General
The remediation strategies shown were developed to provide general guidance for the repair of both 50 and 100 year service life pipes. Each project and pipe condition should be analyzed independently to determine whether the method is applicable or not. In some cases, the pipe size and condition may be a limiting factor in determining whether the repair methods shown can be accomplished or not, based on human entry, safety or other factors. The manufacturer of the pipe should be consulted for recommendations.

Rehabilitation Strategies for All Pipe
Where the pipe condition and defects warrant analysis, and when the analysis indicates that the pipe is structurally unsound, only two options should be considered – either removal and replacement or a relining of the pipe with another pipe to restore the structural capacity to the pipe. In the second case, a hydraulic analysis, which considers both inlet and outlet control conditions, must also be performed and submitted.

In addition, the contractor is responsible for developing and submitting a construction and installation procedure for review and approval by the Engineering District. The procedure must reference the materials and test methods to be used. Materials that are not Bulletin 15 approved must be submitted for evaluation in accordance with Section 106.02 (a) 2 along with any applicable component or finished product testing requirements for verification by the Department.

Design Requirements and Assumptions for Rehabilitation of All Pipe Deemed Not Structurally Adequate
- The existing pipe provides no strength and does not reduce loads to a new lining or pipe insert
- Design the new lining or pipe insert for full dead load, live load, and external water pressure
- Any reduction of the inside diameter of the existing pipe must be hydraulically acceptable
- Design is to be in accordance with Design Manual 4
- Pipe Analysis and rehabilitation strategy is to be submitted to the Department for approval

Cost Adjustments
The District should reference Table B to determine cost adjustment when repairs or remediation methods are unlikely to restore the full design service life of the pipe and/or result in future anticipated maintenance. Remediation procedures shall consider diameter/ span and cover depth in determining repair methods.

April 2014 Edition
Table B identifies remediation thresholds to consider for the appropriate rebate to the Department. The contractor must submit a remediation plan for approval when any pipe deficiency exceeds remediation allowance. Upon approval of the remediation plan, the contractor repairs the deficiencies AND provides the Department the specified rebate. If the contractor elects to replace the pipe, no rebate is necessary.

If the pipe deficiency exceeds remediation tolerances and there is soil infiltration, the contractor must submit a pipe analysis that shows structural adequacy of the in place pipe. If the analysis is not approved by the Department the pipe must be replaced or relined in accordance with “Rehabilitation Strategies for all Pipe” indicated above. If the pipe analysis is approved, the contractor must submit a remediation plan for approval. Upon approval of the remediation plan, the contractor repairs the deficiencies AND provides the Department the specified rebate. If the contractor elects to replace the pipe, no rebate is necessary.
SUGGESTED REMEDIATION FOR PIPE DEFECTS IN INSTALLED CONCRETE PIPE

Remediation - Cracking

Flexural Cracks (See Fig. 1, Pg 9)

- Crack Width ≤ 0.007"
  - No Action or Repair Required

- Crack Width > 0.007"
  - Pipe analysis required, submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1)
  - Reduce pay per Table B

Shear Cracks (See Fig. 2, Pg 9)

- No Action or Repair Required

- Crack Width ≤ 0.007"

- Crack Width > 0.007"
  - Monitor Crack Widths for a Minimum of 3 Months
  - Pipe analysis required, submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1)
  - Reduce pay per Table B

Radial Tension Cracks (See Fig. 3, Pg 9)

- Increase in Crack Width?
  - No
  - Yes
    - Yes
      - Continue Monitoring at minimum 1 month intervals to determine if crack width stabilizes. Monitor for 3 months
    - No
      - Yes
        - Crack Width ≤ 0.125"
          - Adequate Capacity?
            - Yes
              - Pressure injection Epoxy Crack Repair (See pgs. 17-18, Technical Specification for the Epoxy Injection of Cracks From 0.008” to 0.125”) Reduce pay per Table B
            - No
              - Remove and Replace
        - No
          - Crack Width > 0.007"
            - No Action or Repair Required

April 2014 Edition
SUGGESTED REMEDIATION FOR PIPE DEFECTS IN INSTALLED CONCRETE PIPE

Remediation Spalling

No

Exposed Reinforcement

"Non-Structural Repair" Repair as per Pub 145, Part 4 Appendices Non-Structural Repair Section

Yes

Single Spall Areas ≤ 150 sq.in. per section

Single Spall Areas > 150 sq.in. per section

Joint Separation

Joint Separation installation > allowance in Pub 408 Section 601.3(n)1.a

No

Yes

Greater than remediation allowance

No

Yes

Leakage or Infiltration visible?

