LARGE DIAMETER PIPELINE (48 INCH AND LARGER)
INTERNAL PIPELINE OVALITY INSPECTION
(AS PROVIDED BY REDZONE ROBOTICS)

1) PART 1 GENERAL

a) SUBMITTALS

A. Shop Drawings: Catalog and manufacturer's data sheets for television equipment.

B. Quality Control Submittals

1) References: Contact names and telephone numbers.
2) List of staff and equipment to be used on Project.
3) Copies of NASSCO PACP Certifications for operators proposed on project.
4) Traffic control plan.
5) Project-specific safety plan.
6) Look-ahead inspection schedules, one week in advance of Work.

b) QUALITY ASSURANCE

A. Qualifications:

1) Contractor has performed work successfully for at least 3 other projects, within last 5 years, with pipe lengths and pipe diameters similar to this Project.
2) Crew Chief has worked on other projects similar to this Project and experienced using proposed equipment and field coding software system as proposed for this Project.

B. Pre-Inspection Meeting: Prior to beginning inspection work, schedule with Owner to review proposed inspection schedule and procedures.

c) SCHEDULING

A. Inspection work shall be scheduled based on current weather forecasts. Do not schedule during storm event or within 24 hours after storm event.

B. Provide updated look-ahead schedules to Owner every week.

d) NOTIFICATIONS

A. Two-week notice of start of inspections in field.

B. Notify Owner immediately:
   1) When obstruction or restricting flow in pipeline is discovered.
   2) If depth of flow in pipeline exceeds 30 percent of pipe diameter.
   3) If conditions for inspection are found to be unsafe or impractical.
   4) Pipe configuration in field is different than shown on maps. Notification shall include diagram clearly indicating location of structure in relation to immediately adjacent structures.

2) PART 2 PRODUCTS

a) Sensor Transport

A. The sensor transport shall be capable of collecting data from all sensors specified at one time wile traveling downstream or upstream from a single assess point. The sensor transport shall be skid steered with molded rubber tracks to move through and over heavy debris. Tracks shall have a minimum of 200 square inches of ground contact for increased traction. The transport shall weigh at least 500lbs to provide better traction in variable conditions and be a stable transport vehicle. The transport shall have a minimum of four horse power with the ability of pulling a mile of cable from a single location. The transport system shall be capable of operating within pipes of 36” in diameter or greater and have auxiliary motion axes that enable the operator to reposition the vehicle in the event that it is flipped on its The transport shall be equipped with an industrial computer with RS-232, RS-485, USB, and Ethernet interfaces which allows for simultaneous collection of data from multiple sensors specified herein.

B. The Sensor transport vehicle shall be used to provide a stable platform for all of the sensors and cameras specified. A stable platform is required to provide the most accurate data from the data sensors. Floating style platforms may not be used for measurable data sensors unless approved by the Engineer. The transport vehicle shall be capable of pulling up to a mile of cable and maneuvering over sediment normally associated with large diameter sewer lines.

C. The transport vehicle shall be capable of being deployed through an access hole with a minimum of 24 inch clear opening.

D. The transport vehicle shall provide auxiliary motion axes that enable the operator to reposition the vehicle in the event that it is flipped.

E. The transport vehicle shall capable of variable speeds from (0 to 30) feet/per minute the actual condition assessment inspection speed shall be determined by the lowest rate specified for any individual sensor specified herein. The sensor transport shall be stopped to take high resolution sonar and laser dwell scans

F. The transport vehicle shall have an onboard integrated inertial measurement unit (IMU) to enable

real-time monitoring of vehicle position and orientation. The IMU shall measure three axis of rotation and three axis of acceleration. The transport shall provide real-time measurement and display at the operator's station of pitch and roll measurements with respect to gravity that are accurate to ±1°.

G. A turret tool capable of sweeping the specified CCTV and sensor package through a range of (-90, 90) degrees its lateral axis.

H. Equip with a minimum of 5,000 lf tag line with a minimum strength of 5,000 lb suitable for pulling camera backwards.

I. During the inspection, if a camera will not pass through the entire pipeline section, the SERVICE PROVIDER shall reset the equipment and attempt to inspect the section of the pipe from the opposite direction. If the service provider has equipment meeting the above minimum standards they will be paid a reset up fee as approved in advance by the Engineer.

