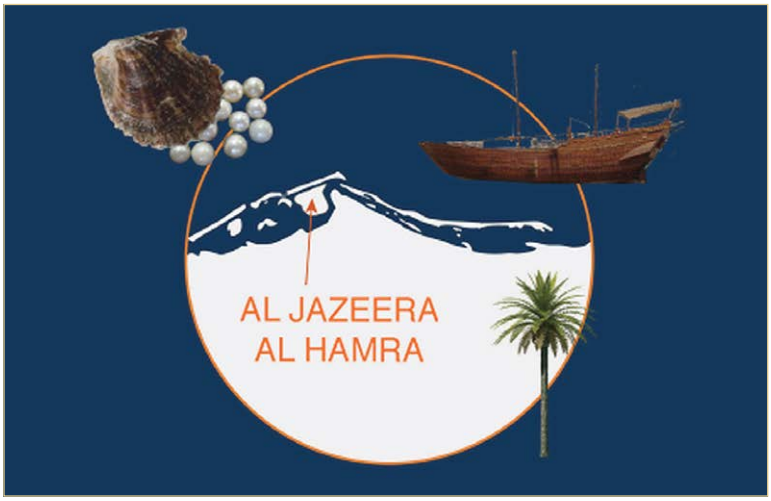
The abandoned village of Al Jazeera Al Hamra is approximately 1.25 km$^2$. The village was an island until 1957, after which some of its coasts were filled in, joining the isle to its adjacent mainland (Parker & Al-Farraj, 2000). The main sources of income for its people were the pearl trade and fishing. However, during the hot summer months, its tribes would travel to cooler areas farther inland, where they owned date palm farms since spring water was available to irrigate the trees throughout the year (Figure 1). The families who previously inhabited the village have since moved to larger homes equipped with modern facilities in the neighborhood as well as to other emirates; however, they still possess ownership of their land and homes in the village.

In the last few years, the site has garnered interest among its former inhabitants and the media in an effort to preserve it. People recognize that Al Jazeera preserves a unique heritage and has sentimental value to its former residents and the emirate.

Nevertheless, at the time of the author's 2012 survey, neglect had taken its toll on the village. One main road surrounds the village, but there are no demarcated paths within the settlement. Most of the abandoned buildings are dilapidated, and rubble lies scattered around some structures. Homes that are in slightly better condition tend to rest at the edge of the site. Expatriate workers often occupy these homes as a result of their low rent prices.

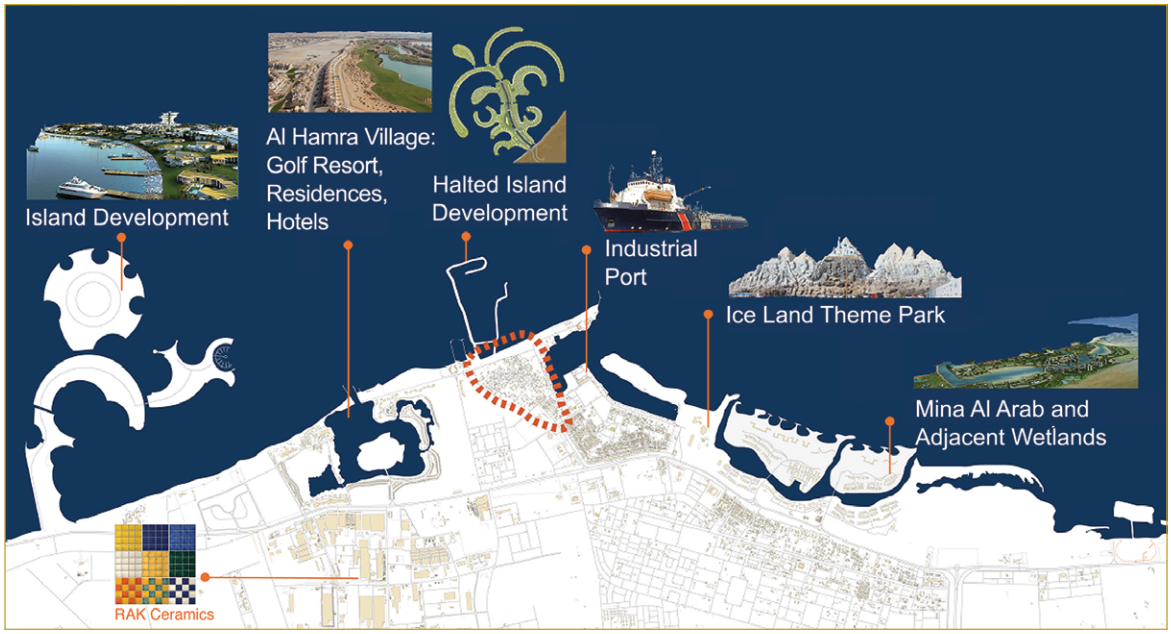
In recent years, families who own the village have cleared away almost all of the overgrown vegetation. Some trees have grown directly adjacent to the abandoned structures, and their root structures, if left unchecked, could cause the buildings' walls to collapse. However, many such trees are native and require no maintenance, as they are well suited to this type of environment. Trees also provide sufficient shade and protection for the existing structures against the intense sun and heat, especially during summer months. Since these trees have several advantages, it is therefore essential to consider a planned demolition in a site like this, one in which only those trees that could affect the existing structures are removed.

