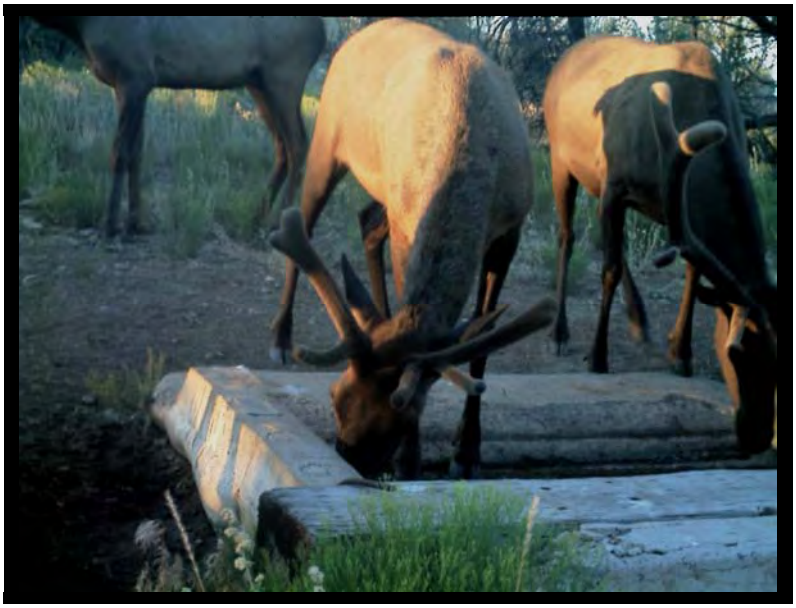
ARIZONA GAME AND FISH DEPARTMENT

WILDLIFE WATER CONSTRUCTION STANDARDS



REVISION
August 2008

ARIZONA GAME AND FISH DEPARTMENT
WILDLIFE WATER DEVELOPMENT STANDARDS

Revised

August 2008

TABLE OF CONTENTS

DETAILS

FORWARD

Since assembling the first “Arizona guzzler” in 1946, the Arizona Game and Fish Department (Department) has constructed more than 700 wildlife water developments statewide. The first water developments were designed to support desert quail and upland game bird reintroduction efforts in the 1950s and early 1960s. Since then, the Department’s primary focus has remained on game species, with the exception of a handful of water developments built to specifically benefit non-game species. Over the last five decades, water development design, site selection, materials, and construction methods have continued to evolve. This has resulted in an array of catchment types, some functioning well, others not, but all contributing to a growing maintenance load.

It is the Department’s commitment to achieve a financially sustainable water development program based on sound biological assessments, appropriate design, construction and material applications, and efficient resource allocation. To that end, one critical step was to develop this design standards manual by which the Department, its contractors and other project proponents can construct facilities that optimize past design experience, utilize standardized materials, employ efficient construction methods and reduce life cycle costs. It is also the objective of this document to catalogue a sufficient variety of details and specifications such that given the diversity of project specific parameters that can be anticipated in the development of man-made wildlife waters throughout Arizona, the following criteria can be met:

- A long lifespan (40-50 years for storage and collection systems, 25 years for drinking troughs).
- Standardized materials applied in accordance with manufacturers recommendations.
- Year-round, acceptable water quality for wildlife use.
- Maximized passive design elements.
- No supplemental water hauling required, except in rare or exceptional circumstances.
- Minimal visual impacts and blends in with the surrounding landscape.
- Construction details reflect efficiencies in both cost and time required.
- Minimal routine maintenance required.
- Accessible to and used by target species and excludes undesirable/feral species to the greatest extent possible.
- Minimized risk of animal entrapment and mortality.

The Department and its conservation partners have found that passive (no valves) underground system designs utilizing large volume fiberglass tanks, or PVC/HDPE tube type reservoirs with natural, hard surface aprons to ideally meet these

criteria. These specifications however are intended to provide a sufficient catalogue of components to support an assortment of configurations necessary to modify or redevelop existing systems of various designs (to satisfy the above criteria), accommodate environmental compliance limitations or adapt new development designs to site specific restrictions found in the field. This manual will be reviewed regularly for revision.

Comments and input are welcome and can be submitted directly to the Engineering Section of the Department's Development Branch.

SECTION 1 – GENERAL SPECIFICATIONS

In the absence of special provisions and details, all work shall be constructed in accordance with the latest editions of these water development standard specifications and details.

Unless otherwise specified in the special provisions the Contractor shall furnish all labor, materials, equipment, transportation, utilities, services and facilities required to perform the work described in the plans and specifications within the time specified. The Contractor shall follow all government guidelines and utilize appropriate suitable personal protective equipment during the performance of all work under these standards.

Arizona Game and Fish Department, Development Branch (623) 236-7485 can provide assistance in contacting current materials vendors.

1.1 AUTHORITY OF THE ENGINEER:

The Engineer will decide all questions, which may arise as to the quality and acceptability of materials and work performed and as to the rate of progress of the work; all questions, which may arise as to the interpretation of the plans and specifications; all questions as to the acceptable fulfillment of the contract on the part of the Contractor. The Engineer's estimates and decisions shall be final and conclusive. In case any question should arise, relative to the Contract Documents, the determination of the Engineer shall be a condition precedent to the right of the Contractor to receive final approval of the work questioned under the contract.

In giving instructions, the Engineer may make changes, not inconsistent with the purpose of the work.

The Engineer may, at his or her discretion, suspend the work wholly or in part due to the failure of the Contractor; to correct conditions unsafe for the workmen or the general public; for failure to carry out provisions of the contract; for failure to carry out the Engineer's orders; for such periods as he or she may deem necessary due to unsuitable weather; for conditions considered unsuitable for the prosecution of the work or for any other condition or reason deemed to be in the public interest.

The Engineer may designate inspector(s), assistants or other field staff to assist the Engineer in observing the performance of the work.

1.2 CLEARING AND GRUBBING:

This work shall consist of removal of all objectionable material including trees, stumps, brush, roots, rubbish and debris from the area required for construction. The Contractor shall conduct clearing and grubbing in such a fashion as to minimize disturbance of adjacent property, utilities, natural drainages, geologic formations, trees and plants. Plants protected under environmental regulations shall be marked by Department staff and shall be avoided during all construction. Archeological resources shall be carefully preserved during construction and any collection or disturbance of such materials is strictly forbidden.

All stumps and roots shall be grubbed to 18 inches below finish grade. Cavities left by the removal of stumps or roots shall be carefully backfilled and compacted to a minimum 95% density.

No payment shall be made for clearing and grubbing as such the cost thereof shall be included in the lump sum price for construction.

1.3 AVAILABILITY OF WATER AND ELECTRICITY:

The Contractor shall be responsible for providing all water and/or electric power, which may be required for construction. The Department will not provide water and/or electric power.

No payment shall be made for water and/or electric power; as such the cost thereof shall be included in the lump sum price for construction.

1.4 WASTE MATERIALS:

All unusable (waste) materials such as wood, rubbish, construction debris, waste asphalt and concrete shall be removed from the site and properly disposed of at a licensed waste disposal facility. All costs associated with such removal and disposal shall be included in the lump sum price for construction.

1.5 SUBMITTALS:

The Contractor shall submit three copies of a proposed project construction schedule and shop drawings and product data for the fabrication and installation of all improvements at least two weeks prior to the proposed start of construction. The project construction schedule(s), shop drawings and product date shall be approved by the Engineer prior to the start of construction.

1.6 WARRANTEES:

The Contractor shall furnish the Department with a one-year guarantee on all materials and installation. All materials and replacement or repair shall be provided at no cost to the owner during the warranty period. The warranty period shall begin at the date of acceptance of the completed work by the Department Engineer.

2 – TANKS

2.1 FIBERGLASS "SAUSAGE" TANKS

The specification describes three types of fiberglass "sausage" tanks as shown in Standard Details 001, 002 & 003: Two manufactured for above ground installation, and one manufactured for below ground installation.

GENERAL MATERIAL STANDARDS (All types)

In this specification, "fiberglass" refers to glass fiber reinforced epoxy plastic. All components shall be of standard fiberglass construction and shall conform to American Society for Testing and Materials (ASTM) C582-95, D3299, D4097-95ae1, D5421-93, or other equivalent Arizona Game and Fish Department (AGFD) approved standards. The material of fabrication shall consist of 30% glass fibers and 70% resin.

A. AIR LIFT DESIGN

Above ground tanks shall be designed for helicopter airlift to the project site utilizing standard lifting cables and/or slings. Any strong-backs and/or special lifting apparatus required ensuring safe, undamaged installation of the tanks shall be provided by the manufacturer.

B. CAPACITY

Tank capacity varies according to type; an actual capacity variance of up to 50 gallons shall be acceptable. The detailed drawings depict the tank dimensions.

C. ACCESS OPENING

A 20-inch diameter access opening with a minimum 4-inch wide flanged rim shall be centrally located on the top of the tank. The opening shall be constructed with the same material and wall thickness as the tank. The access saddle and riser shall extend at least 6 inches above the top of the tank. A removable flat fiberglass bolt-down cover and neoprene gasket shall be provided. The cover shall be constructed of fiberglass having a minimum thickness of 1/4 inch. A minimum of eight, ¼-inch diameter by 1½-inch long bolt assemblies shall be

installed at equal spacing around the flange. The bolt assembly shall include a bolt, two flat washers, a lock washer and a hex nut, all of type 304 or type 316 stainless steel. The flange of the access opening and the cover shall form a watertight seal when the access cover and gasket are bolted in place.

D. TANK SUPPORTS

Fiberglass tank supports may be fabricated and glassed-in to the tank base for aboveground installation as required in the detailed specifications. Tank supports shall be fabricated to ensure stability of a full tank on steel or concrete pedestals. The tank supports shall be installed at the intervals specified in the drawings to ensure compatibility with existing pedestals and standard plans for the construction of pedestals. All tank supports shall be constructed so that the empty tank with supports in place, when placed on a flat slab, shall bear evenly and fully. In no case shall there be any gap between the support bottom and the slab greater than 1/8 inch.

E. GEL COAT

For maximum durability, it is important that all exterior surfaces have a continuous resin-rich surface. External tank and trough surfaces shall be coated with a colored polyester gel coat to preclude the deterioration of fiber surfaces from ultraviolet ray exposure. All tanks and troughs shall be treated with an ultraviolet resistant coating. The interior surfaces of all tanks and troughs shall be coated with a non-toxic, polyester gel coat formulated for potable water storage. Gel coat applications shall conform to commercial standards CS-221-59 and shall cover all fiberglass surfaces with a 15-mil minimum thickness.

F. PERFORMANCE TESTING

The manufacturer shall be responsible for performance testing of each tank prior to delivery. The AGFD may require that an AGFD representative be present during testing. Two tests shall be required. In the first test, the empty tank with supports in place shall be placed on a flat slab; the tank shall bear evenly and fully and there shall be no gap between the support bottom and the slab greater than 1/8 inch. For the second test, the lower fittings on the tanks shall be plugged and the tank shall be placed on a level surface and filled with water. All supports must create a firm contact with the surface. Tanks shall be observed over a period of one hour. The tank shall be inspected for leaks and any structural defects. Any failure to fully contact supporting surfaces, leaks, structural defects, or irregularities in the supports shall be considered reason for rejection and must be repaired to the satisfaction of the engineer, and the tank shall pass a re-test prior to delivery. The manufacturer shall certify that the tank is watertight and structurally sound. A record of each test signed by the manufacturer's quality assurance representative shall be provided with delivery. The AGFD may approve alternative methods to test the product.

G. DEFECTS

All components shall be free of defects, including foreign inclusions, dry spots, air bubbles, delaminating, cracks, and other irregularities that may break and expose fiber. All surfaces shall be free of cracks, crazing or other defects detrimental to facility performance. All surfaces shall have a smooth, continuous finish. Glass fiber shall not be exposed directly from cracks or pinhole porosity. The surfaces shall be free of any defect that may break and expose fibers. All seams and joints shall be constructed to equal or exceed the strength of the adjacent non-seamed material.

2.2 "XERXES" FIBERGLASS REINFORCED PLASTIC TANKS

The Contractor shall provide the Department with single-wall fiberglass reinforced plastic (FRP) underground water storage tank as detailed in the project plans and specifications. Capacity, dimensions, fitting(s) size(s) and location(s) and accessories shall be as detailed in the project plans and specifications. Tanks provided under this specification shall be as manufactured by Xerxes Corporation and conforming to the requirements of NSF Standard 61.

A. APPLICABLE REFERENCE STANDARDS

In these specifications fiberglass refers to fiber reinforced plastic (FRP). All components shall be of standard fiberglass construction and shall conform to the following:

1) American Society for Testing and Materials (ASTM) C582-95, D3299, D4021-86, D4097-95ae1, D5421-93, or other equivalent Arizona Game and Fish Department (AGFD) approved standards.

2) Underwriters Laboratories, Inc. (U.L.) Standard for Safety 1316, File MH 9061 for storage of flammable liquids. A U.L. certification plate shall be attached to each tank.

3) Factory Mutual Systems approval IM7AOAF

4) Military Specifications No. MIL-T-52777A

B. MATERIAL

The material of fabrication shall consist of 30% glass fibers and 70% resin. *No sand fillers shall be permitted.*

C. DEFECTS

All components shall be free of defects, including foreign inclusions, dry spots, air bubbles, delaminating, cracks, and other irregularities that may break and expose fiber. All surfaces shall be free of cracks, crazing or other defects detrimental to facility performance. All surfaces shall have a smooth, continuous finish. Glass fiber shall not be exposed directly from cracks or pinhole porosity. The surfaces shall be free of any defect that may break and expose fibers. All seams and joints shall be constructed to equal or exceed the strength of the adjacent non-seamed material.

D. GEL COAT

For maximum durability, it is important that all exterior surfaces have a continuous resin-rich surface. External tank and trough surfaces shall be coated with a colored polyester gel coat to preclude the deterioration of fiber surfaces from ultraviolet light exposure. All tanks and troughs shall be treated with an ultraviolet resistant coating. The interior surfaces of all tanks and troughs shall be coated with a non-toxic, polyester gel coat formulated for potable water storage. Gel coat applications shall conform to commercial standards CS-221-59 and shall cover all fiberglass surfaces with a 15-mil minimum thickness.

