LONG-THROATED PALMER-BOWLUS FLUMES

1. REFERENCE SPECIFICATIONS, CODES, AND STANDARDS
	1. ANSI/AWWA F101 – AWWA Standard for Contact-Molded, Fiberglas-Reinforced Plastic Wash Water Troughs and Launders.
	2. ASTM D256 – Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
	3. ASTM D570 – Standard Test Method for Water Absorption of Plastics.
	4. ASTM D638 – Standard Test Method for Tensile Properties of Plastics.
	5. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
	6. ASTM D 2563 – Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
	7. ASTM D2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
	8. ASTM D5390 – Standard Test Method for Open-Channel Flow Measurement of Water with Palmer-Bowlus Flumes.
	9. All references shall be of the latest revision.
2. SUBMITTALS
	1. Units
		1. All submittals, specifications, drawings, brochures, installation instructions, descriptive literature, etc. shall have all units of measurement in both Imperial and SI units.
	2. Drawings
		1. Project specific drawings, showing:
			1. Critical dimensions.
			2. Joints, connections, fasteners.
			3. Sizes, spacing, and locations of structural members, ribs, anchoring clips, and dimensional bracing.
			4. Materials and thicknesses of construction.
			5. Minimum and maximum flow rates.
		2. Generic layouts or check marked brochures shall be rejected without review.
	3. Specifications
		1. Project specific specifications.
		2. Generic or check marked specifications shall be rejected without review.
	4. Discharge Tables
		1. Level-to-flow discharge tables, showing:
			1. Flow equations.
			2. Submergence transition, where published.
			3. Accuracy, where published.
			4. Plan view layout showing critical dimensions and primary point of measurement (Ha).
			5. Discharge table source.
	5. Receiving, Handling, and Storage Instructions
	6. Installation Instructions
	7. Operation and Maintenance Instructions
	8. Product Warranty
	9. Test Data
		1. Independent certified test results confirming material properties.
			1. Test results are to be performed on specimens representative of the resins and reinforcements submitted upon with such resins and reinforcements listed by the certifying party.
			2. Data shall be no more than three (3) years old.
	10. Laminate Sample
		1. 6-inch [15.24 cm] square sample of representative laminate, upon request.
3. RECEIVING, HANDLING, AND STORAGE
	1. Receiving
		1. Inspect for damage
			1. All parts should be inspected upon delivery to the site, noting any missing items or visible damage.
			2. Verify that the interior flow surfaces have not been damaged or otherwise marked during transit.
			3. Flanges, anchor clips, and dimensional bracing should also be inspected.
			4. For smaller boxed items make sure to verify that all packaging seals are in place and that there is no visible damage to the packaging.
		2. Investigate for order correctness and count
			1. Once the order has been received review the packing list against what has been received. Should any items not appear to be present or the configuration of the items does not match the description on the packing list, contact Openchannelflow immediately.
			2. Small connection hardware (nuts, bolts, etc.) not attached to the flumes ship in individual boxes – with those contents clearly marked. Special care should be taken to secure these and any other small items that can be misplaced on a job site.
	2. Handling
		1. Flumes are specialty items and are fabricated to strict dimensional tolerances. While rugged and designed for a long service life, flumes must be handled with care. Flow surfaces are particularly important and in handling flumes this should always be kept in mind.
		2. When cranes, hoists, and other machinery are used to lift flumes or flume sections, spreader bars and lifting straps should always be used. When performing any overhead lift, all lifting eyes must be used in conjunction with good rigging practices. Rigging and lifting sequences and schedules of equipment are solely the responsibility of the installing party.
		3. Chains, ropes, and the like should never be used to move or position any flume as they may serrate the fiberglass laminate or compromise the protective gel coat surfaces.
	3. Storage
		1. Flumes not intended for immediate installation may be stored until the site is ready for their installation.
		2. Flumes should only be stored in a location that is clean, level, and protected from construction traffic.
		3. When shipped on pallets, flumes should be left on those pallets until such time as they are needed. Otherwise flumes should be stored upside down so that the interior flow surfaces are protected. Flumes should then be covered as an additional protection for the flow surfaces.

