Sustainable Development of Drylands in Asia and the Middle East:
Jordan Component

Jordan Visit Report

May 20, 2005 to June 3, 2005

Report Number
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Prepared

by

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I. Visit Objectives

Dr. Akrum Tamimi and Ph.D. candidate Susan O'Shaughnessy traveled to Jordan to accomplish the following objectives:

- Establish initial salmonella readings on biosolids produced by Aqaba WWTP, Wadi Mousa WWTP, As-Samra WWTP, Wadi Hassan WWTP and Irbid Central WWTP in order to update the characterization of biosolids data for reference purposes and for the purpose of data publication.

- Perform at least one helminth assay with Dr. Nisreen Al-Hmoud from RSS utilizing the modified procedure currently being used by Dr. Gerba's lab at The University of Arizona.

- Finalize one paper concerning the disinfection level of biosolids in open solar drying beds in Wadi Hassan based on environmental data collected using the meteorological station at Wadi Hassan.

- Review the winter environmental and microbial data for solar drying project in Arizona and Wadi Hassan.

- Work with Jordanian partners to define the biosolids risk assessment and standards modifications workshop to be held in December 2005.

- Present Reports to ASEZA for updating Aqaba's activities.

- Visit Aqaba Town Park site and discuss ASEZA's requests of design.

- Work with BRDC on starting the architectural design for the Awareness Center at Wadi Mousa.

- Meet with USAID and update Mr. Jim and Dr. Amal on the status of project activities.

II. Biosolids Data Collection

Dr. Tamimi and Ph.D. candidate Susan O'Shaughnessy traveled to Aqaba, Wadi Mousa, Khirbet As-Samra, Wadi Hassan and Irbid to collect biosolids samples from the different WWTPs for characterization purposes. The handling of the biosolids and trends of treatment were observed and recorded.

The samples were gathered, handled and transported to the Royal Scientific Society's, RSS, laboratories based on the lab outlined standard methods. Also, the samples were tested at the RSS laboratories by Ph.D. candidate Susan O'Shaughnessy and the RSS staff based on standard methods.

In the following subsections, the findings from the visits and from testing the samples are presented.

1) Aqaba WWTP

On Monday May 23, 2005 Dr. Tamimi and Ms. Susan O'Shaughnessy traveled from Amman via a BRDC car to Aqaba. They arrived around noon and met with Mr. Moaed. Engr. Osama Hayajneh, a water specialist, an ASEZA employee working with CDM on RIAL project accompanied both Dr. Tamimi and Ms.O'Shaughnessy to the Aqaba WWTP.

The new treatment plant is being tested. The site engineer indicated that the inflow rate is increasing and has reached about 22,000 m^3 per day. The average flow rate for the month of May has been around 14,000 m^3 per day.

a. Sample Collection

Three composite samples were taken at the drying beds of the new Aqaba WWTP. Two (2) dry samples each containing 11 grab samples were taken from the biosolids stored in plastic bags. According to the engineer on site, these biosolids were recently dislodged from the sand drying beds after four (4) weeks of solar drying. The biosolids dry to approximately 4 mm in thickness, the aggregates are hard, porous and consistently have a white upper layer.

Susan O'Shaughnessy was not able to safely sample biosolids directly from a retention tank. However, a third sample was taken from a drying bed in which biosolids had been released the previous day. Seven (7) grab samples were taken from the bed to make one composite sample

b. Drying Process

According to the engineer on site, the initial %TS is approximately 2%. Biosolids are placed at a depth of 30cm and dewatered for 4 weeks. The dry biosolids are removed by manual labor, hand-raking, and placed into plastic bags for transport to Al-Haq date farm for land application.

It appeared that all 64 drying beds were in use. This WWTP became operational in mid February of 2005. The capacity for this new portion is 12,000 m^3 per day. The effluent water is scheduled to receive tertiary treatment via UV radiation and chlorination after the testing period with the primary use is for the local phosphate Mine Company and municipal park irrigation. The ponds of the original plant are still being used now for water coming out of the new treatment plant and the effluent is still secondary type until the full operation of the new treatment plant gets under way.

c. Laboratory Results –

%TS of the dry samples were 95.7% (g/g). Fecal coliforms were undetectable in the dry sample. Salmonella spp. levels were <3MPN/4g dry weight (0.4 MPN/4 g). %TS for the liquid sample was 7.3%. Fecal coliform levels were detected at $1.3X10^7$ MPN/g, while salmonella spp. levels were >599 MPN/4 g. These results are summarized in the following table:

Type of Sample	Time In Drying Bed or From Discharge Pipe*	Percent Total Solids, (%TS)	Fecal Coliforms (MPN/g)	Salmonella (MPN/4g)
Liquid	1 day in drying bed	7.3	1.3E+07	> 599
Solid	4 weeks	95.7	Not Detected	0.4

*Reference is made to the pipe which feeds the biosolids to the drying beds; samples were taken from the point of discharge.

2) Wadi Mousa WWTP

On Tuesday May 24m 2005, Dr. Tamimi and Ms. O'Shaughnessy traveled from Aqaba to Wadi Mousa. They arrived at Wadi Mousa around 11:00am and met with Engr. Twaisi. Engr. Twaisi accompanied them to Wadi Mousa WWTP and they met with the responsible Engineer. The operator indicated an increase in the inflow rate due to tourist activity in the region.

a. Sample Collection

Two liquid samples were taken from the discharge pipe at the drying bed. The samples were 1.8%TS. One liquid sample was assayed for fecal coliform and salmonella spp. and the other was assayed for the presence of helminth ova.