GENERAL TANK STRUCTURAL REQUIREMENTS (All types)

Tanks shall meet the following design criteria:

1) Internal Load: Tank shall withstand a 5-psi air pressure test with 3:1 safety factor.

2) Vacuum Test: To verify structural integrity, every tank shall be vacuum tested by manufacturer at the factory to 11.5 inches of mercury.

3) Surface Loads: Tank shall withstand surface H-20 axle loads when properly installed according to current manufacturer's installation instructions.

4) External Hydrostatic Pressure: Tank shall be buried in ground with 7' of overburden over the top of the tanks, the hole fully flooded and safety factor of 3:2 against general buckling.

PRODUCT STORAGE

1) Tanks shall be capable of storing products with specific gravity up to 1.1.

2) Tanks shall be vented to atmospheric pressure. The tank is not designed as a pressure vessel.

2.3 HDPE CYLINDER TANKS

The polyethylene extrusion compound from which the tank is extruded shall meet the requirements of Type III, Grade 34, Class C, extra high molecular weight, high-density polyethylene material as described in ASTM D3350.

The tank walls shall be homogeneous throughout and free from visible cracks, holes foreign inclusions or other defects. The tank material shall be uniform in color, opacity, density and other physical properties.

Tanks shall meet the following design criteria:

1) Internal Load: Tank shall withstand a 5-psi air pressure test with 3:1 safety factor.

2) Vacuum Test: To verify structural integrity, every tank shall be vacuum tested by manufacturer at the factory to 11.5 inches of mercury.

3) Surface Loads: Tank shall withstand surface H-20 axle loads when properly installed according to current manufacturer's installation instructions.

4) External Hydrostatic Pressure: Tank shall be buried in ground with 7' of overburden over the top of the tanks, the hole fully flooded and safety factor of 3:2 against general buckling.

2.4 PVC "PIPE" TANKS

All PVC pipe furnished under these specifications shall conform to the following. All PVC pipe, couplings and caps shall be made from Class 1245-A or Class 1245-B compounds as defined and set forth in American Water Works Association (AWWA) Standards relating to PVC potable water distribution pipe. The PVC compounds used to manufacture said PVC pipe shall contain no deleterious ingredient in any amount that has been demonstrated to migrate into water in detectable quantities. PVC pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions or other defects. The pipe shall be uniform in color, opacity, density and other physical properties. Any gaskets and/or lubricants used with PVC pipes and couplings shall be manufactured from materials that are compatible with the plastic material and each other when used together. The materials shall not support the growth of bacteria or adversely affect the potable quality of the water.

The pipe shall be permanently marked indicating size and pressure rating. The appropriate markings shall occur on the pipe at least once in every 24 inches. The seal of approval or marking of the testing laboratory shall be included in the marking on all pipe intended for transporting potable water.

PVC pipe shall be handled in accordance with AWWA Guideline M23. PVC pipe shall not be handled with individual chains or single cables, even if padded. Pipe shall not be dropped to the ground or rolled into the trench. Pipe shall not be dropped or rolled against other objects. All PVC pipe, couplings, caps and gaskets shall be stored covered so as to protect from exposure to sunlight, ozone and grease. PVC pipe shall be stored so as to not become deformed or bent during storage.

PVC pipe and fittings to be joined using a primer solvent-cement joining system shall utilize only a manufacturer approved primer solvent-cement joining system.

Primer shall conform to ASTM F-656-80 and shall be purple in color.

Solvent-cement shall conform to ASTM D-2564 and shall be the proper type and viscosity according to pipe size. The solvent-cement shall be of a solution of Type 1, Grade 1, unplasticized PVC resin. The cement shall be free flowing and shall not contain lumps, microscopic undissolved particles or any foreign matter that will adversely affect the ultimate joint strength. It shall show no stratification or separation that cannot be removed by stirring.

Manufacturers recommendations for joining under high temperature (over 100° F) and/or high humidity (over 60%) shall be strictly followed.

2.5 FIBERGLASS “RING” TANKS

Dimensions and construction shall be as indicated in Standard Detail 004. These components are used in a variety of remote installations to serve wildlife. Components may be exposed to any of the weather extremes experienced within the state of Arizona (i.e.: reactive soils, heat and cold extremes, ultraviolet radiation, or other hazardous weather conditions). The intent of this specification is to obtain components that shall provide many years of service with a minimum amount of maintenance.

A. STANDARDS

In this specification, “fiberglass” refers to glass fiber reinforced epoxy plastic. All components shall be of standard fiberglass construction and shall conform to American Society for Testing and Materials (ASTM) D-4097-82, D-4097-88, or other equivalent industry approved standards. The material of fabrication shall consist of 30% glass fibers and 70% resin.

B. DEFECTS

The manufacturer shall ensure that workmanship for all components is of the highest quality and suitable for a long-term, maintenance free, installation. Items shall be free of defects, including foreign inclusions, dry spots, air bubbles, de-lamination, cracks, and other irregularities. All surfaces of the item shall be free of cracks, crazing or other defects detrimental to facility performance. All surfaces shall have a smooth continuous finish with no exposed fibers. The surfaces shall be free of cracks, pinhole porosity, or bubbles that may break and expose fibers. All seams and joints shall be constructed to equal or exceed the strength of the adjacent non-seamed material. All items shall be gel coated. The tinting of the exterior gel coat for components shall be dark brown.

C. GEL COAT

For maximum durability, it is important that all exterior surfaces have a continuous resin-rich surface. External tank and trough surfaces shall be coated with a colored polyester gel coat to preclude the deterioration of fiber surfaces from ultraviolet ray exposure. All tanks and troughs shall be treated with an ultraviolet resistant coating. The gel coat shall be olive, desert tan or dark brown unless otherwise specified at the time of the order. The interior surfaces of all tanks and troughs shall be coated with a non-toxic, polyester gel coat formulated for potable water storage. Gel coat applications shall conform to commercial standards and shall cover all fiberglass surfaces with a 15-mil minimum thickness.

D. DESIGN

The manufacturer shall be responsible for ensuring that the items, supports, plumbing inserts, and lifting lugs are adequate for their intended function. The attached drawings are illustrative only; the manufacturer shall be responsible for providing detailed engineering design to adequately address the intent of the drawings.

E. DRAWINGS

The manufacturer shall submit two copies of shop drawings prior to fabrication of components. On each component, fittings, supports, and lifting lugs shall be located within 1/4 inch of approved location on the shop drawings. Shop drawings shall consist of design drawings, coating and finishing specifications, and other data necessary to clearly describe design, materials, sizes, layouts, construction details, fasteners, and fabrication. The manufacturers engineer shall approve the drawings. Engineering calculations for supports and lifting lugs used on the components shall be included. The manufacturers engineer shall approve the manufacturing requirements for construction and installing the lifting lugs and supports. The shop drawings will be reviewed by the AGFD Engineer and one copy will be returned to the manufacturer marked “Approved”, “Approved with

Changes Noted", or "Rejected". Rejected drawings shall be revised and resubmitted for approval prior to commencing fabrication of components.

F. FITTINGS

All tanks and troughs shall be furnished with professionally installed fittings as specified, properly installed to satisfy the functional requirements for inlet, vent, and outlet. The specification sheet depicts their size and location. It is anticipated that fitting size and location may vary on occasion. Should this occur, the contractor will be provided a modified specification sheet. Fittings shall be professionally installed in the tank shell to provide unit integrity and a watertight seal. Vertical fittings shall be installed so attached plumbing attached to the fitting shall be plumb. Horizontal fittings shall be installed so that attached plumbing shall be parallel with the longitudinal axis of the tank. Fittings shall be threaded for standard connections as indicated on the specification sheets.

G. LIFTING LUGS

Lifting lugs shall be incorporated into walk-in troughs as shown in the details and shall have glassed-in lifting lugs incorporated into the upper sides of the trough. Four lifting lugs shall be required for all troughs. The lugs shall be constructed, placed and installed for use in helicopter airlift and heavy equipment (backhoe) lifting of all tanks and troughs, and two lifting lugs shall be placed near each terminal end to accommodate a balanced cable hookup for the aerial transport by helicopter of all troughs. The manufacturer shall construct all lugs to accommodate cable or strap lifting. The lugs shall meet OSHA requirements for lifting assemblies. The shop drawings shall indicate the size and location of the lifting lugs. The manufacturer shall provide any strong-backs and/or special lifting apparatus required insuring safe, undamaged installation of the tanks and troughs.

H. DELIVERY

The manufacturer is advised that at the time of delivery, an AGFD representative will be present to inspect the products for structural defects or irregularities. Tanks will be assembled and disassembled prior to delivery, including roof sections by the fabricator to verify fit and alignment of surfaces, flanges and bolt holes. A record of each assembly signed by the manufacturer's representative shall be provided with delivery. The weight of each component shall be stenciled on the outside of each piece. In addition the manufacturer will provide written transport and installation instructions/guidelines for the various components.

I. AIR LIFT DESIGN

Above ground tanks shall be designed for helicopter airlift to the project site utilizing standard lifting cables and/or slings.

J. CAPACITY

Tank capacity varies according to type; an actual capacity variance of up to 100 gallons shall be acceptable. The detailed specification sheets depict the tank volumes.

K. ACCESS OPENING

An access opening, with a minimum inside dimension of 20 inches with a flanged rim shall be located on the top of the tank. The opening shall be constructed with the same material and wall thickness as the tank. The access saddle and riser shall extend at least 6 inches above the top of the tank. A removable flat fiberglass bolt-down cover with a minimum thickness of 1/4 in. and neoprene gasket shall be provided. A minimum of eight, ¼-inch diameter by 1 1/2 inch long bolt assemblies shall be installed at equal spacing around the flange. The bolt assembly shall include a bolt, two flat washers, and a hex nut of type 304 or 316 stainless steel. The flange of the access opening and the cover shall match to form a watertight seal when the access cover and gasket are bolted in place.

L. FIBERGLASS ROOF SECTIONS

Roof sections will be structurally sound and of sufficient strength to support the weight of the installation activity and a static or dead load of 1,000 pounds in addition to the weight of the roof after installation. The fiberglass and gel coat of these roof sections will meet or exceed the quality of those materials used in the tank fabrication. This roof when assembled shall be higher in the center than along the circumference. The manufacturer will provide a center support column as part of the components for the purpose of supporting the center of the assembled roof. The manufacturer will provide an appropriate base for this center support that will be permanently fiberglassed in place during field installation. The roof sections may be as few as two but not more than six in number. The roof sections and base sections should be numbered and marked sequentially where the flange holes were mated in the fabricator assembly process.

M. LIP SEAMS

The tanks vertical sides, circumference, and roof seams are to be first attached with cadmium plated bolts. We then intend to permanently mate the various sections in order to produce a single unit. The floor seam will not be bolted prior to fiberglass mating. All interior seams must be rough textured and not be gel coated for a distance of four inches either side of this seam. The manufacturer will determine and provide the appropriate bolts and drill the holes at the spacing the manufacturer determines necessary for this purpose.

N. TANK FLOOR

The floor of the tank shall be fabricated such that it will be a uniform surface to provide uniform contact when placed on a level prepared surface.

O. PERFORMANCE TESTING

The manufacturer is advised that at the time of delivery, an AGFD representative will be present to inspect the products for structural defects or irregularities. Any structural defects, or irregularities shall be repaired and the tank must pass a re-inspection prior to delivery acceptance. Tanks will be assembled and disassembled prior to delivery, including roof sections by the fabricator to verify fit and alignment of surfaces, flanges and boltholes. A record of each assembly signed by the manufacturer's representative shall be provided with delivery. The AGFD may require other methods to test the product when the visual inspection indicates the potential for problems with the functioning of any component. The weight of each component shall be stenciled on the outside of each piece. In addition the manufacturer will provide written transport and installation instructions and guidelines for the various components.

2.7 RECONDITIONED USED STEEL FUEL TANKS

Prior re-use as water storage tanks, the interiors of reconditioned, used, steel fuel tanks shall be thoroughly cleaned to remove all deposits or rust by sand or bead blasting and the interior surfaces of all tanks shall be coated with a non-toxic, polyester gel coat formulated for potable water storage. Gel coat applications shall conform to commercial standards CS-221-59 and shall cover all fiberglass surfaces with a 15-mil minimum thickness.

SECTION 3 – TROUGHS

3.1 WALK-IN TROUGHS

Troughs are designed to provide an access to the water source for wildlife. Walk-in troughs are to allow wildlife to enter the trough to access water at a low level. Dimensions and construction shall be as indicated in Standard Details 050, 051, 052, 054, 055 or 056 as applicable. Troughs of all types shall be suitable for above ground or below ground installation.

A. INTERIOR CORNERS

All interior corners shall have a thickened fiberglass section that forms a 1" radius interior curve to prevent cracking.

B. RETAINMENT RIBS

Walk-in troughs shall have retainment ribs attached to the ramp on the interior of the trough. The retainment ribs shall be 1.5 inches wide, 3/16 inches thick, and 4 feet long. The ribs shall be installed at 12-inch spacing to support a masonry and native stone ramp to be cast within the trough during installation. Walk-in troughs shall have steel reinforcement incorporated into the fiberglass. The reinforcement shall be an integral part of the component. The size and location of the reinforcement is indicated in the attached drawings.

3.2 FLOAT TROUGHS

Float troughs are designed to provide an access to the water source for wildlife. Troughs shall be suitable for above ground or below ground installation. All interior corners shall have a thickened fiberglass section that forms a 1" radius interior curve to prevent cracking. All float troughs shall be provided with small animal escape ramps.

SECTION 4 – PRECIPITATION COLLECTION APRONS

Dimensions and construction shall be as indicated in Standard Details 112, 113, 114, 115 & 116. Precipitation collection aprons shall be constructed of one or more standard 24 foot square standard panels screwed together, arranged in rectangle(s) or square(s) and provided with standard fiberglass gutter(s) on the down gradient side(s) as shown in the detailed project plans and specifications. Individual panels shall be constructed of 16-gage steel “C” channel frame, 4 inch steel track, 16-gage steel studs covered with 26-gage steel “R” panel roofing. Panels shall be factory finished with a baked-on enamel coating, the color of the enamel finish shall be as selected by the Engineer, with a minimum 1-year guarantee, to provide camouflage for the completed apron assembly. All assembly and materials shall be in accordance with the American Standard Association (ASA) Specification A24.4. All metal construction shall be so erected that finished surfaces shall be square and true to line and grade.

