Section 26 - Trenchless Installations and Rehabilitation

A. Introduction –In this section, information is presented on trenchless techniques and processes for both new and rehabilitation projects. Separate sections are also included on cleaning, closed-circuit television (CCTV), diversion pumping, and general items, which apply to most trenchless and rehabilitation projects. The FIRM shall also be familiar with the *HRPDC Regional Construction Standards* latest edition for the sanitary sewer system rehabilitation means and methods.

B. General Evaluation Criteria

1. The FIRM shall consider and evaluate all appropriate technologies including conventional techniques in the preliminary engineering report (PER) stage.

2. Use n=0.013 and consider the flow capacity based first on the HRSD hydraulic model and second with all major pump stations that feed the system simultaneously operating at design flow. Consider metered flow, current line capacity and current peak flow, which may exceed HRSD hydraulic model flow.

3. Evaluate carefully the special features of existing lines to be rehabilitated (i.e. concrete pipe cradles, previous repair history, etc.) that may have a strong bearing on the techniques or processes recommended.

4. Evaluate potable water needs and availability for installation and testing.

5. Consider space required for installation equipment.

6. Require final acceptance leakage testing and use of a mandrel or other approved method to verify deflection and minimum internal diameter requirements as applicable to rehabilitation method.

7. Consider option of continuing liners through manholes. Specify limits of liner to be removed in manholes.

8. Evaluate effect of ground water infiltration on methods proposed.

C. New Trenchless Pipe Installations - FIRMs, under the direction of HRSD's Engineering Department, Design and Construction Divisions, are required to work closely with contractors who are preparing to use approved trenchless crossing means and methods for installation of force mains or gravity sewer mains under roadways and waterways. HRSD developed a trenchless crossing checklist that has been based upon our progressive learning by doing and preparing for these installations. This checklist is located in this standards manual in Section 27 - Checklist for Trenchless Crossing Operations and is to be used, completed and submitted to HRSD jointly by the Inspector and Contractor.

1. Horizontal Directional Drilling (HDD) – HRSD has used HDD primarily for river crossings and other long crossings of environmentally sensitive areas. It can be considered for new construction or pipe replacement.

    a. Measurement and payment for HDD projects shall be on a lump sum basis paid to the Contractor upon successful completion (as defined in the Bid Documents) of each crossing.

    b. The FIRM to consider the limitations of materials for use with HDD projects on a case by case basis for Welded Steel Pipe (WSP), High Density Polyethylene (HDPE) and Fusible Polyvinyl Chloride pipe (FPVC).

    c. For WSP, provide external coatings on steel pipe using fusion-bonded epoxy. Internal linings are also required and may vary depending on the pipe diameter. Perform a corrosion analysis study and specify a cathodic protection system as necessary.

    d. Removal of internal weld beads is required for fused HDPE due to the size of the bead and likely impact on velocity and debris accumulation.

    e. Require a ground grid system or other equipment to ensure accuracy of the pipe at the exit point.

    f. Require the Contractor to provide a pilot hole survey alignment, to be approved by the FIRM, prior to commencement of the reaming operation.

    g. Indicate that no payment will be made to the Contractor until the directionally drilled pipeline is completely installed and satisfactorily tested. HDD projects should be bid using a lump sum basis for the work.

    h. Locate soil borings so that they will not be over the centerline of the pipe. Borings are a potential blowout point for drilling mud.

    i. Consider the environmental impacts of this construction method including location of entry and exit points, depth of cover and disposal of drilling mud and spoils.

    j. Consider the area needed for both the drill rig and the pull-back pipe.

    k. Delineate a water source for drilling mud make-up in the contract documents.

    l. At the conclusion of a successful HDD project and prior to connection to other pipe sections, a tethered instrument (SmartProbe or approved equivalent) shall be pulled through the new HDD pipe to collect XYZ coordinates tied to project coordinates to create accurate recorded installation information to be incorporated into HRSD's

record drawings and GIS. This requirement may be waived only with advance approval by HRSD's Project Manager.

