SPRAY-APPLIED-PIPE-LINER (SAPL) INSTALLATION FOR GRAVITY PIPELINES

MORTAR BASED SYSTEMS

PERFORMANCE SPECIFICATION GUIDELINE (PSG)

Thanks to NASSCO's Pipe Rehabilitation Committee and Technical Advisory Council for their many contributions to this document.

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Disclaimer

These Specification Guidelines were prepared by a committee comprised of representatives of NASSCO members and peer-reviewed by industry professionals. These Specification Guidelines are not specific to any one product, project, or job site, and should be considered as guidelines only. Conditions for use may require additions, deletions, or amendments to these guidelines so as to conform to project-specific site conditions and to comply with applicable laws, regulations, and ordinances. NASSCO does not guarantee, certify, or assure any result and assumes no liability as to content, use and application of these guidelines.

EFECTIVE SPECIFICATIONS

Effective specifications should encourage the most innovative, efficient and experienced contractor to provide the level of quality required by the Owner at the best and lowest competitive price.

The specification should not strive to encourage the contractor to seek the cheapest approach and product delivery available to provide the lowest price.

Effective specifications are critical for project success and include:

1. Product selection for the best solution.
2. Definition of project goals and requirements, both short and long-term.
3. Construction means and methods as defined, in writing, by the contractor.
4. Product provided and installed as specified by the product manufacturer.
5. Product quality and quantity confirmed through inspection and testing.
6. Product design and service life verified through warranty inspection.

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PART 1 GENERAL

This performance specification guideline (PSG) is for the rehabilitation of gravity sewers, either sanitary or storm, by the installation of spray-applied-pipe-liner (SAPL) and will focus on cementitious mortar-based products. Cementitious mortars used for SAPL shall be specifically formulated materials designed for pipe rehabilitation and include materials that can be classified as formulations of standard cement binders and/or geopolymer systems.

A. This performance specification guideline (PSG) includes the minimum requirements for the rehabilitation of sanitary and storm sewer pipelines by the installation of Spray- Applied-Pipe-Liner (SAPL) material within the existing, deteriorated pipe as shown on the plans included as part of these contract documents. The types of structures that can be prepared include but are not limited to reinforced concrete pipes (PCP), corrugated metal pipes (CMP), steel, brick, stone or pipes made of other materials. This PSG is limited to gravity conduits only.

B. The rehabilitation of pipelines shall be completed by the installation of a mortar-based spray applied liner which, once cured, shall be continuous and tight-fitting in a constrained condition with a shear interface with the original pipe (host pipe) throughout its' entire length. The SAPL shall extend the full length of the host pipe and provide a structurally sound, jointless rehabilitation-solution with no annular space between the SAPL and the host pipe. The Contractor is responsible for proper, accurate and complete installation of the SAPL using the system selected by the Contractor meeting the Owners requirements and these specifications.

C. Neither the SAPL product, system, nor its installation, shall cause adverse effects to the Owner's processes or repaired assets within this project. The installation pressure for the product shall not damage the system, and the use of the product shall not result in the formation or production of pollutants that may adversely affect normal operation of the Owner's assets. The Contractor shall restore disturbed surface conditions and structures to pre-rehabilitation conditions, unless otherwise noted within the Contract Documents. Identified defects in workmanship of the SAPL shall be repaired prior to payment for work.

D. The prices submitted by the Contractor shall include costs of permits, labor, equipment, and materials for the various bid items necessary for furnishing and installing the SAPL in accordance with these specifications. All items of work not specifically mentioned herein which are required to make the selected product perform as intended and deliver the final product as specified herein shall be included in the respective lump sum and/or unit prices bid.

E. Project Specific Design Objectives

1. The Contract Documents shall clearly state the Project Specific Design Objectives for the rehabilitation and define the condition of the host pipe in a manner consistent

with ASTM F3706. Appropriate design approaches will vary based on the condition of the host pipe and the pipe-soil system required by the host pipe and its deterioration mode. The design methods of ASCE MOP 145 or ASTM F1216 are specifically for flexible systems and are not applicable or appropriate for the design of rigid or semi-rigid pipe liners.

2. In ASTM F3706 (Nonmandatory Information Appendix X1), design states are categorized and design considerations outlined as follows:

    a. Design for State I —Host pipe structure can be either rigid or flexible but is considered safe for the soil, the soil adjacent to the existing pipe providing adequate side support, and live loading conditions but has infiltration or exfiltration concerns: there are no fractures of structural concern, significant tears or holes within pipe wall, deflection is less than 10 % and remains in the permissible limit for serviceability specific to the host material. Minor corrosion/abrasion has occurred. The only load on the liner is ground water pressure.

    b. Design for State II — Host pipe can be either rigid or flexible but the host pipe–soil system is not considered safe for the soil, hydraulic or live loading conditions, or the host pipe is expected to reach this condition over the design life of the rehabilitated pipe. In rigid pipes, longitudinal fractures break the pipe into pieces, which can now freely move relative to each other and will move if the soil support weakens over time. In flexible pipes, specifically corrugated metal pipe (CMP), the long-term vertical deflection is limited to 20 % of pipe diameter/width. Significant loss of pipe wall thickness and reinforcement may be observed because of interior/exterior corrosion or abrasion; or the external loading has increased since the original pipe design. The load on the liner includes all applicable groundwater pressure and soil overburden pressure and surface or live loads.

3. Design shall be compliant with ASTM F3706 requirements.

1.1 DESCRIPTION OF WORK AND PRODUCT DELIVERY

The specifications must include a description of the work required, including products required for a complete-in-place installation. Sufficient detail regarding the scope of work pertaining to the lining and support services required such as traffic control, bypass/flow diversion, cleaning, etc. should be presented in the Contract Documents to facilitate preparation of a well-informed bid. Supplemental information such as Condition and/or Capacity Assessments, Inspection Reports, Photos, Video, Flow Meter Data, Geotechnical Borings, etc. should also be provided.

A. This PSG covers the work necessary to furnish and install the SAPL. The Contractor shall provide materials, labor, equipment, and design services necessary for traffic control (if required), bypass pumping and/or diversion of flows, cleaning, infiltration control utilizing injection grouting, measurement and television inspection of sewers to be rehabilitated, SAPL installation, reconnection of service connections, quality controls, provide samples

for performance of required material tests, final television inspection, testing of the rehabilitated pipe system, warranty work and other work, as specified herein.

B. The furnished product shall be a complete SAPL system including materials, equipment, and installation procedures. If prequalification is required, then the SAPL system manufacturer shall submit appropriate data/information to the Owner. Submitted SAPL or multi-component products for consideration shall be required to meet the submittal requirements as contained herein.