### Figure 1: Al Jazeera Al Hamra and its Resources




[1] As referenced above, when the Gulf's economy shifted to oil exports as the main source of income, many coastal villages disappeared, with only a few remaining largely intact. Many have become abandoned or isolated, such as Al Askar in Bahrain or Al Areesh in Qatar ("Qatar's Abandoned fishing villages," 2012). Others have been gentrified and modernized as the economy has developed. Jeddah historic city, Al Bastakiyah in Dubai, and a few others remain, but little efforts have been given to sustaining or revitalizing them.

**Figure 2: Developments surrounding Al Jazeera Al Hamra**




Due to the neglect of this village, Al Jazeera Al Hamra has slowly become gentrified over the last decade. During the village's heyday, the sea was the main source of income, as its people collected oysters for trade with the larger pearl industry, and the villagers relied on fish as a main food resource. Since 2008, there has been no direct access from Al Jazeera to the sea, since an island development began construction that blocked access to water. This construction was halted in 2009, but its infrastructure remains to this day. However, recent efforts to protect the site mean that gentrification can work as an opportunity for the village's future revival. The village sits in close proximity to various developments such as the modern Al Hamra Village—which includes a golf resort, personal residences (villas and apartments), and hotel properties—an industrial port, a theme park, and Ras Al Khaimah Ceramics, one of the world's largest producers of ceramics (Figure 2). People who visit these areas could easily visit Al Jazeera Al Hamra after its revival due to its convenient location.

## Adaptive Reuse: Proposal for Al Jazeera Al Hamra

The first step in addressing this site is to understand the various methods through which historic locations are typically approached. In general, there are three ways to respond to a historic site:

1. Preserve the site as it stands;
2. Modernize the site according to its contemporary surroundings; or
3. Equip the site for adaptive reuse.

In this case of Al Jazeera Al Hamra, adaptive reuse is the preferred course of action, as it considers several factors: people and culture, local biological diversity, and current development trends. This approach builds on the "UNESCO Biosphere Reserve" introduced by the UNESCO Man and the Biosphere Programme, which state:

> Biosphere reserves are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Programme to promote sustainable development based on local community efforts and sound science. As places that seek to reconcile conservation of biological and cultural diversity, and economic and social development through partnerships between people and nature, they are ideal to test and demonstrate innovative approaches to sustainable development from local to international scales. (Biosphere Reserves, n.d.; Figure 3)

