

CULVERT

REHABILITATION GUIDE

CULVERT REHABILITATION INSTRUCTIONS

STEPS

1. Before undertaking the work
2. Worksite procedure
3. Concrete grout injection

ANNEX

Wehoseal installation

STEP 1

BEFORE UNDERTAKING THE WORK

Before ordering materials, ensure that the pipe specified will fit easily into the existing pipe or culvert¹. This verification can be done using a template or by measuring the interior dimension at several points: consider the greater deflections as well as the deviations. A free space of at least 50 mm (2 in) between the two pipes is recommended. The length of the pipes can be chosen according to the working space available on the site.

Contact your Soleno representative at least 48 hours before work begins to obtain assistance during installation.

Choose the filling grout injection mode.

- By gravity injection (vertical chimneys): see point 14a
- By injection under pressure (parallel pipes): see points 6 and 14b

Choose the end (upstream or downstream) that will serve as a work surface. Take into consideration the length of the pipes, the space available for the equipment, the natural slope of the ground as well as the ease of access.



Note 1: Under no circumstances will Soleno replace pipes ordered following a diameter error. The customer is responsible for this verification.

STEP 2

WORKSITE PROCEDURE

1. Completely clean the pipe to be rehabilitated and remove any obstacle that may hinder the insertion of the new pipe.



2. If necessary, remove any dent or protrusions before inserting the new pipe.



STEP 2

WORKSITE PROCEDURE (CONTINUED)

3. Prepare the work surface so that it is flat, uniform, with the same slope as that of the planned culvert, to facilitate the assembly of the pipes. Make sure that the work surface can support the weight of the equipment and that it remains relatively dry. Provide a free width of at least 1m on either side of the pipe and a trench long enough to ensure good handling of the pipes.



4. Lay the first section of pipe in front of the pipe to be rehabilitated, the male end towards the inlet. Readjust the seat if necessary: the alignment between the new and the old pipe must be perfect.



5. If required, install spacers on top of the new pipe. These spacers will make it possible to maintain the correct positioning of the pipe during grouting as well as an adequate distribution of the buoyancy between the two pipes, caused by the injection of the filling grout. Use the number of spacers, representing the area needed to support the pressure exerted by the grout (Step 3 - point 13). If the diameter allows, the spacers should be installed in the existing pipe. Make sure spacers do not interfere with grout flow. Railings can be installed and greased at the bottom of the existing pipe to facilitate insertion (ex: 2" x 6").



6. If the injection is to be made using parallel pipes, these should be attached to the new pipe as the insertion proceeds. Provide a pipe for each casting.



STEP 2

WORKSITE PROCEDURE (CONTINUED)

7. Insert the pipe section, pushing gently using suitable equipment, such as an excavator. With a sacrificial pipe or plywood, make sure to push evenly on the end of the pipe so as not to damage it. Keep at least 600 mm (24 in) of pipe outside the pipe to be rehabilitated. Secure or restrain the inserted section to prevent it from moving when assembling the next section.



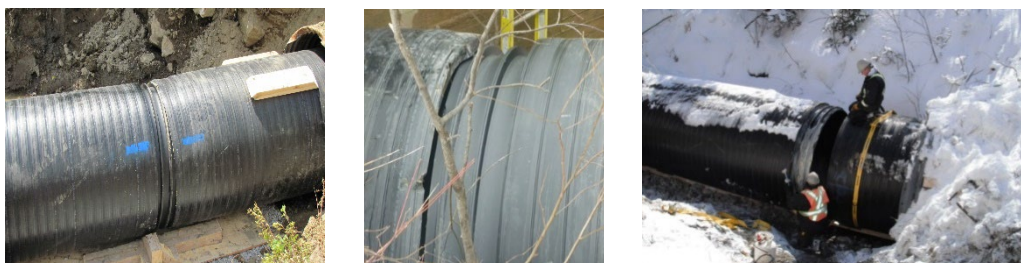
8. Sections can also be inserted by pulling. For a pipe with restrained joints (screwed or welded), bolt the plates at the end where you pull. For a pipe with unrestrained joints (bells), install the cross in the bell of your last pipe.