C. The SAPL shall be continuous and jointless from manhole to manhole or access point to access point, unless specified, and shall be free of defects that will affect the service life and operation of the asset.

D. The intended design life for the application shall be defined in the Contract Documents in terms of an appropriate suite of conformance testing verifying that the product and the quality assurance procedures associated with its installation are “fit for the intended purpose.”

E. The SAPL shall be designed to resist the loads imparted on the liner as described in Part 1 – E: Project Specific Design Objectives and to meet the intended design life objectives stated in the Project Documents.

F. The installed SAPL shall comply with the physical performance requirements of Paragraph 2.5: Minimum Physical Properties.

G. Confirmed connections are to be reinstated, as directed by the Owner, and shall be re-opened to their original shape and to 95% - 100% of their original area.

H. Materials furnished, as part of this contract shall be marked with product information, stored in a manner specified by the manufacturer, and tested per standard as listed in Section 1.2, or to the requirements of the Contract Documents.

I. Warranty inspections shall be executed by the Owner. Warranty-related workmanship and/or material deficiencies provided in writing by the Owner to the Contractor shall be addressed per warranty requirements by the Contractor.

J. On-site quality control testing shall be executed by a third-party testing laboratory that is financially and otherwise independent of the Contractor performing the work. The Contractor shall obtain the services of an independent third-party testing laboratory to collect material and produce samples onsite during the project installation, at the request of the Owner. The Laboratory shall take possession of the mixed wet material used for sample production and testing and shall maintain the chain of custody, store samples onsite, transport the samples to their laboratory, demold and store onsite until testing, test and report on all samples produced under this contract. The Contractor shall pay for all material, sample production and product testing and reporting performed under this contract.

1.2 REFERENCES

Applicable reference documents should be listed in this section. If a document does not apply, is not pertinent or has unknown content, it should not be included. Specific reference document requirements should be defined in the contract documents or by reference to a specific section of the document. Specific contractor requirements and/or test procedures contained in the references should be defined in detail in the contract documents

A. The following documents form a part of this specification to the extent stated herein and shall be the latest editions thereof. Where differences exist between codes and standards, the requirements of this specification shall apply. References to codes and standards shall be to the latest revised version.

- American Society for Testing and Materials (ASTM):
  - ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field
  - ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
  - ASTM C78 – Flexural Strength of Concrete
  - ASTM C109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)
  - ASTM C496 – Splitting Tensile Strength of Cylindrical Concrete Specimens
  - ASTM C666 – Freeze Thaw Durability
  - ASTM C807 – Set Time of Hydraulic Cement Mortar
  - ASTM C882 – Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
  - ASTM C1090 – Shrinkage Test
  - ASTM C1138 - Standard Test Method for Abrasion Resistance of Concrete (Underwater Method)
  - ASTM C1898 – Standard Test Methods for Determining the Chemical Resistance of Concrete Products to Acid Attack
  - ASTM C1904 – Standard Test Methods for Determination of the Effects of Biogenic Acidification on Concrete Antimicrobial Additives and/or Concrete Products
  - ASTM F2414 – Standard Practice for Sealing Sewer Manhole Using Chemical Grouting
  - ASTM F2551 – Standard Practice for Installing a Protective Cementitious Liner System in Sanitary Sewer Manholes
  - ASTM F3706 – Standard Practice for in Field Spray Applied Mortar Linings for Large Diameter Stormwater and Sewer Conduits
- German Institute for Standardization - Deutsches Institute für Normung (DIN)
  - DIN 19573 - Mortar for construction and renovation of drains and sewers outside buildings (Specifically, resistance to biogenic sulfuric/sulphuric acid attack as covered in Appendix A XWW4 and Appendix B XWW1 to XWW3)
- American Concrete Institute (ACI):
  - ACI Certified Concrete Field-Testing Technician, Level 1
  - ACI PRC-229-13 Report on Controlled Low-Strength Materials

- ACI 305R-99 Hot Weather Concreting
- ACI 306R-88 Cold Weather Concreting

- National Association of Sewer Service Companies (NASSCO)
  - Pipeline Assessment Certification Program (PACP), including MACP and LACP requirements, as applicable
  - Sewer Pipe Cleaning Specification Guidelines

1.3 PERFORMANCE WORK STATEMENT (PWS) SUBMITTAL

> In place of the engineer defining the specific method for product installation, the Contractor defines the installation means and methods through a written plan called the Performance Work Statement (PWS). During construction the PWS provides information to the inspector to determine if the submitted means and methods are being followed. The PWS also outlines the necessary quality checks to be performed and installation crew qualifications.

A. The Contractor shall submit, to the Owner, a Performance Work Statement (PWS) that defines the SAPL product delivery in conformance with the requirements of the Contract Documents. Unless otherwise directed by the Owner, the PWS shall, at a minimum, contain the following:

1. Confirm that the SAPL will conform to the project requirements per Paragraph 1.1: Description of Work. and as otherwise described in the Contract Documents.

2. Prepare an installation plan describing preparation work, cleaning operations, pre-CCTV inspections, bypass pumping, traffic control, installation procedure, curing instructions (as applicable), dust control plan, service reconnection, quality control, testing to be performed, final CCTV inspection, warrantees furnished necessary and appropriate for a complete SAPL installation. An installation schedule shall be prepared, submitted, and conform to the requirements of the Contract Documents.

3. Contractor's description of the proposed SAPL technology, including a plan for identifying active service connections and maintaining service during mainline installation to each connected service to the section of pipe being rehabilitated, including temporary service as required by the Contract Documents.

4. A description of the SAPL materials to be furnished for the project. Materials shall conform to these specifications and/or shall conform to the pre-approved product submission.

5. A statement of the Contractors experience. The Contractor shall have a minimum of three (3) years of cumulative experience installing SAPL in pipe of a similar size, depth, length, and configuration as contained in this contract. The lead personnel, including the superintendent, the foreman and the lead crew personnel for the operation of the mix/pump equipment and the SAPL installation must be trained and

certified by the material manufacturer and have a minimum of one (1) year of experience with the SAPL technology proposed for this contract and must have demonstrated competency and experience to perform the scope of work contained in this contract. The name and experience of each lead individual performing work on this contract shall be submitted with the PWS. Personnel replaced by the Contractor, on this contract, shall have similar, verifiable experience as the personnel originally submitted for the project.

6. Design of the SAPL shall be performed and submitted under seal by an engineer licensed to practice by the State/Province/Country where the works are taking place. The designer shall have specific experience in relevant SAPL design. The specific nature and degree of experience shall be per requirements in the Contract Documents and shall be commensurate with the Design Objectives stated by the Owner and the design state of the pipe being rehabilitated.