1. MANUFACTURER
	1. Supply Palmer-Bowlus flumes as manufactured by:
		1. Openchannelflow (phone: 855.481.1118 / fax: 855.3316475 / [www.openchannelflow.com)](http://www.openchannelflow.com))
			1. Locally represented by:
				1. XX
2. SUBSTITUTIONS
	1. Manufacturers wishing consideration as acceptable substitutes must follow the steps outlined below.
	2. Include a copy of this specification section with all applicable plans sheets / details, addendum updates, and all referenced / applicable sections.
	3. Each paragraph must be check marked to indicate complete compliance with the specification or clearly marked to indicate a request for deviation from the specification requirements.
		1. Use check marks (✔) to denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested, underline each deviation and denote by a number in the margin to the right of the identified paragraph.
		2. The remaining portions of the paragraph not underlined will signify compliance on the part of the Manufacturer with the specifications.
		3. Include a detailed, written justification for each numbered deviation.
		4. Failure to comply with the above is sufficient cause to summarily reject the entire request for substitution.
	4. Requests for substitution must be made in writing and be received by the engineer’s office a minimum of ten (10) business days before the bid opening.
	5. Manufacturers not pre-approved shall not be given consideration.
	6. Manufacturers requesting pre-approval must have been regularly engaged in the application, design, and manufacturing of open channel primary devices for at least ten (10) years.
		1. Manufacturing alone shall not be deemed sufficient.
		2. The majority of the Manufacturer’s operations must consist of the control, conditioning, or measurement of open channel flow.
	7. To ensure strict quality control, the Manufacturer may incorporate raw materials from outside vendors, but the Manufacturer must fabricate the final product.
		1. Job shopping or outside fabrication / sourcing shall not be acceptable.
	8. Test Data
		1. Independent certified test results confirming material properties.
			1. Test results are to be performed on specimens representative of the resins and reinforcements submitted upon with such resins and reinforcements listed by the certifying party.
			2. Data shall be no more than three (3) years old.
	9. Laminate Sample
		1. 6-inch [15.24 cm] square sample of representative laminate, upon request.
	10. In addition, the request for substitution must provide information regarding a minimum of ten (10) comparable North American installations, including:
		1. Owner’s name, location, and contact information.
		2. Application and performance specifications.
		3. Date of installation.
		4. Operational history.
		5. Equipment arrangement, including configuration and materials of construction.
3. WARRANTY
	1. Flumes shall be warranted to be free of defects in workmanship and materials for five (5) years with a completed warranty registration.
	2. The warranty period shall begin from the date of shipment.
4. SYSTEM DESCRIPTION
	1. Configuration
		1. Single flume
			1. Size:
				1. \_\_\_\_\_-inch Palmer-Bowlus flume.
			2. Style:
				1. Permanent

4D+1-inch long.

3D+1-inch long.

2D+1-inch long.

* + - * 1. Insert

4D+1-inch long.

2D+2-inch long.

* + - * 1. Cut-back

2D+2-inch long.

* + - 1. Construction:
				1. One-piece construction (4-21-inch Palmer-Bowlus flumes).
				2. Two-piece construction, with connection hardware (24-72-inch Palmer-Bowlus flumes).
				3. Multi-piece construction, with connection hardware, for insertion through a Ø22 1/2-inch [57.15 cm] manhole opening.
	1. Materials of Construction
		1. Fiberglass reinforced plastic laminate
			1. ISO certified polyester laminating resin:
				1. Low HAP.
				2. Properties shall meet or exceed:

Tensile Strength (ASTM D638) 14,000 psi [96.53 MPa].

Flexural Strength (ASTM D790) 22,000 psi [151.7 MPa].

Flexural Modulus (ASTM D790) 900,000 psi [6.205 GPa].

ANSI/AWWA F101 Type II.

