Political effluent: Implementing wastewater re-use in Wadi Musa, Jordan

by Erin Addison

Note: This is the author's version of the paper by the same title published in the online journal *Arid Lands Newsletter* in 2005. The published version is accessible at http://ag.arizona.edu/oals/ALN/aln57/addison.html. This version is for personal/scholarly use only, and not for reproduction and circulation. Images here are slightly different and included at higher-resolution. This text also includes some comments, added to the Endnotes in January 2012 **in bold red font**, about the current status of the project. Please cite only from published text and reference as Addison, E. 2005. Political effluent: Implementing wastewater re-use in Wadi Musa Jordan. *Arid Lands Newsletter 57*: May/June 2005.

The Wadi Musa Wastewater Re-Use Implementation Project is located in the shallow valley of Sidd al-Ahmar (1) in southern Jordan, at the northernmost end of Petra Archaeological Park (the Park). The ancient Nabataean city of Petra, Jordan, which was placed on the UNESCO World Heritage List in 1985, is one of the world's most famous archaeological sites, and thus an important source of tourism income to Jordan. In 1999 alone, more than 400,000 tourists visited Petra and stayed in its "host" village, Wadi Musa (USAID 2002). The influx of tourists, while economically beneficial, exerts enormous strain on local water resources — a matter of deep concern to one of the world's most water-poor countries.

Figure 1: local Bedouin herder waters his flocks at the spring on the Ayl Road, Petra Region.

The Project comprises the WWTP and 1,069 dunums (2) (~264 acres) of farmland intended

to demonstrate the use of treated wastewater for agricultural activities. The WWTP was begun in 1998 under the aegis of USAID and the Water Authority of Jordan (WAJ) in an effort to handle the increases in waste anticipated from expected tourism and population growth in the Petra Region, and to reduce stress on Jordan's already overdrawn aquifers by reducing the need for pumped water. Completed in early 2001, the WWTP was designed to serve some 20,000 residents of Wadi Musa and the neighboring villages of Tayyibeh, Umm Sayhoun and Beidha, as well as the tourists to Petra.

When the WWTP was finished in 2001, stakeholders and sponsors were then faced with the question of how to dispose of the treated effluent, estimated to amount to as much as 1.25 million cubic meters [~330.22 MG] per year (USDoS 2001). Petra Archaeological Park is nestled in the steep, rocky Wadi `Araba watershed; Sidd al-Ahmar is traversed by three wadi (wash) systems which drain directly into Wadi `Araba and thence, less than 100 km (~62 mi) south, into the Gulf of `Aqaba. As the area typically receives less than 200 mm (~8 in) annual rainfall, it would have been environmentally imprudent to release the effluent into the fragile wadi ecosystem. Although there had been general references to agricultural re-use in the original project scheme, a detailed plan had yet to be developed.

Figure 2: Wadi Musa Wastewater Treatment Plant (WMWWTP) and Wastewater Re-Use Project, Sadd al-Ahmar, 2005.

Thus the farm portion of the Project: a demonstration farm was initiated in November, 2002, under the auspices of USAID, the Badia Research & Development Center (BRDC), WAJ and Petra Regional Authority (PRA). The demonstration farm utilized some 70 dunums (~17.3 ac) at the south end of the valley, immediately adjacent to the WWTP.

Beyond the demonstration area the remaining 1000 dunums (~247 ac) were subdivided into 35 parcels to be farmed by a new farmers' society. These plots, known as the "expansion area," were gradually to be brought under irrigation as the WWTP moved toward full capacity. The implementation phase of the Project is to be accomplished by mid-2007. At that point the management of the entire farming aspect will be turned over to the "Jama`iyya Sidd al-Ahmar Zara`iyya `ala al-Miyya' al-`Adimah" — the Sidd al-Ahmar Society for Farming with Reclaimed Water.

An interpretive element of the Project has been underwritten by the International Arid Lands Consortium through their Jordanian partner, BRDC, funded by USAID (Freitas, Tamimi and Shahbaz 2004). It was intended that there be constructed some sort of interpretive center at Sidd al-Ahmar, accompanied by landscaping and interpretive materials. The present author has been charged with the task of developing an "interpretive landscape master plan" for the Project area. The material for this article has been gathered in the course of site analysis and the development of the interpretive materials themselves.

The wastewater treatment plant

The Wadi Musa WWTP was designed to handle all wastewater flows from the four communities adjacent to the Petra Archaeological Park, with four pump stations located respectively in the communities of Wadi Musa, Tayyibeh, Beidha and Umm Sayhoun. The string of five-star hotels on the road between the Park and Tayyibeh are also significant potential contributors to the line. The plant itself has an average flow capacity of 3,400 cubic meters per day (~0.9 MGD) (Morganti n.d.), but at present during the hottest month of the year, July, only 1,400 cubic meters per day (~0.35 MGD) of effluent are being produced, due to the poor condition of the tourist market.