One solid sample was taken from a drying bed that was in the process of having the biosolids dislodged. The %TS for this sample was 53.6%. Seven grab samples were taken from different parts of the bed. For each grab sample, the top crust was scraped off a portion of biosolids was collected to include a portion representing the entire remaining depth. As an observation, the moist portions of the biosolids were harboring fly larvae.

b. Drying Process

According to the wastewater treatment plant operator, the biosolids are retained in the drying beds for two weeks and then dislodged irregardless of the %TS. The holding capacity of the aerobic digesting tanks is the limiting factor and do not allow for additional drying time at the current influent rate of the plant. The biosolids are removed with a rake and shovel and piled on the asphalt road immediately in front of the bed prior to their relocation to the large pile located on the concrete apron next to the farthest drying bed.

c. Laboratory Results

The assay results of the liquid samples were 5.0×10^5 MPN/g and 49.8 MPN/4g for fecal coliforms and salmonella spp., respectively. The results for the solid sample indicated the fecal coliform levels to be at 1.7×10^5 MPN/g; salmonella spp. results were < 3 MPN/4g (0.7 MPN/4g). Helminthes ova were determined to be 0 organisms/4g dry weight and were assayed in accordance with EPA document EPA/625/R-92/013: Environmental Regulations and Technology, Control of Pathogens and Vector Attraction in Sewage Sludge.

The results from Wadi Mousa are summarized in the following table:

Type of Sample	Time In Drying Bed or From Discharge Pipe*	Percent Total Solids, (%TS)	Fecal Coliforms (MPN/g)	Salmonella (MPN/4g)
Liquid	Discharge Pipe	1.8	5.0E+05	49.8
Solid	2 weeks	53.6	1.7E+05	0.7

*Reference is made to the pipe which feeds the biosolids to the drying beds; samples were taken from the point of discharge.

3) As-Samra WWTP

On Wednesday May 25, 2005 Dr. Akrum Tamimi and Ph.D. candidate Susan O'Shaughnessy departed the hotel to the RSS laboratory and Ph.D. candidate O'Shaughnessy worked in the labs on the collected samples from Aqaba and Wadi Mousa for some time. Accompanied with Engr. Bayan Athamneh from RSS, Dr. Tamimi and Ph.D. candidate O'Shaughnessy drove to As-Samra WWTP in the BRDC car.

a. Sample Collection

Approximately 1 kg of biosolids was collected at one of the open drying ponds containing biosolids. The approximate size of the drying pond was 30 m x 80 m x 8 m (depth). It was not possible to take a representative sample of these biosolids because of the enormous size and lack of proper equipment. In addition, the biosolids are too old and have been sitting in the ponds for few years.

b. Drying Process

The current wastewater treatment system for this plant is a series of waste stabilization ponds; there are no constructed drying facilities. The biosolids described in the previous paragraph were dredged from the primary ponds in 1996 and placed in these unlined open pits.

c. Laboratory Results

Samples were collected for the purpose of doing physical and chemical analysis at the request of RSS. No microbial assays were performed.

4) Wadi Hassan WWTP

Dr. Tamimi, Ms. O'Shaughnessy, and Engr. Bayan drove to Wadi Hassan on the same day, Wednesday May 25, 2005, and checked the weather station located there for the purpose of developing drying technology for Jordan as part of the biosolids activities.

After collecting the samples as described below, the three visited the biosolids application experiment at Ar-Ramtha NCARTT experimental station. The barley grown at the experiment station was ready to be harvested and the harvesting actually was started on Sunday May 29 and continued for a week. The results from this experiment will be presented by RSS in a technical report during the following months.

a. Sample Collection

Sampling at this site was done in accordance with the experimental protocol for solar drying, due to the fact that RSS was conducting their third seasonal experiment (which began on April 27, 2005). Two composite samples were taken from the experimental bed. Four grab samples within 1 meter from each of the thermocouples at location 1 and location 2 were taken to make the two composite samples. The thickness of the biosolids was less than 3 cm; the material was cracked and uniformly dried from top to bottom. A third additional sample of 1 kg was taken from the bed just opposite to the experimental bed at the request of RSS. According to the wastewater treatment plant operator, the biosolids had been drying in that bed for three weeks.

b. Drying Process

During the warmer months, the biosolids are allowed to dry for two to three weeks prior to removal. The biosolids are removed from the beds by the use of a small front-end loader and

piled for storage until transported to the land-fill. During the winter months, biosolids from the sludge retention tank are pumped into a tanker and transported to the land-fill.

c. Laboratory Results

The %TS for the two experimental specific samples were 91.9 and 92.8%TS. The third sample was determined to be 91.8% TS. Fecal coliform levels were determined to be 47 MPN/g, 46 MPN/g, and 100 MPN/g for samples 1, 2 and 3 respectively. Salmonella spp. levels were determined to be < 3 MPN/4 g (1.0 MPN/4g) for all three samples.