Barcol Hardness (ASTM D2583) 30.

Water Absorption (ASTM D2583) <0.15%.

Allowable Defects (ASTM D2563) Level I.

* + - 1. E-glass:
				1. Minimum of 30% of laminate content by weight.
				2. Silane coupling agent.
				3. C-glass shall not be allowed.
			2. Laminate thickness:
				1. 1/4 inch [0.635 cm] (4-48 inch Palmer-Bowlus flumes).
				2. 3/8 inches [3.49 cm] (60-72 inch Palmer-Bowlus flumes).
		1. Gel coat:
			1. All surfaces must be gel coated.
			2. 15 mil cured thickness.
			3. U.V. inhibitors in all gel coat formulations, regardless of application or installation location.
			4. Color:
				1. Interior surfaces: white gloss.
				2. Exterior surfaces: gray.
		2. Dimensional bracing:
			1. Removable, gray equal leg pultruded fiberglass bracing with T-304 stainless steel hardware capable of providing sufficient strength and structural support to resist the stresses of shipping and installation (cribbing of the flume is still required during installation).
				1. 1-inch x 1-inch [2.54 cm x 2.54 cm] (4-6-inch Palmer-Bowlus flumes).
				2. 2-inch x 2-inch [5.08 cm x 5.08 cm] (8-21-inch Palmer-Bowlus flumes).
				3. 3-inch x 3-inch [7.62 cm x 7.62 cm] (24-72-inch Palmer-Bowlus flumes).
		3. Flanges:
			1. Integral top and end flanges:
				1. 2-inches [5.08 cm] wide (minimum) (4-12-inch Palmer-Bowlus flumes).
				2. 3-inches [7.62 cm] wide (minimum) (15-72-inch Palmer-Bowlus flumes).
		4. Stiffening ribs:
			1. Encapsulated stiffening ribs to provide sufficient strength and rigidity to allow the flume to be self-supporting and capable of holding the rated maximum head of water without visible distortion.
		5. Anchoring clips:
			1. Anchor clips chemically bonded to the exterior of the flume to aid in securing the flume during installation.
			2. Pre-drilled with Ø5/8 inch [1.59 cm] hole.
			3. Permanent style Palmer-Bowlus flumes only.
	1. Dimensional Tolerances:
		1. Flume throat dimensions shall be plus or minus:
			1. 1/16-inch [1.59 mm] (12-inch or smaller Palmer-Bowlus flumes).
			2. 3/32-inch [2.38 mm] (18-24-inch Palmer-Bowlus flumes).
			3. 1/4-inch [6.3518 mm] (36-72 Palmer-Bowlus flumes).
		2. Other flume dimensions shall be plus or minus:
			1. 1/8-inch [3.18 mm] (24-inch or smaller Palmer-Bowlus flumes).
			2. 1/2-inch [12.7 mm] (27-72-inch Palmer-Bowlus flumes).
	2. Level:
		1. High-visibility two-axis spirit level mounted at the throat ramp.
1. ACCESSORIES
	1. End Connections
		1. End adapters
			1. Inlet end adapter to transition the flow into the flume, with:
				1. \_\_\_\_\_-inch [\_\_\_\_\_ cm] O.D. pipe stub

Elastomeric polyvinyl chloride coupling with stainless steel bands to connection to \_\_\_\_\_-inch [\_\_\_\_\_ cm] O.D. pipe.

* + - * 1. ANSI 150 lb. pattern, flat faced fiberglass flange to connect to \_\_\_\_\_-inch [\_\_\_\_\_ cm] flange.
				2. Fiberglass caulking collar with internal Ø\_\_\_\_\_-inches [\_\_\_\_\_ cm].
				3. Removable manual bar screen / trash rack for occasional solids screening.
				4. Removable energy absorber to break up the velocity profile of energetic incoming pipe flow.
				5. Removable set of T-304 stainless steel flow straighteners to break up incoming flow patterns and provide a more uniformly distributed velocity profile.
				6. Removable set of perforated polyvinyl chloride plates to provide a more uniformly distributed velocity profile.
			1. Outlet end adapter to transition the flow out of the flume, with:
				1. \_\_\_\_\_-inch [\_\_\_\_\_ cm] O.D. pipe stub

Elastomeric polyvinyl chloride coupling with stainless steel bands to connection to \_\_\_\_\_-inch [\_\_\_\_\_ cm] O.D. pipe.