SECTION 5 – TINAJA SEALANTS

Tinajas (naturally occurring water pockets), which show evidence of leakage, may be sealed as required with asphalt-epoxy tar coating, hydraulic cement, a layer of steel reinforced concrete or other products as directed by the Engineer. Care shall be taken to carefully clean and dry all surfaces to be coated using wire brushes, sand or bead blasting or very high-pressure water sprays.

SECTION 6 – SHADE STRUCTURES

Shade structures shall be constructed of steel tubing posts and frames, 16-gage steel “C” channel shade frame, 3 5/8 inch steel track, 16-gage steel studs covered

with 26-gage steel “R” panel roofing or other structural system as shown in Standard Detail 111, indicated on the project plans or specifically allowed by the Engineer. The roofing panels shall be factory finished with a baked-on enamel coating, the color of the enamel finish shall be as selected by the Engineer to provide camouflage for the completed shade assembly. All assembly and materials shall be in accordance with the American Standard Association (ASA) Specification A24.4. All metal construction shall be so erected that finished surfaces shall be square and true to the line and grade indicated in the plans.

SECTION 7 – GABIONS

Gabions, which are constructed so as to limit or prevent accumulation of sand and silt in Tinajas and water catchments shall be constructed from either locally available, on-site stone or imported stone, steel wire baskets and steel pipe or “T” post supports. Construction of any gabion greater than six (6) feet in height shall be undertaken only after completion of an engineering design, prepared by an Engineer registered to practice in the State of Arizona with specialization in either Civil or Structural Engineering. Prior to construction, two copies of the design shall be provided to the Department Engineer for review and approval. Construction of such a dam or water retention structure shall take place only under the direct supervision of the designing Engineer.

SECTION 8 – DAMS

Construction of any dam or other water retention structure greater than six (6) feet in height shall be undertaken only after completion of an engineering design, prepared by an Engineer registered to practice in the State of Arizona with specialization in either Civil or Structural Engineering, the design shall include any geotechnical evaluations and/or borings the Engineer may deem necessary. Prior to construction, two copies of the design shall be provided to the Department Engineer for review and approval. Construction of such a dam or water retention structure shall take place only under the direct supervision of the designing Engineer.

8.1 MASONRY

Construction of masonry dams shall be constructed of bond beam concrete block with reinforcing steel placed both horizontally and vertically throughout the structure and all cells fully filled with Portland cement concrete as shown in the Standard Detail. Dams shall be securely attached to sound bedrock with steel reinforcing bars drilled and mortared into the rock. Reinforcement shall extend a minimum of 20 bar diameters into sound rock.

8.2 STONE

As general practice, the construction of stone dams shall be limited to the construction of diversion dams along small intermittent watercourses in desert locals. Such dams shall be constructed of clean, sound stones and cement mortar and shall be "toed" into the subsurface as required to prevent undercutting by stream flows. Stone dams shall be limited in height above grade to no greater than 2 feet and shall be constructed as "gravity dams" with a height (above grade) to thickness ratio no greater than 1.25. Stone to be used in such dam construction shall consist of sound stones having a minimum of 4 fractured faces. Prior to placement, stones shall be carefully cleaned, to the satisfaction of the Engineer, with water and steel brushes insuring a secure bond to the surrounding cement mortar.

SECTION 9 – SAND POINTS

Sand points are defined for the purposes of these specifications, as runoff collection facilities located in intermittent desert streams generally consisting of either a slotted well screen, 0.020" stainless steel mesh screen or other collection device as shown in the plans, located in a streambed. Sand points shall be constructed as shown in the project plans or Standard Detail 085.

SECTION 10 – FENCING

10.1 WIRE FENCES

10.1.1 Standard Wildlife Fence

Standard wildlife fencing shall consist of 4 wire strands, the top and bottom strands shall consist of 11-gage galvanized steel wire and the center two shall consist of barbed wire of a 2-point pattern; composed of 2 strands of 12½-gage galvanized steel wire with barbs spaced 5 inches apart, conforming to ASTM A-121. Wire shall be placed at the following spacing, the bottom wire 18 inches above the ground, the second wire 22 inches above the ground, the third wire 30 inches above the ground and the fourth or top 42 inches above the ground. Wire shall be placed on #133 steel "T" posts set solidly in the ground placed no further than 15 feet apart with two stays (wood preferred) set at 5 foot intervals between the posts. Corner and tension posts shall be constructed of 3-inch diameter 3/16 inch wall steel pipe set into the ground in 18 inch diameter by 24 inch deep MAG Class "B" concrete footers.

10.1.2 Antelope Fence

Antelope fencing shall consist of 3 wire strands, the top and bottom strands shall consist of 11-gage galvanized steel wire and the remaining strand shall consist of barbed wire of a 2-point pattern; composed of 2 strands of 12½-gage galvanized steel wire with barbs spaced 5 inches apart and shall conform to ASTM A-121. Wire shall be placed at the following spacing, the bottom wire at least 20 inches above the ground, the second wire 30 inches above the ground and the third wire 42 inches above the ground. Wire shall be placed on #133 steel "T" posts set solidly in the ground placed no further than 15 feet apart with two stays (wood preferred) set at 5 foot intervals between the posts. Corner and tension posts shall be constructed of 3-inch diameter 3/16 inch wall steel pipe set into the ground in 18 inch diameter by 24 inch deep MAG Class "B" concrete footers.

10.1.3 Elk Fence

Dimensions and construction shall be as indicated in Standard Detail 074. Elk fencing shall consist of 96-inch tall woven wire fencing. The fencing shall be constructed of two 48 inch widths of 10 to 12½-gage Class I field fence, 6" spacing, with 10-gage top and bottom wires fastened together with "hog rings" at intervals of no greater than 6-inches to assemble the fence panel. The bottom of fence wire shall be placed at ground level.

The fencing shall be supported with either 3-inch diameter wood posts, 11/2-inch diameter steel pipe posts or appropriate length #133 studded "T" steel posts. Wooden posts shall be sunk 3 feet into firm ground. Steel posts shall be set in 12 inch diameter by 30 inch deep MAG Class "B" concrete footers, alternatively posts set in rock may be grouted in to drilled holes. Posts shall be set no further than 10 feet apart.

10.2 CHAIN LINK FENCE

Chain link fencing shall be constructed according to project plans and specifications and shall conform to the following:

a. All materials shall be new and upon request of the Engineer, the Contractor shall furnish a certification of inspection stating that the materials have been manufactured, sampled and tested so as to meet the requirements of these specifications.
b. Posts, rails and braces shall be manufactured of hot-rolled steel strip in compliance with ASTM F-569 having a minimum yield strength of 50,000 psi. The pipe shall be manufactured by electric arc welded cold-formed process per ASTM A-669. The exterior shall be triple coated and the interior single coated per ASTM F-1234. The triple coated exterior surface shall be hot-dipped zinc coated (galvanized) having a weight of not less

than 1.0 oz./square foot ±0.1 oz. Posts shall be fitted with tops or extension rails as specified designed to fit securely over the post top providing suitable bearing length to securely support barbed wire where specified.

c. Chain link fabric shall conform to the requirements of ASTM A-392 (zinc coated) or ASTM A-491 (aluminum coated). The wire used in manufacture of the fabric shall be a minimum 9-gage unless otherwise specified. The coating process shall leave the fabric completely free of barbs, snags, icicles or other projections, which might be hazardous.
d. Barbed wire shall be 4-point pattern; composed of 2 strands of 12½-gage galvanized steel wire with barbs spaced 5 inches apart and shall conform to ASTM A-121.
e. Line posts shall be placed no further than 10 feet apart and firmly set in MAG Class "B" concrete footers not less than 12 inches in diameter and 18 inches in depth.
f. Corner and tension posts shall be firmly set in MAG Class "B" concrete footers not less than 18 inches in diameter and 30 inches in depth.

10.3 PIPE RAIL FENCE

10.3.1 Standard Pipe Rail Fence

Standard pipe rail fencing shall be constructed of ½-inch diameter black steel welded or seamless pipe with male ½-inch NPT male threads on both ends fastened together with ½-inch NPT female couplers. Dimensions and construction shall be as indicated in Standard Detail 071.

10.3.2 Heavy-Duty Pipe Rail Fence

Heavy-duty pipe rail fencing shall be constructed of ½-inch diameter black steel welded or seamless pipe with male ½-inch NPT male threads on both ends fastened together with ½-inch NPT female couplers. Dimensions and construction shall be as indicated in Standard Detail 072.

10.4 WILDLIFE CROSSINGS

Wildlife crossings shall be constructed in wire fences wherever experience indicates that wildlife concentrates to cross the fences. Crossings shall be constructed so as to allow ingress and egress by targeted wildlife species without compromising the ability of the fence to prevent livestock crossing the fence as specified by the Engineer.

10.4.1 Elk Jumps

Elk jumps shall be constructed by enclosing the top wire of a standard livestock fence in 1" diameter black PVC or HDPE pipe.

10.4.2 Wildlife Escape Passages

Wildlife escape passages shall be constructed in habitat restoration Elk exclosure fences as required to allow movement of non-targeted wildlife through the fence. Escape passages for habitat restoration exclosures shall be limited to 18”X18” square framed openings located adjacent (within 3 feet) to the corners of Elk exclosure fences. Openings shall be framed with 1” square steel tube or similar material at the discretion of the Engineer.

SECTION 11 – PIPE AND FITTINGS

11.1 COPPER PIPE

All copper pipe and tubing shall be new seamless copper pipes and tubes, designed for water service, plumbing purposes, etc. They shall conform to all the requirements of ASTM B-88, Type K.

All pipe and fittings shall be made of copper free from cuprous oxide, as determined by microscopic examination at a magnification of 75 diameters.

Type K tubing, when furnished in coil, shall be annealed after coiling.

All fittings used in connection with copper pipe or tubing, shall be copper or bronze fittings as manufactured by Jones, Muller, or approved equal, as shown on standard details. All solder used in joining copper pipe, tubing and fittings shall be lead free, approved for joining of potable water lines.

In locations over 3,000 feet in elevation, all above ground pipe shall be insulated either with fiberglass tape or by casing the pipe in perforated PVC pipe at least 2 inches in diameter greater than the water carrying pipe with the annular space between the copper and PVC pipes filled with expanded-in-place urethane foam, as directed by the Engineer.

11.2 GALVANIZED STEEL

All galvanized pipe shall be new galvanized welded or seamless steel pipe, conforming to the requirements of ASTM A-120, standard weight, schedule 40.

All buried galvanized pipe shall be protected from corrosion by the application of a tight fitting, extruded or wrapped polyethylene or polyvinyl coating no less than 0.030 inches thick. Wrapped coatings shall be edge lapped no less than ¼ inch.

All fittings for screwed galvanized pipe shall be 150 psi, banded, galvanized malleable iron screwed fittings.

11.3 GRUVLOK/VICTAULIC PIPE

All “GRUVLOK”/”VICTAULIC” type pipe and fittings furnished under these specifications shall conform to the following; American Society for Testing and Materials (ASTM) Specification F-1476, ASTM Specification C-606, ASTM Specification A-536, ASTM Specification A-47, ASTM Specification B-633 and ASTM Specification A-183, as applicable.

11.4 HDPE PIPE

All HDPE pipe and tubing furnished under these specifications shall conform to the following; American Society for Testing and Materials (ASTM) Specification C-901: Polyethylene Pressure Pipe, Tubing and Fittings, for Water; ASTM D2239: Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) (Iron Pipe Size, Inside Diameter); ASTM D2737: Specification for Polyethylene (PE) Plastic Tubing (Copper Tube Size, Outside Diameter); ASTM D3350: Specification for Polyethylene Plastic Pipe and Fittings Materials. This specification describes pipe of the nominal I.D. and O.D. size as manufactured by Carlson, Celanese, Orangeburg, Phillips 66, Driscopipe and Triangle Aycee and shall provide water pressure tight joints when heat fusion welded or used with compression type fittings as manufactured by Hays, Haystite, Ford Meter Box, Ford Pack Joint, or approved equal.

The polyethylene extrusion compound from which the pipe and tubing are extruded shall meet the requirements of Type III, Grade 34, Class C, extra high molecular weight, high-density polyethylene material as described in ASTM D3350.

The pipe shall be homogeneous throughout and free from visible cracks, holes foreign inclusions or other defects. The pipe shall be uniform in color, opacity, density and other physical properties.

The average inside diameters and wall thickness and respective tolerances shall be, for any cross section as shown in ASTM D2239, when measured in accordance with ASTM D1599. Where applicable, pipe sizing shall comply with ASTM D2239 (Iron Pipe Size, Inside Diameter).

The standard thermoplastic pipe dimension ratio (SDR), the ratio of pipe diameter to wall thickness, shall not exceed seven for 160 psi design pressure.

The Contractor shall furnish a certification from the manufacturer that the polyethylene pipe is of uniform quality, will fully comply with these specifications and that the pipe is manufactured of virgin polyethylene, that no scrap material has been used and that the pipe is suitable for potable water in accordance with the specifications of the National Sanitation Foundation Testing Laboratories, Inc. The pipe manufacturer shall further furnish a certification from the manufacturer of the

polyethylene extrusion compound used to make the pipe that the compound fully complies with these specifications.

The pipe shall be permanently marked indicating size and pressure-temperature rating. The appropriate markings shall occur on the pipe at least once in every 24 inches. The seal of approval or marking of the testing laboratory shall be included in the marking on all pipe intended for transporting potable water.

All pipe, fittings and valves shall be carefully lowered into the trench hand or by means of slings and/or appropriate mechanical equipment.

Cutting of HDPE pipe for closure or other reasons shall be done in a neat, clean fashion. All loose cuttings shall be carefully removed from the pipe interior. The outside edge of the cut pipe shall be beveled.

11.5 PVC PIPE

All PVC pipe furnished under these specifications shall conform to the following. All PVC pipe, couplings and fittings shall be made from Class 1245-A or Class 1245-B compounds as defined and set forth in American Water Works Association (AWWA) Standards relating to PVC potable water distribution pipe. The PVC compounds used to manufacture said PVC pipe shall contain no deleterious ingredient in any amount that has been demonstrated to migrate into water in detectable quantities. PVC pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions or other defects. The pipe shall be uniform in color, opacity, density and other physical properties. Any gaskets and/or lubricants used with PVC pipes and couplings shall be manufactured from materials that are compatible with the plastic material and each other when used together. The materials shall not support the growth of bacteria or adversely affect the potable quality of the water to be transported.