No

Yes

Leakage or Infiltration visible?

No

Yes

Leakage or Infiltration visible?

No

Yes

Pipe analysis required, submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1) Reduce pay per Table B

Accept

No

Yes

Accept with reduced pay per Table B

Pipe Analysis Required

Yes

Adequate Capacity?

No

Remove and Replace

April 2014 Edition
SUGGESTED REMEDIATION FOR PIPE DEFECTS IN INSTALLED METAL PIPE

Coating Damage

- Pinholes, blisters, cracks in coating, lack of coating bond to surface; loss of galvanizing

  Repair per AASHTO M36 and AASHTO M245 Reduce pay per Table B

Hole

- Hole Size ≥ ½"Φ
  - No
    - Infiltration of soil or water visible?
      - No
        - Accept
      - Yes
        - pipe Φ > 30"
          - Yes
            - Install internal repair patch (see Fig 4, Pg 10)
          - No

- Hole Size > width of 1.5 corrugations
  - Yes
    - Pipe analysis required, submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1)
      - Reduce pay per Table B
  - No
    - Submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1)
      - Reduce pay per Table B
SUGGESTED REMEDIATION FOR PIPE DEFECTS IN INSTALLED METAL PIPE

Joint Separation

Joint Separation installation > allowance in Pub 408 Section 601.3(n)2.a

Greater than remediation allowance

Leakage or infiltration visible?

Accept

Leakage or Infiltration visible?

Pipe analysis required, submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1) Reduce pay per Table B

Accept with reduced pay per Table B

Dents

Dent Exceeds 5% deflection of diameter or 1sq ft. or is greater than 10% of circumference

Accept

Leakage or Infiltration visible?

Pipe analysis required, submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1) Reduce pay per Table B

Accept

No

Buckling or Deflection

Uniform Deflection > 7.5% of diameter, + 1% or ½” whichever is greater

Accept

No

Yes

Yes

Pipe analysis required, submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1) Reduce pay per Table B

Accept with reduced pay per Table B

No

Yes

April 2014 Edition
SUGGESTED REMEDIATION FOR DEFECTS IN INSTALLED THERMOPLASTIC PIPE

Buckling or Deflection

Deflection > 5% of diameter?

Yes

Pipe analysis required, submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1) Reduce pay per Table B

No

Accept

Joint Separation

Joint Separation installation limits > 3/8”

No

Leakage or Infiltration visible?

No

Accept

Yes

Greater than 1”

Yes

Leakage or infiltration visible?

Yes

Pipe analysis required, submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1) Reduce pay per Table B

No

Submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1) Reduce pay per Table B

No

Accept with reduced pay per Table B

Yes

Leakage or Infiltration visible

No

Accept

April 2014 Edition
SUGGESTED REMEDIATION FOR PIPE DEFECTS IN INSTALLED THERMOPLASTIC PIPE

**Cracking**

- **Crack ≥ 1/8” in width or Rip/Tear/Crack ≥ 6” in length**
  - **Yes**
    - Pipe analysis required, submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1)
  - **No**
    - **Infiltration soil or water visible?**
      - **Yes**
        - Submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1)
      - **No**
        - **Accept**