Treatment of incoming wastewater is comprised of three bundles of processes. Preliminary treatment includes removing floating materials and sieving out trash, stones, sticks, sand and other larger objects to prevent damage to downstream equipment. Large objects are screened by a mechanical bar screen, and inorganic solids are removed via grit channel.

After preliminary treatment the "mixed liquor" — fluids and biosolids, or "sludge" — is distributed from the oxidation ditch into secondary clarifiers. Secondary treatment employs two identical process trains, either or both of which can be used depending on the amount of inflow. These process trains employ the Modified Ludzack-Ettinger (MLE) process. The biological treatment components are configured and sized to obtain the optimum removal efficiency of biochemical oxygen demand (BOD), total suspended solids (TSS) and nitrogen to comply with the Jordanian standards for effluent disposal. The capacity of these components was designed based on flows and connections anticipated during the conditions prevailing during high season, when the resident population of the area is swollen by the influx of tourists into the hotels. At the time of writing only one train is being used: due to the collapse of tourism following political events of 2000-2001, there is insufficient continuous flow to sustain the operation of both trains (3).

The MLE process consists of a biological reactor followed by secondary settling. The biological reactor consists of two zones: an "anoxic" zone, without aeration, and an "oxic" zone, with aeration. Nitrogen removal is a two-phase process, one occurring in each zone. The oxidation phase, in which ammonia is oxidized to nitrate, occurs in the oxic zone.

Influent wastewater and activated sludge from the clarifiers is combined in the anoxic zone with nitrate-rich mixed liquor pumped back from the effluent end of the aeration tanks (the oxic zone). The influent is the carbon source for bacteria, the activated sludge from the clarifiers supplies the microorganisms, and the anoxic recycle pumps provide nitrate as an oxygen source (FRWA n.d.). In the anoxic zone, nitrate is reduced to nitrogen gas which escapes into the atmosphere.

Solids are removed rapidly from the clarifiers and either returned to the anoxic zone or pumped to sludge holding tanks. Once in the tanks, this remaining sludge is thickened and stabilized in a mechanical process. In the upper part of the tank the incoming sludge is discharged tangentially by the motion of a rotating cylinder toward the tank wall, and agitated by gas bubbles generated in the process. The more solid components of the sludge sink to the base of the cone in the bottom portion of the tank, thicken there and are drawn off into drying beds. The clear supernatant thus separated from the solids is returned to the upstream end of the treatment train.

Tertiary treatment is accomplished by retaining the secondary effluent for 10 days in a lined polishing pond. Four meters (~13 ft) in effective depth, the pond exposes the effluent to sufficient sunlight to kill nematode eggs. At peak flow the exposure time would be 10 days, enough time to yield a high-quality polished effluent. Presently retention time is 34 days, due to low flow. Disinfection is accomplished by introducing chlorine at the rate of 2 mg/L into the effluent. Chlorine is received as gas in 1-ton cylinders, mixed with water to form a solution, and introduced into the effluent in a contact tank downstream from the polishing pond. At peak flow contact would be 30 minutes detention in the tank; presently detention time is 100 minutes.

There are 16 drying beds for further processing of the thickened sludge drawn off from the sludge holding tanks. These drying beds are built on a sloped, impermeable base which is covered with a layer of coarse gravel and then a layer of sand. Sludge is deposited on top of the sand and fluids drain off and evaporate. At peak use the sludge would be dried to a solid content of ~30%; under present conditions it dries to nearly 70%. The dried sludge is "harvested" by hand with shovels and carted to a storage area. The intent is eventually to use the biosolids to improve the quality of soils in the expansion area.

The plant and all four pumping stations contain biological odor control units; these use sulfate-eating bacteria which consume the odor-causing sulfide (S^{-2}) from the hydrogen sulfide (H_2S) produced during treatment. The system as a whole is monitored by a telemetry cable connecting the wastewater treatment plant with the pump stations and all associated electrical and mechanical works (Morganti n.d.). In addition, the plant is served by over 13 kilometers (~8 mi) of wastewater conveyance lines. The plant site also includes buildings for operation, administration and maintenance.