2. Jack & Bore and Microtunneling - HRSD has used jack & bore and microtunneling methods in various locations where traditional open cut and HDD are not accessible and/or economically feasible. It should be considered where applicable for new construction or rehabilitation by replacement.

    a. Measurement and payment for jack & bore, microtunneling, and similar trenchless methods for installation of casings and pipeline projects shall be on a lump sum basis paid to the Contractor upon successful completion (as defined in the Bid Documents) of each crossing.

    b. Steel pipe shall be used as the casing material and shall be in accordance with the latest edition of applicable ASTM standards unless otherwise approved in writing by HRSD's Project Manager and allowed by the permitting agency.

    c. Permalok pipe joining system may be considered on a case-by-case basis as an acceptable method to butt welds for adjoining steel casing pipe sections.

    d. Casing pipe design shall include casing spacers, bulkhead at each pipe end, and leak detection.

    e. High density polyethylene (HDPE), Ductile Iron (DI), and Polyvinyl Chloride (PVC) should be evaluated as pipe material for the carrier pipe. Removal of internal weld bead is required for HDPE.

    f. FIRM shall give special consideration to the extents of the casing pipe in the design to account for future road improvements and for maintenance or repair of the installed pipeline.

    g. The bored hole shall be essentially the same size as the outside diameter of the casing pipe, and over-cutting by the cutting head is not to exceed the outside diameter of the casing pipe by more than one-half inch.

    h. The FIRM shall evaluate if corrosion protection is required on the casing pipes.

    i. Consider the environmental impacts of this construction method including location of entry and exit points, depth of cover and disposal of drilling mud and spoils.

    j. For slurry microtunneling installations, locate soil borings so that they will not be over the centerline of the pipe. Borings are a potential blowout point for drilling mud. Consider requiring the Contractor to grout the bore holes with cement if practical to reduce a soil fracture.

    k. Consider the area needed for both the jacking pit and receiving pit.

l. Jack & bore should be used for relatively short crossings or under secondary roadways.

m. Microtunneling should be used for long crossings or heavily traveled roadways.

3. Ground Penetrating Radar (GPR) shall be considered for use on all projects involving trenchless pipe installation. The GPR testing is recommended for the following:

a. Pre-construction to help identify near surface voids, unknown utilities and obstructions not identified by subsurface utility designation,

b. Following dewatering of the trenchless launching / receiving pits to the planned groundwater elevation and prior to advancing casing or pipe,

c. Post-construction to help identify any voids created as part of the trenchless pipe operation.

d. GPR testing requirements when utilized, including the limits of testing, shall be written into the contract documents by the FIRM and shall be included as a bid item. When used, GPR testing shall include a real time imaging, recordable output that can be viewed on a computer screen and printed without the use of proprietary software. The test area shall be laid out in a grid fashion over the existing plans and shall be referenced using swing ties, State Plane Coordinates, latitude/longitude or other means to allow the contractor to reestablish the grid in order to conduct post-construction GPR testing. The FIRM shall evaluate the subsurface conditions and make recommendations as to the type of GPR required. At a minimum 2D scans and reports shall be required and discussion on the testing done and technology used in final submitted reports. One of the scans to be performed following lowering of the groundwater table to the elevation necessary for preparation for the trenchless installation. GPR results are not reliable below ground water levels.

D. Sanitary Sewer System Rehabilitation

1. Cleaning – All gravity sewers must be cleaned before any rehabilitation process can be utilized. The following items should be considered and specified in cleaning.

i. Estimate the amount of material that needs to be removed from the line.

ii. Outline or require the Contractor to submit a detailed procedure for removal of obstructions and capturing any loose material removed when cleaning pipe and structures such as manholes and wet wells.

iii. Consider where and how the cleaned material will be disposed.

iv. Consider the need to build sediment traps to capture grit or the requirement for diversion pumping during cleaning operations.

v. Require close communication with HRSD Interceptor Operations, HRSD Treatment Plants fed by the line being cleaned and the affected municipalities to coordinate upstream cleaning efforts so that excessive material is not fed to this project while cleaning and lining is in progress.

vi. Specify the requirement to perform pH testing on cleaned wet well and manhole surfaces before applying coating.

vii. Consider structural integrity of pipe to be cleaned before choosing method of cleaning.