9. Assembly

a. For pipes with threaded joints

Lay down the next section of pipe, aligning the start of the male thread with the female thread; line up the paint marks. To reduce friction, lubricate both ends with pipe grease.



STEP 2

WORKSITE PROCEDURE (CONTINUED)

Use nylon slings to screw the pipe. To completely close a joint, two and a half turns are required. Make sure that the two outer surfaces are in contact around the entire perimeter of the joint.



At the joint, apply a heated Wehoseal membrane to prevent grout infiltration. See the instructions for the installation of the membrane in the annex.

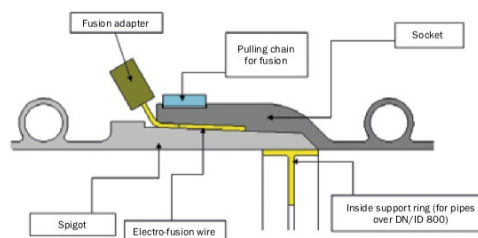


b. For pipes with bell joints

Draw an insertion line on the male end, according to the depth of the bell. For proper connection, make sure the male end is pushed all the way to this line. Check inside that there is no free space between the pipes.

c. For electrofused joints

For some specific applications. Please contact your Soleno representative.



STEP 3

CONCRETE GROUT INJECTION

10. Installation of formwork at both ends of the culvert to seal the space between the two pipes. This can be done using wooden formwork, masonry, impermeable soil (ex: clay) with geotextile, etc.
11. Ensure the integrity of the pipe by preventing it from deforming during the concrete grout injection step. To do this, wooden posts (4x4") can be used. Support the post on a larger piece of wood at each end of it, to better distribute the pressure on the pipe. The larger the diameter and the greater the space between the two pipes, the closer the posts will have to be. It is recommended to align the poles in rotation to better distribute the resistance around the perimeter of the pipe.

Jack posts can also be used. The screwed end of these posts must pierce the upper wall of the pipe, to rest on the existing pipe, thus preventing potential uplift.



12. Proceed with grouting, respecting the number of pours specified in the following table. If more than one pour is necessary, allow it to set for at least 12 hours before pouring the next one. The pipe should be carefully monitored and if necessary, internal bracing should be installed to restrict any deflection to this limit.

| Nominal diameter | | Number of pours of : | | Nominal diameter | | Number of pours of : | |
|------------------|------|----------------------|--------------|------------------|-----|----------------------|--------------|
| mm | in | Sealing foam | Cement grout | mm | in | Sealing foam | Cement grout |
| 450 | 18 | 1 | 1 | 1600 | 63 | 1 | 2 |
| 500 | 19.5 | 1 | 1 | 1680 | 66 | 1 | 2 |
| 530 | 21 | 1 | 1 | 1800 | 72 | 1 | 2 |
| 610 | 24 | 1 | 1 | 2000 | 78 | 1 | 2 |
| 690 | 27 | 1 | 1 | 2130 | 84 | 2 | 2 |
| 760 | 30 | 1 | 1 | 2200 | 87 | 2 | 3 |
| 840 | 33 | 1 | 1 | 2290 | 90 | 2 | 3 |
| 910 | 36 | 1 | 1 | 2400 | 96 | 2 | 3 |
| 1020 | 40 | 1 | 1 | 2590 | 102 | 2 | 3 |
| 1070 | 42 | 1 | 1 | 2740 | 108 | 2 | 4 |
| 1200 | 48 | 1 | 1 | 3000 | 120 | 2 | 4 |
| 1400 | 55 | 1 | 1 | 3300 | 120 | 3 | 5 |
| 1500 | 60 | 1 | 2 | | | | |

STEP 3

CONCRETE GROUT INJECTION (CONTINUED)

NOTES :

- Calculations for cement grout are based on :
 - Safety factor : 1,5
 - Short-term Poisson's ratio : 0,35
 - Modulus value at 10 hours/ 38°C
 - Specific gravity : 2.0
 - Density of 2000 kg/m³ (125 lb/ft³).