   The technical requirements for Design Approach shall be per the Contract Documents and shall use recognized engineering design theory to address the loads imparted to the SAPL based on design state of the host pipe and the design objectives for the rehabilitation stated by the Owner. These should be consistent with ASTM F3706 guidelines.

   The design approach can be based on either Load and Resistance Factor Design (LRFD) or Allowable Stress Design (ASD) methods per the Contract Document requirements. The design approach shall also provide guidance on combined loads imparted to the liner in a manner consistent with ASCE 7-16 “Minimum Design Loads and Associated Criteria for Buildings and Other Structures”.

   ASCE MOP 145 and ASTM F1216 design methodologies which are based on flexible design methods shall not be acceptable design approaches.

7. Proposed manufacturers’ technology data shall be submitted for SAPL products and associated technologies to be furnished.

   a. Submittals shall include:
      - Information on the SAPL material intended for installation, including the lining material, invert repair, and infiltration control materials, and tools and equipment required for a complete installation.
      - For wastewater or other potentially corrosive operational environments, include manufacturer certified testing documentation for corrosion resistance or antimicrobial activity of the SAPL materials in accordance with an appropriate standard substantiating product suitability (Acceptable methods referenced herein include ASTM C1898, ASTM C1904, DIN 19573. Manufacturers should be consulted with acceptance criteria where the standard does not provide a pass/fail criteria.

b. The PWS shall identify which tools, and equipment will be redundant on the job site in the event of equipment breakdown. Equipment to be furnished for the project, including proposed back-up equipment, shall be described. The Contractor shall outline the mitigation procedure to be implemented in the event of equipment failure during the installation process.

c. A description of the Contractor's proposed procedures for removal of existing blockages/obstructions in the pipeline that may be encountered during the cleaning process.

d. A public notification plan shall be prepared and submitted including staged notification to stakeholders affected by the SAPL installation.

A SAPL installation typically includes the onsite mixing of dry mortar materials, which can emit a dust cloud that is considered a nuisance. To minimize this nuisance the contractor should devise a dust control plan that will mitigate the nuisance effect to the public and residents at the project site during the liner installation.

8. The Contractor shall submit a construction work plan which should include a flow control plan, infiltration control, cleaning methods and SAPL installation procedures and Quality Control Plan meeting the requirements of Paragraph 1.6.
9. The dust control plan included in the PWS minimizes dust at the project site and surrounding area. The plan will include no less than the following:

    a. Description of Personal Protective Equipment (PPE) required for personnel working on job site
    b. Protection of dust emission points
    c. Collection and disposal of dust and debris developed during rehabilitation operations

B. Compensation for all work required for the submittal of the PWS shall be included in the various pipelining items contained in the bid.

1.4 PRODUCT SUBMITTALS

Product submittals require the Contractor to submit the materials to be incorporated in the installation. This also allows the Contractor to submit alternative materials that may be equal or better than those specified. The Owner must be prepared to evaluate alternative materials through evaluation, certifications and third-party testing to validate alternative materials meet the specified requirements of the contract.

This section includes a list of SAPL products and procedures that should be included in the submittal package. These include the liner, repair, and preparation materials, in addition to handling and storing these items from the manufacturing plant to the installation site. Also included are procedures for application and installation.

A. Manufacturer-certified copies of all test reports on each product used, including:

1. Test results indicating the product conforms to and is suitable for its intended use per these specifications. Test reports shall be performed at the Licensed Applicator's expense and shall be carried out by an approved independent third-party testing laboratory or by a reputable independent testing body. As a minimum, the test reports should include properties listed in Paragraph 2.5 of this specification.

When pipes are corrugated the specifier must determine what the hydraulic and thickness requirements are, specifically related to whether the corrugations should be filled or followed. If specifying that the corrugations are to be filled, the specifier should consult with SAPL manufacturers and installers to confirm there are not foreseeable issues or concerns with the required process.

Filling the corrugations will improve the hydraulic capacity and pipe smoothness but will increase the material and associated application costs. Further, such installations may not be practically achievable in smaller conduit sizes.

B. Minimum Thickness Calculations as required in Paragraph 1.3.A.6, along with proposed plan for ensuring that the installed SAPL meets the minimum thickness requirements. For pipes that are corrugated, the minimum thickness shall be measured from the peaks / crests of the corrugation, plus an additional ½" cover over any bolts.

C. Manufacturers' shipping, storage, and handling recommendations for components of the SAPL system.

D. Safety Data Sheets (SDS) for materials to be furnished for the project.

E. Contractor Qualifications

1. Manufacturer Certification that Contractor has been trained and approved in the

handling, mixing and application of the products to be used.

2. Manufacturer Certification that the equipment to be used for applying the products has been manufactured or approved by the Manufacturer and Contractor personnel have been trained and certified for proper use of the equipment by the Manufacturer.

F. Proof of required permits or licenses necessary for the project.

G. After cleaning and preparation of host pipe by the Contractor and before beginning SAPL installation, the Licensed Applicator/Contractor shall submit to the Owner/Engineer for their records the following:

1. Video 1 (1 copy) of the Contractor's TV inspection of the infrastructure prior to preparation work showing existing condition of asset prior to preparation and lining activities.
2. Video 2 (1 copy) of the Contractor's TV inspection of the infrastructure post preparation and prior to product application, clearly showing installation of depth gauges, treatment of active infiltration and other preparation steps.

H. After rehabilitation of the infrastructure, the Contractor shall submit to the Owner/Engineer for their records the following:

1. Video 3 (1 copy) of the Contractor's TV inspection of the completed Work performed in compliance with NASSCO PACP™ by trained and certified personnel.
2. Test results of field samples of SAPL material per Paragraph 3.5 of this specification and as specified in the Contract Documents.

I. Daily logs shall be completed and submitted, including:

1. Completed anytime a work crew is on site. This log includes listing the personnel present at the site, when they arrived, and when they left the site.
2. Times material was mixed, and applied and under which atmospheric conditions, the ambient air temperature, the dry powder temperature, the mixing water temperature, and the temperature inside the pipe.
3. Operating conditions including the water addition rate taken at the meter tube, the retrieval speed of the retraction system and the pump motor speed recorded at the pump.
4. The amount of material used per pass and per segment.

Worker safety should be the number one priority on a job site. No work should start until the contractor submits a safety plan, and all work should be conducted in accordance with the safety plan. The plan should be sufficiently detailed to describe daily safety meeting requirements, procedures, and documentation. Emergency procedures and location of medical facilities should be identified

1.5 SAFETY

A. The Contractor shall conform to Work safety requirements of pertinent regulatory agencies and shall secure the site for the working conditions in compliance with the same. The Contractor shall erect signs and other devices as necessary for the safety of the work site.

B. The Contractor shall perform Work in accordance with applicable OSHA standards. Emphasis shall be placed upon the requirements for entering confined spaces and with the equipment being utilized for pipe renewal.