2. Closed-Circuit Television Video (CCTV) – CCTV inspection is required for all rehabilitation projects. HRSD generally has a pre-design CCTV of each proposed project. Require the following minimum requirements for performing CCTV.

    a. Require videos immediately following cleaning and at the completion of the project. If lining is not installed immediately after cleaning, the pipe shall be inspected immediately prior to installation of liner with additional cleaning as required. The first CCTV inspection should be made with no articulation of the camera. A second run should then be made utilizing an articulating camera to evaluate laterals and other points of concern.

    b. Specify the maximum amount of water in the pipe when CCTV is performed. Determine if diversion pumping is required.

    c. Use a lamp to evaluate lines for straightness.

    d. Recommend that the FIRM be present during the CCTV process. Specify that Contractor shall complete the post-CCTV of each section and receive FIRM approval prior to moving to the next section.

    e. NASSCO PACP, MACP and LACP shall be adhered to for the coding and reporting of any defects encountered during CCTV operations.

3. Diversion Pumping

    a. HRSD will provide the maximum flows and average flows to be handled by diversion pumping. The actual pumping quantity to be diversion pumped will depend on whether the flows can be returned to the pipe during non-working hours or storm events. If flows cannot be readily returned to the pipe, the Contractor shall provide resources and staffing for 24/7 pump operation and shall provide level control lights and other automatic controls on the system as detailed in Master Specification 01520 Maintenance of Pipeline Operations in Section 38 of this standards manual.

b. Specify the maximum dB limits for the diversion pumping equipment.

c. No leaking is allowed on diversion piping or pumping equipment.

d. Maintain sewer service to all customers along the line.

e. Consider routing for diversion pipe.

4. Gravity Sewer Rehabilitation – The following methods have been used or considered by HRSD. Other methods may be considered as appropriate in this rapidly changing market. During the PER phase of design the FIRM shall evaluate rehabilitation methods for suitability and shall perform pipeline assessment certification program (PACP), manhole assessment certification program (MACP) and/or lateral assessment certification program (LACP) inspections on the proposed sections of gravity pipeline designated for rehabilitation in accordance with NASSCO guidelines.

   a. Cured In Place Pipe (CIPP)

      i. The FIRM shall specify minimum liner thickness. The minimum may be different for different CIPP processes.

      ii. CIPP shall be designed based on the assumption the host pipe is fully deteriorated.

      iii. Determine if material samples are required for post-cure testing. If so, determine how samples will be obtained.

      iv. Provide performance specification for the liners. Require a Professional Engineer, licensed in the Commonwealth of Virginia, to seal the liner structural design.

      v. Utilize existing standards such as ASTM, NASTT, NASSCO, PRC, etc. where ever possible.

      vi. Require verification tickets for each liner section installed. Each ticket should include resin manufacturer and type, time and date of wet-out and other critical information.

      vii. Provide a water tight seal between the liner and the existing pipe at the manhole.

      viii. Rework the flow line through the manhole to account for the thickness of the liner.

ix. Require that all water / wastewater be removed from pipe prior to and during installation of liner.

x. Require that all inflow into pipe (groundwater, laterals and side lines) shall be stopped prior to installation of liner.

xi. Require that diversion pumping system be activated and flow removed from pipe during cleaning and CCTV inspection.

xii. Require a detailed submittal from the contractor that states design assumptions, calculation methods, material properties, and proposed installation approach.

xiii. Evaluate whether or not a continuous temperature monitoring system (Zia Systems or approved equal), should be utilized as an additional QA/QC measure during the curing process.

xiv. If continuous temperature monitoring is used, require final submittal of all temperature data.

b. Folded and Reformed Liners

i. Specify minimum thickness required.

ii. Evaluate available material types.

iii. Require that diversion pumping system be activated and flow removed from pipe during cleaning.

c. Formed In Place Pipe (FIPP)

i. Specify grouting procedures to be used.

ii. Where man entry is possible, require tapping test with a hammer as a part of the final inspection.

iii. Require that diversion pumping system be activated and flow removed from pipe during cleaning.

d. Sliplining

i. HRSD has used HDPE, FRP and A2 as sliplining materials.

ii. Require grouting of the annular space for all sliplining projects.

iii. Design and detail a watertight bulkhead between the slipliner and the host pipe at the manholes.

iv. Do not use clamps to join sections of pipe liner.

v. Require certified fusion welder if HDPE or fusable PVC is used.

vi. Require removal of internal beads flush with pipe wall on HDPE pipe before installing the liner.

vii. Specify minimum SDR or other appropriate thickness.

viii. Evaluate whether diversion pumping is required for installation or if liner can be installed under flow.

e. Pipe Bursting – HRSD has limited experience with this rehabilitation technology.