The results of the three biosolids samples taken from Wadi Hassan are shown in the following table:

Type of Sample	Time In Drying Bed or From Discharge Pipe*	Percent Total Solids, (%TS)	Fecal Coliforms (MPN/g)	Salmonella (MPN/4g)
Solid Sample 1	4 weeks	91.6	47	1
Solid Sample 2	4 weeks	92.8	46	1
Solid Sample 3	3 weeks	91.8	100	1

*Reference is made to the pipe which feeds the biosolids to the drying beds; samples were taken from the point of discharge.

5) Irbid Central WWTP

On the same day and finishing with Wadi Hassan WWTP, the group drove to Irbid Central WWTP. The reason for sampling from Irbid Central WWTP is the fact that biosolids produced there are treated using an anaerobic process similar to the process that will be used at As-Samra WWTP. The results should serve as a guide to what is to be expected at As-Samra WWTP.

a. Sample Collection

A liquid sample was taken by a wastewater treatment operator at the sludge retention tank for the purposes of microbiological and chemical assays. Additionally, a solid sample was taken from one of the drying bed areas. These biosolids were 4 weeks old. 6 grab samples were taken to make 1 composite sample. The top 6 cm were scraped away and discarded, and the actual samples were taken from the remaining depth. The bio-solids had a very strong ammonia odor. Interestingly, the drying beds are shaded by large trees that have been planted to landscape the WWTP.

b. Drying Process

According to the wastewater treatment plant operator, biosolids are discharged onto the drying bed areas to a depth of 30 - 35 cm and are a combination of sludge from the anaerobic digester and activated sludge. The drying beds are large; the sand is of a course nature, almost a gravel size. Biosolids are typically left to dry longer than 4 week period of time, prior to dislodging. After removal by manual labor, they are transported to a landfill.

c. Laboratory Results

The %TS for the liquid sample was 4.1% and 13.3% for the solid sample. Fecal coliform levels were determined to be 1.0×10^4 MPN/g and 3.2×10^4 MPN/g for the liquid and solid sample respectively. The salmonella spp. levels were 14.5 MPN/4g and non-detectable for the liquid and solid samples respectively.

The results for the samples obtained from Irbid Central WWTP are shown in the following table:

Type of Sample	Time In Drying Bed or From Discharge Pipe*	Percent Total Solids, (%TS)	Fecal Coliforms (MPN/g)	Salmonella (MPN/4g)
Liquid	Discharge Pipe	4.1	1.0E+04	14.5
Solid	4 weeks	13.3	3.2E+04	0.0

*Reference is made to the pipe which feeds the biosolids to the drying beds; samples were taken from the point of discharge.

6) References

For all laboratory tests performed and presented in this report, Fecal Coliforms assays were performed in accordance with EPA Method 1680: Fecal Coliforms in Biosolids by Multiple Tube Fermentation Procedures, Draft Document, October 2002.

Salmonella spp. assays were performed in accordance with EPA Method 1682: Salmonella in Biosolids by Modified Semisolid Rappaport-Vassiliadis (MSRV) Medium, Draft Document, March 2003.

III. Biosolids Related Activities

Existing wastewater treatment plants in Jordan are producing unprecedented amounts of sludge due to the fact that most of the treatment plants employ aerobic processes that generate large amounts of sludge compared to anaerobic processes. Disposal of liquid and dewatered sludge treated using drying beds at dumping sites and landfills is currently the main method practiced in Jordan. Generated quantities are estimated at 260,000 m^3 of liquid sludge and 12,000 m^3 of dewatered bio-solids during the year 2004 in addition to about 200,000 m^3 of dried sludge accumulated at As-Samra wastewater treatment plant that treat approximately 75% of the wastewater in Jordan.[1]

1) Biosolids Risk Assessment and Standards Development Methods: A Workshop and Seminar

The following activities related to the workshop have been concluded after ample discussions with RSS and BRDC. In addition, a need assessment of what is appropriate to be presented in the workshop in conjunction with the meetings was discussed and developed by Dr. Tamimi and Ms. O'Shaughnessy in cooperation with Sustainable Development of Dry Lands Project Jordanian partners.

The following represent the conclusions of the needs assessment and the meetings and discussions held with the Sustainable Development of Dry Lands Project primary partners and in consultation with The University of Arizona technical assistant team.

A. This activity will consist of two different and distinct functions: a 3 day workshop and a 2 day seminar. The audience of the two functions will not be the same.

[1] Tamimi et al. 2005. *Characterizing of Biosolids in Jordan*. Research results Submitted for publication.

B. The workshop will be held at RSS/ERC, Amman – Jordan starting Tuesday, December 13, 2005 to Thursday, December 15, 2005. The workshop outline and materials will be ready at the end of August, 2005 and will be shared and discussed with Jordanian Partners and with USAID. Fifty participants working in the area related to biosolids and the reuse of biosolids will be invited to attend through BRDC and in consultation with USAID. Jordanian partnering institutions will present biosolids knowledge and research findings and monitoring results from Jordan during the workshop.

C. The seminar will be held from Sunday, ,December 18 to Monday, December 19 to work on developing the Jordanian biosolids standards to a final modified version. During the seminar the biosolids ad hoc committee and other Jordanian agencies and organizations will start the work on modifying the Jordanian biosolids standards. Members of the Technical Assistant Team from The University of Arizona will be available during the two days to provide technical assistance as needed and as requested by the seminar participants.

D. The workshop content will concentrate mostly on biosolids and will not include risk assessment of wastewater. Risk assessment of the three areas of biosolids standards would be addressed: pollutant concentrations (chemical characteristics), pathogenic concentrations (biological characteristics), and process criteria to reduce vector attraction.