* + - * 1. ANSI 150 lb. pattern, flat faced fiberglass flange to connect to \_\_\_\_\_-inch [\_\_\_\_ cm] flange.
				2. Fiberglass caulking collar with internal Ø\_\_\_\_\_-inches [\_\_\_\_\_ cm].
	1. Flow / Level Options
		1. Bubbler tube
			1. Field removable / replaceable T-304 stainless steel bubbler tube mounted in recessed cavity open to the flow stream and secured through the use of (2) nuts on the top flange of the flume.
			2. Compression couplings shall be not allowed.
		2. Probe well
			1. Ø2-inch [5.08 cm] diameter tube with Ø2-inch [5.08 cm] opening laminated to the flume sidewall and extending 3-inches [7.62 cm] below the crest (floor) of the flume (for the installation of a submerged probe).
		3. Stilling well
			1. Attached, with Ø2-inch [5.08 cm] opening in flume sidewall and extending 3-inches [7.62 cm] below the crest (floor) of the flume.
				1. 6-inch [15.24 cm].
				2. 8-inch [20.32 cm].
				3. 12-inch [30.48 cm].
				4. 16-inch [40.64 cm].
			2. Detached, with Ø2-inch [5.08 cm] coupling in flume sidewall (interconnection tubing by others) and extending 3-inches [7.62 cm] below the crest (floor) of the flume.
				1. 6-inch [15.24 cm].
				2. 8-inch [20.32 cm].
				3. 12-inch [30.48 cm].
				4. 16-inch [40.64 cm].
		4. Ultrasonic mounting bracket
			1. Horizontally and vertically adjustable T-304 stainless steel construction.
			2. Capable of simultaneously mounting ultrasonic transducers up to Ø1-inch [2.54 cm] NPT and temperature sensors up to Ø1-inch [2.54 cm] NPT.
	2. Parameter Monitoring Options
		1. Probe holder
			1. Field removable / replaceable T-304 stainless steel probe holder (for pH, DO, conductivity, etc. probes) mounted in recessed cavity open to the flow stream and secured through the use of a nut on the top flange of the flume.
			2. Holder to extend 1-inch [2.54 cm] below crest (floor) of the flume to aid in keeping the probe wetted.
			3. Holder shall accommodate Ø7/8-inch [2.223 cm] to Ø1 1/8-inch [2.858 cm].
		2. Probe well
			1. Ø2-inch [5.08 cm] diameter tube with Ø2-inch [5.08 cm] opening laminated to the flume sidewall and extending 3-inches [7.62 cm] below the crest (floor) of the flume (for pH, DO, conductivity, etc. probes).
		3. Sampler tube
			1. Field removable / replaceable T-304 stainless steel sampler tube secured through the use of (2) nuts on the top flange of the flume.
			2. 3/8-inch [9.525 mm] tube to accept standard 3/8-inch [9.525 mm] suction line.
	3. Customization
		1. Bolt down cover
			1. Removable flat bolt down fiberglass cover over flume, with free (non-encapsulated) T-304 stainless steel hardware. U.V. inhibited gel coat on all covers surfaces.
			2. Removable clear, U.V. stable polycarbonate (Lexan) flat cover over flume, with free (non-encapsulated) T-304 stainless steel hardware.
			3. Removable tinted, U.V. stable polycarbonate (Lexan) flat cover over flume, with free (non-encapsulated) T-304 stainless steel hardware.
		2. Custom gel coat color
			1. Gel coat color other than standard white / gray, with U.V. inhibitors, from manufacturer supplied color chart.
				1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
				2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
		3. Recessed grating
			1. Removable, recessed, narrow opening fiberglass grating with slip resistant top surface.
1. FIELD ASSISTANCE
	1. Qualified factory representative shall provide on-site assistance, consisting of:
		1. (\_\_\_) days of installation observation.
			1. Factory representative shall complete a Certification of Installation Observation.
			2. Installation observation shall not alleviate installing party from proper installation liability.
		2. (\_\_\_) days of operator training.
2. EXECUTION
	1. Examination
		1. Verify that the flume dimensions are correct and that the site conditions are suitable for installing the flume.
		2. Flumes supplied with bolt-on end adapters or wing walls must remain sealed between the joints. Where required, apply one or two continuous beads of silicone on all seating surfaces before proceeding with the installation.