Figure 3: Installation of irrigation system on Re-Use Project, 2004

The raison d'être for the Project accrues from challenges surrounding development in Wadi Musa, the town which serves the Park. Wadi Musa and the hotels associated with it are host to Jordan's single most important generator of tourism revenues. Tourism is Jordan's largest export sector, its second-largest producer of foreign exchange (at 11%), and its second largest private sector employer. Tourism is the nation's fastest growing development sector, and Petra accounts for over 90% of the total income from tourism in Jordan. Thus Petra produces a staggering 9-10% of Jordan's overall GDP (JTB 2004). In 1994, in the wake of the Jordan-Israel Peace Treaty, development burgeoned: in 1994 there were no five-star hotels in Wadi Musa — by 1997 there were five, and dozens more two-, three- and four-star hotels. Saad ar-Rawajfeh, Director of Planning and Organization at the Petra Regional Authority, states that in 2005 — even after a long slump in tourism revenues — applications for building permits in Wadi Musa exceed applications for the rest of the Ma'an directorate combined (7). In sum, the economic importance for Jordan of development around Petra cannot be underestimated. The Petra Regional Authority was established in 2001 to plan and administer the rapid development of Wadi Musa and the vicinity (8). It functions as a more or less independent governmental unit, and all matters of property acquisition or development within the 900 km^2 (~348 mi^2) Petra Region require review and permission by PRA.

At the same time the Jordanian Department of Antiquities (DoA) — a sub-section of the Ministry of Tourism — is charged with protecting the archaeological remains that make Petra the cultural and economic treasure it is. The Park (which is also the World Heritage

Site) is administered by a division of the DoA, which retains the right to disallow any development or activity which it deems harmful — even in areas not directly within the Park, if the activities are thought to threaten the archaeological remains. All development within the Park is required to secure from DoA an archaeological survey and permit to proceed.

Figure 4: The Neolithic archaeological site of Ba'aja, only about 750m from the edge of the Re-Use Project site.

The need to address the pressures of economic development on the Petra Region is undeniable. The WWTP serves both tourism development and local residents by tackling urgent water and waste issues. The agricultural aspect of the Project attempts to broaden the effectiveness of the WWTP by demonstrating environmentally appropriate re-use of effluent, as well as addressing economic development issues in the area. Sidd al-Ahmar, however, and thus the Project, is located squarely within the boundaries of the Park. The Project site is laced throughout with the 2000-year-old Nabataean agricultural and water harvesting remains, and sits adjacent to the pre-pottery Neolithic bronze age settlement of Ba'aja. Neolithic remains are also scattered across the site. Thus permits from both PRA and DoA are necessary for development activities at Sidd al-Ahmar.

Present-day residents and their history

One might well ask at this point — what of the present-day, indigenous residents of Petra Region and their history? Jordanian society is historically, and remains, tribally based. The

area which today constitutes the Park has for centuries, perhaps millennia (9), been occupied by the Layathneh, Bidoul, and `Amareen tribes (10). These tribes are historically Bedouin, but they have traditionally farmed barley and other crops in addition to herding sheep and goats. Until recently they used the traditional Nabataean infrastructure for water harvesting and often inhabited the excavated Nabataean dwellings or "caves" of Petra. In the early 1980's residents within the newly constituted Park were moved out: some — especially the Bidoul and `Amareen — were resettled in government-subsidized housing in the present villages of Umm Sayhoun and Beidha, respectively. The resettlement was conducted without consulting the tribes themselves (UMP 2001) and resulted in the profound alienation of the residents not only from the government agencies involved, but from their former means of subsistence. The Bidoul were housed almost entirely within Umm Sayhoun. Some `Amareen moved to Beidha, but many simply moved their tents outside the Park boundary and declined to settle in government housing. The prohibition on grazing within the Park, however, diminished the range available for their herds and exerted additional economic pressure on an already marginalized group.

Figure 5: Umm Sayhoun village

When the Jordan-Israel Peace Agreement was signed in October 1994, the Jordanian government encouraged local residents to invest heavily in tourism development; foreign assistance poured into the area in anticipation of a huge surge in tourism to Jordan. However, with the onset of the new intifada in the West Bank in 2000 and then events following September 11, 2001, Jordan's tourism industry was decimated. Three of the aforementioned five-star hotels have closed — another more recent establishment failed before it ever received guests. At the time of writing the Jordanian government has taken steps to relieve the debt burden on Wadi Musa by allowing its residents to service only the interest on domestic bank loans. Still, the economy of the Petra Region is profoundly depressed. The situation is exacerbated by the fact that during the 1980s and '90s many families ceased agricultural pursuits and turned their energies entirely to tourism.

Though still impacted by regional conflicts, tourism is once again improving in Jordan: the spring of 2005 has been the best high season since 1999. Yet the combined effects of population displacement, restricted grazing ranges, centralization of the economy in tourism, heavy debt burden and four years of severe depression continue to strain the economy of the Petra Region. In addition to these local issues Jordan as a whole has just emerged from nine years of drought. One of the world's most water-poor countries, it is also one of the fastest growing: as of 2002, 40% of the Jordanian population was under 15

years old (WRI 2005).