- Calculations for foam sealant are based on :
 - Safety factor : 1,5
 - Short-term Poisson's ratio : 0,35
 - Modulus value of 46 900 at 10 hours/ 100°F
 - Density of 1040 kg/m³ (65 lb/ft³)
 - Refer to the PPI Engineering Handbook, Chapter 6, to determine subsidence resistance characteristics for temperatures and times under load that differ from those listed here.
 - The number of grout layers is based on the need to limit the deflection caused by buoyancy of the grout to no more than 2% of the pipe diameter.

13. When pouring the grout, make sure to respect the maximum allowable external pressure of the pipe.

| mm | in | kPa | psi |
|------|------|------|------|
| 450 | 18 | 78.6 | 11.4 |
| 500 | 19.5 | 62.1 | 9.0 |
| 530 | 21 | 50.3 | 7.3 |
| 610 | 24 | 58.6 | 8.5 |
| 690 | 27 | 53.1 | 7.7 |
| 760 | 30 | 46.9 | 6.8 |
| 840 | 33 | 70.3 | 10.2 |
| 910 | 36 | 46.9 | 6.8 |
| 1020 | 40 | 42.8 | 6.2 |
| 1070 | 42 | 40.7 | 5.9 |
| 1200 | 48 | 36.5 | 5.3 |
| 1400 | 55 | 32.4 | 4.7 |
| 1500 | 60 | 29.7 | 4.3 |
| 1600 | 63 | 28.3 | 4.1 |
| 1680 | 66 | 26.9 | 3.9 |
| 1800 | 72 | 24.8 | 3.6 |
| 2000 | 78 | 23.4 | 3.4 |
| 2130 | 84 | 22.1 | 3.2 |
| 2200 | 87 | 21.4 | 3.1 |
| 2290 | 90 | 20.7 | 3.0 |
| 2400 | 96 | 19.3 | 2.8 |
| 2590 | 102 | 20.7 | 3.0 |
| 2740 | 108 | 17.2 | 2.5 |
| 3000 | 120 | 15.9 | 2.3 |
| 3300 | 132 | 15.2 | 2.2 |

STEP 3

CONCRETE GROUT INJECTION (CONTINUED)

14. Injections

a. Gravity injection (vertical chimneys)

Drill holes on the top of the existing pipe and install the chimneys. Chimney connections must be airtight. Chimneys should be spaced no more than 50 meters (168 feet) apart.



Inject from one of the chimneys. The grout flow should not exceed 0.2 m³/minute. It is essential to ensure a free flow of the concrete in the chimney, do not let the grout rise in the filling chimney. Otherwise, excessive pressure will be exerted on the pipe, which can lead to severe deformation.

Pouring is complete when the grout begins to rise in the upstream chimney.

b. Injection under pressure (parallel pipes)

Make an air outlet (vent) at the top of the upstream formwork. Connect the concrete pump to the injection pipe coming out of the downstream formwork. Consult the table for the maximum injection pressures. Pouring is complete when the vents are filled.



15. During pouring, watch for grout leaks at the ends or through the joints of the pipes; seal as needed. Make sure that no abnormal movement of the new pipe occurs. Measure the vertical inside diameter regularly. If deformation occurs, stop casting.

16. Make sure the space between the two pipes is completely filled. Plug the vents. Remove chimneys.

STEP 3

CONCRETE GROUT INJECTION (CONTINUED)

17. Complete the landscaping at the ends, using geotextiles and metalling. If beveled ends are required, contact your Soleno representative.



