German-Lebanese Technical Cooperation Project

Support by the BGR project to the Wastewater Planning Process in Lebanon
(project component 1)

Final Project Workshop
11 July 2014

Dr. Armin Margane
1. Integration of water resources protection aspects into the investment planning and implementation process in the wastewater sector

- Support of CDR and other institutions concerning the prioritization of wastewater projects as well as the design and site selection for WWTPs, collector lines and effluent discharge locations;
- Support of CDR concerning the preparation of EIAs for wastewater projects, with regards to their impact on the water resources;
- Preparation of best practice guidelines for the implementation of wastewater projects with special consideration of the aspect of ground and surface water protection.
Contamination Risks from Wastewater

Currently wastewater is discharged
- into injection wells
- into open cess pits or
- into nearby creeks/rivers/wadis

residences with no wastewater collection and treatment

Infiltration of untreated wastewater into highly karstified Jurassic limestone (Faitroun)

► microbiological contamination of Jeita spring
Specific Problems concerning Wastewater Treatment

- **Topography** (WW must be pumped up at several locations; extremely high gradients)

- **Electricity** not available 24/7 (max 25%)

- Large **spacing** between residential areas (often only up to 70 % of a village can be serviced by a wastewater scheme)

- Households cannot be forced to **connect** to WW collector lines

- Municipalities have begun to **construct** WW collector lines without coordinating with the responsible agencies (aim: divert WW out of the village)

- Their concept, material, etc. does not fit with KfW’s/EIBs concept, material, ...

- **Geo-risks**: karst (sinkholes), tectonics, landslides, rock slides, earthquakes, flooding

- ► wastewater master plan is urgently needed
High and continuous microbiological contamination

Dbayeh raw water (treatment plant)

Maximum allowable limit: < 1 mpn/100 ml

Analysis frequency: 4 days

Exceedances:
- >1 100%
- >50 97%
- >100 85%

Protection of Jeita Spring
In order to establish a wastewater scheme (collection & treatment),
• a **Wastewater Master Plan** (WMP) has to be developed. This WMP defines the
target for a specific planning horizon (e.g. 25 years), i.e. what principally be
done to cover a certain area with adequate collection and treatment facilities.
The WMP proposes several individual wastewater schemes and includes a rough
estimation of costs.
• An **initial site investigation** for the proposed wastewater treatment plants (WWTP) has
to be conducted to determine their suitability (draft environmental impact assessment
(EIA), especially on water resources). Based on this draft EIA an update of the WMP
is done.
• The agencies responsible for planning in the wastewater sector (here: CDR, MoEW),
according to the available funds, define which **wastewater schemes** will be
implemented, what are the exact boundaries of these schemes and what is the time
line for implementation.
• The **municipalities** involved in the proposed wastewater schemes have to agree to
the planned wastewater facilities.
• Tender documents are prepared and a **consultant is contracted** to build the
wastewater scheme.
• The **detailed site investigation/planning & EIA for the scheme are prepared** by the
consultant and discussed with all stakeholders (public participation).
• The wastewater facilities are built and transferred to the agency operating it (WEBML)
### Site Selection for Wastewater Facilities

- General criteria
- Geological/hydrogeological criteria ← BGR
- Financial criteria

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**ANNEX 1: Criteria for Site Selection and Design of Wastewater Facilities in Lebanon**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Collector Lines</th>
<th>WWTP Location</th>
<th>WWTP Design</th>
<th>discharge Location</th>
<th>Remarks</th>
<th>Tasks / source</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of inhabitants to be serviced</td>
<td></td>
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<tr>
<td>WW/industrial plant/pool</td>
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<tr>
<td>plan (industrial plant/pool)</td>
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<td>geological (rock type, underground as a barrier, dip direction/angle)</td>
<td>xx</td>
<td>xx</td>
<td></td>
<td></td>
<td>if natural geological barrier is existing, it should be used</td>
<td>geological mapping</td>
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<td>stability</td>
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<td>landslides effect</td>
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<td>tectonic</td>
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<tr>
<td>earthquake effect</td>
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<td>ground velocities</td>
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<tr>
<td>recharge area</td>
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<tr>
<td>topography</td>
<td></td>
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<tr>
<td>karst features</td>
<td></td>
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<td>risk of becoming sink</td>
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<tr>
<td>distance (used for control)</td>
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<td></td>
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<tr>
<td>annual costs for maintenance and operation (available funds)</td>
<td>xx</td>
<td>xx</td>
<td></td>
<td></td>
<td>can existing regulations / guidelines for quality of (organics) fertilizer to be maintained at all times?</td>
<td></td>
</tr>
<tr>
<td>costs for primary collector lines</td>
<td>xx</td>
<td>xx</td>
<td></td>
<td></td>
<td>analysis of sludge content; determine sites for sludge application; determine treatment of sludge and related feasibility</td>
<td></td>
</tr>
<tr>
<td>costs for secondary collector lines</td>
<td>xx</td>
<td>xx</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>costs for household connections</td>
<td>xx</td>
<td>xx</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>costs for WWTP construction</td>
<td>xx</td>
<td>xx</td>
<td></td>
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</tr>
</tbody>
</table>