With all of the foregoing in mind, in 2002 BRDC conducted a socio-anthropological study of the area to navigate a way to turn the land at Sidd al-Ahmar to a use which would benefit local residents and effect some poverty relief. This study documented an already well-known fact: that the Layathneh tribe vastly dominates the tourist industry in Petra. The study also established that the Bidoul have suffered the most severe stresses resulting from relocation and lost most of the marginal stake they once had in Petra tourism, and that together the Bidoul and `Amareen had been effectively marginalized from economic life in the Petra Region (Tarawneh 2002). Subsequently BRDC recommended the establishment of a trans-tribal jama`iyyah, or society, which would be granted the agricultural use of lands inhabited by the `Amareen before the establishment of the Park.

The Jama`iyya Sidd al-Ahmar Zara`iyya `ala al-Miyya' al-`Adimah (JSAZ) which exists today is actually the coalescence of two original groups of farmers, one comprised of Bidoul and `Amareen farmers, the other of Layathneh farmers from the Wadi Musa Retired Military Association. From 2002 until early 2005 these two groups met together to make decisions, but yet reflected the traditional social alignments within the Petra Region. The leader of the Shawasheh `Amareen, Sheikh Salim Saleem Abu Shusheh al-`Amareen, has taken a significant leap of faith in moving forward with the land use scheme posed for the Project. In the process of conducting focus groups in the summer of 2004, we found that some `Amareen continue to press claim for lands annexed by the government when the Park was formed. Others, including some JSAZ members, still harbor deep suspicions about the motives of the farmers from the more powerful and affluent Layathneh tribe. The decision to unite both groups into one separate organization, governed only by farmers who actually work the parcels at Sidd al-Ahmar, is a very significant social development. This coalition also significantly increases the chances for a successful transfer of the facilities to JSAZ in 2007.

Natural and cultural heritage conservation issues

What, then, were the concerns which led the Department of Antiquities to call in UNESCO, ostensibly to halt the Project, in 2004? Clearly there were concerns for the archaeological remains which quite obviously underlie the Project site. Beyond this there were objections raised by both DoA (Kraysheh 2004) and UNESCO regarding the illegal planting of trees, "constructions or modification of the landscape" and picnicking infrastructure, as well as concern that "this entire project is being advanced without proper consultation with the Park authorities." (Palumbo 2004, 11) UNESCO's recommendations urged "implementation of sustainable site development and management practices," while acknowledging the absence of enforced park regulations. The reviewers suggested the use of the Petra Archaeological Park Operating Plan as a reference and guide, and commented further that "stricter control must be exercised towards proposals that may affect the integrity of the Park landscape." (Palumbo 2004, 13-14)

Figure 6: Stumps of *Juniperus phoenicia* at Sidd al-Ahmar

The sad fact is that presently the natural landscape of the Petra Region, including the Park, lacks any discernible "integrity." Overgrazed, over-hunted, deforested, and overbuilt, the entire region bears witness to the pressures of 12,000 years of human habitation. A century ago the hillsides of Sidd al-Ahmar were thickly covered with a mixed oak-juniper association (FAO 1952). Today these hillsides are nearly barren. Of the four predominant native tree species at Sidd al-Ahmar (Kermes oak, *Quercus coccifera*; Phoenician juniper, *Juniperus phoenicia*; Mt. Atlas pistache, *Pistacia atlantica*; and carob, *Ceratonia siliqua*), three appear on the world list of endangered species, and the fourth is found on the Project site only in a few sheltered crevasses inaccessible to human fuelwood-gathering efforts. If we consider again the national economic significance of Petra tourism, the staggering rate of population growth in Wadi Musa, and add to these the fact that at present no detailed land-use zoning exists, the forecast for the natural environment is bleak.

In voicing their concerns, UNESCO and DoA were responding to presentations by BRDC and the present author of concepts for the proposed activities at Sidd al-Ahmar: a visitors center on a site designated by PRA, signed and paved interpretive trails, allees of both native trees and the more than 3,000 cypress trees which had already been planted along a transecting public road, salvage and protection of existing mature native trees, archaeological conservation, erosion control measures and picnicking infrastructure. These design interventions were developed over months of mapping, site analysis, stakeholder interviews and focus groups. Design interventions were aimed at remediating severe deforestation and erosion, and accommodating the impact of local tourism patterns. UNESCO and DoA, however, moved to disallow any interventions in the stated interests of conserving the "integrity" of the Park's natural landscape. Particularly troubling to both agencies were proposals for picnic infrastructure and the possibility of encouraging tourism in the area. UNESCO balked so stiffly at the term "visitors center" that a search

commenced for a new description of the building (11). Given the importance of tourism to the Park, these reactions might seem puzzling. Once placed within the context of recent development patterns in Petra, however, they become entirely comprehensible.