Primer shall conform to ASTM F-656-80 and shall be purple in color.

Solvent-cement shall conform to ASTM D-2564 and shall be the proper type and viscosity according to pipe size. The solvent-cement shall be of a solution of Type 1, Grade 1, un-plasticized PVC resin. The cement shall be free flowing and shall not contain lumps, microscopic un-dissolved particles or any foreign matter that will adversely affect the ultimate joint strength. It shall show no stratification or separation that cannot be removed by stirring.

PVC pipe and fittings joined using the solvent-cement method shall be joined using a manufacturer approved primer solvent-cement joining system. Manufacturers recommendations for joining under high temperature (over 100° F) and/or high humidity (over 60%) shall be strictly followed.

Fittings for PVC pipe may include tees, elbows, caps, plugs, tapping saddles, reducers, increasers and valves. Push-on, gasket type joints shall be constructed in accordance with the manufacturer's specifications.

The pipe shall be permanently marked indicating size and pressure rating. The appropriate markings shall occur on the pipe at least once in every 24 inches. The seal of approval or marking of the testing laboratory shall be included in the marking on all pipe intended for transporting potable water.

PVC pipe shall be handled in accordance with AWWA Guideline M23. PVC pipe shall not be handled with individual chains or single cables, even if padded. Pipe shall not be dropped to the ground or rolled into the trench. Pipe shall not be dropped or rolled against other objects. All PVC pipe, fittings and gaskets shall be stored covered so as to protect from exposure to sunlight, ozone and grease. PVC pipe shall be stored so as to not become deformed or bent during storage.

11.6 VALVES

Valves shall be of the type, size and capacity designated on the plans or in the special provisions and shall comply with the requirements specified therein. All valves shall be capable of satisfactory performance at a working pressure of 150 psi. Valves shall be designed to permit disassembly to replace sealing components without removal of the valve body from the pipeline.

SECTION 12 – SUPPORTS

Pipe and tank supports shall be of the size and design as designated on the plans. Construction of any tank supports over 3 feet in height shall be constructed only after completion of an engineering design, prepared by an Engineer registered to practice in the State of Arizona with specialization in either Civil or Structural Engineering, the design shall include any geotechnical evaluations and/or borings the Engineer may deem necessary. Prior to construction, two copies of the design shall be provided to the Department Engineer for review and approval. Construction of such structure shall take place only under the direct supervision of the designing Engineer.

SECTION 13 – CONCRETE

Portland cement concrete shall be as described in the latest revision of the Maricopa Association of Governments Specification 725.

SECTION 14 – FIBERGLASS COMPONENT ASSEMBLY

Fiberglass components requiring field assembly shall be carefully assembled following the manufacturer's directions. All assembly shall be under the direct supervision of a worker having at least one year of experience in fiberglass

construction and assembly. The Contractor shall follow all manufacture's specifications and government guidelines and utilize appropriate suitable personal protective equipment during all installation work.

SECTION 15 – MEMBRANES

15.1 LINERS

Membrane liners may be utilized to prevent leakage from existing rigid tanks or to prevent leakage from earthen tanks at the discretion of the Engineer.

15.1.1 Hyperlon/PVC/HDPE Liners

At the discretion of the Engineer, Hyperlon, PVC or HDPE liners may be utilized to prevent leakage from either ridged walled or earthen tanks. The thickness of membranes to be utilized shall be as specified in the project documents and specific material specifications shall be subject to approval by the Engineer.

15.1.2 Fiberglass Liners

The use of fiberglass liners shall be limited to providing leakage prevention for rigid walled type tanks. Fiberglass liners shall conform to American Society for Testing and Materials (ASTM) C582-95, D3299, D4097-95ae1, D5421-93, or other equivalent Arizona Game and Fish Department (AGFD) approved standards. The material of fabrication shall consist of 30% glass fibers and 70% resin. The Contractor shall follow all manufacture's specifications and government guidelines and utilize appropriate suitable personal protective equipment during all installation.

SECTION 16 – BEDDING AND BACKFILL

SPECIAL NOTE: Bedding and backfill methods and materials for commercial products covered under this section are based on manufacturer's installation specifications under typical application conditions. They are provided such that project designers can assure full compliance with product warranties should they desire to do so. However, under most circumstances when constructing wildlife waters at remote locations, compliance with these specifications is impractical and/or cost prohibitive. As such, the Department takes a site-by-site "best practice" approach to achieving bedding and backfill applications that will result in adequate structural support and reduce the potential for long term damage to critical components of the development. Specifications for this approach are as follows:

Bedding: Bedding thickness shall comply with manufacturer's recommendations. All cobbles and angular material shall be manually removed to the satisfaction of

the Department Engineer or his designee. In severely course materials, screening may be necessary, at the discretion of the Department Engineer or his designee.

Backfill: Effort shall be made to use backfill material as free of cobbles and angular material as possible. When mechanical backfilling is used, "swamper(s)" shall be present to observe backfill operations and displace any cobbles or angular rock that lodges immediately against a component installation. Backfill material shall be carefully placed in lifts and worked around tanks or pipe until one foot of cover is achieved. Remaining backfill may be applied with no further restrictions. Backfill should, at a minimum, exceed natural grade by 6" to 12" to allow for settlement.

16.1 FIBERGLASS "SAUSAGE" TANKS

16.1.1 "Buried" Fiberglass Tanks

The fiberglass tank(s) referred to in this specification are 2,150 or 3,150-gallon single wall tanks such as those supplied by Desert Sun Fiberglass Company. Tank(s) shall be placed on a smooth leveled bed of ¼" minus granular bedding material 1 foot in depth. Two lifts of bedding material shall be carefully placed in lifts not exceeding 1 foot in depth and carefully worked under the tank haunches using a non-metallic probe. After placement of the second lift, the tank(s) may be backfilled to the top of the tank(s) using native materials free of any deleterious materials or stones over ¾" in diameter. The remainder of the tank pit shall then be backfilled with either native or imported granular material.

16.1.2 "Supported" Fiberglass Tanks

Supported fiberglass tank(s) referred to in these specifications are 2,150 or 3,150-gallon single wall tanks such as those supplied by Desert Sun Fiberglass Company provided with supporting legs as shown in the Standard Details. Tank(s) shall be placed on steel reinforced concrete piers. Piers shall be placed on firm bedrock or undisturbed granular soil declared to be suitable by the Engineer. Pier tops shall be constructed true and level to within 1/8" as shown in the details. The tank feet shall be filled with 90% sand/10% Portland cement concrete slurry and allowed to set for a minimum of 24-hours prior to filling the tank(s) with water.

16.2 "XERXES" FRP TANKS

"XERXES" style FRP tanks shall be bedded and backfilled in accordance with the tank backfill guidelines provided by the XERXES Corporation as follows;

Backfill materials shall be either pea gravel having a minimum diameter of 1/8 inch and a maximum diameter of ¾ inch or crushed stone consisting of a mix of

particles between 1/8 inch and ½ inch meeting ASTM Specification C-33 paragraph 9.1.

The tank(s) shall be placed on a smooth leveled bed of backfill material 1 foot in depth. Two lifts of backfill materials shall be carefully placed in lifts not exceeding 1 foot in depth and carefully worked under the tank haunches using a non-metallic probe. After placement of the second lift, the tank may be backfilled to the top of the tank using native materials free of any deleterious materials or stones over ¾" in diameter. The remainder of the tank pit shall then be backfilled with either native or imported granular material.

16.3 HDPE CYLINDER TANKS

Backfill materials shall be either pea gravel having a minimum diameter of 1/8 inch and a maximum diameter of ¾ inch or crushed stone consisting of a mix of particles between 1/8 inch and ½ inch meeting ASTM Specification C-33 paragraph 9.1.

The tank(s) shall be placed on a smooth leveled bed of backfill material 1 foot in depth. Two lifts of backfill materials shall be carefully placed in lifts not exceeding 1 foot in depth and carefully worked under the tank haunches using a non-metallic probe. After placement of the second lift, the tank may be backfilled to 1 foot above the top of the tank using native materials free of any deleterious materials or stones over ¾" in diameter. The remainder of the tank pit shall then be backfilled with either native or imported granular material.

16.4 PVC "PIPE" TANKS

Backfill materials shall be either pea gravel having a minimum diameter of 1/8 inch and a maximum diameter of ¾ inch or crushed stone consisting of a mix of particles between 1/8 inch and ½ inch meeting ASTM Specification C-33 paragraph 9.1.

The tank(s) shall be placed on a smooth leveled bed of backfill material 1 foot in depth. Two lifts of backfill materials shall be carefully placed in lifts not exceeding 1 foot in depth and carefully worked under the tank haunches using a non-metallic probe. After placement of the second lift, the tank may be backfilled to 1 foot above the top of the tank using native materials free of any deleterious materials or stones over ¾" in diameter. The remainder of the tank pit shall then be backfilled with either native or imported granular material.

16.5 FIBERGLASS "RING" TANKS

The fiberglass ring tank(s) referred to in these specifications are 16' and 20' diameter fiberglass ring tank(s). Tank(s) shall be placed on a leveled pad of either raked, compacted, native granular material, free of all deleterious materials and

stones over ¾" in diameter or on a 6" layer imported granular bedding material having a minimum diameter of 1/8 inch and a maximum diameter of ¾ inch.

16.6 PIPELINES

Pipelines shall be bedded on either selected native material, free of all deleterious materials and stones over ¼ inch in diameter or imported sand up to 1/3 of the pipe diameter. Pipelines shall then be backfilled to at least 3 inches above the top of the pipe with selected native material, free of all deleterious materials and stones over ¾ inch in diameter. The remainder of the pipe trench shall then be backfilled with either native or imported granular material.

SECTION 17 – EVAPORATION COVERS

Evaporation covers shall be constructed in accordance with individual project special provisions and details. Such covers shall be constructed from closed-cell polyurethane foam, high-density polyethylene membrane and polypropylene rope or other materials as shown in the details.

SECTION 18 – MISCELLANEOUS APPURTENANCES

18.1 GUTTERS

Gutters shall be manufactured of fiberglass and resin meeting the same specifications described for the fabrication of fiberglass tanks. The general dimensions for this gutter are indicated on the drawings.

1) Design parameters: The fiberglass gutter extension is used to collect rainwater at the end of an artificial watershed. The water then recharges the storage tanks via one or more feed lines.

2) On occasion, there will be the need to insert 12' sections into the standard gutter to extend the total length of the gutter. These inserts will be identical to the two-piece sections except that they will not have the boxed or closed ends on them.

18.2 FLOAT ASSEMBLIES

Float assemblies shall be constructed entirely of corrosion resistant stainless steel, copper, brass and bronze. No ferrous metals shall be permitted in any float valve installation.

18.3 FIBERGLASS MATING AND REPAIR KITS

FIBERGLASS MATING KIT

The manufacturer shall provide a fiberglass mating kit for each ring tank (typically, FGRT 4500, 7000, 7500, or 11500). Troughs are excluded from this requirement.

Each fiberglass kit shall include resin, interior gel coat, exterior gel coat, fiberglass matting, and the commensurate quantity of catalyst, in sufficient quantity to effectively mate the two tank halves. All materials shall be equivalent to and compatible with the materials used in the manufacturing of the fiberglass components. All such fluids shall be provided in new, marked, resealable metal containers appropriate for this purpose.

Detailed requirements for this Mating Kit:

1) FIBERGLASS RESIN: Provide 4 gallons of resin with catalyst. Catalyst shall be provided per the resin manufacturers recommendations for type and quantity. Resin and catalyst to be provided in separate containers.

2) GEL COAT: Provide 1 gallon each of interior gel coat and exterior gel coat with catalyst. Catalyst shall be provided per the resin manufacturers recommendations for type and quantity. Gel coat and catalyst to be provided in separate containers.

3) FIBERGLASS MAT: Provide two 100' x 6" wide rolls of industrial grade 2 ounce/ sq. ft. chopped strand fiberglass mat with each mating kit.

4) CONTAINERS: All liquids are to be provided in new, marked, resealable, metal containers appropriate for the storage of these materials.

5) SPECIAL REQUIREMENTS: The quality of all materials shall be equivalent to the quality of the materials used in the manufacture of fiberglass components under this contract. All materials shall be compatible with the materials used in the manufacture of fiberglass components.

FIBERGLASS REPAIR KIT

Each fiberglass repair kit shall include a request for one gallon of resin, one gallon of exterior gel coat, fiberglass matting, and the commensurate quantity of catalyst, in order to effect field repairs and modifications. All materials shall be equivalent to and compatible with the materials used in the manufacturing of the fiberglass components. All such fluids shall be provided in new, marked, resealable metal containers appropriate for this purpose.

Detailed requirements for this Repair Kit:

1) Fiberglass Resin: Provide 1 gallon of resin with catalyst. Catalyst shall be provided per the resin manufacturer's recommendations for type and quantity. Resin and catalyst to be provided in separate containers.

2) Gel Coat: Provide 1 gallon of exterior gel coat with catalyst. The gel coat is to include tinting and additives to protect from ultraviolet rays. Catalyst shall be provided per the resin manufacturer's recommendations for type and quantity. Gel coat and catalyst to be provided in separate containers.

3) Fiberglass Mat: Provide 4-ft x 8-ft. sheet of 2-ounce/sq. ft. chopped strand fiberglass mat with each repair kit.

4) Containers: All liquids are to be provided in new, marked, resealable, metal containers appropriate for the storage of these materials.

5) Special Requirements: The quality of all materials shall be equivalent to the quality of the materials used in the manufacture of fiberglass components under this contract. All materials shall be compatible with the materials used in the manufacture of fiberglass components.

SECTION 19 – CAMOUFLAGE AND FINISHES

19.1 ARTIFICIAL "ROCK" PANELS

19.1.1 Artificial "Rock" Panels-Concrete

Artificial rock panels to be obtained from manufacturer experienced in creating zoo or museum exhibits and approved by Department. Panels will be fabricated from molds taken of natural rock formations, the pattern/type matching geology of the specific project site and approved by Department. Concrete used in each panel shall have an integral base color (from an organic pigment) similar to rock formations at project site. Panels shall be a minimum of ½" thickness with integrated reinforcement fibers or other reinforcement material. No rock panel may weigh more than 300 pounds, and measure more than 4' in width or height. Each panel will have fasteners (galvanized wire, zip ties) integrated into the backside to facilitate attachment to the supporting rebar frame.