5. Lateral Reinstatement – Internal routing processes attempted to date are not satisfactory. Consider external excavation and saw cutting or products as Insert–A-Tee. This is a developing area and considerable research should be performed before making recommendations

6. Manhole Rehabilitation – This section covers rehabilitation of manholes and junction chambers.

   a. Utilize diversion pumping if work below the bench is required.

   b. Modify the inverts to provide a smooth flow line through the manhole.

   c. Raise the bench to the top of the pipe, forming a "U" channel through the manhole and provide sufficient slope to make benches self cleaning when benches must be modified.

   d. Require a system to capture and remove cleaning material from the manhole without entry into the flow line.

   e. Hydroblast or water blast all interior surfaces of the manhole using equipment capable of providing 4,000 to 7,000 psi pressures to remove all corrosion products, loose concrete, and other debris leaving a clean, sound substrate with a minimum concrete surface profile of CSP5 in accordance with ICRI 03732. The surface pH of the concrete must be a minimum of 8.0 following surface preparation as measured using pH indicating papers in accordance with ASTM D4262. Also, conduct test for excess moisture in concrete using the Plastic Sheet Test in accordance with ASTM D4263. If condensation is indicated under the sheet, the substrate is too wet to coat. Allow the substrate to dry longer or force dry prior to performing coating work.

f. Consider whether structural rehabilitation or repair is required or whether resurfacing to fill substrate profile and air voids ("bugholes") followed by corrosion resistant lining application is sufficient. Rebuild the structure to original dimensions before applying specified lining.

g. Stop all leaks in the manhole before resurfacing, repair, or lining materials are applied. Pressure grouting of active leaks using water reactive polyurethane grouts is an approved method for stopping inflow and infiltration into manholes or junction chambers. The water reactive, chemical polyurethane grouts used shall be one of the following materials:

   i. AV – 100 by AVANTI international of Webster, Texas

   ii. Sealfoam NF by DeNeef of Houston, Texas

   iii. No. F-370 Hydroactive Urethane Grout by Sauereisen of Pittsburgh, Pennsylvania

h. Evaluate conditions of the frames and covers. The Contractor shall provide frames and covers as required.

i. Remove any steps entirely (minimum one inch recess), and do not replace. Restore surfaces before applying coatings.

j. For manholes or junction chambers requiring extensive structural rehabilitation, consider the use of wet shotcrete using 7 – 8% of microsilica by weight of cement in the mix design and follow the requirements for shotcrete application found in ACI 506.

k. For localized repairs of spalls or degraded areas deeper than ¼" in depth in manholes or junction chambers, the following materials shall be used. These materials can be trowel applied, cast in place, or applied by shotcrete type methods as recommended by the selected manufacturer.

   i. Carboguard 510 by Carboline Company of St. Louis, Missouri

   ii. Underlayment F-120 or F-121 by Sauereisen of Pittsburgh, Pennsylvania

   iii. Series 219 MortarCast by Tnemec Company of North Kansas City, Missouri

l. For Resurfacing and Filling of "Bugholes" or Air Voids, and to hide substrate roughness of profile the following materials shall be used to skim coat the prepared concrete surfaces of the manholes or junction chambers. These materials can be applied to the concrete substrates using specialty spray equipment, but must be trowel finished to close-up the mortar and leave a relatively smooth surface free of pinholes, voids, and excessive profile.