**Hole**

- **Hole Size ≥ ½”Φ**
  - **No**
    - **Accept**
  - **Yes**
    - **Hole Size > Width of 1.5 corrugation?**
      - **Yes**
        - **pipe Φ > 30”**
          - **Yes**
            - Install internal repair patch (see Fig 4, Pg 10)
          - **No**
            - **Submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1)
              - Reduce pay per Table B
        - **pipe Φ > 30”**
          - **Yes**
            - **Accept**
          - **No**
            - **Submit plan for repair or remediation per 601.3(p) of Pub 408 (See Pg 1)
              - Reduce pay per Table B
      - **No**
        - **Accept**

April 2014 Edition
CONCRETE PIPE

FIGURE NO.1 – FLEXURAL CRACKS

FIGURE NO.2 – SHEAR CRACKS

FIGURE NO.3 – RADIAL TENSION CRACKS (SLABBING)

PHOTO NO. 1, Example of Flexural Crack

PHOTO NO. 2, Example of Shear Crack

PHOTO NO. 3, Example of Radial Tension Cracks

April 2014 Edition
FIGURE NO.4 – INTERNAL REPAIR PATCH

Stainless Steel Screws @ 1 inch cc with caulking (see 705.8(b) ASTM C920) all around under screw line.

For thermoplastic and CMP, 3/8” stainless steel or hot-dipped galvanized screws to be placed at each crest. Use repair plate that matches the existing material.
Table A provides a sample of pipe repair methods. Contractors may provide other repair methods not included in the Table A as their remediation plan. Pipe repair methods will continue to be evaluated and added to Bulletin 15 if performance is acceptable.

Table A - Pipe Repair Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Whole or spot repair</th>
<th>Diameter*</th>
<th>Structural or non-structural</th>
<th>Estimated Service Life*</th>
<th>Pipe material can repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spray-on Concrete</td>
<td>Whole</td>
<td>30” to 144”</td>
<td>Structural</td>
<td>50-75 years</td>
<td>All</td>
</tr>
<tr>
<td>Spray On Polyurethane-Rigid Hybrid</td>
<td>Whole</td>
<td>42” or greater</td>
<td>Structural or Non-Structural</td>
<td>At least 50 years</td>
<td>All</td>
</tr>
<tr>
<td>Spray On Polyurethane-Elastomeric</td>
<td>Whole</td>
<td>42” or greater</td>
<td>Non-Structural</td>
<td>At least 50 years</td>
<td>All</td>
</tr>
<tr>
<td>CIPP – Steam</td>
<td>Whole</td>
<td>4” to 108”</td>
<td>Structural</td>
<td>50-75 years</td>
<td>All</td>
</tr>
<tr>
<td>CIPP – UV</td>
<td>Whole</td>
<td>6” to 50”</td>
<td>Structural</td>
<td>50-75 years</td>
<td>All</td>
</tr>
<tr>
<td>CIPP – Spot Repair</td>
<td>Spot</td>
<td>3” to 48”</td>
<td>Structural</td>
<td>50-75 years</td>
<td>All</td>
</tr>
<tr>
<td>Slip liner – PVC, HDPE</td>
<td>Whole</td>
<td>4” to 158”</td>
<td>Structural</td>
<td>At least 50 years</td>
<td>All</td>
</tr>
<tr>
<td>Internal Joint Seal</td>
<td>Spot</td>
<td>18” to 122”</td>
<td>Non-Structural</td>
<td>50 years</td>
<td>All</td>
</tr>
<tr>
<td>Welding</td>
<td>Spot</td>
<td>36” or greater</td>
<td>Non-Structural</td>
<td>25 years</td>
<td>Metal, Thermoplastic</td>
</tr>
<tr>
<td>Mechanical Repair Sleeve</td>
<td>Spot</td>
<td>6” to 72”</td>
<td>Structural</td>
<td>50 years</td>
<td>All</td>
</tr>
<tr>
<td>Epoxy Injection</td>
<td>Spot</td>
<td>36” or greater</td>
<td>Non-Structural</td>
<td>50 years</td>
<td>Concrete</td>
</tr>
</tbody>
</table>