E. The workshop will follow the same sequence of the Sustainable Development of Dry Lands Project activities related to biosolids that were developed in the Scope of Work to arrive at the modification of the biosolids standards. These are:

   i. Present the characterization of the biosolids and present the work/papers that have been developed in phase I. Dr. Tamimi in cooperation with RSS/ERC will be able to present these results and papers.

   ii. Present the data that was gathered during year 1 of the application of biosolids. This can be presented by RSS/ERC staff members and in cooperation with Sustainable Development of Dry Lands Project technical assistance team members.

   iii. Review the current practices of handling, testing, dumping and applying biosolids to land in Jordan. This information will be developed from the following task:

      A study would start during Fall 2005 that would be lead by RSS/ERC in cooperation with the biosolids ad hoc committee to collect data from the different WWTPs in Jordan. The study will be based on a survey that would take into consideration the following questions: total solids, TS, for both liquid and solids before applying the sludge to the drying bed and after the removal from the drying bed. Holding tank and drying beds resident times; disposal practices; testing practices; knowledge of handling biosolids; etc… The study would be completed at the end of November 2005 and a report would be generated from the study.

The study will be presented in the Biosolids Risk Assessment and Standards Development Methods Workshop.

iv. During summer 2005 and early fall 2005 Dr. Chuck Gerba from The University of Arizona technical assistance team member and in cooperation with other members from the team will work to **define the risks** involved in treating/not treating, handling/dumping, and reusing biosolids to the people, environment, dumping sites, and to land. The technical assistant team member would then work on determining **how to assess** these risks and **develop methodology** for that assessment. Based on the assessment of the risk, they will define how to deal with the risks and determine if Jordan is ready to deal with these risks in terms of human resources and laboratory capabilities.

v. The above mentioned studies and reports will be used by the ad hoc committee and the various Jordanian partners to modify the biosolids standards based on the existing biosolids standards during the seminar that will be held on December 18 and 19, 2005.

2) Misinterpretation of the Characterization of Biosolids Phase I Results

There are few points that need to be realized in regard to RSS/ERC technical report presented to the Sustainable Development of Dry Lands Project for Phase I. Before presenting these points it is worthwhile to review both the US EPA and the Jordanian standards related to classifying biosolids.

US EPA Class A Pathogen Requirements[2] [3]

The Class A pathogen criteria require that both: (1) prescribed densities of **either** fecal coliforms **or** Salmonella **and** (2) treatment-process control requirements are satisfied.

(1) One of the following organism density requirements listed below must be satisfied for all Class A biosolids:

- The fecal coliforms density must be < 1,000 (MPN per gram of TS) and that must be satisfied immediately after the treatment process is completed; **or**
- The Salmonella density must be less than 3 (MPN per 4 grams of TS), and that must be satisfied immediately after the treatment process is completed.

  If the material is bagged, distributed, or land applied at a later time, it must be retested and the density requirement must be satisfied to ensure that re-growth of bacteria has not occurred.

(2) One of 12 alternative treatment processes must be met for the biosolids to be

[2] U.S. EPA. 1989. Technical support document for pathogen reduction in sewage sludge. NTS No. PB89-136618. Springfield, VA: National Technical Information Service.

[3] Biosolids Applied To Land: Advancing Standards And Practices. 2002. Committee on Toxicants and Pathogens in Biosolids Applied to Land. National Academy Press. 2101 Constitution Ave., N.W. Washington, D.C. 20418.

designated Class A biosolids4. The goal of the treatment processes is to reduce pathogen densities below specified detection limits for three types of organisms: Salmonella sp. < 3 (MPN per 4 grams total solids), enteric viruses < 1 (PFU {plaque-forming unit} per 4 grams total solids), and helminths < 1 (viable organism per 4 grams total solids).

The alternative treatment processes are listed below. For further description of the processes please see reference 4 shown below as a footnote.

i. Alternative 1: Temperature and Time Process
ii. Alternative 2: Alkaline Treatment Process
iii. Alternative 3: Prior Test for Enteric Virus and Viable Helminth Ova Process
iv. Alternative 4: Post-Test for Enteric Virus and Viable Helminth Ova Process
v. Alternative 5a: Processes to Further Reduce Pathogens (PFRP) - Composting Process
vi. Alternative 5b: Processes to Further Reduce Pathogens (PFRP) - Heat Drying Process
vii. Alternative 5c: Processes to Further Reduce Pathogens (PFRP) - Heat Treatment Process
viii. Alternative 5d: Processes to Further Reduce Pathogens (PFRP) - Thermophilic Aerobic Digestion Process
ix. Alternative 5e: Processes to Further Reduce Pathogens (PFRP) - Beta Ray Irradiation Process
x. Alternative 5f: Processes to Further Reduce Pathogens (PFRP) - Gamma Ray Irradiation Process
xi. Alternative 5g: Processes to Further Reduce Pathogens (PFRP) - Pasteurization Process
xii. **Alternative 6**: Process Equivalent to Process to Further Reduce Pathogens (PFRP): Treat the sewage sludge in a process that is equivalent to PFRP, as approved by the permit authority. To obtain a Class A biosolids rating, the process must reduce Salmonella species or fecal coliforms to below Class A criteria and must operate under the specified conditions used in its application demonstration to the EPA Pathogen Equivalency Committee.
There are many processes equivalent to PFRP, one of which can be drying biosolids in drying beds as the case in Jordan. But this process has to be proven by detecting for the criteria below.