ANNEX

WEHOSEAL^{MD}

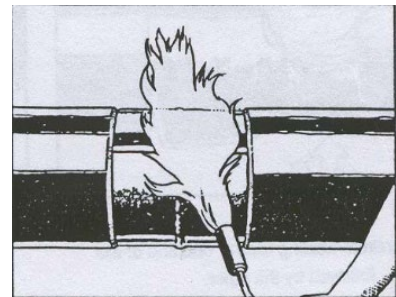
TOOLS

- Appropriate size Wehoseal sleeve and closure
- Propane tank
- AD-1358 Propane regulator and gauge
- AD-1434 30-foot propane hose
- Propane torch and 2954 burner
- Contact pyrometer
- Hand roller (curved)
- Hand roller (straight)
- Standard safety equipment such as: gloves, goggles, hard hat, etc.

Installation is to be done according to local regulations and all safety precautions must be taken.

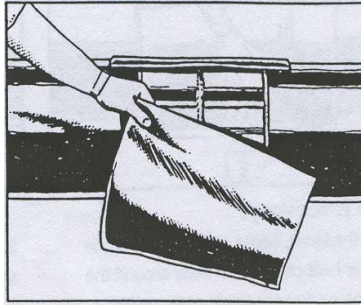
For installation, two people are recommended.

1. Sleeve application
 - a. Clean exposed pipe to be covered by the sleeve. Remove loose and foreign materials. Wiping may be necessary to remove the particles from cleaning.
 - b. Butt and align the pipe ends.
 - c. Preheat the joint area to approximately 158°F (70°C) minimum. Preheating reduces installation time and ensures proper bonding of the sleeve.



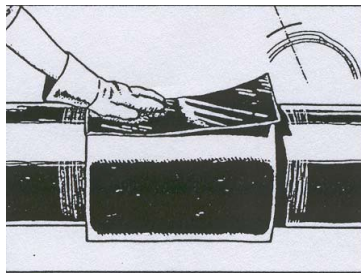
ANNEXE WEHOSEAL^{MD} (CONTINUED)

- d. Remove the protective plastic from the coated sleeve. Center the sleeve over the joint so it is evenly overlapping the adjacent pipe. Wrap loosely around pipe so that the logo runs circumferentially around the pipe.

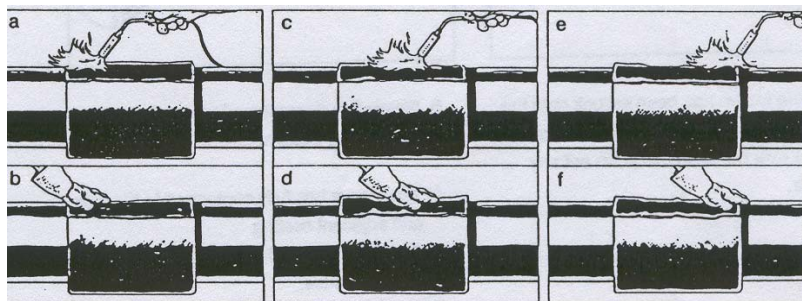


2. Closure Application

- a. Press the closure in position, centering over the exposed sheet end. The sheet should overlap (excluding closure) by 2" (50mm) minimum.



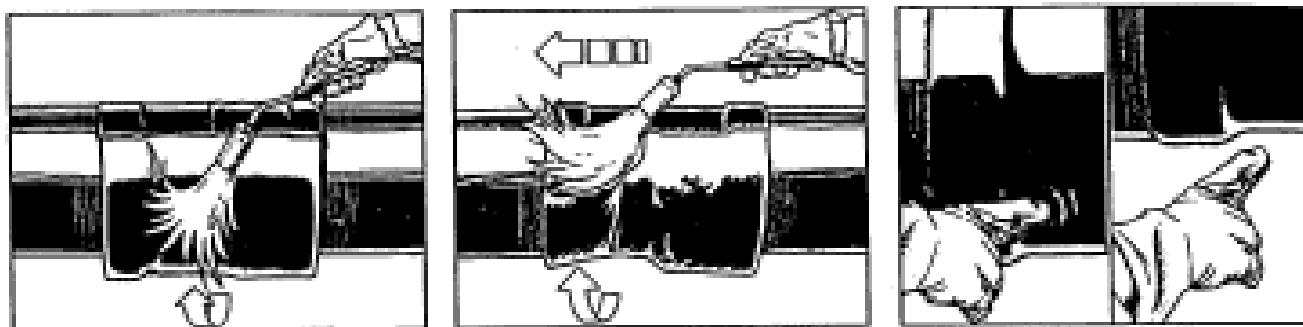
- b. Using a torch, adjust the flame length to approximately 20" (50cm) to produce a yellow flame. Using the yellow portion of the flame, heat the closure evenly until the pattern of the fabric reinforcement is visible. With a gloved hand, pat down the closure and smooth away any wrinkles by gently working them outward from the center of the closure.