Due to the high caliber of aesthetic forms in the region, the proposed design for the village is inspired by the undulating form of the oyster shell, as oysters once represented a highly treasured resource for the locals. This site will be looked at mainly from a landscape perspective, and, in this proposal, the buildings will be preserved and maintained. The proposed development will be named Oysterland (Figure 4). However, rather than being a static representation of an oyster, the development designs will respond to the surrounding ecology and type of program that will be introduced to the site. The flow of seawater will be considered such that water can continuously take its natural course. Several main pathways will act as striations along the site, dividing it into zones. As

**Figure 3: Components of Sustainable Development**


discussed below in the design approach, the site will be renovated to consist of local restaurants, shops, visitors lodges, and educational and research areas. The shops and restaurants shall be located at the northern end of the site, since these existing structures served as shops at the time the village was in its prime. By incorporating features of the environment into the plans for Al Jazeera Al Hamra, the site can become an educational and recreational attraction where people can learn about the region's natural environment.

## Water Considerations in a Desert Development

Because, in this proposal, the site will be revitalized and serve as an attraction for visitors, it is necessary to consider water circulation within and around Al Jazeera Al Hamra. Currently, the average amount of wastewater created per person in the UAE is approximately 550 liters per day, which is more than double the global national average (Szabo, 2011). The water cycle includes greywater and blackwater. Greywater is wastewater that typically consists of water released from kitchen taps, washing machines, showers, dishwashers, and bathroom sinks. Blackwater, however, is sewage, which is water released from toilets. Currently, the typical water cycle follows this process:

1. Water is transported from a desalination plant via pipes to serve kitchen taps, washing machines, dishwashers, showers, bathroom sinks, and toilets.
2. The resultant wastewater is then transferred via pipes to a treatment plant located away from the main cities.
3. That treated effluent blackwater is then partly used for irrigation in the city but is mostly released as treated waste into sea (Szabo, 2011).

**Figure 4: Proposed Features of Al Jazeera Al Hamra**

Overall, this process involves extensive transportation over far distances and requires significant investment in infrastructure, which is excessively costly.

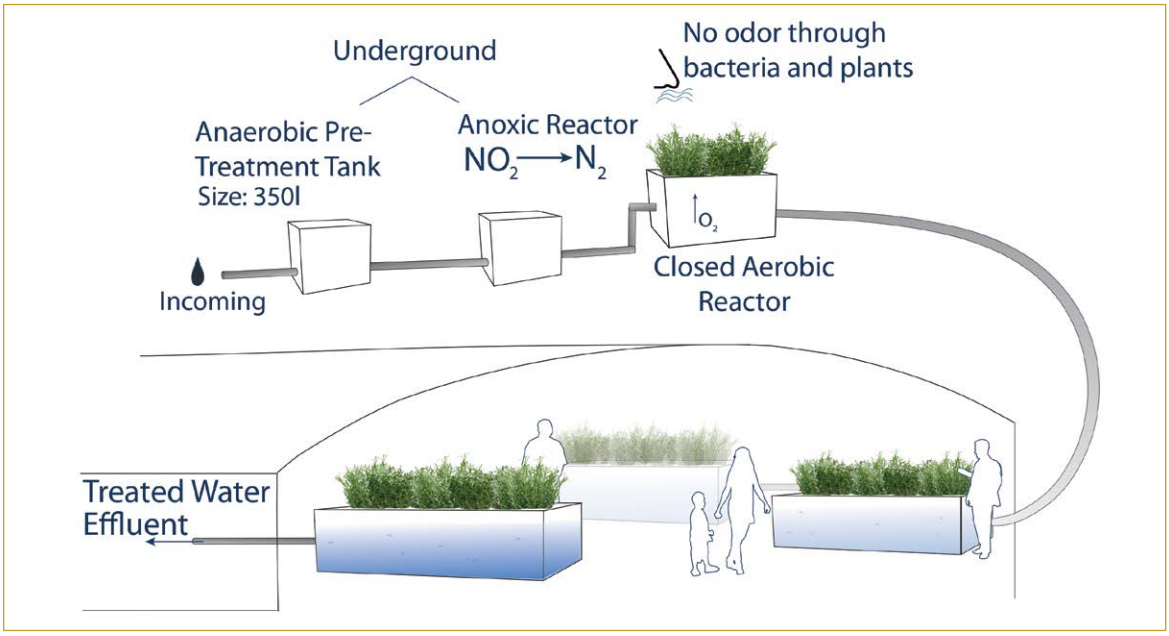
In contrast, this proposal will suggest methods for adapting the above water process to a localized context. Traditionally, local inhabitants made the most use of what little resources were available to them since high-tech infrastructure and water treatment plants were nonexistent. This proposal will assume that an average of 400 visitors will enter the village per day, based on the number of structures available, which includes approximately 340 abandoned courtyard homes. Water-saving devices such as the installation of water-efficient taps, shower heads, and toilets will be introduced, and, as such, the daily water requirements per person in Al Jazeera Al Hamra would decrease to 124 liters per day, and will be split into greywater and blackwater forms for separate treatment. This amount released is 75% less than the average amount of wastewater (550 liters per day) produced by a typical UAE resident.