**Criteria catalogue**

- General criteria
- Geological/hydrogeological criteria ← BGR
- Financial criteria
Site Selection

Treatment plant:

*Centralized approach:*

Because of **impact on water resources** the treatment location must be outside (downstream) of the GW catchment of drinking water resources.

Also the **potential impact by geohazards** (flooding, active faults, landslides, rockfalls, cave collapse, etc.) must be low.

Collector line:

- should collect most wastewater to reduce groundwater pollution
- must avoid pumpage (pollution risk if not operated)
- cannot be along river (too steep, no possibility for maintenance road)

► only possibility: along escarpment
Fragmented wastewater schemes because of lack of systematic planning
> wastewater master plan not existing > carried out by KfW/BGR projects
Site Selection

Main road collector requires pumping
► high pollution risk
Valley collector goes through virgin land
► no place to accommodate service road
► high pollution risk due to rockfall risk
Valley collector not feasible & environmental objection

Site Selection

- Valley collector not feasible & environmental objection
- Stilted collector and road
- Flooding level
BGR Proposal: adjust boundaries between foreign donor projects based on hydrogeological criteria

WW reuse not allowed and not feasible (pumping in summer only 300 m)
### Alternative Ranking and Main Advantages/Disadvantages

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Rank</th>
<th>Main Advantages/Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Principally acceptable solutions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4b*</td>
<td>1</td>
<td>Lowest pollution risk because no Jeita WWTP – Mokhada bridge collector/conveyor would be required but poor feasibility prospects for coast WWTP</td>
</tr>
<tr>
<td>B4a*</td>
<td>2</td>
<td>Special protective measures in protection zone 2 necessary for escarpment collector and Jeita WWTP – Mokhada bridge conveyor/collector</td>
</tr>
<tr>
<td>A2b</td>
<td>3</td>
<td>Special protective measures in protection zone 2 necessary for escarpment collector and Jeita WWTP – Mokhada bridge conveyor/collector</td>
</tr>
<tr>
<td><strong>A2a</strong></td>
<td>4</td>
<td>Special protective measures in protection zone 2 necessary for Jeita WWTP – Mokhada bridge conveyor/collector</td>
</tr>
<tr>
<td>A1b</td>
<td>5</td>
<td>Uncertain reuse concept for Kfar Debbiane</td>
</tr>
<tr>
<td>A1a</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>B2b</td>
<td>7</td>
<td>High costs for relatively small Jeita WWTP, poor feasibility prospects for coast WWTP</td>
</tr>
<tr>
<td>B1b</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>B2a</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>B1a</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

| **Objected solutions** | | |
|------------------------|--------------------------------|
| A3a | The Daraya WWTP would be located in open karst where sinkholes are reported which are probably connected with Jeita cave. Discharge of treated effluent under these conditions is problematic. |
| A3b | | |
| B3a | | |
| B3b | | |
Proposed EIA Guideline for WW Facilities:

- **Standard outline**
- Integration of all relevant *geoscientific aspects*
  - impacts on water resources
  - impacts from geohazards (tectonic movements, earthquakes, landslides, rock falls, rock collapse structures, soil liquefaction, soil stability, flooding)

Potential negative impacts on the quality of water resources must be considered separately for all individual components of a proposed wastewater facility or scheme (collector lines, treatment plant, effluent discharge location) and mitigation measures must be proposed for each of those.
Standard Outline of EIA for WW Facilities

1. Introduction
2. Legislative and Institutional Frameworks
3. Description of the Project
4. Description of the Environment
5. Impact Identification and Analysis
6. Mitigating Adverse Project Impacts
7. Environmental Management Plan
8. Public Involvement and Participation
9. References

Annex 1: Topographic Map of the Study Area
Annex 2: Geological Map of the Study Area
Annex 3: Hydrogeological Map of the Study Area
Annex 4: Map showing all Components of the Proposed Wastewater Facility (overview and detailed views)
Impact on Water Resources

Impacts on water resources might be caused by:
- inadequate site selection
- inadequate design (methods, technology, capacities, diameters, etc.)
- inadequate materials
- mistakes during installation/construction
- mistakes during operation (e.g. inadequate maintenance, monitoring, etc.)
- impacts of geohazards