C. The Contractor shall submit a proposed Safety Plan to the Owner prior to beginning Work. The plan shall include a description of a daily safety program for the job site and emergency procedures to be implemented in the event of a safety incident. Work shall be conducted in accordance with the Contractor's submitted Safety Plan.

D. Compensation for the work required for the submittal of the Safety Plan shall be considered incidental to the project work.

1.6 QUALITY CONTROL PLAN (QCP)

A Quality Control Plan (QCP) should be submitted by the contractor. The QCP should include a discussion of the proposed quality controls to be performed by the contractor during installation including material protection and handling, equipment operation and documentation requirements. The contractor personnel, including names and cell phone numbers for those that are responsible for assuring that quality requirements are met, should be identified, and submitted.

A. A Quality Control Plan (QCP) that represents and conforms to the requirements of these specifications shall be submitted to the Owner. At a minimum, the QCP shall include the following:

1. A discussion of the proposed quality controls to be performed by the Contractor.

2. Defined responsibilities, of the Contractor's personnel, for assuring that quality requirements for this contract are met. These shall be assigned by the Contractor to specific onsite personnel.

3. Proposed procedures for quality control, product sampling and testing shall be defined and submitted as part of the plan.

4. Proposed methods for product performance controls, including method of and frequency of product sampling and testing both in raw material form and cured product form.

5. Scheduled performance and product test result reviews between the Contractor and the Owner at a regularly scheduled job meeting.

6. Inspection forms and guidelines for quality control inspections shall be prepared in accordance with the standards specified in this contract and submitted with the QCP.

1.7 SAPL REPAIR/REPLACEMENT

As part of the PWS, the contractor should submit repair and replacement procedures for common SAPL defects. Defects should be categorized as those that need no repair, those that can be repaired and those that must be removed and replaced. Defects that affect the operation and/or longevity of the SAPL should be repaired or replaced.

A. The Contractor shall outline specific repair or replacement procedures for potential defects that may occur in the installed SAPL. Repair/replacement procedures shall be as recommended by the SAPL system manufacturer and shall be submitted as part of the PWS.

B. Defects in the installed SAPL that will not affect the operation and service life of the product shall be identified and defined.

1.8 AS-BUILT DRAWINGS/RECORDS

As-Built drawings/records include the identification of the work completed by the contractor and should include the pre- and post-inspection documentation. As- Built drawings/records should be kept current and should be available on the project site. As-Built drawings/records can be in the form of actual drawings, either paper or electronic, spreadsheets or Word documents.

A. As-Built drawings/records, pre- and post-inspection video inspections, flash drives or other electronic media shall be submitted to the Owner, by the Contractor, within 2 weeks of final acceptance of said work or as specified by the Owner. As-Built drawings/records will include the identification of the work completed by the Contractor and shall be prepared on one set of Contract Drawings/Records provided to the Contractor at the onset of the project.

B. As-Built drawings/records shall be kept on the project site, shall include information as outlined in the PWS or as agreed to by the Owner and the Contractor at the start of the Contract, shall be updated as the work is being completed and shall be clearly legible.

C. Compensation for the work required for the submittal and approval of As-Built drawings/records shall be included in the Contract Document bid items.

1.9 WARRANTY

The contractor should warrant the SAPL material and installation for a period as specified. If required by the Owner, the contractor should warrant defective work that has been repaired for an extended period as agreed. After completion of the work but before the warranty period has expired, the Owner should inspect a portion of the rehabilitated system. Initial warranty inspection should include up to 15% of the completed work. The warranty inspection should be based on the recommendations documented by the project inspector during the execution of the project. Defects found should be handled in accordance with the repair/replacement plan submitted in the PWS. Depending on the frequency of defects found, the Owner may require more of the installations to be inspected as necessary.

A. The materials used for the project shall be certified by the manufacturer for the specified purpose. The Contractor shall warrant the SAPL material and installation for a period of one (1) year. During the Contractor warranty period, defects which may materially affect the integrity, strength, function and/or operation of the pipe shall be repaired at the Contractor's expense in accordance with procedures included in Paragraph 1.7 SAPL Repair/Replacement and as recommended by the Manufacturer.

B. For work completed by the contractor that is defective and/or has been repaired, the contractor shall warrant this work for (1) year in addition to the warranty required by the Contract Documents.

C. After a pipe section has been rehabilitated and for a period of time up to one (1) year following completion of the project, the Owner may inspect the rehabilitated system. The specific locations will be selected at random by the Owner's inspector and should include representative sizes of SAPL from the project. If it is found that any of the SAPL has developed abnormalities since the time of the post rehabilitation inspection, the abnormalities shall be repaired and/or replaced as defined in Paragraph 1.7 - SAPL Repair/Replacement and as recommended by the manufacturer. If, after inspection of a portion of the rehabilitated system under the contract, problems are found, the Owner may televise all the SAPL installed on the contract. Verified defects shall be repaired and/or replaced by the Contractor and shall be performed in accordance with Paragraph 1.7: SAPL Repair/Replacement, and per the original specifications, at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 MATERIALS

> The cured SAPL product must meet the physical performance requirements as referenced in Paragraph 2.5. The tested product should be of the same material formulation as those used on the project and shall have been completed within the past 5 years.
>
> Chemical or Antimicrobial testing should be exempt from this requirement based on time and cost and should be confirmed by the SAPL manufacturer to be unchanged since testing.

A. The SAPL system must meet the physical performance requirements of these contract documents.

B. Deliver materials in original containers with unbroken seals and labels intact and free of moisture. Do not use materials that have been directly exposed to moisture or if there is visible damage to the packaging.

C. Project materials shall be inspected by the Contractor upon receipt and the Bill of Lading reviewed to confirm it properly documents amount(s) and type(s) of material(s) received, date and time of delivery as well as the shipping company delivering the material. The Contractor shall log and make available for review Bill of Lading and material batch numbers upon receipt of the material(s). Receipt of material should also be noted in daily activity logs.

D. Materials may be stored offsite, such as in a yard, for a period prior to use on the project. Upon delivery to the project, Contractor shall designate a specific protected space at the project site for staging and mixing materials. Do not store kerosene, gasoline, or other flammable liquids in this space. Remove oily rags at the end of each day's work. Regardless of storage location, materials used for rehabilitation are to be kept dry, protected from weather, and stored under cover within the temperature ranges recommended by the Manufacturer. Products are to be stored and handled according to their SDSs or appropriate classification. Damaged or unsuitable products shall be promptly removed from the job site and shall be replaced with suitable materials.

2.2 MORTAR LINER MATERIALS

> The liner is the material for rehabilitation of the host pipeline. The quantity of material applied, and installation procedures will determine the finished thickness of the SAPL. A properly designed and specified liner is critical to achieving the specified finished SAPL thickness.