Approximately 435 villas, small shops, and restaurants currently exist around the abandoned Al Jazeera Al Hamra site. Although any new development at Al Jazeera would allow for separate greywater and blackwater systems, the infrastructure of the existing buildings does not. Thus, the greywater and blackwater for the older surrounding buildings will be combined and treated and reused on site rather than being transferred to a distant treatment facility. After water from the existing sections of the original village is rerouted, collected, and reused, the site will produce a combined 1,385 $m^3$ of greywater and blackwater each day. When the 1,385 $m^3$ of water from the existing structures is combined with the blackwater that will result from the proposed village additions, the total daily amount of wastewater produced at the site will be 1,401 $m^3$. Therefore, the positive impact of this proposal is twofold. First, new structures will produce only 16 $m^3$ of blackwater each day. Second, all of the wastewater from Al Jazeera's new and existing buildings can be treated on site.

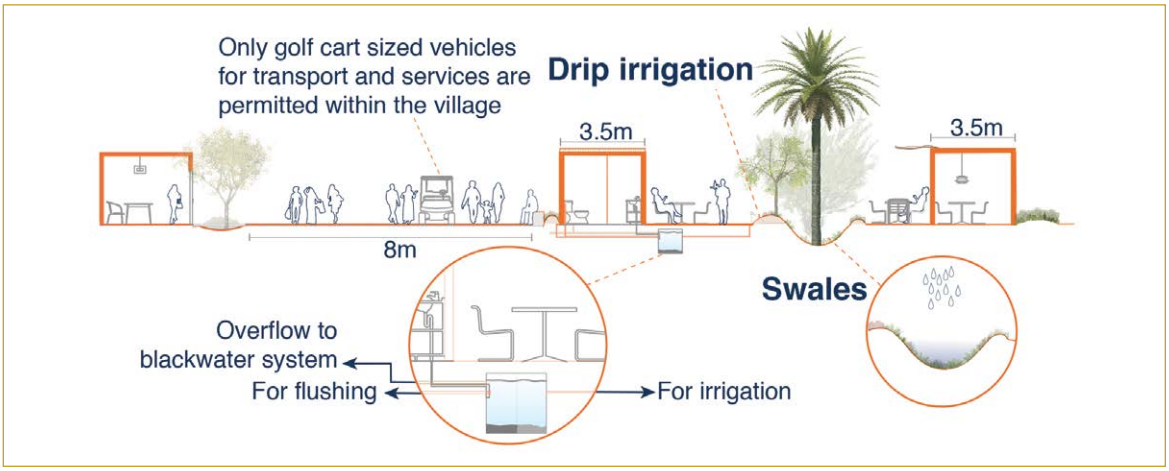
This blackwater will be collected from within and around Al Jazeera and channeled to the southern edge of the site through pipes, where it will be treated via an aquaponics system. The aquaponics system here is as follows: solid waste from blackwater is collected in an underground anaerobic pre-treatment tank, after which the remaining blackwater is taken to a closed aerobic reactor tank above ground. In contrast to standard sewage treatment plants, there will be no foul odor emitted because there will be bacteria present in the closed reactor that work to capture this odor. After the water has passed through, it will then be taken via pipes to tanks located indoors, where fish can thrive. Fish will provide nutrients for the plants, and in return, the plants purify the water and provide a clean environment for the fish to live in. Once the water has passed through all these stages, this effluent treated water will be transferred via pipes and released partly to the Oasis Zone and partly to the lagoon (Figure 5).