To designate biosolids as Class A one has to prove that:

- The fecal coliforms density must be < 1,000 (MPN per gram of TS) **or**
- The Salmonella density must be less than 3 (MPN per 4 grams of TS) **and**
- Must use an alternative or permitted process to further reduce pathogens (PFRP) to make sure that (without required testing):
    - Salmonella is < 3 MPN per 4 grams total solids
    - Enteric viruses is < 1 PFU per 4 grams total solids
    - Helminths ova is < 1 viable organism per 4 grams total solids

[4] U.S. EPA 1999. Environmental Regulations and Technology: Control of Pathogens and Vector Attraction in Sewage Sludge. EPA/625/R-92/013. Office of Research and Development, U.S. Environmental Protection Agency, Washington DC. [Online]. Available: http://www.epa.gov/ttbnrmrl/625/R-92/013.htm [January 4, 2002].

It should be mentioned here that if the process is not permitted, one needs to test for Salmonella, Enteric Viruses and Helminths Ova to prove that the process reduces pathogens.

- Notice that if a permitted process to further reduce pathogens (PFRP) is followed then there is no need to test for the three pathogens shown above because it is assumed that the process has taken care of the pathogens. These pathogens levels for emphasis are:
  - Salmonella is < 3 MPN per 4 grams total solids
  - Enteric viruses is < 1 PFU per 4 grams total solids
  - Helminths ova s < 1 viable organism per 4 grams total solids
- The PFRP that is used in Arizona and would be used in Jordan is using drying beds for 90 days, 60 days of which should be above 0° C.

Jordan Type II (Equivalent to Class A) Pathogen Requirements

These are the same as the U.S. EPA requirement presented above. An official translation of the JS:1145/1996 is being officially translated from Arabic into English.

The following remarks have been discussed with RSS during the different meetings held at RSS headquarters. These remarks pertain to the Characterization of Biosolids Phase I project funded by Sustainable Development of Dry Lands Project.

A. Pathogenic requirements for Class A were not met for some samples contrary to what was concluded in the technical report. RSS are using a geometric mean when calculating fecal coliforms density for all months and are indicating that since the geometric mean is below 1000 MPN/gram total solids based on dry weight then the biosolids can be classified as Class A and unrestricted land application can be established. This conclusion has few flaws:

   i. According to EPA standards, the time of solarization has not been indicated and was not met since the general practice is to remove the biosolids after a maximum drying time of 49 days. Most of the samples tested received solar drying of less than 4 weeks. The EPA requirement of solarization indicates that 90 days of solarization is required in addition to the Fecal Coliforms Concentrations and heavy metals requirement.

   ii. Different WWTP have different practices in regard to biosolids. The solarization time is based on the influent flow rate. If the WWTP operator has to remove the biosolids from the drying bed to make place for the new incoming sludge. The average time of drying is less than 4 weeks with a maximum of 6 weeks. 1 and 2 weeks have been observed.

   iii. The geometric mean can not be used in Class A classification. Each sample has to have coliforms density less than 1000 MPN/gram total solids based on dry weight.

   iv. The biosolids at Wadi Mousa does not necessarily meet Class A requirements. Actually these requirements indicate that a test needs to be conducted just before the application of the Biosolids to the land.

v. JS: 1145/1996 standards are stricter than the U.S. EPA regulations in that they require testing for Salmonella, Enteric viruses and helminths ova. This was not conducted during the characterization study and hence the biosolids can not be typed as type II biosolids that allows for unrestricted reuse for agriculture.

vi. The need of gathering the prevailing practices of biosolids treatment in Jordan is important to make sure when the task of modifying the standards is under way that fact would be taken into considerations.

vii. RSS/ERC indicated that they will review Phase I technical report and issue a new modified one based on Dr. Tamimi's findings.

3) Papers for Publications

a. Characterization of Biosolids in Jordan

- The only paper from the Technical report
- Dr. Akrum Tamimi is the lead on this paper
- Authors: Dr. Tamimi, Dr. Bassam Hayek, Dr. Chuck Gerba, Engr. Bayan Athamneh, Project Director Robert Freitas and Dr. Chris Choi
- Journal: to be determined later
- Acknowledge: USAID, IALC, BRDC, WAJ
- Paper Outline:
    - Background: to include EPA & Jordanian Biosolids standards. Also include amounts of biosolids generated in US and in Jordan.
    - Justification for the study
    - Methods and Materials
    - Data collected and data analysis
    - Data Discussion
    - Conclusion
    - Proposed future work

b. Modeling Pathogen Reduction of Biosolids in Jordan (Wadi Hassan Data)

Dr. Tamimi developed a statistical model to predict pathogen reduction based on metrological data. This model has proved valid for different weather conditions at Wadi Hassan. This paper will be developed based on his findings.

