A case study in successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies.

- Wastewater Network in Ras Al Khaimah, U.A.E. -

Börje Persson
BKP Berolina Polyester GmbH & Co. KG
Content Outline

1. Partners involved
2. Project Scope
3. Inspection
4. Pipe Rehabilitation
5. Project Outcomes
PARTNERS INVOLVED
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

PARTNERS INVOLVED:

Client.

Public Services Department

RAK Wastewater Agency
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

PARTNERS INVOLVED:

Client.

Public Works and Services Department (PWSD) - established 1965

Divided into four agencies

- **Waste water agency.**
- Waste management agency.
- Works agency
- Landscape agency
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

PARTNERS INVOLVED:

Contactor - Rehabilitation.

International Aramoon Co. Ltd (IAC)

Specialist contractor for the installation. Berolina-Liner partner since 2009
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PARTNERS INVOLVED:**

Contactor - Rehabilitation.
Established 1990

11 branches in Saudi Arabia, offices in UAE and Qatar

Inspected and managed +1000 of km of Sewer Network in the major cities of Saudi Arabia and rehabilitated defective network using Trenchless Technologies

Services for Wastewater sector include:
- Trenchless Pipe Rehabilitation
- Installed more than 100Km the Berolina-Liner
- CCTV/Sonar/Laser Inspection & Assessment
- Flow Control Bypass / Over-pumping
- High Pressure Jet Cleaning
- Traffic Management & Site Preparation

Specialist contractor for the RAK CIPP installation
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PARTNERS INVOLVED:**

Contactor - Rehabilitation.

BKP Berolina Polyester GmbH & Co. KG

Producer and supplier of the BKP Berolina-Liner System
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PARTNERS INVOLVED:**

Contactor - Rehabilitation.

**BKP Berolina Polyester GmbH & Co. KG**

- Origins 1959
- Established 1991
- Development of the Berolina-Liner System 1995
- First commercial installation 1997
- More than 3.000 Km delivered till to date world wide

[Logo of BKP Berolina Polyester GmbH & Co. KG]
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

PARTNERS INVOLVED:

Global Markets Development – BKP Berolina Liner

- Sweden
- Ireland
- Poland
- Denmark
- Japan
- Liechtenstein
- Lithuania
- Slovenia
- South Africa
- England
- Italy
- Latvia
- Canada
- Estonia
- Singapore
- Luxembourg
- Spain
- Gulf Region
- Brunei
- Russia
- Ukraine
- Argentina
- Finland
- Kazakhstan
- Luxembourg
- Abu Dhabi
- Malaysia
- Germany
- France
- Netherlands
- Austria
- Norway
- Switzerland
- Australia
- Belgium
- Hungary
- Mexico
- Saudi Arabia
- USA
- Czech Republic
- China
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PARTNERS INVOLVED:**

Contactor - Inspection.

**Electro Scan Inc**

Supplier of FELL® inspection system
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**Partners Involved:**

Contactor - Inspection.

**Electro Scan Inc**

- Founded 2011
- HQ – California, USA
- Offices in Florida, U.K., Germany & Australia
- FELL® - Focused Electrode Leak Location

**FELL®**

ES-620: *flagship probe* designed for *6 – 30 Inch Diameter* Gravity Mains
PROJECT SCOPE
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PROJECT Scope:**

Location.

**Ras Al Khaimah U.A.E.**
(Pop. 0.39 million)
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PROJECT Scope:**

Project Location.

**Ras Al Khaimah U.A.E.**
(Pop. 0.39 million)
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PROJECT Scope:**

**Extent:**

- Rehabilitation of 3.3 kilometres of the wastewater network in Ras Al Khaima, in the United Arab Emirates.
- The 3.3 kilometres of rehabilitated pipes formed part of a total of network of 16 kilometres.
- Original pipe construction material was PVC.
- Diameters ranged from 200mm to 500mm.
Inspection:

- In total 214 pipes were inspected.
- Seventy-two percent of the network was inspected using a combination of traditional CCTV and Electroscan's FELL® system.
- Inspection of the remaining 28% was not possible due mostly to excessive debris, obstructions and other adverse operating conditions.
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

PROJECT Scope:

Assessment:

- FELL® inspection showed that an estimated 41% of defect flow occurred in 11% of pipes or 21 of the 214 pipes surveyed.
- Defects at pipe joints identified as the main culprits for defect flows.
- Further assessment of CCTV and FELL data showed poorly sealed joints.
- Opinion of IAC and Electroscan was that proper care and workmanship may have been poor during the original installation of the pipes.
INSPECTION
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**Inspection:**

**Project Plan:**

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Mode</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Rehabilitation of Wastewater Networks in Ras Al Khaimah City West Trunk Main and Mairid Network</td>
<td>213 days</td>
<td>Sat 01/07/17</td>
<td>Mon 05/03/18</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>PRE-REHABILITATION PHASE</td>
<td>213 days</td>
<td>Sat 01/07/17</td>
<td>Mon 05/03/18</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Mobilization to RAK (FELL-manpower &amp; Equipment from USA)</td>
<td>14 days</td>
<td>Sat 01/07/17</td>
<td>Sun 16/07/17</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Flow Control</td>
<td>200 days</td>
<td>Sun 16/07/17</td>
<td>Mon 05/03/18</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>FELL Inspection</td>
<td>40 days</td>
<td>Sun 16/07/17</td>
<td>Wed 30/08/17</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Jet Cleaning</td>
<td>32 days</td>
<td>Sun 13/08/17</td>
<td>Mon 18/09/17</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>CCTV Inspection and Deflection Measurement</td>
<td>32 days</td>
<td>Sun 13/08/17</td>
<td>Mon 18/09/17</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Submission of report</td>
<td>7 days</td>
<td>Tue 19/09/17</td>
<td>Tue 26/09/17</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Engineers assessment &amp; final decision of means of rectification</td>
<td>18 days</td>
<td>Thu 28/09/17</td>
<td>Wed 18/10/17</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>REHABILITATION PHASE</td>
<td>95 days</td>
<td>Thu 19/10/17</td>
<td>Tue 06/02/18</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Order for FELL</td>
<td>1 day</td>
<td>Thu 19/10/17</td>
<td>Thu 19/10/17</td>
</tr>
</tbody>
</table>
Inspection:

- Seventy-two percent of the network was inspected using a combination of traditional CCTV and Electroscan's FELL® system.
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**Inspection:**

FELL® inspection summary:

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>Number of Defects</th>
<th>Defect Flow (Liters Per Second)</th>
<th>Liters Per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small  Medium</td>
<td>Large  Total</td>
<td>Minor  Moderate  Severe   Total</td>
</tr>
<tr>
<td>14,842</td>
<td>1,082   504</td>
<td>555     2,141</td>
<td>27    82         64        173   14,957,507</td>
</tr>
</tbody>
</table>

Electro Scan only detected and measured openings that were in contact with water so it could properly quantify the amount of electric current flowing through an opening returning to the surface grounding stake. If any defects or active infiltration exist in the upper crown of the pipe, and are not fully surcharged or submerged, then either ‘NO’ reading or ‘LOW’ reading may exist.
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

Inspection results from FELL® and CCTV

25 Total Leaks

FELL Survey Date: 22/09/2017

CCTV Date: 06/09/2017

2 Displaced Joints
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**Inspection:**

Project summary - FELL® surveys with associated CCTV Inspections

<table>
<thead>
<tr>
<th>Total Project</th>
<th>Scans</th>
<th>Footage (m)</th>
<th>Total Defects</th>
<th>LITERS PER DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total:</td>
<td>211</td>
<td>14,586</td>
<td>2,101</td>
<td>14,675,636</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Worst 20 Lines</th>
<th>Scans</th>
<th>Footage (m)</th>
<th>Total Defects</th>
<th>LITERS PER DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total:</td>
<td>20</td>
<td>1,670</td>
<td>525</td>
<td>5,926,261</td>
</tr>
</tbody>
</table>

- 9.5% Sewer Mains
- 11% Distance Scanned
- 25% Number of Defects
- 40% Defect Flow
Project summary - FELL® surveys versus CCTV Inspections

211 SEWER MAINS
Defects Found

FELL: 2,101
CCTV: 642 (30%)

1. Focused Electrode Leak Location (FELL) automated defect identification & quantification.
2. Closed-Circuit Television (CCTV) using manual qualitative visual inspection.
Pipe Rehabilitation
**A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.**