A. The liner material may be centrifugally cast, manually sprayed or hand troweled.

B. Liner materials shall be a factory blended, one-component-formulation that only requires the addition of water before installation. Liner materials shall be formulated to meet the project design objectives and for ease of mechanical pumping, spraying and spin casting.

C. The product shall be formulated to produce an installed liner that can be installed in layers at a minimum of ½" per layer and adhere to the existing host pipe surface to a sufficient level to cure and meet the design state objectives. Overall installation minimum thickness shall comply with requirements of the Contract Documents.

D. The finished installation must be such that once the liner cures, the total liner thickness will be homogeneous, monolithic and meet design thickness requirements.

2.3 PREPARATION AND SUPPORT MATERIALS

> In SAPL, the liner can be designed to for up to a Design State II condition. The preparation and support materials are important in providing the appropriate conditions so as to allow the SAPL to be successfully applied to the host pipeline. Thus, it is important that the applicable preparation and support materials be specified and delivered to the jobsite.

A. Cleaning

1. Pipe should be cleaned to remove debris and soft deposits. Deteriorated concrete surfaces should be prepared by bushing or other means to get down to a solid concrete surface.

B. Infiltration Control (Mild to Moderate).

1. Mild to Moderate infiltration means infiltration that meets the definition of a "Weeper" or "Dripper", as defined by NASSCO's PACP:

2. Fast-setting materials furnished shall be formulated to be applied in dry powder form, with no prior mixing of water, directly to active leaks under hydrostatic pressure in pipes, manholes or related structures. Alternatively, material can be mixed into the consistency of a putty and used to slow the leak prior to application of additional products. Materials shall consist of rapid setting cements, siliceous aggregates, and various accelerating agents. Material shall not contain chlorides, gypsum, or metallic particles. Infiltration control material shall be in accordance with SAPL manufacturer's recommendations.

C. Infiltration Control (Heavy).

1. Heavy infiltration means infiltration that meets the definition of a "Runner" or "Gusher", as defined by NASSCO's PACP:

2. Injection grouting material shall be used to address heavy infiltration following manufacturer's instructions. Apply injection grouting material as approved by the SAPL Manufacture. Injection grouting material shall be in accordance with SAPL manufacturer

recommendations.

D. Filling of Voids behind the host pipe.

1. Any voids behind the pipe walls must be filled using an expandable foam grout to ensure the host pipe is in full interaction with the soil. Invert Repair and Patching (Fast Return to Service).
2. Material furnished shall be formulated to fill voids in pipe, manholes and structure walls, and to repair or reconstruct inverts.
3. For infrastructure that must be returned to service quickly, material shall consist of rapid setting cements, monocrystalline quartz aggregates, and various accelerating agents. Invert repair and patching material shall be in accordance with SAPL manufacturer recommendations and shall achieve a 1-day compressive strength of 2,000 psi | 13.8 MPa or greater.

E. Invert Repair and Patching (Bypassed or No Flow).

1. Material furnished shall be formulated to fill voids in pipe, manholes and structure walls and to repair or reconstruct inverts.
2. For infrastructure with heavily deteriorated inverts with no flow or bypass conditions, where flow will not be returned until at least 12 hours after SAPL application, the invert repair and patching material shall be in accordance with SAPL manufacturer recommendations.

2.4 STRUCTURAL REQUIREMENTS

Typically, the minimum physical properties of the liner material are specified, and, with this information, the contractor submits a SAPL wall thickness design with the PWS submittal. If the physical properties used in the wall thickness design exceed the minimum properties specified, the contractor must meet the higher physical properties during SAPL third-party sample testing. Minimum wall thickness of SAPL should also be considered when infiltration reduction is a primary objective of the rehabilitation project.

A. The SAPL shall be designed as per Paragraph 1.3.A.6 and compliant with ASTM F3706. The SAPL design shall assume no bonding to the original pipe wall unless a composite design is proposed, and bond testing is conducted.

B. The cured material (SAPL) shall, at a minimum, meet or exceed the structural properties, as listed below or as discussed in Paragraph 1.3.A.6

2.5 MINIMUM PHYSICAL PROPERTIES

Physical Property	Test Method	Performing Requirements
Compressive Strength	ASTM C39	Min. 8,000 psi | 55 MPa @ 28 days
Flexural Strength	ASTM C78	Min. 800 psi | 5.5 MPa @ 28 days
Split Tensile Strength	ASTM C496	Min. 700 psi | 4.8 MPa @ 28 days
Freeze Thaw Durability	ASTM C666	Max 0.5% Loss @ 300 cycles
Bond Strength to Concrete	ASTM C882	Min. 2,500 psi | 17 MPa @ 28 days
Shrinkage Test	ASTM C1090	Max 0.02% @ 28 days
Abrasion Resistance	ASTM C1138	Max 36.3 in^3 | 0.0006m^3 Total Volume Loss @ 6 cycles on 28-day sample
Chemical Resistance / Antimicrobial Activity **See Recommendations Per Paragraph 1.3.A.7**	N/A	Per PWS

A. The required structural SAPL wall thickness shall be based, as a minimum, on the physical properties of the cured liner and per the design the design requirements in Paragraph 1.3.

Pipe Size, Shape & Length	As specified or indicated on the Plans
Design State (Per Part 1-E)	State I or II
Design Safety Factor	per the Contract Documents and applicable design code
Constrained Soil Modulus	Per AASHTO LRFD Section 12 and AWWA Manual M45
Groundwater Depth	As specified or indicated in the Contract Documents
Soil Depth	As specified or indicated in the Contract Documents
Live Load	Highway, railroad, airport or permanent structures per the Contract Documents
Soil Density (assumed)	120 lb/ft^3 or as specified in the Contract Documents
Minimum Design Thickness **(NOTE: The minimum thickness here is a guideline and should not be considered as basis for design, but rather a rule of thumb for typical minimum thickness of these sizes)**	Greater of: • 1.0-inch | 25mm or as design dictates for assets under 54-

	inch | 1350mm equivalent diameter/span • 1.5-inch | 38mm or as design dictates for assets equal to or greater than 54-inch | 1350mm and up to 96-inch | 2400mm equivalent diameter/span • 2.0-inch | 50mm or as design dictates for assets greater than 96-inch | 2400mm equivalent diameter/span. For corrugated host pipe materials, refer to Paragraph 1.4.B for thickness measurement details. For other host conduit materials, the minimum design thickness shall be measured from the interior face of the host conduit wall.

B. The Contractor shall submit, prior to installation of the lining materials, certification of compliance with these specifications and/or the requirements of the pre-approved SAPL system. Certified material test results shall be included that confirm that materials conform to these specifications and/or the pre-approved system. Materials not complying with these requirements will be rejected.