Greywater will be collected underground in each set of the courtyards between the existing buildings. It will be treated in an underground tank, then taken to be used for flushing in adjacent buildings and for irrigation within the courtyard areas. Any excess greywater in the tanks can be taken via an overflow pipe to the blackwater treatment system (Figure 5).

**Figure 5: Blackwater Treatment Process**



## Figure 6: Greywater Conservation System




The Al Jazeera designs also maximize rain as a water source. Albeit rare, rainfall in this region is often intense and usually floods streets and neighborhoods, whose infrastructures are not equipped to handle large amounts of water. According to this proposal, swales (of one to two meters in depth) are included in the infrastructure redesign of Al Jazeera. Rainwater can be collected in these swales and slowly seep into the ground, where it can irrigate newly planted native trees, shrubs, and groundcover plants (Figure 6).

These practices, if implemented during the early design stages of a project, will have several advantages. First, the cost of infrastructure and transportation of wastewater to distant treatment plants is significantly reduced, since water is treated on site. The abundance of water also promotes increased vegetation on site, as plants would be irrigated from this treated water. This is more cost-effective than delivering water to the site. The treated greywater can be used for flushing toilets, rather than using freshly desalinated water for flushing.

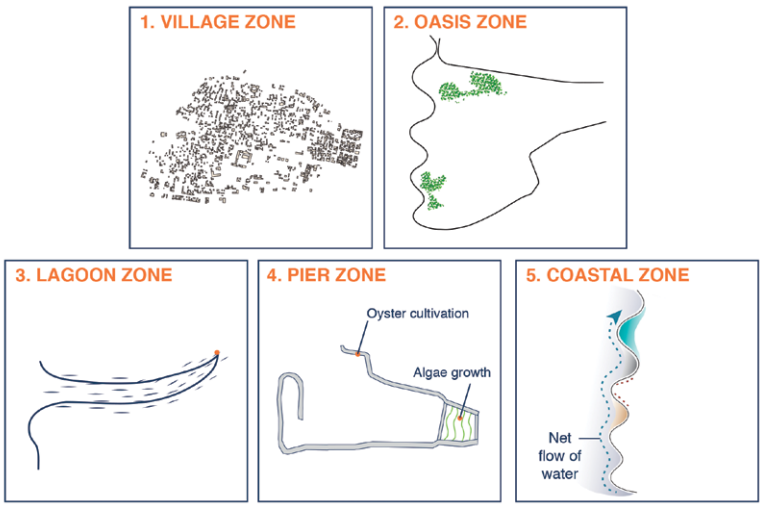
Such practices encourage a localized, off-the-grid network, allowing developments to function independently and with minimal reliance on external resources and infrastructure.

## Site Design and Development Proposal

After a formal survey of the site, Al Jazeera will be divided into five zones (Figure 7):

1. The Village Zone, which will consist of all the structures and open spaces between them.
2. The Oasis Zone, which will be located in the large open spaces around the village to allow for sufficient area for the oases. Water used for irrigation will be transported directly from the water treatment facility.
3. The Lagoon Zone, which will extend from the sea to the area adjacent to the blackwater treatment area, since the treated water will be released at the tip of the lagoon.