ANNEX WEHOSEAL^{MD} (CONTINUED)

3. Sleeve recovery

- a. Using the torch, begin at the center¹ of the sleeve and heat circumferentially around the pipe, using a constant paintbrush motion.
- b. Continue heating toward one end of the sleeve, followed by the other.
- c. During shrinkdown, occasionally check adhesive flow with gloved finger. Wrinkles should disappear automatically.



NOTE 1: Le The sleeve may be recovered starting at one end and proceeding toward the opposite end, depending on conditions (ex: wind).

- d. When the sleeve has been shrunk onto the joint area, and is still hot and soft, run a small hand roller over the sleeve to push out any trapped air.
- e. Sleeve is fully recovered when all the following have occurred:
 - i. The sleeve has fully conformed to the pipe and adjacent coating.
 - ii. There are no cold spots or dimples on the sleeve surface.
 - iii. After sleeve is cool, adhesive flow is evident on both edges.

| Wehoseal Length Required per Joint | | | | | | | | | | | |
|------------------------------------|------|-------------------|------|--------|------|--------------|-----|-------------------|-------|--------|------|
| Nominal dia. | | Max. outside dia. | | Length | | Nominal dia. | | Max. outside dia. | | Length | |
| mm | in | mm | in | m | foot | mm | in | mm | in | m | foot |
| 450 | 18 | 528 | 20.8 | 1.84 | 6.0 | 1680 | 66 | 1895 | 74.6 | 6.13 | 20.1 |
| 500 | 19.5 | 577 | 22.7 | 1.99 | 6.5 | 1800 | 72 | 2067 | 81.4 | 6.67 | 21.9 |
| 530 | 21 | 615 | 24.2 | 2.11 | 6.9 | 2000 | 78 | 2220 | 87.4 | 7.15 | 23.5 |
| 610 | 24 | 701 | 27.6 | 2.38 | 7.8 | 2130 | 84 | 2393 | 94.2 | 7.69 | 25.2 |
| 690 | 27 | 787 | 31 | 2.65 | 8.7 | 2290 | 90 | 2548 | 100.3 | 8.18 | 26.8 |
| 760 | 30 | 871 | 34.3 | 2.91 | 9.6 | 2400 | 96 | 2718 | 107 | 8.72 | 28.6 |
| 840 | 33 | 967 | 38.1 | 3.22 | 10.6 | 2590 | 102 | 2890 | 113.8 | 9.26 | 30.4 |
| 910 | 36 | 1024 | 40.3 | 3.39 | 11.1 | 2740 | 108 | 3045 | 119.9 | 9.74 | 32.0 |
| 1020 | 40 | 1140 | 44.9 | 3.76 | 12.3 | 3000 | 120 | 3371 | 132.7 | 10.77 | 35.3 |
| 1070 | 42 | 1219 | 48 | 4.01 | 13.1 | | | | | | |
| 1200 | 48 | 1376 | 54.2 | 4.50 | 14.8 | | | | | | |
| 1400 | 55 | 1549 | 61 | 5.04 | 16.5 | | | | | | |
| 1500 | 60 | 1722 | 67.8 | 5.59 | 18.3 | | | | | | |

Note : The length of a standard roll of Wehoseal is 30.5 m (100'). The length in the above table is based on providing 178 mm (7") of overlap on the largest OD in that size. The overlap for stiffness classes other than the highest stiffness will exceed 178 mm (7").