- Dr. Tamimi is the lead on this paper
- Authors: Dr. Tamimi, Ph.D. candidate Susan O'Shaughnessy, Engr. Wael Suleiman and project director Robert Freitas
- Journal: to be determined
- Acknowledge: USAID, IALC, BRDC, WAJ
- Paper Outline:
    - Background: to include Wadi Hassan WWTP description, Met Station description
    - Justification for model development for WWTP based on weather data
    - Methods and Materials

- Data collected and data modeling
- Discussion of the model and validation
- Conclusion
- Proposed future work

c. Using Solar Energy for Pathogen reduction in Biosolids

- Dr. Chris Choi is the lead on this paper
- Authors: Dr. Chris Choi, Ph.D. candidate Susan O'Shaughnessy, Dr. Chuck Gerba, Dr. Nisreen Al-Hmoud
- Journal: to be determined
- Acknowledge: USAID, IALC, BRDC, WAJ
- Paper Outline: to be determined later

d. Application of biosolids to Agricultural Lands in Jordan

- Paper will start with Technical report is provided by RSS
- Lead: To be determined later
- Authors: to be determined later
- Journal: to be determined later

4) Solar Drying at Wadi Hassan

Biological laboratory testing results for the drying beds experiment at Wadi Hassan have been completed for the winter and spring seasons and have been obtained by Dr. Tamimi and by Ms.Susan O'Shaughnessy. The biological testing was performed by RSS.

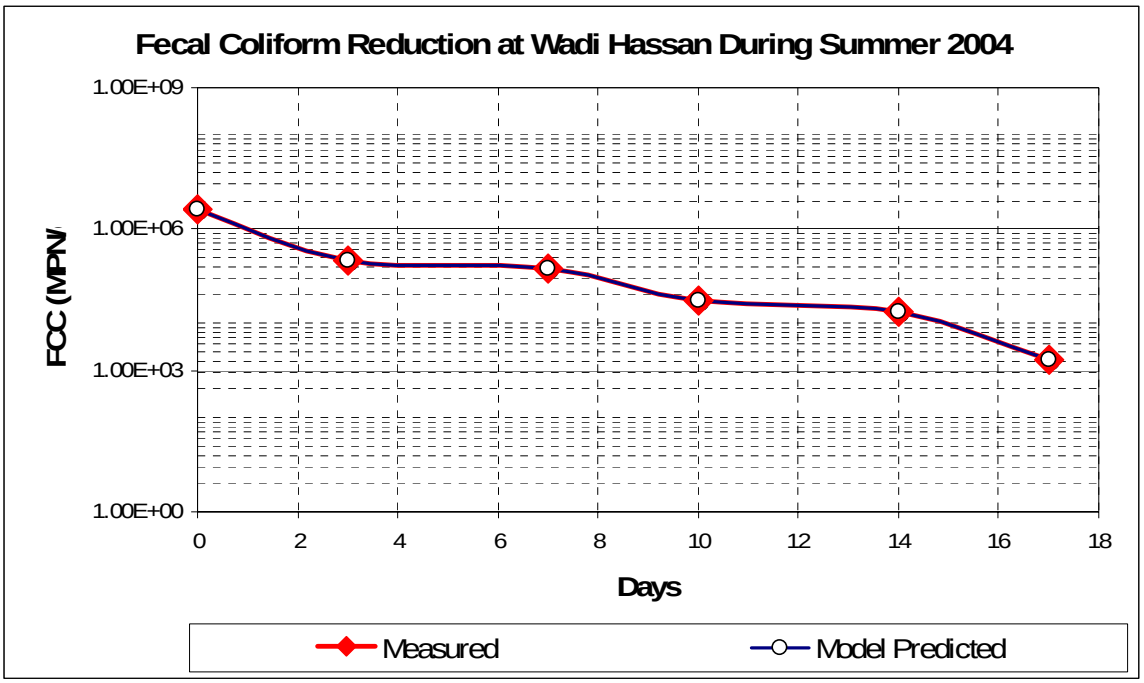
Weather data from Wadi Hassan meteorological station have also been obtained for the period extending from August 14, 2004 until January 10, 2005. RSS will provide weather data up to May 31, 2005 in a text file format.

After reviewing the weather data by Dr. Tamimi it turned out that some of the data is missing from the data logger especially during the winter months. Every time the battery voltage drops from about 13 volts down to about 9.5 volts the data logger shuts down and weather data gets lost. This happened during days when the sun does not come out because of clouds. The solar panel installed at Wadi Hassan can not generate power from day light without sun due to cloudy conditions. It is recommended here that a new solar panel would be purchased to eliminate this problem. The International Long Term Ecological Research, ILTER, can provide specifications for solar panels that generate power during cloudy days.

5) Modeling Pathogen Reduction of Biosolids in Jordan (Wadi Hassan Data)

Weather data and biological testing results were manipulated by Dr. Tamimi and he found out that a model can be generated to mimic the reduction of pathogens in biosolids.