## Figure 7: Functional Zones of Al Jazeera Al Hamra



4. The Pier Zone, which is the remaining infrastructure of a halted development project.
5. The Coastal Zone, which also makes use of the infrastructure left over from unrealized island development.

Each zone will consist of activities suited to the site, as well as water treatment and reuse facilities.

## Village Zone

At the Village Zone, the existing abandoned structures will be renovated, and this village zone will be divided into four main sections, which will consist of: 1. Shopping area; 2. Restaurants; 3. Research and educational facilities; and 4. Water services and maintenance area, which will be located south of the Village Zone. Since this zone will be an area highly used by people due to its numerous facilities and structures, greywater will be collected for treatment and reuse in the open spaces and courtyards located within this zone. Blackwater however, will be taken via pipes to the blackwater treatment area.

As shown in Figure 8, the various landscape strategies proposed will conserve and use the water collected. The swales will collect rainwater to avoid flooding, and the rainwater will be used for irrigation and will also seep down to recharge the groundwater with time. Native trees that are adapted to an urban environment will be introduced and will be selected such that they provide sufficient shade for the pathways and open spaces within the village. These shaded areas act as a shelter against the sun's sweltering rays, and can serve as outdoor classrooms or resting areas while visitors stroll through the village (Figures 8 and 9). The dew condenser devices, also shown as white structures in Figure 8, collect the dew that accumulates overnight and channel it to the ground for the plants to use. This way, dew can also be taken advantage of rather than evaporating into the air when the sun rises.

## Oasis Zone

Oases have long been a main source of survival for desert tribes due to their cooler temperatures, availability of food from their trees, and access to freshwater from wells or springs. However, the inhabitants of Al Jazeera Al Hamra would only travel to the oases in the hot summer months, when it became unbearable to live at the village. As such, the oasis was an important part of their lifestyle. In this project, since current technologies allow for a large amount of treated wastewater to be collected, there is an opportunity to reuse this water to irrigate oases around the village rather than dumping it as waste out to sea.

Due to the abundance of treated wastewater, lush vegetation will characterize the Oasis Zone. Traditionally, the people would build water channels, or falaj systems, in order to channel water throughout the oasis from the water source. In this case, the treated wastewater is transferred through a pipe to the source of the oasis, where pumps and valves control its release into the newly created oasis plots. Based on the amount of water available per day (46 $m^3$), approximately 300 palm trees can be introduced to serve as the area's overstory. Additionally, about 300 shade trees—which could include fruit-bearing trees—can populate the understory, and 1,000 types of herbs and other native groundcover species can be introduced at the base.

Within the oasis, as shown in Figure 10, platforms and pathways will give people the opportunity to gather in a shaded environment in which thick vegetation cover can decrease the temperature by as much as five degrees Celsius (Okeil, n.d.).

**Figure 8: Sustainable Landscaping in the Village Zone**

## Figure 9: Village Shopping Area at Night

As part of the site's attractions, visitors can participate in the Oasis Zone's planting, maintenance, and irrigation activities. By doing so, visitors can learn how oases typically function and understand how well-shaded areas can drastically improve an outdoor environment and make it a more inviting place in which to spend time.

### Lagoon Zone

Since Al Jazeera has been abandoned for several decades and significant development has appeared in its adjacent areas, much of the natural environment that existed has been displaced. The natural environment is currently in poor condition since the site has been gentrified and an island development was in progress for several years. Since the site has been devoid of a large variety of species and wildlife for decades, the resources available in this proposal allow for the reintroduction of species that were once present in the Ras Al Khaimah region. In order to revive the nature that once existed in the area and make efficient use of the waste produced in the village, a lagoon will be introduce into which the remainder of the treated blackwater effluent will be released, at its tip. Since the lagoon connects to the sea, the combination of salty water and treated water would create a brackish water system that could allow various native plants, aquatic fauna and flora, and bird species to be attracted to the Lagoon Zone and thrive within it. As the lagoon area will be shallow, the seasonal and annual tidal fluxes will require that the native plant species selected are adapted to these fluctuations.