We might begin by noting the differing interpretations of "mahmiyya" — the Arabic word for "reserve," or "protected area." Translated into English as "park" (as in Petra Archaeological Park), the possible misunderstandings are immediately apparent. For many of the stakeholders involved in the discussions of activities at Sidd al-Ahmar, a mahmiyya is a place where nothing should change, where no interventions are acceptable — except, under highly circumscribed conditions, archaeological conservation. To "protect" the integrity of the landscape, nothing should be touched. For other stakeholders the Park is first and foremost a tourist attraction, a recreational area — and thus interventions ("development") are to be expected and even encouraged.

A catalyst for this discussion was the matter of local tourism. Perhaps the most serious impact on the environment at Sidd al-Ahmar and the surrounding area is picnicking. Seemingly innocent enough, "hash u nash" — the barbecue picnic — is perhaps the most prevalent diversion in traditional Jordanian society. In fine weather, no matter what day of the week, one finds groups parked near roadways grilling meat. Picnics are not private affairs. On a typical summer weekend afternoon we have counted over 200 vehicles on the Project site. If one calculates five people per vehicle (a conservative estimate), we have a thousand people picnicking along less than nine kilometers (~5.5 mi) of roadside. People come from as much as 200 km (~125 mi) away for the shade trees and scenery afforded by the Petra area. Frequently they bring tables, chairs, and livestock to slaughter onsite. Jordanians are connoisseurs of lamb, goat — and firewood. The ideal picnic uses firewood gathered on-site.

In the summer of 2004 over 150 picnic groups were interviewed at Sidd al-Ahmar and in neighboring Siq Umm al-Heiran, partly to ascertain the extent of firewood gathering. Groups were asked what kind of wood they were using, where they had gathered it, and what kind of wood they ideally preferred to use. Technically, picnicking is forbidden within the Park, though there is no specific rule prohibiting firewood gathering. But there is no management of the activity. Many of the locals, as well as the long-distance visitors, have picnicked in the same areas for four generations or more (12). Local park personnel, entirely over-extended anyway, are hardly going to tell their relatives that this one simple recreational activity is proscribed.

In addition, local tourist guides, hotels and tour operators regularly stage glamorous picnics for tourist groups, complete with hundreds of luminarias, freshly slaughtered lamb, local musicians, bonfires and so on. One such evening for a five-person group yields JD 200 profit — about US$300. When one considers that a substantial middle-class professional salary is about JD 300 a month, it is hard to ignore the impact of this tourism component. What is more, the vast bulk of high-end food and lodging profits at Petra are garnered, not by local tour operators, but by corporate hotel chains — which increases the significance of the picnic industry. Like picnickers and Park personnel, by far the majority of local tour operators belong to Layathneh families; officials are likely to turn a blind eye to activities that garner such significant profit for local business.

It is not difficult to envisage the potential impact of such numbers on Park areas, especially

given the fact that there are no waste management facilities available to picnickers. Glamour picnics around archaeological sites cause ongoing damage to the very antiquities which draw tourists in the first place. The demand for firewood is the single most damaging impact on local forests, with clear implications for the biodiversity those forests shelter. UNESCO, DoA and Petra National Trust (PNT) (13) — which entered late into the discussion of Sidd al-Ahmar — are justifiably apprehensive about promoting picnicking activities within the Park.

As ironic as it may seem in the context of Petra, development of overnight tourist accommodations is potentially even more worrisome. Less than a kilometer from the turnoff to Sidd al-Ahmar is the so-called "Ammarin Bedouin Camp." A mock-Bedouin tent encampment which hosts tour groups and organizes overnight jeep and horseback excursions, the facility was established without proper permits well within the boundaries of the World Heritage Site. Even though it lies within the Park, the land is leased from the `Amareen by entrepreneurs in Amman. Locals claim that over 300 carob trees were bulldozed to clear the Camp's site. After vitriolic opposition by PNT and officials within DoA and PRA both, the Camp prevailed in a court case in 2004 and both agencies were compelled to permit its existence. The rationale for the court decision was familiar in Jordan: the camp exists now, the damage is done — let it be. Although the Amareen Camp was a contentious example, it is not isolated.