	2. Installation
		1. The flat floor of the flume (the crest) should be set upstream and the throat (ramp) set downstream.
		2. The crest of the flume must be installed level from front-to-back and from side-to-side (using a level on the top of the ramp - not the top – of the flume).
		3. The inlet of the flume must be set at or above the invert of the inlet channel / pipe. If set higher, a 1:4 (rise:run) slope ramp should be grouted from the channel / pipe to the inlet of the flume. The inlet of the flume should never be below the invert of the channel / pipe.
		4. The internal dimensions of the flume are critical to its proper operation. The flume must be braced internally (plywood and lumber are typically used) during installation to ensure that distortion does not occur. The dimensional bracing on the top of the flume is provided to ensure dimensional accuracy. The bracing should be left on the flume until the installation has been completed. For installations where the flume is set in concrete, the bracing may be removed once the installation has been completed and verified. For installations where the flume is freestanding or otherwise not set in concrete, the bracing should be left in place.
		5. Flumes supplied with end adapters and pipe stubs may also be supplied with flexible couplings and stainless steel bands. Considerable force must be exerted by the coupling sealing surfaces during installation, if the coupling installs with little effort or appears loose, stop and contact the coupling manufacturer.
		6. Larger flumes may be placed on piers (poured perpendicular to the flow stream) or concrete blocks to allow sufficient access during installation.
		7. Key the flume into the concrete by securing the anchoring clips on the sides of the flume to rebar with wire. The anchoring clips are not intended to prevent the flume from floating or shifting during installation.
		8. The flume should be weighted as well as lined and braced internally to prevent flotation and / or distortion during installation. Floor distortion is a particular concern on flumes with large, flat bottoms. Make sure to take the necessary steps to avoid distortion before proceeding.
		9. Flowable grout should be used to secure the flume in place. The initial lift should be slowly poured from one side of the flume so that the grout will flow under the flume to the other side, thereby helping to eliminate any void areas under the flume.
		10. The initial lift should just cover the bottom of the flume and extend no more than 6-inches [15.24 cm] up the sidewalls. It (and all subsequent lifts) should be allowed to set before proceeding. Pouring grout too much or too fast can deform the floor or sides of the flume, shift it out of alignment, or move it out of level. As the grouting continues, periodically check that the sidewalls have not distorted.
		11. Use vibrator sticks or chaining to ensure that no void or air pockets remain in the grout. Care must be taken, though, when using a vibrator stick, as excessive use can cause distortion of the flume.
		12. On larger flumes, grout one section between piers (or blocks) at a time, letting the grout set before proceeding to the next section. A grout hose may be required due to the distances involved. Flow grout from only one side of the flume.
		13. Once the initial pour has set, grout up the sidewalls in 6-10-inch [15.24-25.4 cm] lifts, letting each lift set before proceeding.
		14. The finished surface or shoulder of grout should be even with the top of the flume and should be sloped towards the flume so that any overflow will drain back in to the flume.
	3. Adjust and Clean
		1. Verify that the complete installation meets the criteria above and any additional criteria supplied by the Engineer.
		2. Clean the flow surfaces in accordance with the manufacturer’s operation and maintenance instructions.
		3. Remove all trash and debris, leaving the site in a clean condition.