The following figure shows results for the summer 2004 data with $R^2 = 1.0$:



6) Research Ideas and Proposals on Biosolids

During the meeting with RSS staff that included Dr. Bassam Hayek, the following ideas and research proposals transpired:

a. Validate the Wadi Hassan Model in Other Areas of Jordan

This research study would take place in Wadi Mousa WWTP for three seasons: summer 2005, winter 2005 and spring 2006. The following is proposed to complete this study:

i. It is believed that the study of biosolids drying at Wadi Hassan has been completed and there are no new objectives in repeating the experiment there; therefore, it is suggested that the weather station should be relocated to Wadi Mousa WWTP.

ii. RSS/ERC will run the same experiment that was running at Wadi Hassan and will collect data for 2005 summer month. RSS/ERC will cover the expenses of collecting weather and biological data for the drying beds for the summer.

iii. Dr. Tamimi would submit a proposal to the Sustainable Development of Dry Lands Project asking for funds to cover expenses for winter 2005 and spring 2006 weather and biological data collection. The funds will be part of a subcontract to RSS to cover basic needs to keep the project going.

b. Modeling Biosolids Treatment in Jordan

Dr. Tamimi in cooperation with RSS/ERC will prepare a proposal to be submitted to RADAC and to other funding organizations to fund work on the development of a model on biosolids treatment in Jordan and the development of a computer program. The computer

program will be used to broadcast the fate of pathogens in biosolids treated in drying beds. The computer program will be provided to WWTP. The proposal will use some of the existing data to explain what needs to be done.

c. Application of Treated Biosolids to Land Irrigated with Reclaimed Wastewater in Wadi Mousa

The application of biosolids to agricultural lands is being investigated by RSS/ERC in Ar-Ramtha NCARTT experimental field. This experiment is being run with rain fed crops, specifically rain fed barley. No research has been conducted on land application of biosolids to crops irrigated with reclaimed wastewater.

Since most WWTP in Jordan have/will have reuse sites irrigated with reclaimed water and since biosolids will be generated from these WWTPs, it is suggested here that Dr. Tamimi in cooperation with RSS/ERC would run an experiment similar to that being conducted at Ar-Ramtha NCARTT experimental field but with reclaimed water irrigated crops.

Again, the proposal will be submitted for funding to RADAC and to other funding organizations and projects including the Sustainable Development of Dry Lands Project.

IV. ASEZA Activities

Dr. Tamimi traveled to Aqaba to meet with Dr. Bilal Bashir on Sunday May 29, 2005. In the next subsections, ASEZA's activities would be presented as discussed with Dr. Bashir.

a. Water Conserving Garden

Dr. Tamimi presented the final copy of the Water Conserving Garden (WCG) irrigation system design to Dr. Bilal Bashir. He indicated that an official copy of the design will be sent to ASEZA by either BRDC and/or USAID. Dr. Bashir expressed his pleasure with the work Sustainable Development of Dry Lands Project has been doing for ASEZA and commented on the WCG master plan and design.

It is believed that some of the ideas that Ms. Karen Vitkay presented in her WCG master plan and design are being used in the designs of the Darb Street being part of the RIAL project CDM is implementing for ASEZA under a USAID contract.

Dr. Bashir indicated that the WCG master will be budgeted in next year budget and will be implemented. He commented on the design and indicated that the IALC Sustainable Development of Dry Lands Project is doing a good job for ASEZA.

b. Reclaimed Water Balance Study for the City of Aqaba

Dr. Tamimi also presented a printed copy of the second version pf the reclaimed water balance study to Dr. Bilal and requested feed back from ASEZA by the end of June. Dr. Bashir indicated that he will go over the study and send Dr. Tamimi any comments he might have.

c. Town Park

Dr. Tamimi indicated to Dr. Bilal Bashir that the IALC Sustainable Development of Dry Lands Project is interested in working on the Town Park project and provide ASEZA with an irrigation design for the proposed green land cover. He also requested information about the water that will be used and the type of plants that will be planted in the park.

Dr. Bashir indicated that tertiary reclaimed water will be used and low water plants will be grown. During the meeting Dr. Bashir called Ms. Dima Abu Diab from ASEZA physical planning department and asked her if the landscape design can be accomplished by ASEZA staff. Ms. Abu Dian indicated that ASEZA does not have the staffing or the experience to plan such a project. Then Dr. Bashir requested if the IALC Sustainable Development of Dry Lands Project can perform the landscape design for the Town Park project.

Dr. Tamimi indicated that the IALC Sustainable Development of Dry Lands Project is under severe financial constraints due to the different activities the project is dealing with. But Dr. Tamimi advised Dr. Bashir to contact USAID and request that the IALC Sustainable Development of Dry Lands Project perform the design of the Town Park landscape master plan. In addition, Dr. Tamimi advised Dr. Bashir to commit to implementing the WCG master plan designed by IALC Sustainable Development of Dry Lands Project.

It is believed that a letter is going to be sent to USAID – Amman mission committing to implementing the WCG next year and requesting that IALC Sustainable Development of Dry Lands Project develop a master landscape plan including an irrigation system for the Town Park project in Aqaba.

d. Meeting with Engr. Ali Nimer

Engineer Ali Nimer is the division head and senior standards officer at ASEZA environmental Department. Dr. Bilal Bashir indicated that he represents ASEZA at the biosolids ad hoc committee.

During the meeting with Engr. Nimer, Dr. Tamimi summarized the biosolids workshop and standards development activities. Engr. Nimer indicated that he has vast experience working with the Jordan Institute for Standards and Metrology (JISM) and there is a long process that needs to be followed in regard to modifying the biosolids standards. Dr. Tamimi requested that Engr. Nimer be an active member in the ad hoc committee.

It will be requested from BRDC and RSS/ERC to invite Engr. Nimer from ASEZA to the next ad hoc committee meeting.

V. Meeting with USAID

On Monday, May 30, 2005 a meeting was held at USAID – mission at the US Embassy, Amman to discuss the IALC Sustainable Development of Dry Lands Project activities. Present were: Dr. Tamimi, Ms.Susan O'Shaughnessy from IALC, Mr. Jim Franckiewicz, and Dr. Amal Hijazi from USAID. Dr. Saad Al-Ayyash representing BRDC excused himself from attending earlier that day. Dr. Amal Hijazi left his name at the security check desk at the embassy and asked about him before the start of the meeting.