*This information may vary depending on manufacturer.
Table B - Rebates

**Concrete Pipe**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Correction Plan</th>
<th>Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>JOINTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater than Section 601.3(n)1.a specification required joint gap installation allowance but less than the remediation allowance without leakage or soil infiltration</td>
<td>No action</td>
<td>Reduce payment by one foot on each side of the joint (including excavation, pipe and backfill)</td>
</tr>
<tr>
<td>Greater than the remediation allowance without leakage or soil infiltration</td>
<td>Submit a plan for repair or replacement as specified in Section 601.3(p).</td>
<td>Reduce payment by two foot on each side of the joint (including excavation, pipe and backfill)</td>
</tr>
<tr>
<td>Any leakage or soil infiltration</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>Reduce payment by 95% of the total cost for the length of each pipe section on both side of the joint (including excavation, pipe and backfill).</td>
</tr>
<tr>
<td><strong>CRACKS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cracks with a width less than or equal to 0.007 inches</td>
<td>Note in inspection report, No remedial action</td>
<td>No Rebate required</td>
</tr>
<tr>
<td>Cracks with a width greater than 0.007 inches</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td><strong>SPALLS/CHIPS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spalled area has no exposed reinforcement.</td>
<td>Repair according to Pub 145, Part 4 Appendices Non-Structural Repair Section</td>
<td>No Rebate required</td>
</tr>
<tr>
<td>Spalled area has exposed reinforcement with single spall area less than or equal to 150 sq. in.</td>
<td>Repair according to Pub 145, Part 4 Appendices Structural Repair Section</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>Spalled area has exposed reinforcement with single spall area greater than 150 sq. in.</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
</tbody>
</table>
## Metal Pipe

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Correction Plan</th>
<th>Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>JOINTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater than Section 601.3(n)2.a specification required joint gap installation allowance but less than the remediation allowance without leakage or soil infiltration.</td>
<td>No action</td>
<td>Reduce payment by one foot on each side of the joint (including excavation, pipe and backfill)</td>
</tr>
<tr>
<td>Greater than the remediation allowance without leakage or soil infiltration.</td>
<td>Submit a plan for repair or replacement as specified in Section 601.3(p).</td>
<td>Reduce payment by five foot on each side of the joint (including excavation, pipe and backfill)</td>
</tr>
<tr>
<td>Any leakage or soil infiltration</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>Reduce payment by 95% of the total cost for the length of each pipe section on both sides of the joint (including excavation, pipe and backfill).</td>
</tr>
<tr>
<td><strong>COATING</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original coating has pinholes, blisters, cracks in coating, lack of coating bond to surface or loss of galvanizing</td>
<td>Coating damage noted in inspection report. Repairs shall be performed as specified in Section 601.3(n)2.b by and at the expense of the contractor.</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td><strong>DEFLECTION/BUCKLING</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any deflection less than 7.5% of round pipe</td>
<td>Note in inspection report, No remedial action</td>
<td>No Rebate required</td>
</tr>
<tr>
<td>ROUND PIPE - Any deflection greater than 7.5% of diameter plus manufacturer tolerance of 1% or 1/2 inch undersize, whichever is greater.</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>ARCH PIPE - Any deflection 7.5% decrease in rise and 7.5% increase in span from nominal dimension</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
</tbody>
</table>
## HOLES

<table>
<thead>
<tr>
<th>Description</th>
<th>Action</th>
<th>Cost Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holes with a diameter less than ( \frac{1}{2} ) inch without leakage or soil infiltration</td>
<td>Note in inspection report, No remedial action</td>
<td>No Rebate required</td>
</tr>
<tr>
<td>Holes with a diameter less than ( \frac{1}{2} ) inch with leakage or soil infiltration</td>
<td>Install internal repair patch for pipes with diameter larger than 30 inches</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>Holes with a diameter less than ( \frac{1}{2} ) inch with leakage or soil infiltration</td>
<td>Pipes 30 inches and less in diameter submit a plan for repair or replacement as specified in Section 601.3(p)</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>Holes with a diameter greater than or equal to ( \frac{1}{2} ) inch with holes less than the width of 1.5 of corrugation</td>
<td>Pipes 30 inches and less in diameter submit a plan for repair or replacement as specified in Section 601.3(p)</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>Holes with a diameter greater than or equal to ( \frac{1}{2} ) inch with holes less than the width of 1.5 of corrugation</td>
<td>Install internal repair patch for pipes with diameter larger than 30 inches</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>Holes with a diameter greater than or equal to ( \frac{1}{2} ) inch with holes greater than the width of 1.5 of corrugation</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
</tbody>
</table>