Rock panels will be arranged and assembled to imitate nearby natural geological formations to hide water development components. Intersections or meeting points of panels will be seamed with mortar mixture or fiberglass. Seams will blend with the texture, color, and shape of adjoining panels. Large gaps or meeting points will be reinforced/filled with wire mesh and coated to the thickness of adjoining panels. Concrete adhesive/bonder will be applied to both sides of the seam.

An armature of rebar, tubing, or pipe will be erected, and properly anchored, to support the panels so that the weight of the panels will not bear on the water development components (e.g. tank, trough, apron). Intersections of the steel frame may be welded or tied.

19.1.2 Artificial "Rock"- Cast-In-Place

Casting artificial rock in situ may also simulate artificial geological formations. An armature of rebar, tubing, or pipe will be erected, and properly anchored, to support the concrete so that excessive weight is not bearing on the water development components (e.g. tank, trough, apron). Intersections between two pieces of steel armature may be welded or tied. The armature shall be designed, shaped, and built to simulate the surrounding geological formations nearby.

The backside of the rockwork, the side not visible to the eye, shall have stucco lath (175 or heavier) attached to the armature to provide strength, protect the components, and reduce concrete waste. The front side of the armature shall have 1" galvanized chicken wire attached and be completely integrated into subsequent cement layers. Wire lath and stucco mesh may be attached with hog rings, tie wire, zip ties, or other fasteners provided that all exterior surfaces shall be covered with a minimum of ½" of cement material.

Cement mixture formula shall be the same as that for a rich block laying mortar. It may be hand applied or spray on, in a minimum of two layers. No portion of the infrastructure or fasteners will be exposed, with at least ½" of material. A minimum of two layers will be applied, achieving a final minimum thickness of ¾". If more than 7 days passes between application of coats, concrete adhesive or bonder will be applied to the underlying surface. While fresh and pliable the cement material will be molded, sculpted colored and textured to simulate the surrounding geology to the satisfaction of the Engineer.

19.1.3 Artificial Fiberglass "Rock" Panels

Artificial rock panels to be obtained from manufacturer experienced in creating zoo or museum exhibits and approved by Department. Panels will be fabricated from molds taken of natural rock formations, the pattern/type matching geology of the specific project site and approved by Department. Fiberglass material of each panel will have an integral base color similar to rock formations at project site. Panels a minimum of 3/8" thickness of fiberglass, with integral reinforcement fibers or other reinforcement material. Each panel will have fasteners (galvanized wire, zip ties) integrated into the backside to facilitate attachment to the supporting rebar armature.

Rock panels will be arranged and assembled to imitate nearby natural geological formations, to hide water development components. Intersections or meeting points of panels will be seamed with fiberglass mat and resin, the same thickness

of adjoining panels. Seams will blend with the texture, color, and shape of adjoining panels. Large gaps or meeting points will be reinforced/filled with mesh, or other material, and coated to the thickness of adjoining panels.

An armature of rebar, tubing, or pipe will be erected, and properly anchored, to support the panels so that the weight of the panels will not bear on the water development components (e.g. tank, trough, apron). Intersections of the steel frame may be welded or tied.

19.2 PAINTS

Paint shall be Dunn Edwards, or other brand as approved by the Department. Paint to be exterior grade flat latex. Colors, basic painting pattern, and percentage shall be determined by the Department representative at the individual project site.

All surfaces must be cured, clean, and dry. Paint may be thinned with water up to ½ pint per gallon to maintain good flow and workability.

Differing colors of paint shall be applied while preceding layer is still fresh, to facilitate blending between colors. Paint may be applied by brush, roller, or airless sprayer as required.

Follow all manufacturer specifications.

19.3 CONCRETE STAINS

Concrete rock panels or cast in place, may be colored/stained use acidic stains designed for that purpose. Preferred product is Lithochrome® however other products may be reviewed and approved by the Department. The colors, stain pattern, and percent coverage to be determined by the Department.

Concrete should be sufficiently cured, at least 14 days, before applying. Surrounding rocks and vegetation protected from over spray or contact. Staining to be applied in two coats, with at least 24 hours between applications. After the final application has cured for 4 hours, wash coated surfaces with a solution of baking soda and water (1 lb. sodium bicarbonate per 5 gallons water).

The Contractor shall follow all manufacture’s specifications and government guidelines and utilize appropriate suitable personal protective equipment.

19.4 BLOCK FACING

In some applications split face block will be specified. When installing the rough, or split-faced side, will be visible. Before installing, a material sample and manufacturer's name will be submitted to the Department for approval.

SECTION 20 – USE OF EXPLOSIVES

20.1 GENERAL

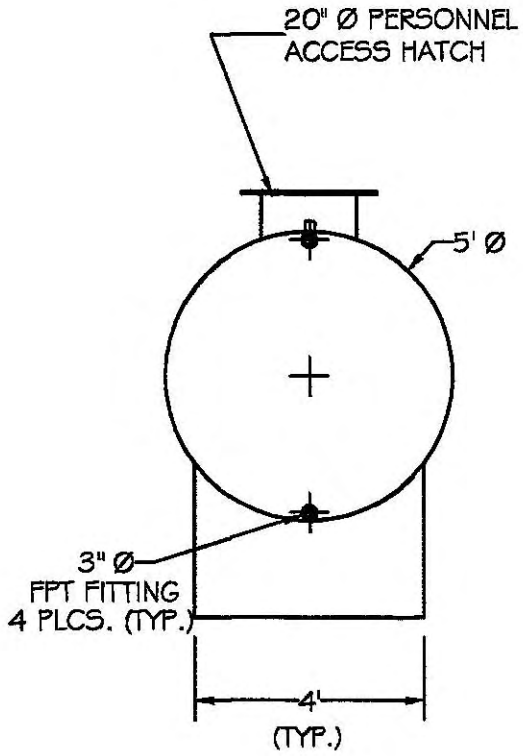
Construction of wildlife water developments utilizing explosives in any manner shall be undertaken only after approval of site specific blasting and safety plans by the Department Engineer. In addition to detailed charge placement, charge strength, explosive type and firing method, the blasting plan shall include information from any geotechnical evaluations and/or borings the Department Engineer may deem necessary. The blasting plan shall identify the person in responsible charge of the blasting operations and furnish evidence they possess at least 5 years experience in the handling of explosives and performing the type of blasting that will be required. Other personnel directly associated with the blasting operations shall be identified in the blasting plan. All on-site personnel present during blasting operations shall be able to hear and understand oral directions.

Blasting shall be performed under the direct supervision of the project engineer or his designee. The Department Loss Prevention Coordinator or designee shall be notified at least 7 days prior to scheduled blasting.

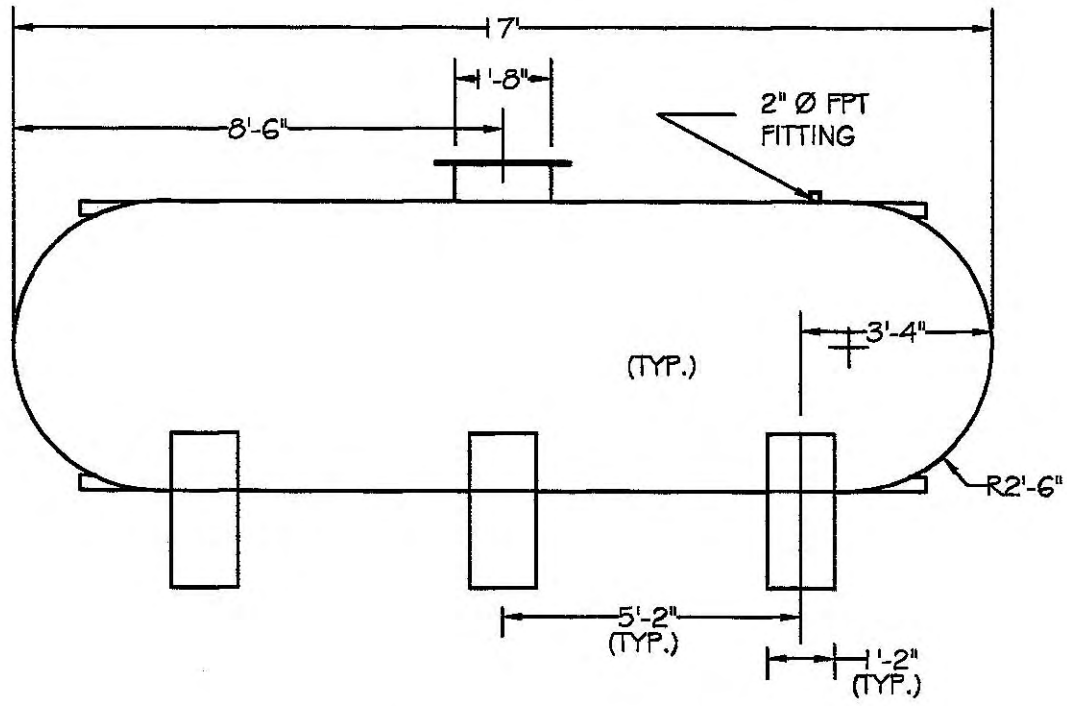
All blasting operations shall be conducted in compliance with applicable laws, statutes and regulations, particularly the provisions of 29 CFR 1926.900, *et. al*. Contractors or other entities performing blasting operations shall provide the Department an insurance of not less than $2,000,000.00 per occurrence, minimum unimpaired Products, Completed Operations aggregate, and General Aggregate minimum limits of $5,000,000.00. Coverage shall be at least as broad as the Insurance Service Office, Inc. Form CG00010196, issued on an Occurrence basis. The policy shall include coverage for:

- Bodily Injury;
- Broad Form Property Damage (including completed operations);
- Personal Injury;
- Blanket Contractual Liability;
- Fire Legal Liability;

Proof of insurance shall be submitted to the Department Engineer at least 7 days prior to scheduled blasting.