Dr. Tamimi presented the final copy of the WCG irrigation system design technical report to USAID and explained that with this item the design of a master landscape plan for the WCG has been completed. Official copies of the irrigation system design technical report will be sent to USAID with an official copy from BRDC.

Dr. Tamimi then presented a copy of the second version of the Reclaimed Water Balance Study for Aqaba and requested feed back. Dr. Hijazi indicated that she will get someone

from her department to review the study and probably send it to the Aqaba Water Company for feed back. Dr. Tamimi indicated that IALC Sustainable Development of Dry Lands Project will entertain comments and modifications to the study until the end of June 2005.

Dr. Tamimi then presented two copies of the F03-04 Report CD to Dr. Amal and Mr. Jim Franckiewicz. He ran the program on an LCD provided by USAID and explained that all the reports and the studies are present on the CD and can be printed directly from the CD and if USAID would like the Sustainable Development of Dry Lands Project to print any or all the reports that the project will accommodate the request. Mr. Jim Franckiewicz requested that Dr. Hijazi would go over what is required by USAID for filing purpose and would get back to Dr. Tamimi for any printing required. Dr. Tamimi indicated that USAID can use the CD for their reporting as needed.

Dr. Tamimi indicated that he will not be discussing the F05-06 budget and that project director Mr. Bob Freitas is available to travel to Jordan to consult with USAID on the budget between July 6 and July 7, 2005. Both Mr. Franckiewicz and Dr. Hijazi indicated they will be available on those dates to meet with Mr. Freitas to discuss F05-06 SOW and budget. Dr. Tamimi promised to get back to them to confirm the meeting.

Even though Dr. Tamimi indicated that he will not discus the F05-06 budget, he indicated that the IALC Sustainable Development of Dry Lands Project has activities in Jordan for F05-06 that require a minimum amount of $900K of which $270K will be provided from the core money from USAID Washington. He indicated that if the scenario of USAID – Amman Mission buy-in will be limited to $250K then that will be a disaster and many excellent opportunities will be lost due to the fact that the $250K will be solely committed to the Rusaifah project. He also indicated that what IALC Sustainable Development of Dry Lands Project delivers is many folds greater than what would a contractor provide for the same amount of money. Mr. Franckiewicz calculated the difference required to have enough funds to carry on all project activities to be $380K. It is Dr. Tamimi's believe from the impression and the talk he observed during the meeting that USAID – Amman mission will be able to provide the missing $380K in addition to the $250K for Rusaifah for the coming fiscal year.

Dr. Tamimi then discussed the Wadi Mousa guidelines and activities. He indicated that the IALC Sustainable Development of Dry Lands Project will start the process of developing the architectural design plans and will develop the tender documents when all permits and approvals for implementation are ready and provided by the Jordanian partners. He also indicated that there are enough funds in the CDM contract to implement both the Awareness Center and Landscape master plan. The cost for constructing the center should not exceed $350 per square meter if a local contractor is subcontracted to do the construction leaving an ample amount of money to be used for the furnishing the center and implementing the landscape master plan. It should be mentioned here that USAID has budgeted to CDM $150K for both activities and the area of the Awareness Center 150 square meters.

Ph.D. candidate Susan O'Shaughnessy delivered an informative presentation about the objectives of her trip to Jordan and presented the different activities being conducted in Jordan and Arizona about biosolids.

Dr. Tamimi then presented the sequence proposed to lead to the modifications of the biosolids standards including the workshop as presented in this report (Please see Item # III above: Biosolids Related Activities). He also indicated that USAID will be consulted in

regard to the participants of the workshop when the logistics and materials of the workshop are ready.

Dr. Tamimi then discussed ASEZA's request to design landscape master plan for the Town Park project in Aqaba and indicated that Dr. Bashir will be contacting them soon as he indicated.

Dr. Tamimi presented the status of the anaerobic workshop that is being planned to take place in Egypt. He indicated that the workshop will be held between November 13 and 17, 2005. He also stated that Mr. Ramzi Sabella who was selected by USAID will participate in the workshop on behalf of USAID. Dr. Hijazi indicated that she is interested in participating in the workshop and Dr. Tamimi welcomed the idea and encouraged her participation.

The meeting ended on a good note and it is believed that USAID appreciates IALC Sustainable Development of Dry Lands Project activities and deliverables and that they are happy with the progress the project is making.

VI. Wadi Mousa Activities

Dr. Tamimi modified the Scope of Work (SOW) for the development of the Wadi Mousa Awareness Center architectural plans. The SOW and a letter to the architect were sent to BRDC to start pricing and contract signing with the architect to develop the architectural plans for the Awareness Center.

VII. Conclusion and Recommendations

All objectives of the visit were met and many findings were obtained by Dr. Tamimi and Ms. Susan O'Shaughnessy. Planning of future work and publications were identified and the biosolids activities were discussed with RSS/ERC and Jordanian partners.

The objective of working on the Wadi Mousa Awareness Center have been slow and BRDC needs to sign a contract with the Architect after requesting an offer to perform the architectural design and tasks outlined in the Scope of Work developed by Dr. Tamimi.