**PIPELINE REHABILITATION:**

**Project Plan:**

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Mode</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td></td>
<td>Material Order for Full relining</td>
<td>95 days</td>
<td>Thu 19/10/17</td>
<td>Tue 06/02/18</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>1 day</td>
<td></td>
<td>Thu 19/10/17</td>
<td>Thu 19/10/17</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>Start of Patch repair works</td>
<td>50 days</td>
<td>Thu 21/10/17</td>
<td>Wed 27/12/17</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Production of BKP material</td>
<td>21 days</td>
<td>Thu 21/10/17</td>
<td>Mon 13/11/17</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Shipment of BKP Material</td>
<td>35 days</td>
<td>Sun 14/11/17</td>
<td>Sun 24/12/17</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>Shipment of Rehabilitation</td>
<td>15 days</td>
<td>Sun 17/12/17</td>
<td>Tue 02/01/18</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>Equipment to RAK from KSA</td>
<td>7 days</td>
<td>Mon 25/12/17</td>
<td>Mon 01/01/18</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>Arrival &amp; Customs Clearance for BKP Material</td>
<td>19 days</td>
<td>Tue 12/12/17</td>
<td>Tue 02/01/18</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>Continuous Preparation of lines for rehabilitation</td>
<td>19 days</td>
<td>Tue 02/01/18</td>
<td>Tue 02/01/18</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>Transfer of Material to RAK</td>
<td>1 day</td>
<td>Tue 02/01/18</td>
<td>Tue 02/01/18</td>
</tr>
<tr>
<td>21</td>
<td></td>
<td>Pipe Rehabilitation by CIPP of an estimated per 50 meters per line</td>
<td>30 days</td>
<td>Wed 03/01/18</td>
<td>Tue 06/02/18</td>
</tr>
<tr>
<td>22</td>
<td></td>
<td>POST REHABILITATION PHASE</td>
<td>14 days</td>
<td>Wed 07/02/18</td>
<td>Thu 22/02/18</td>
</tr>
</tbody>
</table>
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PIPELINE REHABILITATION:**

- **Installation - The Berolina-Liner System**
- Berolina-Liner System is certified excellent quality. Available from Diameter 150 mm to 1600 mm

The BKP Berolina-Liner System.
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

PIPELINE REHABILITAION:

The BKP Berolina-Liner System.

UV-light Cured-in-Place (CIPP) methods are now the preferred in developed markets.

PROF.DR.-ING. VOLKER WAGNER
Freelance surveyor in urban water management
European Engineer No.: 14470 DE, German Delegate in the CEN, DIB Sachverständiger-Obmann
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PIPELINE REHABILITAION:**

The BKP Berolina-Liner System.

**UV Light Cured CIPP System (UVC)**

- Control unit for UV-Light Curing
  - *(NO boiler requirement)*

- Liner winched in place
  - *(NO scaffolding need)*

- Transportation of the liner
  - *(NO need refrigeration / ice)*
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

PIPECline REHABILITAION:

The BKP Berolina-Liner System.

Quality of Liner

UVC: Produced at factory to meet high quality standard. Every batch is inspected. Good value for money.

Excellent in terms of Life Cycle (50 years) Cost.
During production of The Berolina-Liner, at BKP's production a 4m long sample piece from is taken from regular production batches and is cured under actual building site conditions and fully analyzed to assure the quality of the liner.

The following features are tested:

• Thickening and function of the resin
• Wall thickness
• Glass content
• Barcol hardness of the liner
• Short-term ring stiffness
• Impregnation quality of the glass complexes
• Air-tightness according to DIN EN 1610
• Appearance of the cured liner
• Position of the inner hose and the glass complexes
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PIPELINE REHABILITATION:**

- **Production, Crating & Transportation**
- No special refrigeration requirements for transportation

The BKP Berolina-Liner System.
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PROJECT OUTCOMES:**

![Image of workers setting up equipment](image1.png)

![Image of road construction](image2.png)
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

PROJECT OUTCOMES:
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**PROJECT OUTCOMES:**
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**PROJECT OUTCOMES:**
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**ZONE Z – CIPP REHABILITATION.**