PART 3 INSTALLATION

3.1 CONSTRUCTION REQUIREMENTS

The construction requirements cover on-site activities (cleaning, inspection, measurement, bypass, etc.) as explained in the PWS submitted by the contractor. Inspection and testing requirements, during construction, should be defined for the contractor and the Owner.

A. The SAPL shall be constructed of materials and methods that, when installed, shall provide a jointless and continuous structurally sound SAPL for the prescribed design conditions.

B. The Contractor may, under the direction of the Owner and per Contract Document requirements/limitations, utilize existing access points in the project area for installation work. If a street or traffic lane must be closed to traffic because of the location of the sewer, the Contractor shall furnish a traffic control plan approved by roadway owner stakeholder prior to initiating the onsite work. The plan shall be in conformance with the requirements of the local agency having jurisdiction over traffic control, and/or in accordance with the Manual on Uniform Traffic Control Devices (MUTCD).

C. Contractor shall perform pre-cleaning video inspections per PACP standards in Paragraph 1.4. Prior to sealing of active leaks, invert repair and patching and lining, the Contractor will clean the asset to be rehabilitated and provide pre-construction videos of the complete limits of the infrastructure to be rehabilitated as well as the project site and access points utilizing color video inspection equipment. As an alternative, color photos documenting full depth and circumference of access points and host pipe is acceptable per Owner written approval. The interior of the host pipe asset shall be inspected to determine the location of and conditions which may prevent proper installation of the SAPL, and these conditions shall be addressed per the SAPL Manufacturer's standards prior to application of the SAPL material. Documentation shall be submitted to the Owner following commencement of work.

D. Cleaning of Pipes – The Contractor shall remove internal debris from the pipe that will interfere with the installation and the final product delivery of the SAPL. Cleaning shall be performed in accordance with NASSCO standards, Owner requirements and Contract Document requirements. A NASSCO PACP-coded post CCTV inspection should then be performed after cleaning, and the host pipe measured to document the dimensions, shape, and length of the host pipe.

E. Bypassing Existing Flows - The Contractor shall provide for flow control or bypassing active flow per the SAPL manufacturer's requirements and the Contract Documents.

F. Pipe Defects - Loose or defective brick, concrete, grout, ledges, and steps shall be removed to provide a solid and even surface prior to application of the SAPL material. Exposed rebar shall be pressure washed to remove any extraneous materials, such as dirt, oil, grease, debris, and loose rust scale or concrete.

It shall be the responsibility of the Contractor to clear the line of misalignments, broken or collapsed sections or sags that will interfere with the installation and long-term performance of the SAPL. If pre-installation inspection reveals a misalignment, broken or collapsed section or sag that was not identified as part of the original scope of work and will prohibit proper installation of the SAPL, the Contractor may be directed by the Owner to correct the problem(s) prior to installation by utilizing open cut repair methods or alternative means. The Contractor shall be compensated for this work under a contingency pay item or change order. Removal of any previously unknown defects shall be considered as a changed condition. The cost of removal of defects that appeared on pre-bid video documentation and made available to the Contractor, prior to the bid opening, shall be compensated for on a unit price basis in accordance with the contract documents.

G. The Contractor shall be responsible for sealing active points of infiltration utilizing materials in accordance with the SAPL manufacturer's recommendations and the following requirements:

1. The area to be repaired must be clean and free of debris to the extent the repair material will bond to the surface of the host area.
2. For quick-setting grout or mortar, with gloved hand, place a generous amount of the dry quick-setting cementitious material to the active leak, with a smooth fast motion, maintaining external pressure for 60 seconds, repeat until leak is stopped.
3. Proper application should not require any special mixing of product or special curing requirements after application.
4. Injection grouting shall be performed to stop heavy leaks, or to fill voids behind the host pipe.

H. The Contractor shall be responsible for confirming the locations of branch service connections prior to installing the SAPL. If required in the contract documents, each connection will be dye tested to determine whether the connection is live or abandoned. The cost for dye testing of existing service connections shall be compensated at the unit price bid in the Proposal for Dye Testing of Existing Service Connections. In the event the status of a service connection cannot be adequately defined, the Owner shall provide written directive, prior to installation of the SAPL, as to the status. Typically, only service connections deemed "active" shall be reopened by the Contractor.

I. Invert Repair and Patching - The work consists of mixing and applying flowable fill or a rapid setting, high early strength, non-shrink patching material to fill all large voids and repair inverts prior to applying SAPL to the infrastructure. For pipe or manhole invert repairs, flow must be temporarily restricted prior to cleaning and during repair.
1. The area to be repaired must be capable of receiving the appropriate repair material.
2. Mix water shall be clean potable water and require no additives or admixtures for use with patching materials.
3. Flowable fill shall be mixed on-site or delivered to the site ready for use. Material should be mixed in appropriate quantities to avoid setting prior to placement in voids or inverts.
4. Once mixed to proper consistency, the materials shall be applied to the invert or void areas by pump, hand, or trowel. In invert applications, care should be taken to not apply excessive material in the channel, which could restrict flow. Once applied, materials should be smoothed either by hand or trowel in order to facilitate flow.
5. Flows in inverts patched with rapid cure invert repair and patching material can be reestablished within 30 minutes of material placement. Flows in inverts patched with flowable fill material shall not be reestablished until at least 12 hours have passed, unless otherwise directed by the Manufacturer.

J. Depth Gauges – Prior to installation, depth gauges shall be permanently attached to the interior of the host at sufficient positions circumferentially and spacing linearly to allow for visual confirmation of the installation thickness during application. These gauges should be covered at when design thickness is reached.

> It is recommended that depth gauges be installed in at least four clock positions every 20 linear feet for circular pipe. The more out of round or odd shaped the pipe, additional depth gages may be needed at increased frequently.

K. Following the sealing of active leaks, invert repair and patching and preparation of the asset to include setting of depth gauges, prior to application of the SAPL material, the Contractor's experienced personnel competent in the inspection of large diameter pipes and/or related manholes and structures will provide pre-lining videos of the infrastructure to be rehabilitated utilizing color video inspection equipment. Licensed Applicator can perform inspection one section at a time, or as a single inspection of the limits of the work, so long as no spray application of SAPL material is installed until the host pipe's pre-lining condition has been documented. The interior of the host pipe shall be inspected to provide confirmation that the conditions identified during Pre-Construction Inspection, as discussed in Paragraph 3.1/C, have been addressed per SAPL manufacturer's recommendations prior to application of SAPL material. Documentation shall be submitted to the Owner/Engineer following commencement of work.

L. The Contractor shall be allowed to use potable water from an Owner-provided fire hydrant close to the project limits. Backflow preventer and metering requirements shall be per Owner requirements.