b) **Color CCTV Inspection Equipment (Dry portions of the pipe):**

1) Television monitor.
2) Cables.
3) Power source.
4) Lights.
5) Recording Format: Color, digital.
6) High Resolution images.
7) Camera:
   a. 65-degree viewing angle, minimum, and either automatic or remote focus and iris controls.
   b. Operative in 100 percent humidity conditions.
   c. Mount on a self-propelled tracked sensor transport.
   d. Ability to achieve proper balance of tint and brightness.
   e. The digital output of the camera shall be capable of sending a signal through a minimum length of one mile of fiber optic cable without signal loss
   f. The cameras shall have a rotary head with rotational, pan and tilt movement in order to allow a full circumferential inspection and observe all portions of the pipeline.
   g. The cameras shall have the capability of rotating of switching to observe major defects from both upstream and downstream perspectives.
   h. It shall have a high resolution lens capable of spanning 360 degrees circumference and 270 degrees on a horizontal axis to televise pipelines.
   i. Optical focal distance shall be adjustable through a range of 1" to infinity.
   j. The camera source image capture shall provide an image with a minimum resolution of 320 x 240 pixels capture.
   k. The cameras shall be operative while submerged.
   l. The camera shall have a minimum light sensitivity of >1.5 lux.
   m. The camera zoom shall be capable of a 40:1 Zoom (10X optical, 4 times digital)
8) Camera Lighting:
   a. Minimize reflection.

b. Diameters from 36 to 144 inches.
c. Lighting quality to provide clear, in-focus picture of entire inside periphery of pipe.
d. Focal Distance: Adjustable through range from 6 inches to infinity.
Remote Reading Footage Counter:
Accuracy: two-tenths of a foot over length of section being inspected. Marking on cable will not be allowed.
Calibration: Each day prior to setup.

c) **Laser Scanning (Dry portion of pipe)**

A. Laser scanning equipment shall be capable of measuring the distances to objects and surfaces in pipes and shall be capable of imaging pipes from 4 feet to 100 feet in diameter with a minimum of 24" of non submerged area at the top of the pipe. The laser shall support 75 Hz scan rates or higher and be Class 1, eye-safe for operator safety. The laser unit shall be capable of being repeatable actuated to provide data that eliminates six degree-of-freedom sensor alignment problems. The reporting accuracy shall be 1cm at 3 meters in pipelines 48 inches and larger. Overlapping high resolution dwell scans shall be taken by stopping approximately every five feet for a minimum of thirty seconds. The laser data shall be capable of producing high resolution 3 D dwell scans that can be converted to cad drawings. Laser data shall be electronically synchronized with all other data sensors.

3) PART 3 DOCUMENTATION

A. Field Data Acquisition System:

1) Win Can or Similar.

B. Disc (CD, DVD, or External Hard Drive):

C. Labeling: Provide typed label on outside that indicates the following: Name of Owner
1) Project Title or Number
2) Date(s) of Inspection
3) Inspection Company
4) Disc Number

A. Provide jewel case insert that indicates pipe segments included on the disc.

B. External Hard Drive – Provide to Owner with clear instructions on downloading files.

4) PART 4 VIDEO INSPECTION

A. Video Recording:

1) Set camera so axis is at centerline of pipe.
2) Show continuous footage reading on tape image. Place on screen where it is clearly visible (e.g., if black font, do not place on dark background, if white font, do not place on light background). Place high enough on screen to be visible on image when viewing images.
3) Viewing shall be in direction of flow, except while camera is being used in a reverse setup. Inspection shall proceed from upstream to downstream, unless prohibited by an obstruction.
4) If upstream (or reverse) setup is required, establish new inspection run separate from downstream (or normal) setup. Inspection images for both downstream and upstream runs shall be documented on the same disc.
5) Keep camera lens clean, and clear. If material or debris obscures image or causes reduced visibility, clean or replace lens prior to proceeding with recording operation.
6) Camera lens shall remain above visible water level and may submerge only while passing through clearly identifiable line sags (or vertical Misalignments). If flow exceeds 30 percent of diameter, such that camera lens becomes obscured, inspection shall be stopped until flow subsides. If necessary, reschedule inspection. Surcharging (and flooding of camera lens) is not an excusable condition if it has been artificially created upstream, i.e., placement of flow plugs or freshwater flushing in pipe.

7) Recordings shall clearly show corrosion, cracks and fractures, and their severity, in addition to obvious features, i.e., laterals and joints.
8) Immediately report obstructions that restrict flow and cause inspection to be interrupted to **[insert contact name and number].**
9) Provide still images of all moderate and severe defect images. If no defects, provide still images of typical conditions every 100 ft. in pipe or where flow levels change in accordance with NASSCO PACP.
10) Camera Operation: Speed: 30 feet per minute, maximum, during inspection.
11) Loss of color or severe red or green color will be cause for rejection of inspection.
12) Recordings shall be without distortion or outside interference.
13) Line segments shall be televised complete from structure-to-structure in a continuous run.
14) Video must clearly show camera starting and ending at structure, unless defect or manhole configuration does not allow it. If camera starts within the pipe, footage should reflect correct position and not 0.0 feet.
15) Do not record partial televising on one disc and then complete run on another disc. If line is partially televised, due to excusable condition, i.e., collapsed line, televised length shall be viewed for acceptability.
16) View of entire line segment, structure-to-structure (typically manholes) needs to exist in one inspection in order to be acceptable, unless reverse setup or obstruction. If a portion of line is unacceptable, entire segment shall be deemed unacceptable and shall be retelevised.
17) Owner may accept inspection that does not adhere to minimum standards if adverse conditions are encountered and reinspection is not advised. In such a case, enough data shall be provided to permit accurate assessment and Owner must be notified in advance of submittal.