At the Lagoon Zone, visitors can picnic, kayak, and learn about the various species that thrive in this type of environment. Educational walking nature tours can be introduced by the site rangers and offered to school and university research groups, and kayaking tour guides can offer information on the types of aquatic flora and fauna present in the lagoon. Birdwatchers can also find in this zone an opportunity to spot native birds that have become scarce in the Gulf region (Figure 11).

## Figure 10: Oasis Zone

## Figure 11: Lagoon Zone

### Pier Zone

The pier was built as the infrastructure of a proposed island development that has been halted indefinitely. Rather than demolishing the structure, however, it is possible for the existing form to be redesigned in a way that can be used productively. This will eliminate demolition costs and avoid the hassle of transferring demolished construction material elsewhere. As shown in Figure 7, the horizontally placed ropes in the closed portion of the pier can be used proactively to grow algae on ropes made from palm fronds. Algae can easily attach to these ropes and would then be transferred to the farther end of the pier. There, the ropes will be attached to wooden platforms, as shown in Figure 12, and water currents will circulate the algae, which will serve as food for oysters. Oysters will be cultivated and will attach to the breakwater rocks. Over time, the oysters and other marine species could thrive in a region that has seen much of their natural habitat sacrificed to commercial development.

A marina and low-impact activities like scuba diving, snorkeling, and kayaking will attract visitors to the Pier Zone (Figure 12). In order to promote efficient water circulation around the pier and coast, recessions can be dug into the breakwater, such that the water can continuously flow through and avoid water stagnation on the other side of the pier in order to prevent algal blooms and silty, clouded water.

### Coastal Zone

Since the net direction of flow of water around the village is from the southwest to the northeast, the proposed coast will be deliberately designed to be undulating, such that it will allow the water to flow continuously along the coast, thus avoiding shoreline buildup or erosion.

Besides a beach area, several other attractions will characterize this coastal area. Ras Al Khaimah-based restaurants and cafes will enable visitors to taste the local seafood that was once a staple at the village of Al Jazeera Al Hamra. A theater along the coast could also provide an interesting backdrop for performances and events, and its elevated platform could permit users to have a view of the oasis and revived pier.

## Figure 12: Pier Zone

**Figure 13: Theater and Concrete Steps along the Coastal Zone**

Additionally, adding concrete steps along the water would enable visitors to understand seasonal and daily tidal fluctuations based on the number of steps visible at various times of day and at points throughout the year (Figure 13). Turquoise is prominent in this rendition because it was one of the few primary colors that were used in painting the original Al Jazeera village.

## Conclusion

The rapid development of the Arabian Gulf, and the UAE in particular, has caused a great increase in population in only a matter of decades. Additionally, the sudden surge of wealth in the region has created lavish commercial developments, which require large amounts of water in order to irrigate the lush landscapes and supply people's water consumptions. The purpose of this proposal is to use design as a means of integrating water usage and treatment with the environment in order to decrease the strain on desalination plants, help recharge groundwater, reduce infrastructure costs, and make the most of a scarce resource: water.

This paper proposes various landscape strategies that can be implemented throughout coastal desert regions. The proposal aims to bridge the gap between the region's past and present, increasing people's connectedness to their direct surroundings. In the past, inhabitants of the village and the region were able to survive on very limited resources. Currently, the advances in technology provide the opportunity to combine traditional practices with modern innovations in order to make the most of the resources at hand. In visiting the proposed site, people can become aware of how water is used, collected, treated, and reused on site, while still being able to create lush landscapes and shaded areas with the use of the appropriate native vegetation. The five zones of Al Jazeera Al Hamra reveal the site's potential to be used as a prototype for developing coastlines while being inspired by traditional practices, such that they are in sync with people's contemporary lifestyles and enhance their experience of the surrounding landscape.

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