<table>
<thead>
<tr>
<th>SN</th>
<th>SECTION NAME</th>
<th>MATERIAL</th>
<th>DIAMETER</th>
<th>LENGTH</th>
<th>RECOMMENDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MH011Z/53A - MH011Z/53</td>
<td>PVC</td>
<td>200</td>
<td>59.50</td>
<td>CIPP as per deflection, exceeded limits</td>
</tr>
<tr>
<td>2</td>
<td>MH009Z/47 - MH011Z/53</td>
<td>PVC</td>
<td>200</td>
<td>43.60</td>
<td>Cutting of intruding sealing @6.80m, 17.10m &amp; 18.20m, 6 Patchs @0.80m, 6.80m, 17.10m, 18.20m, 41.60m &amp; 42.70 m as per CCTV OR CIPP due to deflection, depth and exceeding numbers of patches</td>
</tr>
<tr>
<td>3</td>
<td>MH008Z/45 - MH011Z/53A</td>
<td>PVC</td>
<td>200</td>
<td>95.80</td>
<td>cutting of intruding seal and patch @ 47.80 and CIPP as per deflection</td>
</tr>
<tr>
<td>4</td>
<td>MH011Z/53 - MH011Z/54</td>
<td>PVC</td>
<td>250</td>
<td>113.70</td>
<td>CIPP as per deflection, exceeded limits and Fell</td>
</tr>
<tr>
<td>5</td>
<td>MH011Z/54 - MH024Z/100</td>
<td>PVC</td>
<td>250</td>
<td>113.60</td>
<td>CIPP as per exceeded limits and Fell</td>
</tr>
<tr>
<td>6</td>
<td>MH024Z/100 - MH024Z/100A</td>
<td>PVC</td>
<td>250</td>
<td>79.20</td>
<td>1 patch @ 2.18 m (infiltration) &amp; CIPP as per deflection, Fell and considering the depth of the line</td>
</tr>
<tr>
<td>7</td>
<td>MH024Z/100A - MH024Z/99</td>
<td>PVC</td>
<td>250</td>
<td>79.00</td>
<td>CIPP as per Fell and considering the depth of the line</td>
</tr>
<tr>
<td>8</td>
<td>MH024Z/99 - MH024Z/98</td>
<td>PVC</td>
<td>250</td>
<td>80.70</td>
<td>cutting intruding seal, Patchs @0.50m, 1.0m, 39.30m &amp; 50.90m as per CCTV OR CIPP as per FELL</td>
</tr>
<tr>
<td>9</td>
<td>MH024Z/97 - MH024Z/98</td>
<td>PVC</td>
<td>200</td>
<td>76.60</td>
<td>9 patches @13.72m, 25.40m, 31.27m, 37.0 m, 43.0, 48.85 m, 66.2 m, 72.2 m &amp; 74.7 m as per FELL. CIPP due to number of patches exceeding 5</td>
</tr>
<tr>
<td>10</td>
<td>MH024Z/99B - MH024Z/100</td>
<td>PVC</td>
<td>200</td>
<td>39.30</td>
<td>@1.45m, 7.95m, 10.74m, 16.8m, 30.3m, 37.95m &amp; 38 m) and CCTV (0.6m, 38.70m) exceeded limits of patches.</td>
</tr>
</tbody>
</table>
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**ZONE Z – CIPP REHABILITATION**

Example: MH011Z/53A – MH011Z/53
A case study: Successful sewer network rehabilitation with UV cured CIPP & traditional/non-traditional survey technologies. - Ras Al Khaimah, U.A.E.

**ZONE Z – CIPP REHABILITATION**

Example: MH024Z/99 – MH024Z/98
PROJECT OUTCOMES
PROJECT OUTCOMES:

IAC (Emirates), the specialist contractor for the CIPP installation was able to take advantage of the benefits of the process, including:

▪ Factory produced material, ready to use when its arrives the site
▪ Lining material not sensitive to heat/climate
▪ Controlled parameters of the curing process & comparably fast curing speeds
▪ Small on-site impact
▪ Technical support from BKP Berolina (Germany)
PROJECT CONCLUSION:

Post installation inspection of the UV cured Berolina-Liner rehabilitated pipes using the FELL® revealed no leakage in all except one of the pipes rehabilitated with less than 0.2% leakage in that particular pipe.

Light cured and Glassfibre reinforced CIPP, very favorable rehabilitation method in terms of deployment, performance and outcome.
Thank You for Your Attention!

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@: info@b kp-berolina.de
: www.bkp-berolina.de