Impact of Geohazards

- tectonic movements
- earthquakes
- landslides
- rockfalls
- rock collapse structures (e.g. dolines)
- land subsidence
- soil liquefaction (instable soil)
- flooding
KfW Jeita Project

Without pumpage

Serviced area
- S Jeita
- (S Sheile)
- Ballouneh
- Aajaltoun
- Daraya
- Kfar Debbiane
- S Zouk Mosbeh

Phase I: 45,000 PE
Phase II: 92,000 PE

EIB/AFD project

- ~150 Mio USD
- Kfar Debbiane, Boqaata, Bqaatouta, Kfartay only partly covered by KfW

~38 Mio USD

Protection of Jeita Spring
BGR prepared **EIA** for all components of KfW wastewater scheme related to impact on water resources and impact from geohazards (collector line, WWTP site, effluent discharge site).

**Geo-risks:**
- flooding
- landslides
- rock falls
- land subsidence
- cave collapse
- sinkhole formation
- earthquakes

**WWTP Mokhada**

Retention wall ~ 1 Mio USD

BGR EIA contribution final in June 2013
detailed geological mapping at WWTP and collector line
Protection of Jeita Spring

Environmental Impact Assessment

EIA for JSPP project

Rock overburden over Jeita Grotto
Upper level: 60-80 m

proposed rerouting escarpment collector

planned route escarpment collector

cave-ceiling_100m

cave-ceiling_125m_pools

cave-ceiling_161m_highest-point

cave-ceiling_125m_platform_3

critical zone cave collapse
Protection of Jeita Spring

EIA for JSPP project

Proposed GW protection zone 1

groundwater protection zones

Data rate 0 kbps - from net 0.00%
Net: qps 0.00, rate 0 kbps, avg latency 0.00 ms, min 0.00 ms, max 0.00 ms
Net response size: gr avg size 0.00 kB, max size 0.00 kB, - q 0.00 kB - i 0.00 kB - 10.00 kB - d 0.00 kB
Protection of Jeita Spring

almost vertical dip of rocks

Active faults - risk of rockfalls

EIA for JSPP project

Jeita Grotto

collector line

collector line
Protection of Jeita Spring

Active faults - risk of rockfalls

EIA for JSPP project

Steep slope & vertical dip
Rockfall risk
Landslide & rockfall risk
Cave collapse risk

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Image © 2013 DigitalGlobe
Construction waste dumps - risk of rockfalls/landslides
Risk of flooding
Risk of flooding

January 2013

maximum flood level

river flow in April 2013
The guideline gives recommendations on the potential impact on water resources with regards to:

- site selection and design process for wastewater treatment plants, collector lines and effluent discharge points
- selection of the optimal treatment method
- criteria for treated wastewater reuse
- criteria for sludge management
- proposal for monitoring of the treated wastewater effluent, sludge quality and effects of wastewater reuse and sludge application

►► Technical Report No. 2
Recommendations:
• Treated industrial wastewater and treated domestic wastewater containing a large share (> 10%) of industrial or commercial wastewater, should not be reused for irrigation.

• Domestic wastewater reuse classes should be based on health concerns, hydrogeological criteria and soil characteristics of the area. Groundwater vulnerability maps should be used to decide where reuse can be allowed.

• The concept for treated wastewater reuse must be agreed upon with the potential users before the planning of a wastewater facility. Treated wastewater will often have to be pumped to the irrigation area so that treatment for reuse in agriculture will be significantly more costly.

• Public awareness for farmers is needed in order to provide an agricultural production which is safe for human consumption. Moreover the safety of farm workers and local population around farms needs to be taken into consideration.
Recommendations:

- **Monitoring** of treated wastewater quality is very important in order to provide that no pollution will occur. Monitoring will require a massive increase in laboratory capacities, which needs to be planned for now.
  - where to monitor
  - what to monitor
  - how often to monitor

- The government agency responsible for the operation of the treatment plant should also be responsible for the monitoring of treated wastewater reuse. All impacts of treated domestic wastewater reuse for irrigation on soil, groundwater and humans have to be monitored regularly.
Integration of Water Resources Protection Aspects into the Investment Planning and Implementation Process in the Wastewater Sector

Technical Report 1: Site Selection for Wastewater Facilities in the Nahr el Kalb Catchment (January 2011)


Special Report 4: Proposed National Standard for Treated Domestic Wastewater Reuse for Irrigation

www.bgr.bund.de/jeita
Protection of Jeita Spring

Reports for Project Component 1

Reports prepared with GITEC

GITEC & BGR: Regional Sewage Plan (October 2011)

LibanConsult & BGR: Environmental Impact Assessment for the Proposed CDR/KfW Wastewater Scheme in the Lower Nahr el Kalb Catchment (~ June 2013)
Thank you for your kind attention

www.bgr.bund.de/jeita

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