B. Measurement:

1) Record in English units.
2) Obtain pipe diameter by physical measurement in upstream (or downstream) access structure.
3) Verify pipe material (e.g., RCP, VCP, CMP), pipe diameter and surface lengths between manholes before beginning inspection.
4) Use calipers or measuring rod to determine diameter of inlet and outlet pipe.
5) Footage measurements shall begin at centerline of upstream manhole.
6) Continuous Footage Readings:
   a. Use to identify location of defects.
   b. Defect identifications are to be called out and recorded to the nearest 1/2 foot.
   c. Line segment recording will be unacceptable if continuous footage meter inaccuracy, or identified defects or features leave doubt as to accuracy of locations or total length.
      i. Check accuracy of measurement meters daily by use of walking meter, roll-a-tape, or other suitable device.

iii. Loss of vertical hold, which has an impact on ability to read and interpret tape, will constitute a cause for rejection.

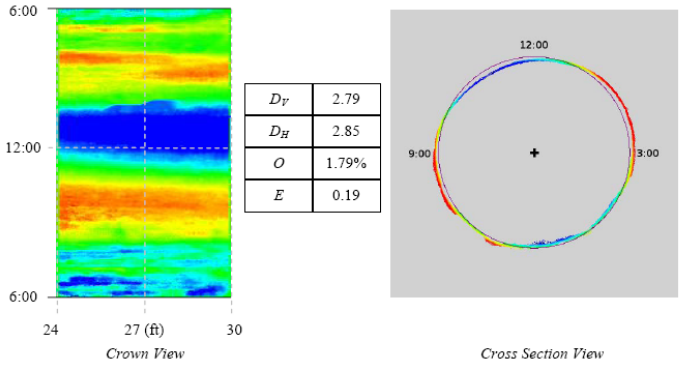
5) DELIVERABLES

a) CCTV (Dry portion of pipe)

A. Provide CCTV reports and video consistent with NASSCO PACP reporting requirements
B. At a minimum, provide report sheets showing photographs of severe or unusual defects, or one photo every 200 feet of pipe and a defect summary report per NASSCO PACP standard format. Owner to provide example reports at pre-inspection meeting.
C. Provide video image at 1:1 scale of vertical to horizontal.
D. Electronic MS ACCESS based-output files and reports from direct entry software as directed by Owner during pre-inspection meeting.

b) Laser Ovality Scans (Dry portion of pipe)

A. Table of contents
B. Results Summary page
C. Results Summary Table listing MH#, Payout location, Scan #, D_V, D_H, Ovality & Eccentricity
D. Deployment summary & project site photo images
E. Precision scan view approximately 1-9 lf (depending on pipe size / see precision scan chart below) section color coded crown view for dry portion of pipe
F. Precision scan view approximately 1-9 lf (depending on pipe size / see precision scan chart below) section graphical cross section view for dry portion of pipe.
G. Table including measured height and width and calculated ovality and eccentricity
   i. Sample:



H. Precision Ovality Scans including but not limited to Sensor error, Axis error, collection error, Pose, etc…. must be accurate to 5 %
I. Signed certification by a PHD of review of data on final report

J. Precision Scan Chart:

Pipe Diameter	Precision Scan Coverage
36”	1’
42”	3’
48”	3’
54”	4’
60”	5’
72”	6’
84”	7’
96”	8’
108”	9’

K. Ovality / Eccentricity Equation:

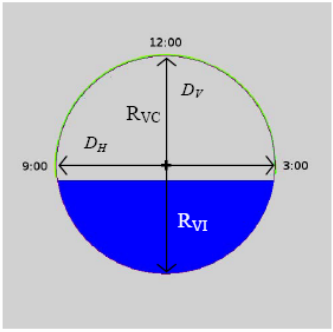
(Eq. 1) $D_V = R_{VC} + R_{VI}$

Ovality, O, is measured from D_H and D_V in a two step process. The first step is the sorting of the vertical and horizontal diameters in to minimum and maximum values as shown in Equation 2. The second and final step computes ovality as a percentage as shown in Equation 3.

(Eq. 2) $D_{\min} = Min\{D_H, D_V\}$
$D_{\max} = Max\{D_H, D_V\}$

(Eq. 3) $O = \left(1 - \frac{D_{\min}}{D_{\max}}\right) \times 100\%$

(Eq. 4) $E = \sqrt{1 - \frac{D_{\min}^2}{D_{\max}^2}}$



D_V	108
D_H	108
O	0%
E	0

Sample Bid Sheet

Item No.	Description	Quantity	Unit of Measure	Unit Price	Total
1	Mobilization		EA		
2	Set up and insertion of equipment or reset up if unable to complete inspection due to pipe conditions		EA		
4	CCTV Data Reporting		LF		
5	Data collection and processing of Laser Ovality Scans		EA		