3.2 INSTALLATION OF LINER

> It is important that the SAPL be installed in accordance with the manufacturer's recommendations. These procedures should have been outlined in detail in the PWS submitted by the contractor. Some key procedures that should be maintained include installation thickness, installation details and additional information as recommended by the manufacturer. Grouts or mortars should be utilized where the infiltration into the pipeline is active and may affect the liner's adhesion to the host and/or the final structure of the SAPL.

A. The liner shall be mixed, installed, and cured (as applicable) in the host pipe per the manufacturer's specifications as described and submitted in the PWS.

B. SAPL installation shall be in accordance with the applicable ASTM/ACI standards and manufacturers' instructions.

C. The SAPL material shall be mixed in accordance with the SAPL manufacturer's recommendations for the water/material ratio, mix time, temperature, and other

requirements. Appropriate documentation shall be kept in a Daily Application Log throughout the installation process. The mixing operations must be performed so that the minimum amount of dust is released into the surrounding environment.

D. The SAPL material may be spray applied, hand-troweled, and/or centrifugally spin-cast to the inside of an existing pipeline or structure. The necessary equipment and application methods to apply the liner materials shall be only as provided by the SAPL material manufacturer. Material shall be mixed in accordance with manufacturer's recommendations to proper consistency, then the materials shall be pumped through a high-pressure material hose for delivery to the appropriate and / or selected application device.

E. The Manufacturer's recommended cure instructions (as applicable) shall be adhered to.

3.3 FINISH

Any defect which could affect the structural integrity or longevity of the SAPL should be repaired. Sealing the ends of the SAPL at access points and at service connection openings is important in cases where the sewer is below the groundwater surface elevation. Leaks through the wall of the SAPL are considered a defect.

A. The installed SAPL shall be continuous over the entire length of a lined section (unless specified) and be free from visual defects such as foreign inclusions, infiltration (defined as PACP™ Infiltration codes), major surface profile deviation and delamination. The SAPL shall be impervious and free of any leakage through the SAPL wall.

B. Defects that affect the structural integrity or strength of the SAPL shall be repaired at the Contractor's expense in accordance with the procedures submitted under Section 1.7: SAPL Repair/Replacement.

C. Using the records from the pre-construction inspections, the Contractor shall ensure that connections are properly reinstated, and service restored. Excess SAPL material at the connection shall be removed. The Contractor shall ensure that no infiltration originates at the point of connection by sealing any leaks with appropriate product(s). The laterals and pipe connections shall then be hand-troweled, applying the SAPL to the outer surface of the connection to the pipe and smoothly tapering it into the lateral or connecting pipe. No rough edges or abrupt transitions that could catch debris or hinder the flow shall remain.

D. Termination of the SAPL at the end of a pipe or manhole shall be completed by hand-applying the SAPL to the outer surface of the pipe or into the interior of the manhole.

The long-term structural capability of the existing underground pipeline is defined by the pipe design and the surrounding soil structure. When a SAPL is installed through an existing pipe that represents such PACP defect observations “Soil visible” or “Void Visible”, the Owner should consider augmenting backfill to fill voids to provide soils support for the installed SAPL system.

3.4 TESTING OF INSTALLED SAPL

SAPL physical properties (Compressive Strength, Flexural Strength, etc.) as relied upon by the liner design should be verified through independent third-party field sampling and testing. Samples should be taken from the material installed, properly marked and stored onsite until they can be transmitted to an independent testing laboratory or obtained from the project site by an independent laboratory. Test results should be transmitted from the laboratory to the Contractor. Sampling should be in accordance with appropriate ASTMs as applicable, and a chain of custody should be maintained. Samples should be acquired as directed and specified by the Owner or the Contract documents.

A. The physical properties of the installed SAPL shall be verified through field sampling and laboratory testing. Mixed materials for testing shall be furnished by the Contractor to the testing laboratory for sample preparation at the job site, transport to the lab and testing. Sample preparation, transport and materials testing shall be performed at the Contractor’s expense by an independent third-party laboratory selected by the Contractor as recommended by the SAPL manufacturer. All tests shall be in accordance with applicable ASTM test methods to confirm compliance with the requirements specified in these contract documents.

B. The Contractor shall provide mixed material samples from the actual installed SAPL for sample preparation to the testing laboratory. Samples shall be provided from the first and last day of installation and every 42,000 lbs | 19,050 kg of material during application of SAPL or as required by the Owner. The sample shall be collected from the mixer/hopper or if appropriate, the end of the application hose. Sample collection and testing hold times will be per manufacturer’s recommendations.

The specifier should identify a regimen of field testing that verifies the design. When only compressive tests are used the material manufacturer should be required to provide correlations to other design properties to identify the proper relationships. Please review the testing requirements and confirm with manufacturer’s recommendation.

For ASTM C39 Compressive samples, it is recommended that nine (9) four (4) by eight (8) inch | 100 x 200 mm test cylinders be prepared following ASTM C 31. Alternatively, ASTM C109 Compressive samples in the form of two (2) by two (2) by two (2) | 50 x 50 x 50 mm test cubes can be prepared. It is recommended that three (3) samples be tested at 7 days, three (3) at 28 days and three (3) retained as directed by the Contractor.

The laboratory results shall identify the project, the test sample date, location as referenced to the nearest manhole and station, product batch and mix information. Final payment for the project shall be withheld pending receipt and approval of the test results. If properties tested do not meet the minimum physical and thickness requirements, the SAPL shall be repaired or replaced by the Contractor unless the actual physical properties and the thickness of the sample tested meet the design requirements as required in the contract.

C. The installed SAPL thickness shall be confirmed during application through the visual observation and monitoring of the permanent depth gauges and use of a handheld depth gauge by the installer. Pre- and post-installation video should show the presence of the depth gauge (pre) and coverage of the depth gauge indicated by it no longer being visible (post).

D. Visual inspection of the installed SAPL lining for installation defects to include cracks, infiltration, surface texture and spray defects.

E. All costs to the Contractor associated with providing mixed SAPL material to an independent third-party testing laboratory for sample preparation, transport, curing and testing shall be included in the Lump Sum price bid for Mobilization.

3.5 FINAL ACCEPTANCE

All sample testing and repairs to the SAPL should be completed. All test results must have been received from the independent laboratory and meet the contract specified requirements, or Owner/Engineer approved design values, as discussed in Paragraph 1.3, prior to final acceptance of the installed SAPL.

A. A visual inspection should be made by Owner and Contractor periodically throughout the progression of construction, prior to the completion of a lining stage. Any deficiencies in the finished lining shall be marked and repaired by the Contractor according to the procedures set forth herein.