## DENTS

<table>
<thead>
<tr>
<th>Description</th>
<th>Action</th>
<th>Cost Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dents less than 5% deflection of diameter or 1 sq.ft. or less than 10% of circumference</td>
<td>Note in inspection report, No remedial action</td>
<td>No Rebate required</td>
</tr>
<tr>
<td>Dents greater than 5% deflection of diameter or 1 sq.ft. or greater than 10% of circumference</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>Thermoplastic Pipe Criteria</td>
<td>Correction Plan</td>
<td>Rebate</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>JOINTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater than Section 601.3(n)3.a specification required joint gap installation allowance but less than the remediation allowance without leakage or soil infiltration</td>
<td>No action</td>
<td>Reduce payment by one foot on each side of the joint (including excavation, pipe and backfill)</td>
</tr>
<tr>
<td>Greater than the remediation allowance without leakage or soil infiltration</td>
<td>Submit a plan for repair or replacement as specified in Section 601.3(p).</td>
<td>Reduce payment by five foot of the cost on each side of the joint (including excavation, pipe and backfill)</td>
</tr>
<tr>
<td>Any leakage or soil infiltration</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>Reduce payment by 95% of the total cost for the length of each pipe section on both sides of the joint (including excavation, pipe and backfill).</td>
</tr>
<tr>
<td><strong>CRACKS/RIPS/TEARS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cracks in the interior wall of pipe less than 1/8 inch in width or less than 6 inches in length without leakage or soil infiltration</td>
<td>Note in inspection report, No remedial action</td>
<td>No Rebate required</td>
</tr>
<tr>
<td>Cracks in the interior wall of pipe less than 1/8 inch in width or less than 6 inches in length with leakage or soil infiltration</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>Cracks in the interior wall of pipe greater than or equal to 1/8 inch in width or greater than or equal to 6 inches in length</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td><strong>HOLES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holes with a diameter less than ½ inch without leakage or soil infiltration</td>
<td>Note in inspection report, No remedial action</td>
<td>No Rebate required</td>
</tr>
<tr>
<td>Holes with a diameter less than ½ inch with leakage or soil infiltration</td>
<td>Install internal repair patch for pipes with diameter larger than 30 inches</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>Holes with a diameter less than ½ inch with leakage or soil infiltration</td>
<td>Pipes 30 inches and less in diameter submit a plan for repair or replacement as specified in Section 601.3(p)</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Holes with a diameter greater than or equal to ½ inch with holes less than the width of 1.5 of corrugation</td>
<td>Pipes 30 inches and less in diameter submit a plan for repair or replacement as specified in Section 601.3(p)</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>Holes with a diameter greater than or equal to ½ inch with holes less than the width of 1.5 of corrugation</td>
<td>Install internal repair patch for pipes with diameter larger than 30 inches</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
<tr>
<td>Holes with a diameter greater than or equal to ½ inch with holes greater than the width of 1.5 of corrugation</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
</tbody>
</table>

**DEFLECTION/BUCKLING**

<table>
<thead>
<tr>
<th>Any deflection less than 5% of original pipe diameter</th>
<th>Note in inspection report, No remedial action</th>
<th>No Rebate required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any deflection greater than 5% of original pipe diameter</td>
<td>Submit a pipe analysis with the plan for repair or replacement as specified in Section 601.3(p).</td>
<td>District shall negotiate a cost adjustment</td>
</tr>
</tbody>
</table>
Technical Specification
for the Epoxy Injection of Cracks from 0.008” to 0.125” in Concrete Pipe
Not in Shear or Radial Tension

General Description
This is a guide specification for the injection of epoxy resin into cracks of 0.008” to 0.125” in surface width in reinforced concrete pipe to prevent water intrusion into the crack and prevent corrosion of the reinforcement for pipe sizes that allow for man entry. This guide specification is not considered a structural repair and therefore is intended only for those applications where through evaluation and analysis the pipe is considered to retain its original structural capacity. Modification of this guide specification may be required based on the individual condition of the pipe and should be evaluated on a case by case basis.