In its resistance to the activities at Sidd al-Ahmar, the DoA was responding to an institutional situation created over the course of many years. The Petra Regional Authority was only established in 2001 and matters of jurisdiction and hierarchy regarding the Park are far from clear. When, in October 2003, PRA sought DoA's approval for the proposed building and agricultural expansion (PRA 2003a), it was promptly denied (DoA 2003). Though an archaeological survey had been conducted for the area of the WWTP and demonstration farm, it did not cover the full extent of the Project's proposed expansion area. The same is the case for the initial environmental impact assessment (EIA)(Moghli et al. n.d.). Notwithstanding this exchange and perhaps unaware of it, USAID, BRDC, and WAJ joined PRA in Wadi Musa to inaugurate the Water Re-Use Implementation Program on 3 November, 2002.

On 20 November 2003 another letter passed from PRA to DoA explaining the fact that the irrigation system had already been installed. The demonstration farm was already in operation, and the farmers' society had been allotted their parcels of land (PRA 2003b). In December 2003 the first sorghum and millet crops were harvested and sold at the demonstration farm and crops were going in on the farm parcels. Given the foregoing discussion, it is not difficult to see why DoA was finally motivated to call in international monitors to protect the World Heritage Site. When UNESCO then confronted rumors of tourism development (Palumbo 2004, 11), plans for the construction of a visitors center, landscaping, and farming — all within the mahmiyya — the reasons for their consternation are obvious.

UNESCO's report on their March 2004 visit did not arrive at DoA until September 2004. By this time activities at Sidd al-Ahmar had continued for over a year without addressing DoA's concerns. Petra National Trust was in an uproar over the situation. At the same time USAID, BRDC and IALC had invested expertise, years and millions of dollars in the overall Project, and farmers were beginning to benefit from much-needed income relief in

the form of harvested forage crops. The `Amareen leadership had taken significant risks to engage in an innovative use of government-annexed land, setting a positive example within a political and economically fraught region. Meanwhile, however, haphazard and illegal development within Petra Region and the Park itself, as well as population pressures and unmanaged recreational use continue, threatening the antiquities and the natural environment which make Petra such a valuable asset to Jordan.

Seeking solutions

The situation at Sidd al-Ahmar would have been enormously simplified by a set of concrete rules or by-laws for the Park, or by detailed land-use zoning for the Region. Neither exists. The Petra Archaeological Park Operating Plan (PAPOP; Comer 2000) referred to by UNESCO was developed in conjunction with the US Park Service from 2000-2003, but objections were raised regarding its suitability for the Jordanian context. The management plan which was to have issued from PAPOP has never been developed. In an effort to respond in good faith to UNESCO's remarks, however, the landscape architect used PAPOP as a guiding reference, along with existing antiquities laws.

PAPOP is clear in its interpretation of Petra as a place for human use and edification — within the limits posed by natural and cultural heritage conservation (14). Interpretive infrastructure, including buildings and trails are not only permitted, but encouraged. PAPOP is equally clear about issues of planting within the Park: the guidelines prohibit the introduction of exotic species under any circumstances, and mandates the removal of exotic species except in limited circumstances with regard to historic species. The permit for building a visitors center thus evolved into an interrogation of the entire Project, which had introduced thousands of non-native species into Sidd al-Ahmar. Indeed, by implication, a farming project to raise commercial crops would inevitably involve the planting of exotic species.

In October 2004 it was determined that officials from PRA, DoA, USAID, the Park, IALC, BRDC, PNT and UNESCO should meet to resolve the complex of issues at hand. The `Amareen and JSAZ, whose willingness to embark on an innovative land-use scheme made the whole endeavor possible, were represented by a member of the Royal Court. In November 2004, the Jordanian government changed and the leadership at PRA passed to a new Director General. In a striking departure from its short preceding history, PRA made explicit overtures to DoA and the local Park staff itself. Between Feb. 1 and March 17, 2005, three meetings were held with PRA and DoA. The first two served to share and discuss the positions of all of the stakeholders; the third was to conclude the discussion and agree finally to permit or not to permit the Project plans regarding agricultural expansion, interpretive center and landscape design.

The landscape design served as the catalyst of the discussion. The design presented in the February-March meetings recommended building the interpretive center, but relocated it to the area included in the initial EIA and archaeological survey, on land already graded and adjacent to the paved entrance road, in order to minimize further intervention within the Park. An integral part of the interpretive material will be a demonstration garden illustrating the use of native plant species at residential and small commercial scale, targeting the

primary user group in the area — local Jordanians. Woven through the Project expansion site are proposed trails with signs in Arabic and English discussing the natural and social history of Sidd al-Ahmar, and interpreting the Project itself.

Figure 7: *Rhamnus disperma* at a spring and traditional irrigation system at Rajif, Petra Region.