B. SAPL sample testing and repairs for the installed SAPL, as applicable, shall be completed before final acceptance, meeting the requirements of these specifications, and documented in written form.

Prior to conducting the final CCTV, the contractor should clean the newly installed SAPL. Sewage flow in the line should be minimized, and standing water in sags should be cleared. The CCTV visual quality of the final inspection shall be per NASSCO PACP requirements. If the quality does not meet the specified requirements, the contractor shall re-inspect those section that are unacceptable.

C. The Contractor shall perform an internal pipe inspection per PACP requirements per Paragraph 1.4.H in the presence of the Owner after installation of the SAPL and reconnection of the side sewers. Unedited digital documentation of the inspection shall be

provided to the Owner within ten (10) working days of the SAPL installation acceptance.

> Final CCTV inspection should be performed using water jets as necessary to eliminate standing water in sags and bellies while the line is being televised.

D. Flow control from the upstream manhole shall be utilized to minimize sewage from entering the line during the inspection. In the case of bellies in the line, the pipe shall be cleared of any standing water to provide continuous visibility during the inspection.

E. Any leaks through the wall of the pipe shall be repaired.

3.6 TYPICAL BID ITEMS

> Additional items such as flowable backfill, demobilization / remobilization, etc. can be added to specific contracts requiring these items.

A. Mobilization – Lump Sum - Includes PWS information, submittals, safety plan, as-built drawings, testing samples, mobilization/demobilization of labor, equipment, and materials to the project site.

B. Traffic Control – Lump Sum – Includes all labor, equipment and materials required to implement a traffic control plan for the entire project and shall include all costs associated with sub-contracted traffic control specialists.

C. Damming, Dewatering, Flow Control (Storm Sewer) – Lump Sum – Includes all labor, equipment and materials required to implement earthen berms, tight sheeting, sandbags, bulk heads, aqua barriers etc. for the entire project. Including the setup, installation, all pumps, hoses, fittings, connections, operations, tear down, and removal for the duration of the project.

D. Sewage Bypass (Sanitary or Storm / Sanitary Combination Sewer) – Lump Sum – Includes all labor, equipment and materials required to implement a flow bypass plan for the entire project, including the cost of all sub-contracted flow bypass specialists.

E. Pre-Installation CCTV Inspection – Per linear foot - Includes pre-cleaning CCTV for Owner review. Does not include CCTV inspection just prior to SAPL installation or post SAPL installation.

F. Dye Testing of Service Connections – Per each - Includes dye testing and documentation of existing service connection on each pipe length to be lined.

G. Point Repairs – Per each or by Lump Sum Contingency - Includes excavation and restoration of a section or sections of pipe that are beyond rehabilitation using SAPL. Note: Point repair items shall be categorized by pipe size, a minimum length of excavation and depth category of excavation to be paid for in the Proposal. If point repairs are not identified

in the contract documents; payment shall be on a contingency basis.

H. Light Sewer Cleaning – Per linear foot for each pipe size category OR post decanted CY of material removed – including all labor, equipment, materials, and cost of material disposal Per NASSCO Sewer Pipe Cleaning Specification Guideline.

I. Heavy Pipe Cleaning – Per linear foot for each pipe category OR post decanted CY of material removed – including all labor, equipment, materials, and cost of material disposal. Defined per NASSCO Sewer Pipe Cleaning Specification Guideline.

1. Normal Cleaning Equipment: Cleaning devices such as rods, metal pigs, porcupines, root saws, snakes, scooters, sewer balls, kites, and other approved equipment in conjunction with hand-winching devices and gas or electric rod- propelled devices. High velocity type or hydraulically propelled material extraction devices that do not release particulate matter or odors to the atmosphere.

2. Large Diameter Cleaning Equipment: Large diameter cleaning equipment includes high velocity type or hydraulically propelled material extraction devices that do not release particulate matter or odors to the atmosphere and are capable of cleaning pipes 30in diameter and larger.

3. Hand Cleaning Equipment: Wheelbarrows, Skid Steer, Motorized Wheelbarrows, Etc.

4. Mechanical Cleaning Equipment: Buckets, scrapers, scooters, porcupines, kites, heavy duty brushes, metal pigs, and other debris removing equipment and accessories used in conjunction with approved power winching machines. High to very high-pressure water nozzles (10,000 psi) are considered mechanical cleaning equipment.

5. Prices to assume non-hazardous debris. Hazardous material disposal will result in additional charges.

J. Mechanical Cleaning – Per linear foot for each pipe category – including labor, equipment, materials, and cost of material disposal. Defined as mechanically assisted cleaning for root, tuberculation, calcium, encrustations, and / or barnacle removal.

K. Existing Liner or Coating Removal – Per linear foot for each pipe category – including labor, equipment, materials, and cost of material disposal. Defined as removing existing coating to the degree required or recommended by the Contract Documents, including but not limited to bituminous or other unconfined liners up to 125 mils thick.

L. Infiltration Control – per pound | kg or EA – including all labor, equipment and materials needed to address active infiltration prior to or following lining.

M. Flowable Fill/Void Filling per cu. yd. of material installed and documented including all labor, equipment and materials required for the complete filling of soil voids.

N. Invert Repair and Patching – per cubic yard per linear foot | meter – including all labor, equipment and materials needed to address invert deterioration prior to lining.

O. Post preparation Pre SAPL-CCTV Inspection - Per linear foot - Includes post preparation CCTV for submission to the Owner.

P. SAPL Installation – Per linear foot for each pipe size category - Includes labor, equipment, materials and testing as required for the complete in-place installation of a SAPL as measured from edge of access point wall to edge of access point wall.

Q. Structure SAPL Installation – Per square foot for each structure size at the specified thickness. Includes labor, equipment and materials required for the complete installation of liner in the termination structures.

R. Structure SAPL Installation (Additional) – Per square foot for each structure size - Includes l labor, equipment and materials required for the complete in place installation of liner in the termination structures.

S. Chimney Treatment – Per each for each structure size - Includes all labor, equipment and materials required for the complete installation of chimney treatment in the termination structures.

T. Service Reconnections – Per each – Includes reconnecting existing live sewer or storm connections to the installed SAPL. The Owner shall review and verify those connections that are not live and will be left unopened.

U. Post Construction CCTV Inspection per PACP Standards- Per linear foot - Includes post lining CCTV for submission to the Owner. All inspections will be performed by PACP™ trained and certified personnel.

V. Restoration of Staging Area and/or Work Area – Per square foot - Includes the cost of regrading, seeding / mulching and/or sod per the Owner or contract requirements

W. Reserve for Testing – Lump Sum Reserve – For Owners use to include additional testing required as directed by the Owner, under this contract, by an independent laboratory. (The amount will be set by the Owner in the Bid Proposal)

END OF SECTION