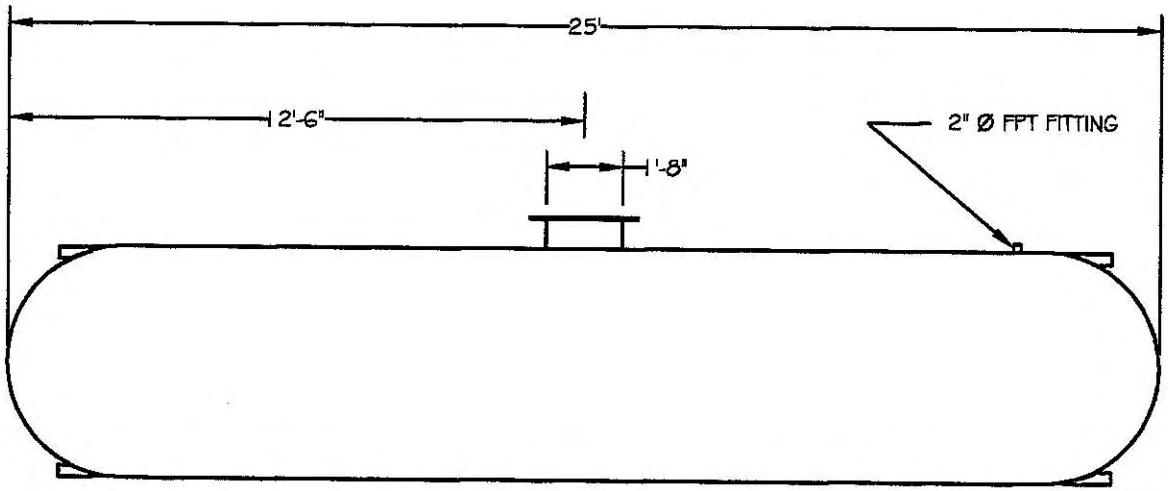
END VIEW



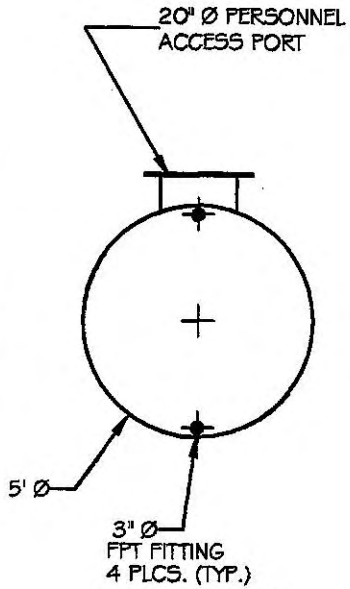
SIDE VIEW

BY:	DATE:	DETAIL NO.	REV. NO.
GM	9/9/1998	001	

TITLE: 2150 GALLON SUPPORTED FIBERGLASS SAUSAGE TANK



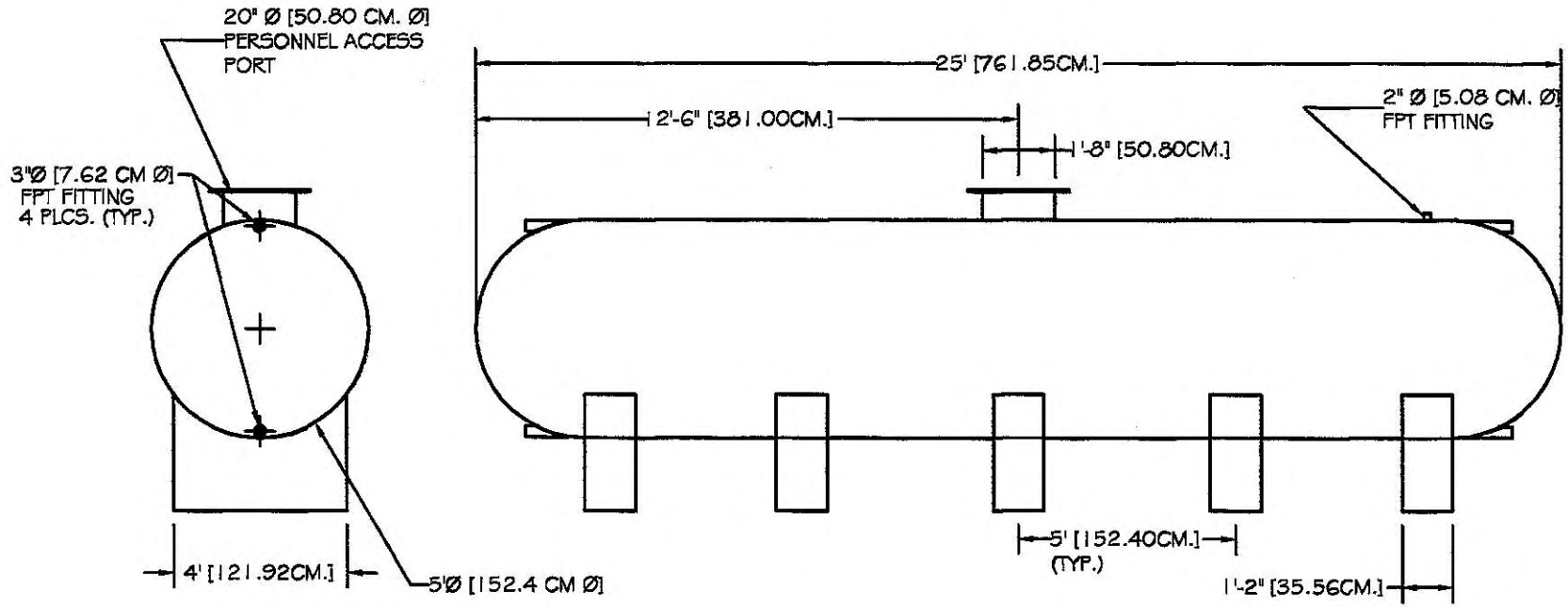
SIDE VIEW



END VIEW

BY:	DATE:	DETAIL NO.	REV. NO.
GM	9/9/1998	002	

TITLE: 3150 GAL. UNSUPPORTED FIBERGLASS SAUSAGE TANK



END VIEW

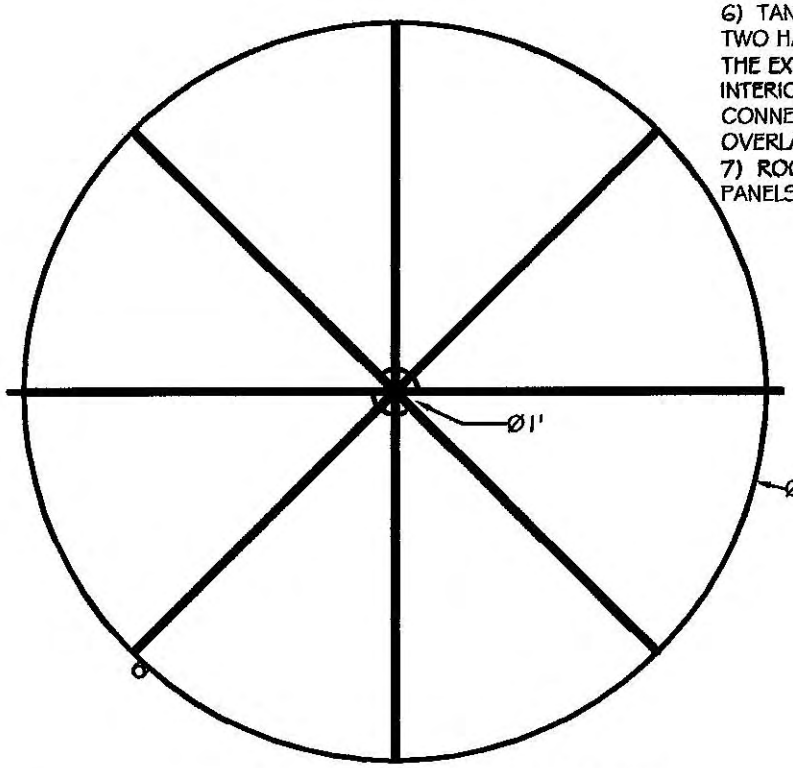
SIDE VIEW

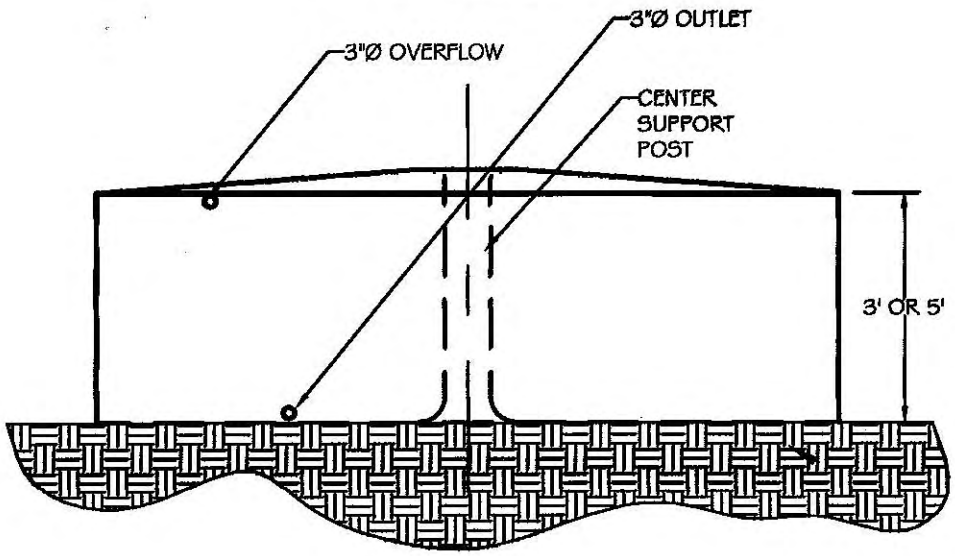
BY:	DATE:	DETAIL NO.	REV. NO.
GM	9/9/1998	003	

TITLE: 3,150 GALLON SUPPORTED FIBERGLASS SAUSAGE TANK

NOTES:

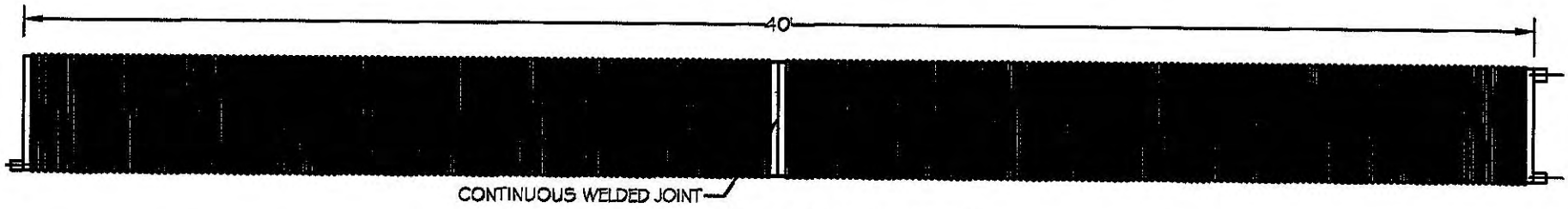
1) WALL THICKNESS 1/4" MINIMUM.
2) LAM. SCH., CHOPPED STRAND, 70% RESIN, 30% GLASS.
3) GELCOAT INTERIOR & EXTERIOR OF TANK.
4) INLETS AND OUTLET FITTINGS SHALL BE SOLID F.G.
5)TANK AND ROOF PANELS SHALL BE MATCHED AND NUMBERED BY THE MANUFACTURER AT FABRICATION.
6) TANK SHALL BE CONSTRUCTED OF TWO HALVES. WALL SHALL BE JOINED ON THE EXTERIOR WITH 1/2" BOLTS AND THE INTERIOR OF THE WALLS AND FLOOR CONNECTED WITH FIBERGLASS MATT OVERLAYS.
7) ROOF SHALL BE CONSTRUCTED OF SIX PANELS BOLTED TOGETHER.



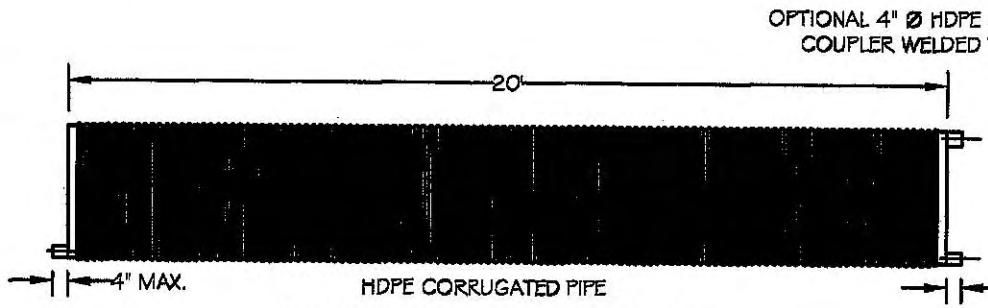


BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	9/27/1999	004	

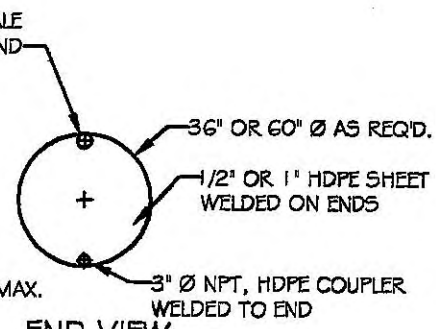
TITLE: FIBERGLASS RING TANK



SIDE VIEW - 40' LONG TANK



SIDE VIEW - 20' LONG TANK



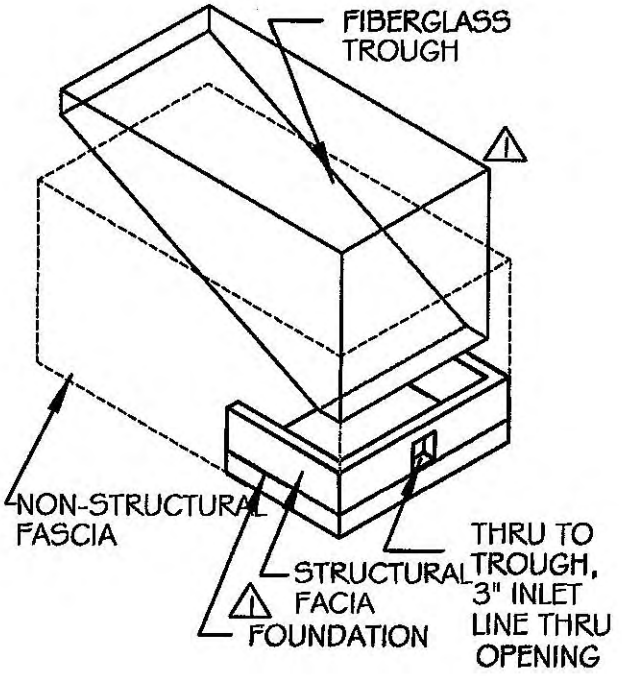
END VIEW

BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	3/24/2003	005	

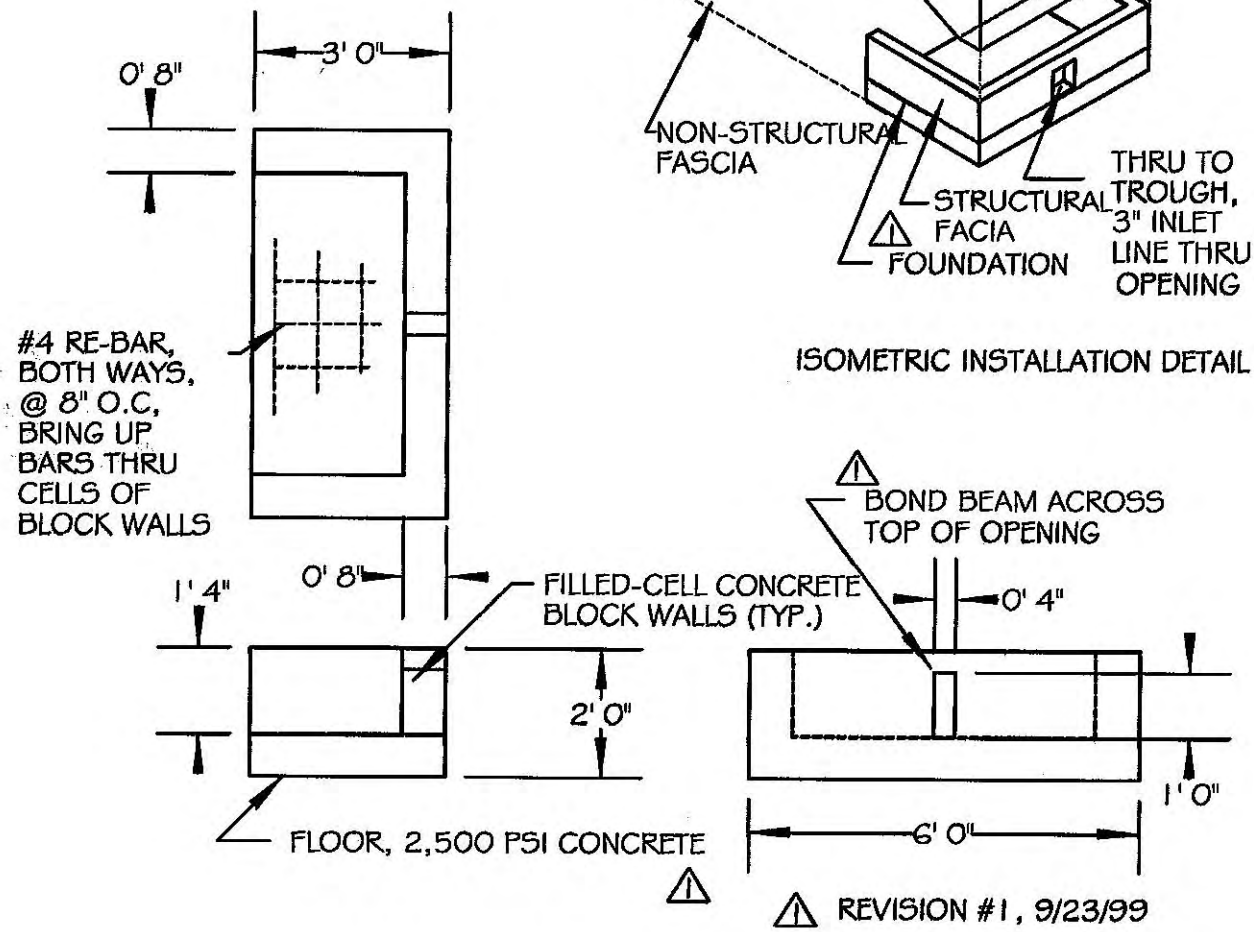
TITLE: 20' AND 40' LONG HDPE CULVERT TANK