For two areas picnic infrastructure is proposed, incorporating interpretive material imprinted in concrete table-tops and benches. One of the picnic areas is located within the demonstration farm and turfed with an irrigated native "Bermuda" grass ("najil"; *Cynodon* spp). The interpretive goal in these sites is to note the amount of water required for the turf and to charge accordingly more for the use of the picnic areas. Another picnic area would be developed in a rocky, uncultivable part of the expansion area along a wadi with significant archaeological remains and mature native trees. These sites would be "dry" sites where the interpretive material focused on natural and cultural history — with an appropriately lower fee for use (15). The individual sites themselves would be defined spatially by a native broom species (*Retama raetam*) cultivated expressly for firewood use, in order to relieve pressure exerted by firewood gathering from native trees.

All the proposed landscape interventions use native plant species. Planting of any kind — including reforestation with local native species — had been questioned by both UNESCO and DoA, and further problematized by PNT's proposal to return the entire area to the 1993 law stipulating only the planting of forage grains within the reserve. Using PAPOP as a reference, the landscape design proposed retaining the thousands of cypress as an historic tree, and otherwise replacing existing exotics with natives. These design interventions include windbreaks, shade trees for picnic areas, and "infill" in previously forested, uncultivable areas where some mature trees still exist.

The discussion of the exotics policy of course problematized on-farm planting. In addition to the forage grasses which were the focus of most farmers, eucalyptus, acacias, and poplars had been planted as windbreaks; fruit trees including olives, date palms, guavas, lemons and apples had been planted on some farm parcels. The entrance to the demonstration farm presently sports ornamental flowers, tropical palms and ornamentals, and a demonstration plot of hibiscus, roses, and lantana. The message in effect is one of water abundance — not water conservation. Although at least two farmers had devoted acreage to propagating natives from local seed, the overwhelming impression of the farm was an incongruous expanse of exotic green.

Proposals for the fate of Sidd al-Ahmar ranged from disallowing the Project altogether to changing the Park boundaries themselves and turning a blind eye to existing institutional and environmental lapses — in effect giving up entirely on regulating the matter. Finally, however, quite a different ethic prevailed: to work through the issues presented and make Sidd al-Ahmar an example of enforcement of both PRA's and the Park's authority over development within the Petra Region, with local users, environmental and cultural heritage conservation at the forefront of considerations.

On March 17, 2005, all the agencies involved agreed to a list of guidelines allowing the project to move forward. USAID has agreed to restrict the expansion farming to a defined list of forage crops. Existing fruit trees will be allowed to live out their bearing lives but will not be replaced. With two exceptions, exotic species planted outside the actual farm units, including windbreaks, are to be removed and replaced with natives. The two exceptions are windbreaks of *Populus iraneus* and *Cupressus* spp. The latter is considered an historic tree within the PAPOP guidelines — particularly in this traditional function; the *Populus* will be retained while native windbreaks mature, and then harvested for firewood. The landscape design will go forward in phases, pending funding: the interpretive center, now approved as a "Theme Center," and demonstration garden will go forward this summer (2005); interpretive trails extending into the farming expansion site constitute a second phase; the installation of picnic infrastructure awaits proper zoning of the Petra Region for land-use. Cultural heritage management will be supervised by DoA, who will prioritize sites to be buffered from interventions. The expansion site has already been surveyed and documented by a DoA archaeologist. USAID has added a detailed appendix to the original EIA, to include the expansion site. As noted earlier, 21 new farm units will go onto the wastewater plant irrigation line by early fall 2005.

Complex realities remain to be navigated. The farmers of JSAZ completed their second harvest year in early summer 2005 — but they have yet to realize a profit from their farm units due to fines levied by the Ministry of Agriculture for illegal grazing of sheep on the farm parcels. As a direct result of the experience at Sidd al-Ahmar, local farmers and

several influential local officials are now actively seeking USAID funding for land-use zoning and the development of a management plan at the watershed level. The management of the environmental impacts of local barbecues and international tourism will languish until land-use zoning is accomplished. But the complex struggles that have marked the course of the Project's progress have yielded a complex — and therefore possibly sustainable — set of solutions.

Conclusions

It is beyond the scope of this article to analyze what amounts to a decade of development travails in Wadi Musa — and ultimately none of discrete conflicts and missteps in this story are that unusual in developing nations. What is worth documenting here is a success story about communication, transparency and at least two instances of outstanding leadership, the outcome of which champions an indigenous people and an endangered arid environment.

Sheikh Abu Shusheh, leader of the Shawasheh `Amareen, declined to engage in a fruitless land-tenure battle and instead sought a constructive alternative in the Jama`iyya Sidd al-Ahmar. Under his leadership, the JSAZ farmers have also stepped across traditionally tense tribal lines and land disputes in order to reap, quite literally, the benefits of the reclaimed land and water. Within the governmental infrastructure which has at times beset the project, PRA's Director General `Abdallah Abu `Alaym has refused to sustain competitive antagonism along agency lines. As a result he has positioned PRA more effectively in this complex region, and managed to move the Project forward with the approval of the Park and Antiquities authorities.