Materials
1) Epoxy Injection Resin
   ASTM – C881, Type 1, Grade 3 – from a manufacturer listed in Bulletin 15.
2) Epoxy Injection Gel
   ASTM – C881, Type 1, Grade 3 – from a manufacturer listed in Bulletin 15.
3) Surface Sealer and Port Adhesive
   As recommended by the manufacturer, and of adequate strength to hold injection fittings firmly in place and to resist injection pressures to prevent leakage during injection.
4) Injection Fittings. As recommended by the manufacturer.
5) Certification. Section 106.03(b)3.

Construction
1) General. Perform injection using trained personnel supervised by an experienced person skilled in the use of epoxy injection equipment and injection resins.

2) Equipment. Use a portable epoxy injection unit equipped with positive displacement type pumps which provide positive ration control of epoxy injection resin compounds. Pumps are to be air or electric powered providing in line mixing and metering for two component epoxies. Conform to the manufacturer recommended tolerances for mixing volume and discharge pressures.

3) Application Limitations. Do not apply or inject materials if ambient or concrete temperature is below 40°F.

4) Water Control. Perform work when invert water level prior to damming is 6 inches or less to eliminate the possibility of hydrostatic pressure. Construct a sandbag dam above the work area which prevents water flow through the pipe. Divert water below work area with a sump pump and hose. Remove sandbag dam each night.
5) Preliminary Work. Cracks and limits of repair to be sealed will be marked by the Engineer.

6) Preparation for Sealing. Prior to setting the ports, air blast the crack to remove excess water. Thoroughly clean the surfaces of rust, scale, grease, loose and disintegrated articles of material. Place ports in the bottom and top inside cracks as required by crack width and manufacturer’s recommendations. Bottom ports are to be set the day of resin injection. Place ports at a 6 inch maximum spacing for radial cracks and pipe section ends. Place ports at a 6 inch maximum spacing for the end 12 inches of longitudinal cracks. Seal the surface and areas surrounding the entry ports with the surface seal. Apply the seal in such a manner that the epoxy injection resin is sealed until initially cured.

7) Mixing. Mix injection resin or injection gel in a clean container in accordance with manufacturer recommendations with a minimum 3 minute mixing time.

8) Injection of Epoxy Gel. Do not inject crack until after the surface sealer has hardened. Inject the epoxy gel with a one piston pump, either hand or motor driven which is capable of developing the pressure required to obtain gel penetration. Inject radial cracks at ends of the pipe sections and at the end 6 inches of longitudinal cracks with injection gel to create a dam for the injection resin. Use injection gel within the stated pot life or dispose of the gel. Complete injection of pipe sections the same day that work is begun. Do not expose epoxy gel to moisture until the epoxy gel has cured for the time specified by the manufacturer of the epoxy gel.

9) Injection of Epoxy Resin. Do not inject until after the surface sealer has hardened. Working from the low end of the pipe, inject bottom cracks first. Attach injection gun to the first port and inject epoxy resin until it overflows the second port. Insert a plug into the first port which is capable of resisting pressures without popping. Move the gun to the second port and repeat the process. Continue in this manner until all ports have been injected with epoxy resin. Additional epoxy resin may be injected with ports capped to ensure further penetration of epoxy into the crack. Inject top cracks in a similar manner. Select pressures for resin injection which provide a uniform flow of material and maintain uniform material flow rates. Recommended starting pressure is 40 to 50 psi. Do not exceed 150 psi of pressure. Complete injection of pipe sections the same day that work is begun. Do not expose the epoxy resin to moisture until the epoxy resin has cured for the time specified by the manufacturer of the epoxy resin.

10) Grinding. After the epoxy has cured, cut off ports and grind flush. Retain surface seal.

Measurement and Payment
No payment will be made for this work.