BILL OF MATERIALS

QUANTITY	DESCRIPTION
0.5 C.Y.	2,500 PSI CONCRETE
17 EA.	1'X2', #4 "L" BARS
5 EA.	5' 2", #4 RE-BAR
9 EA.	2' 4", #4 RE-BAR
0.25 C.Y.	CONCRETE MORTAR



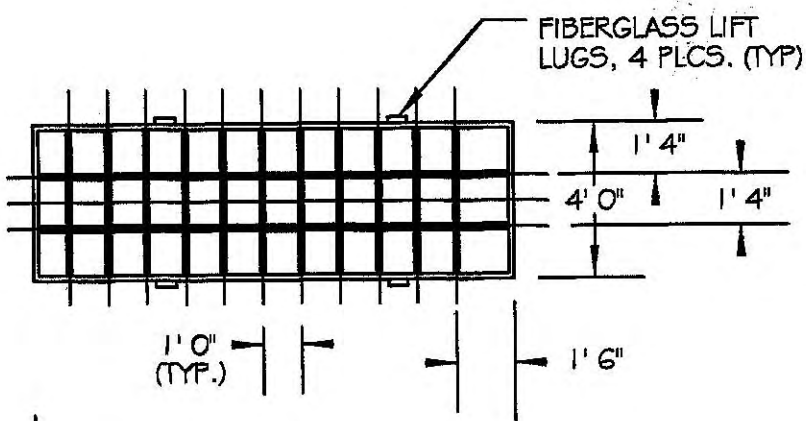
ISOMETRIC INSTALLATION DETAIL

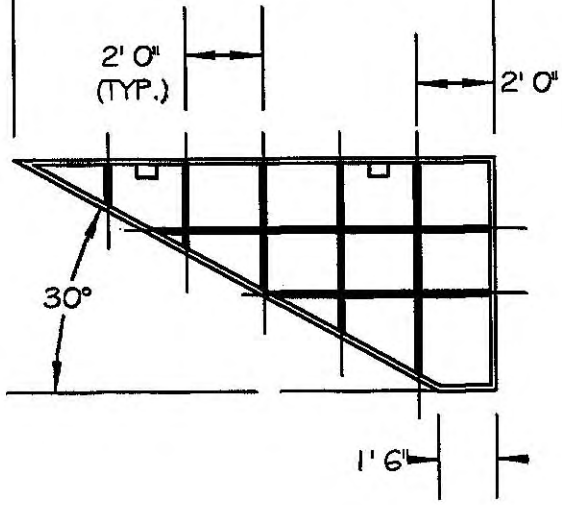


⚠ REVISION #1, 9/23/99

BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	1/12/1998	050	

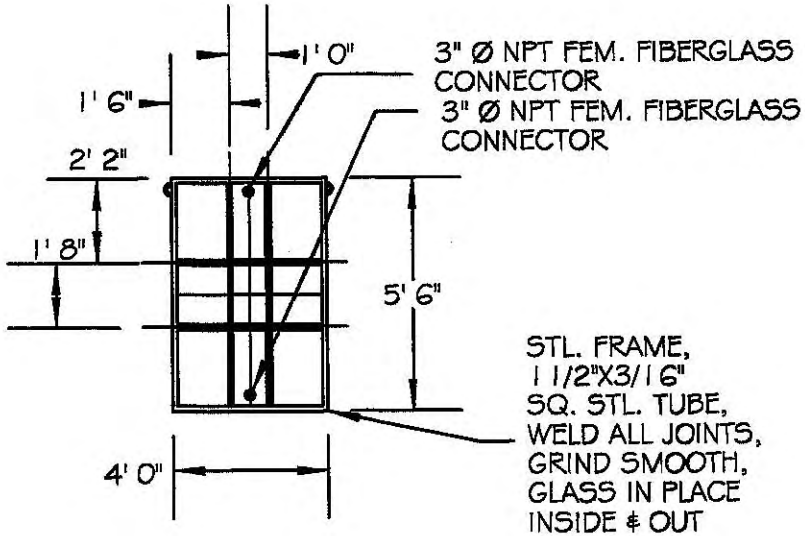
TITLE: STANDARD TROUGH FOUNDATION DETAIL





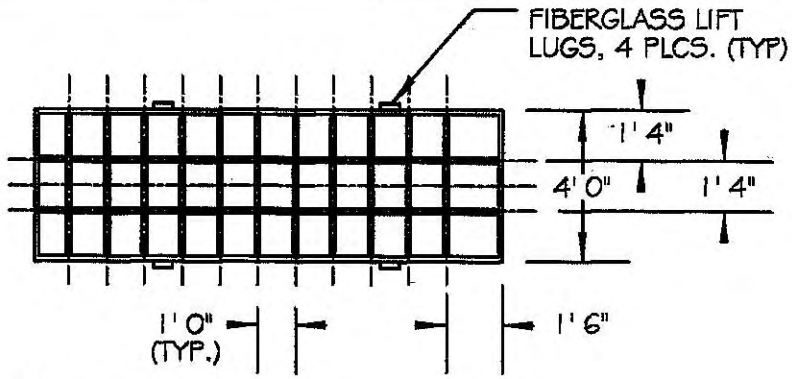
CONSTRUCTION NOTES:

1) WALL THICKNESS, 1/4" MIN.
2) LAM. SCH., CHOPPED STRAND, 70% RESIN, 30% GLASS
3) GELCOAT INTERIOR & EXTERIOR
4) APPROX. WT. 750 LBS.
5) INTERIOR SHALL HAVE 2" SQ. FIBERGLASS RETAINMENT RIBS @ 1' O.C., ACROSS INTERIOR OF TROUGH



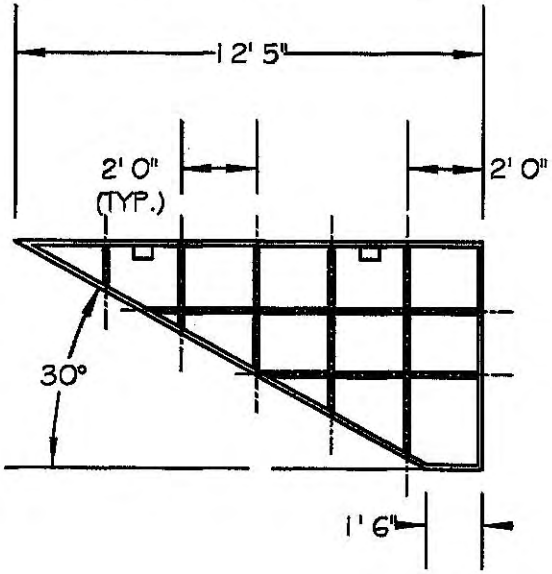
BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	4/8/1998	051	

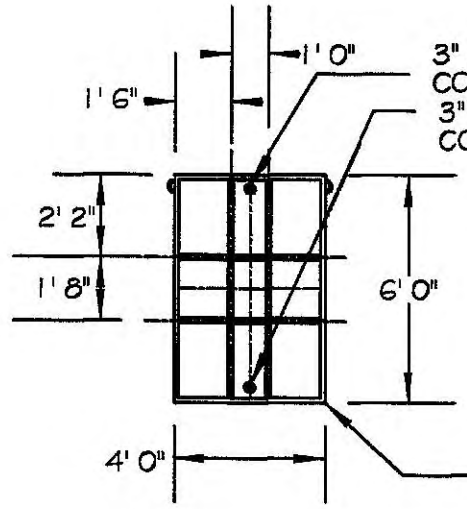
TITLE: 5'-6" WALK-IN FIBERGLASS TROUGH



CONSTRUCTION NOTES:

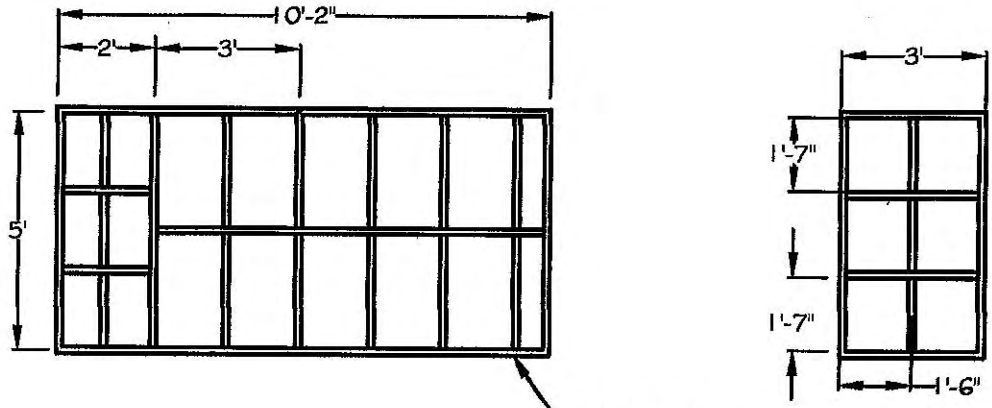
1) WALL THICKNESS, 1/4" MIN.
2) LAM. SCH., CHOPPED STRAND, 70% RESIN, 30% GLASS
3) GELCOAT INTERIOR & EXTERIOR
4) APPROX. WT. 750 LBS.
5) INTERIOR SHALL HAVE 2" SQ. FIBERGLASS RETAINMENT RIBS @ 1' O.C., ACROSS INTERIOR OF TROUGH

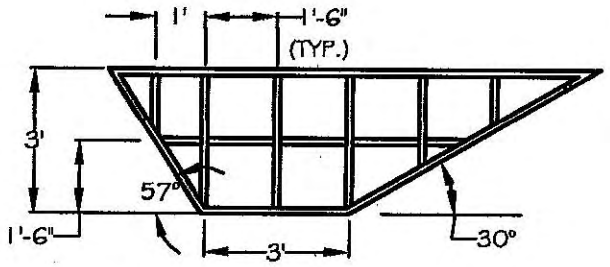




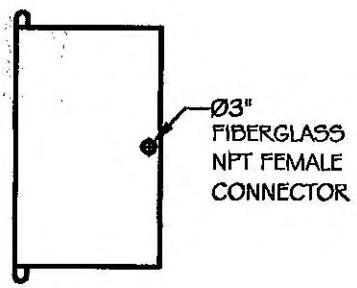
BY:	DATE:	DETAIL NO.	REV. NO.
G.M	7/14/2000	052	