i. Carbogard 510 by Carboline Company of St. Louis, Missouri

ii. Underlayment F-120 by Sauereisen of Pittsburgh, Pennsylvania

iii. Series 219 MortarCast by Tnemec Company of North Kansas City, Missouri

m. Sanitary manholes are often exposed to environments with various degrees of aggressiveness thereby degrading the concrete and reinforcing, and shortening the useful life of the structures. Choosing the appropriate protective measure should be determined during the preliminary engineering evaluation of the project. For Protective Coatings and Liners for manholes, the FIRM shall evaluate the current conditions of the structure and report findings in accordance with NASSCO MACP Guidelines. Any protective system must be applied in strict accordance with the protective system Manufacturer's recommendations. HRSD has had success with cementitious coatings, both Portland based and calcium aluminates, and various epoxies. If severe structural degradation has taken place, the use of Cast-In-Place rehabilitation has been successful, as well as the procedures outlined above for repairs. An anti-microbial additive, such as Conshield, should be considered for any type of cementitious rehabilitation.

n. All epoxies shall be 100% solids materials and contain 0% Volatile Organic Compounds (VOC's). The lining thickness must be checked with a wet film gauge or notch gauge in accordance with ASTM D4414. This needs to occur during the installation. Check at least once for every 10 sq. ft. of surface area to be lined. The wet film thickness measuring avoids the problems associated with destructive dry film thickness measurements and associated coating or lining repair work when using 100% solids materials.

o. The completed lining in each manhole or junction chamber shall pass high voltage holiday testing in strict accordance with ASTM D4787. Simple electrical continuity testing shall be preformed first to ensure that the concrete is sufficiently conductive for holiday testing to be effective. If not, a more careful visual inspection aided by good lighting shall be performed to identify holidays or pinholes. If holiday detection is performed, 100 volts D.C. per mil of lining thickness shall be used for the instrument. This testing shall be conducted over 100 percent of the lined surfaces. All holidays or pinholes shall be repaired and the lining surfaces retested until a pinhole free lining has been achieved.

p. Prior to substantial completion, the HRSD Contractor shall provide the "Manhole Protective Coating Post Installation Certification" form (Exhibit A), which is to be completed by the Contractor, Applicator and Manufacturer.

q. A minimum five (5) year warranty period shall be required for all Manhole rehabilitation installations.

7. Wet Well Rehabilitation – This section covers rehabilitation of pump station wet wells.

   a. Require a system to capture and remove cleaning material from the wet well without entry into the flow line.

   b. Hydroblast or water blast all interior surfaces of the wet well using equipment capable of providing 4,000 to 7,000 psi pressures to remove all corrosion products, loose concrete, and other debris leaving a clean, sound substrate with a minimum concrete surface profile of CSP5 in accordance with ICRI 03732. The surface pH of the concrete must be a minimum of 8.0 following surface preparation as measured using pH indicating papers in accordance with ASTM D4262. Also, conduct test for excess moisture in concrete using the Plastic Sheet Test in accordance with ASTM D4263. If condensation is indicated under the sheet, the substrate is too wet to coat. Allow the substrate to dry longer or force dry prior to performing coating work.

   c. Consider whether structural rehabilitation or repair is required or whether resurfacing to fill substrate profile and airvoids ("bugholes") followed by corrosion resistant lining application is sufficient. Rebuild the structure to original dimensions before applying specified lining dry film thickness.

   d. Stop all leaks in the wet well before resurfacing, repair, or lining materials are applied. Pressure grouting of active leaks using water reactive polyurethane grouts is an approved method for stopping inflow and infiltration into wet wells. The water reactive, chemical polyurethane grouts used shall be one of the following materials:

      i. AV-100 by AVANTI International of Webster, Texas.

      ii. Sealfoam NF by DeNeef of Houston, Texas.

      iii. No. F-370 Hydroactive Urethane Grout by Sauereisen of Pittsburgh, Pennsylvania.

   e. For wet wells requiring extensive structural rehabilitation, consider the use of wet shotcrete using 7 to 8 percent of microsilica by weight of cement in the mix design and follow the requirements for shotcrete application found in ACI 506.

   f. For localized repairs of spalls or degraded areas deeper than ¼" in depth in wet wells the following materials shall be used. These materials can be trowel applied, cast in place, or applied by shotcrete type methods as recommended by the selected manufacturer.