Finally, however, even the most enterprising and generous individual leadership depends on functional institutions. Key in the process of resolving the matrix of issues at Sidd al-Ahmar has been the willingness of the bureaucracies to go beyond headlines and soundbites — to look at a complex whole, to engage in hard and open discussion, and to craft compromises which benefit all. The result, if all goes well, is a project which integrates sustainable and appropriate economic development with environmental and cultural heritage conservation for the benefit of local residents of a World Heritage Site.

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Endnotes

The project at Sadd al-Ahmar (see n. 1, below) still exists, but wealthier local landowners in Wadi Musa have purchased most of the land from the farmers for whom this project was to have functioned as "poverty relief." The poor farmers were more interested in ready cash than farming.

The cut-flowers project for divorced 3Amariin women failed due to poor market research – there is no market for cut flowers in Wadi Musa, and no supply chain or planning to move them to another market.

There is still no interpretive center or landscape. Nine years – three cycles of USAID funding – have not managed to get that project implemented.

***None* of the promises made by implementing agencies was kept regarding the removal of invasive exotic species, nor re: the farming of less water-intensive forage species, nor re: the removal of fruit trees.**

As I write in 2012 I have many more years experience working on development projects than I had when I wrote this article. While I still believe what I wrote in the final paragraphs of the above paper, I feel increasingly strongly that without adequate monitoring and evaluation of projects, without project managers tasked with following up exhaustively and personally on projects, development money is wasted. In the end the Re-Use Project has benefited mainly development consultants, Jordanian NGOs in Amman and contractors in Amman. As for functioning as poverty relief for local bedouin – forget it.

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(1) Sidd al-Ahmar means "little red valley" in local dialect. **This is a matter of debate, but in later research the author decided to accept the prevalent understanding of the name as *Sadd al-Ahmar*, "the red dam." There are indeed the remains onsite of several Nabataean dams built of red stone.**

(2) A dunum is 1000 square meters, or about 1/4 acre.
(3) This situation has occasioned some significant modifications in plant process and operation, including the construction of a new pump station within WWTP to recycle water from the clarifiers to the plant headwork, in order to supplement the low flow to the plant.

(4) For the sake of comparison, the base rate for water supplied by WAJ to Amman residences costs approximately JD 0.15/cubic meter (US$ 0.22), with a steeply graduated increase at increments after 20 cubic meters.

(5) Information on crop irrigation patterns and effluent flows were supplied by Engineers Isma'il at-Twaissi and Majid Hasanat at the Project farm office, 3 August 2005.

(6) One successful local tour operator, JIT, whose schedule has been happily overbooked for 10 months, suddenly has only one booking for August 2005.

(7) Jordan is divided into twelve governmental provinces called "directorates;" Ma'an is one

of the two southernmost.

(8) PRA was created on the foundation of the Petra Regional Planning Council (PRPC), established in 1995, but — in recognition of the complex nature and economic significance of the Petra Region — PRA has much stronger decision-making power than PRPC had.

(9) The tribes mentioned can document their habitation of the area for many centuries; each puts forth competing claims to be direct descendents of the Nabataeans. Such claims are politically fraught and, at this point, moot. A well-known biological anthropologist who studies the Nabataeans of Petra remarked, when queried on this point, "I don't know and I wouldn't touch the issue for love nor money."

(10) The larger area which constitutes the Petra Region includes a variety of other tribes less directly affected by the creation of the Park.

(11) The building has since morphed in identity (though not in structure or function) from "Visitors Center" to "Community Center," "Awareness Center," and finally — or at least most recently — to "Theme Center" ("*markaz at-taw`iyya*").

(12) It is important to consider that in Wadi Musa — like most of Jordan — the predominant recreation is socializing within extended family groups. There are no malls, no clubs or discos, no movie theatres or video arcades; people do not date or dine out. *Hash-ou-nash* is one of the only social activities not explicitly focused on a family occasion such as a wedding. It is an opportunity for women to get out of the house and for families to socialize with people form other families and other towns and villages.

(13) Petra National Trust is an influential NGO, based in Amman, which serves as a watchdog organization over activities which impact Petra archaeology.

(14) This interpretation can be found in vol. 2, book 2, sec. 4, subsections 8.2-9.3, of the Petra Archaeological Park Operating Plan (Comer 2000).

(15) Interviews with over 150 picnic groups yielded not a single objection to paying a small fee for picnicking if services such as bathrooms, tables and benches were provided.

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