      i. Carbogard 510 by Carboline Company of St. Louis, Missouri.

ii. Underlayment F-120 or F121 by Sauereisen of Pittsburgh, Pennsylvania.

iii. Series 219 MortarCast by Tnemec Company of North Kansas City, Missouri.

g. For Resurfacing and Filling of "Bugholes" or Air Voids, and to hide substrate roughness of profile the following materials shall be used to skim coat the prepared concrete surfaces of the manholes or junction chambers. These materials can be applied to the concrete substrate using specialty spray equipment, but must be trowel finished to close-up the mortar and leave a relatively smooth surface free of pinholes, voids, and excessive profile.

i. Carbogard 510 by Carboline Company of St. Louis, Missouri.

ii. Underlayment F-120 by Sauereisen of Pittsburgh, Pennsylvania.

iii. Series 218 MortarClad by Tnemec Company of North Kansas City, Missouri.

h. For Protective Coatings and Liners for wet wells, the FIRM shall evaluate the current conditions of the structure and report findings in accordance with the Specification Section 09900 Protective Coatings. This section identifies specific systems that have been approved for use in wet well rehabilitation; however HRSD has had success with other technologies such as PVC and HDPE Liners, shotcrete and calcium aluminates. The FIRM shall consider the use of an anti-microbial additive, such as Conshield, if a cementitious rehabilitation product is being evaluated. Epoxy coatings systems in addition to those listed in the Specification Section 09900, (e.g. Raven and Warren); have also been successful in HRSD applications. The FIRM's recommendation shall be project specific and based upon the Specification Section 09900, combined staff experience and any applicable newer technologies.

Coating materials shall be applied in strict accordance with the manufacturer's recommendations to produce a pinhole free covering of all interior wet well surfaces. The coating shall be applied directly to the cleaned substrate to the dry film thickness specified by the selected manufacturer.

Coatings shall be 100% solids materials and free of Volatile Organic Compounds (0% VOC). The coating thickness must be checked with a wet film gauge or notch gauge in accordance with ASTM D4414. During the installation, check at least once for every 10 sq. ft. of surface area to be coated. Wet film thickness should be the same as the dry film thickness for 100% solids materials; therefore wet film thickness measuring avoids the problems associated with destructive dry film thickness measurements and associated coating repair work.

i. The completed lining in each wet well shall pass high voltage holiday testing in strict accordance with ASTM D4787. Simple electrical continuity testing shall be performed first to ensure that the concrete is sufficiently conductive for holiday testing to be effective. If not, a more careful visual inspection aided by good lighting

shall be performed to identify holidays or pinholes. If holiday detection is performed, 100 volts D.C. per mil of lining thickness shall be used for the setting of the instrument. This testing shall be conducted over 100 percent of the lined surfaces. All holidays or pinholes shall be repaired and the lining surfaces retested until a pinhole free lining has been achieved.

j. FIRM inspectors shall utilize the Daily Coatings Inspection Report Forms contained in Specification Section 09900 Protective Coatings for all Wet Well rehabilitation projects.

k. The contractor shall provide a warranty for a minimum three (3) year period from the date of Substantial Completion for all Wet Well rehabilitations. The Warranty shall be in accordance with the Three (3) Year Performance Guarantee as outlined in Specification Section 09900 Protective Coatings.

8. Post Construction & Rehabilitation Evaluation for Gravity Sewer Mains and Manholes

a. If included in the original construction contract for the project, the Contractor will conduct a video inspection of the new or rehabilitated project a minium one month prior to the expiration of the warranty. This inspection will be set up by the HRSD Project Manager who will attend the CCTV inspection and notify the FIRM of the inspection date should they desire to participate in the inspection.

b. Existing gravity sewer mains or storm mains that are within 36” vertical clearance of the pipeline to be burst shall be CCTV inspected prior to any pipe bursting and following completion of pipe installation by the Contractor as a record for potential future settling or misalignment issues.

c. For manhole rehabilitation projects, bonding of the coating material will be checked during the inspection and photo documentation will be provided. Special care will also be taken to inspect the bulkheads between the host pipe and the rehabilitated pipes in the manholes.