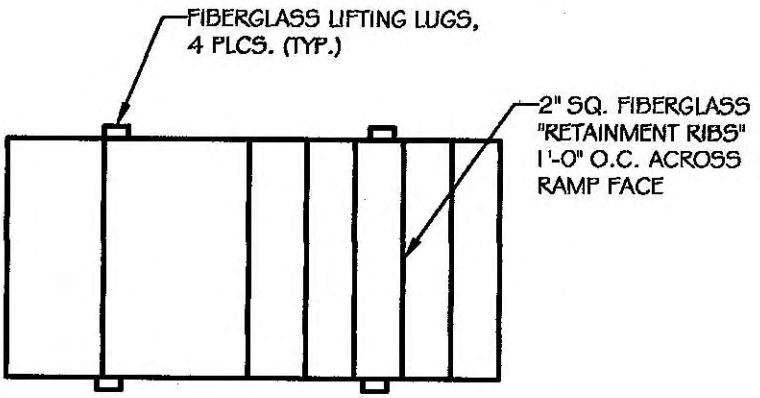
TITLE: 6' WALK-IN TROUGH





STEEL FRAME DETAIL

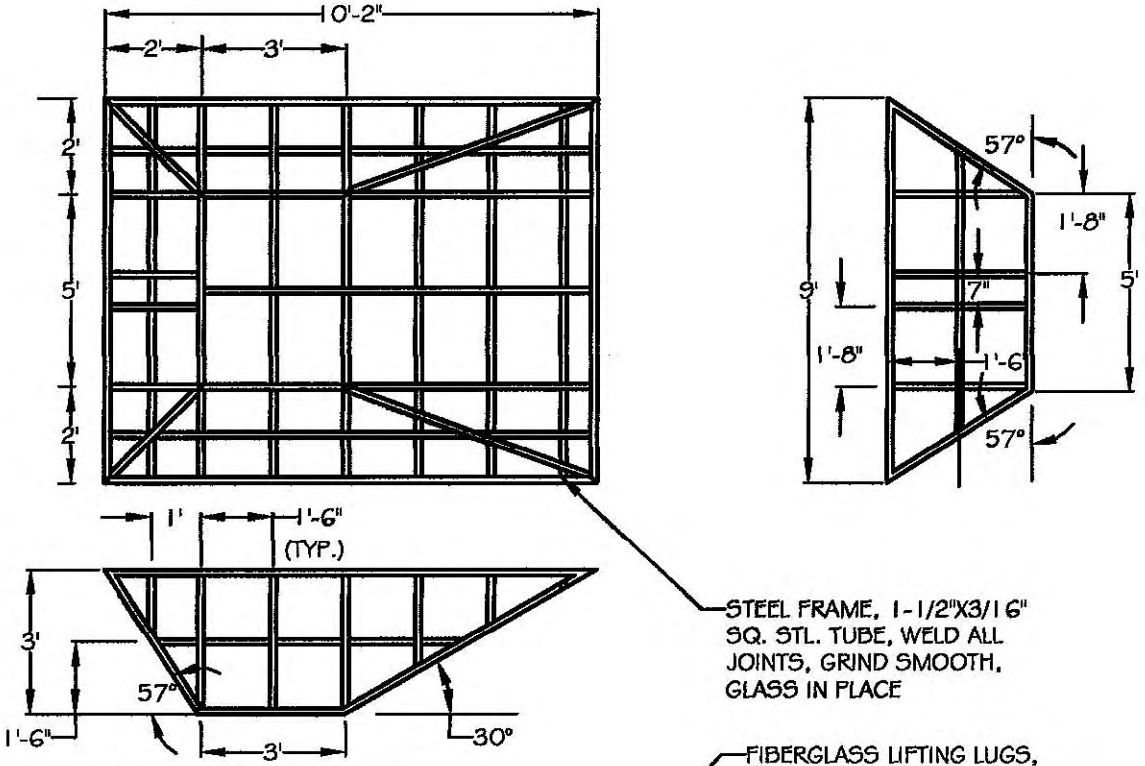




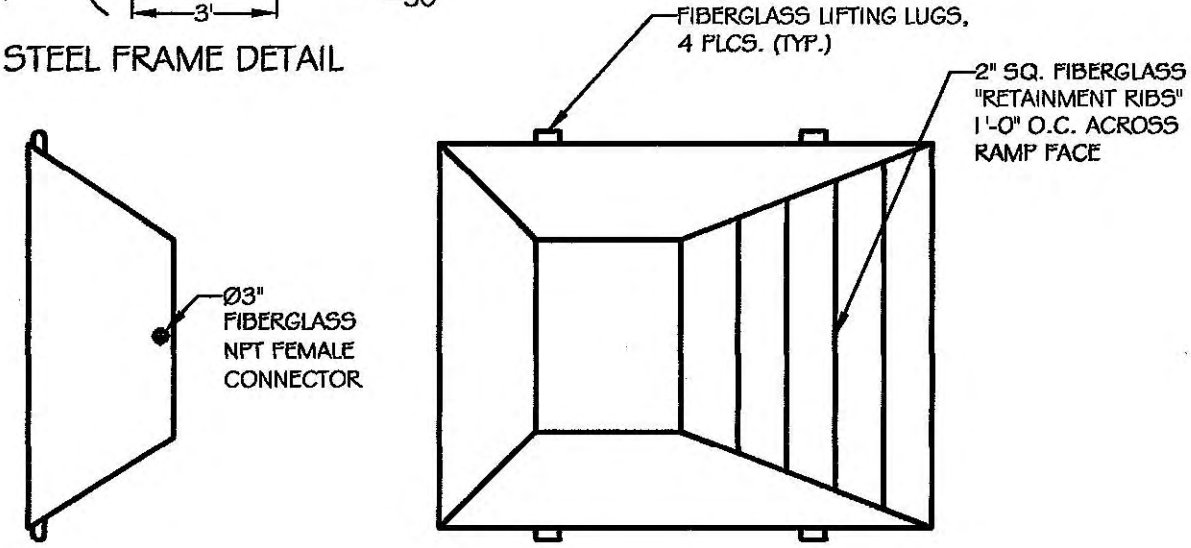
CONSTRUCTION NOTES:
1) 1/4" MIN. WALL THICKNESS.
2) LAMINATE SCHED., CHOPPED STRAND, 70% RESIN, 30% GLASS.
3) GELCOAT INTERIOR & EXTERIOR.

BY:	DATE:	DETAIL NO.	REV. NO.
G.M	9/15/2003	054	

TITLE: 3' DEEP WALK-IN ELK TROUGH

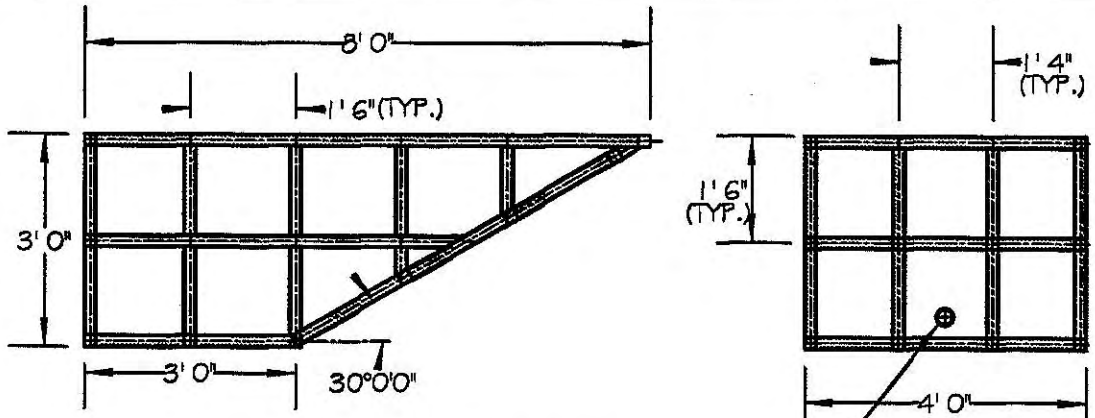


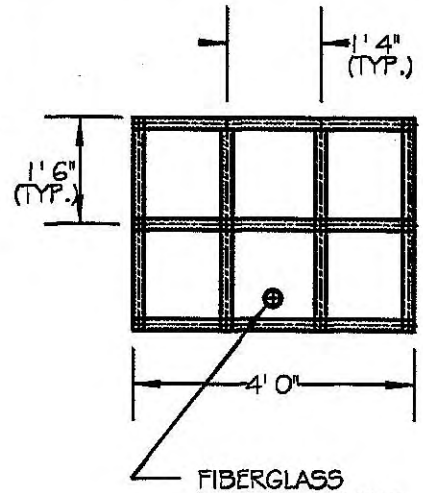
STEEL FRAME DETAIL

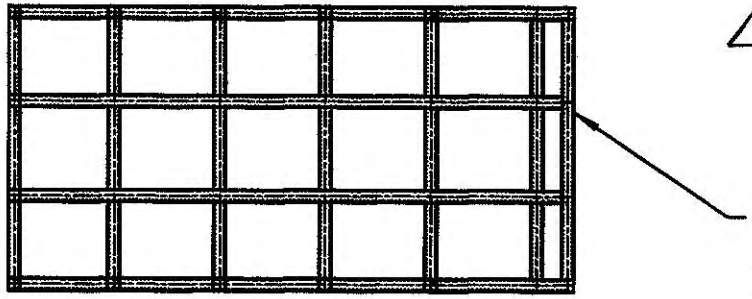


CONSTRUCTION NOTES:
1) 1/4" MIN. WALL THICKNESS.
2) LAMINATE SCHED., CHOPPED STRAND, 70% RESIN, 30% GLASS.
3) GELCOAT INTERIOR & EXTERIOR.

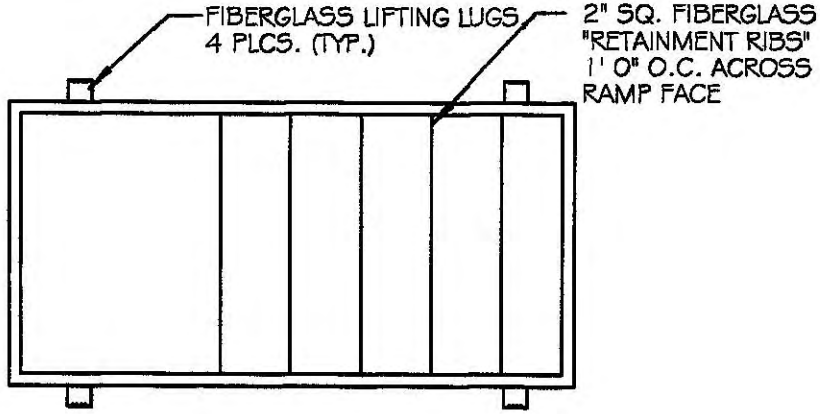
BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	9/15/2003	055	
TITLE	3' DEEP ELK TROUGH		







STEEL FRAME DETAILS



CONSTRUCTION NOTES:

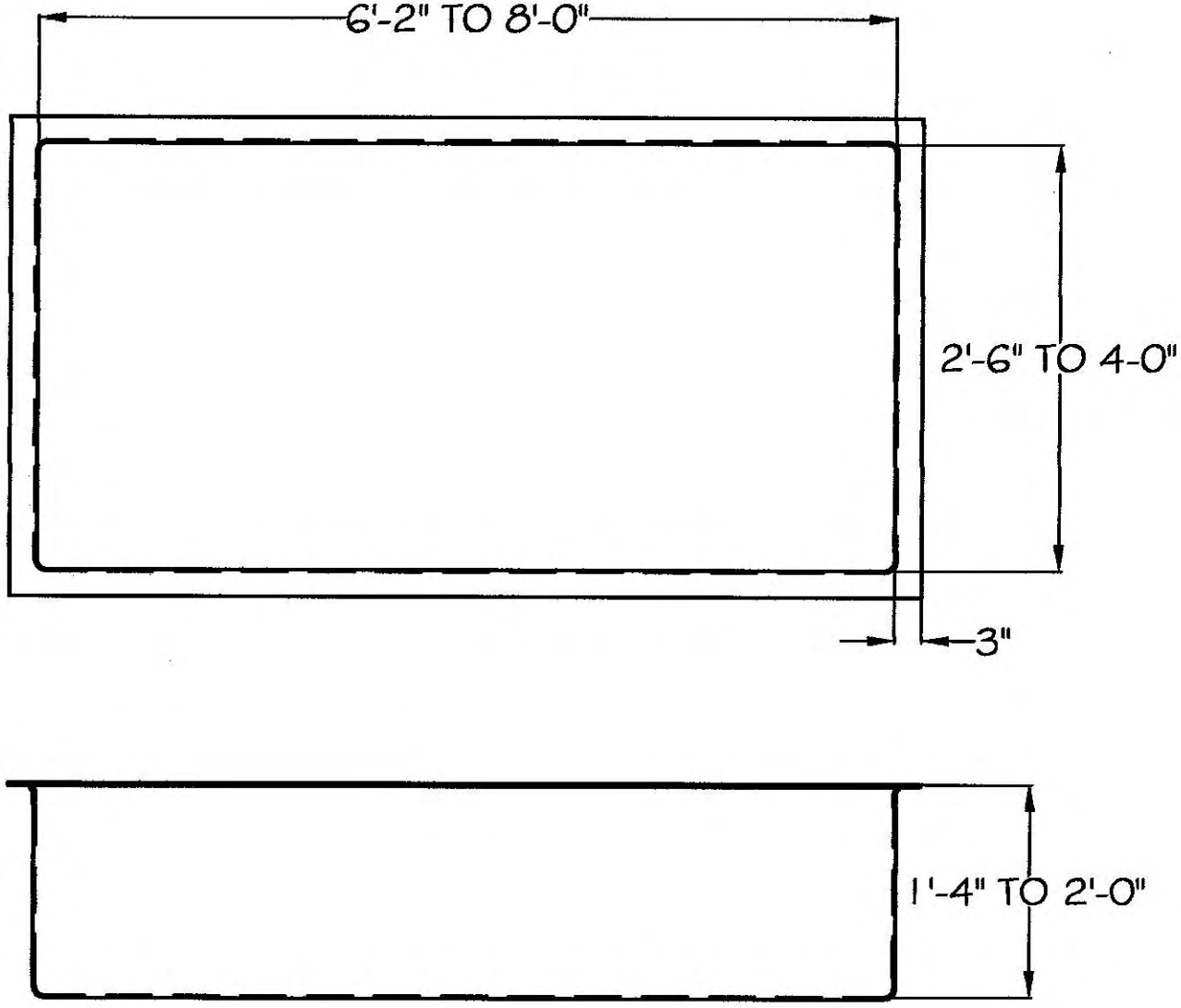
1) 1/4" MIN. WALL THICKNESS
2) LAMINATE SCHED., CHOPPED STRAND, 70% RESIN, 30% GLASS
3) GELCOAT INTERIOR & EXTERIOR

BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	10/27/1999	056	

TITLE: 3' WALK-IN TROUGH

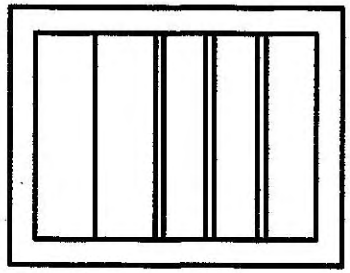
CONSTRUCTION NOTES:

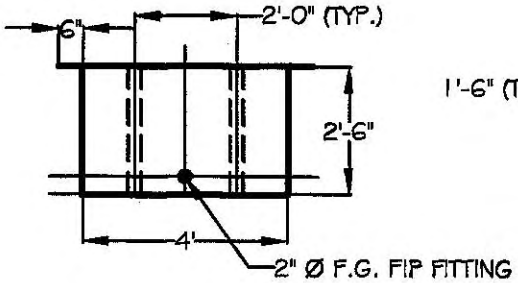
1) 1/4" MIN. WALL THICKNESS
2) LAMINATE SCHED., CHOPPED STRAND, 70% RESIN, 30% GLASS
3) GELCOAT INTERIOR & EXTERIOR

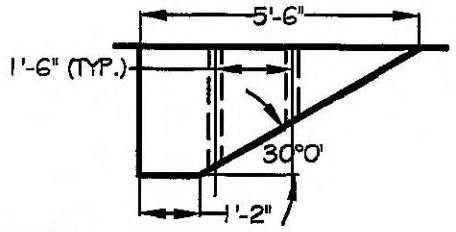


BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	9/17/2003	057	
TITLE	FIBERGLASS FLOAT TROUGH		

CONSTRUCTION NOTES:
1) LAMINATE FIRST LAYER 3/16" MAX. W/ GUN ROVING & GEN. PURPOSE LAM. RESIN & 1 LAYER 24 OZ. WOVEN ROVING.
2) INST. 1/2"x3" 6 LB./C.F. PVC FOAM REINF. & LAM. W/ SECOND LAYER AS FIRST LAYER.
3) INTERIOR SHALL HAVE 2" SQ. F.G RETAINMENT RIBS @ 1' O.C. ACROSS BOTTOM OF TROUGH.
4) 15 mil GREY VINYL ESTER GEL COAT INTERIOR & EXTERIOR.
5) APP. WT. 1,250 LBS.



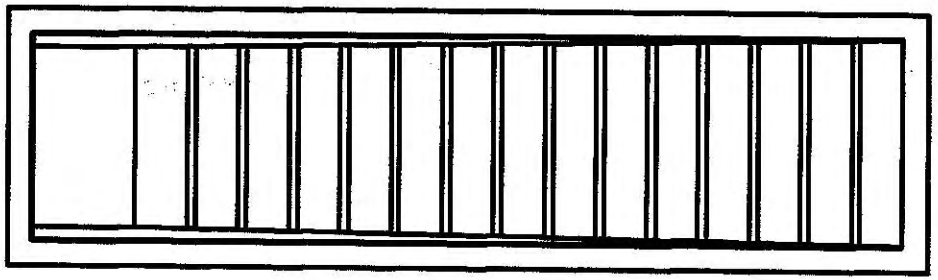


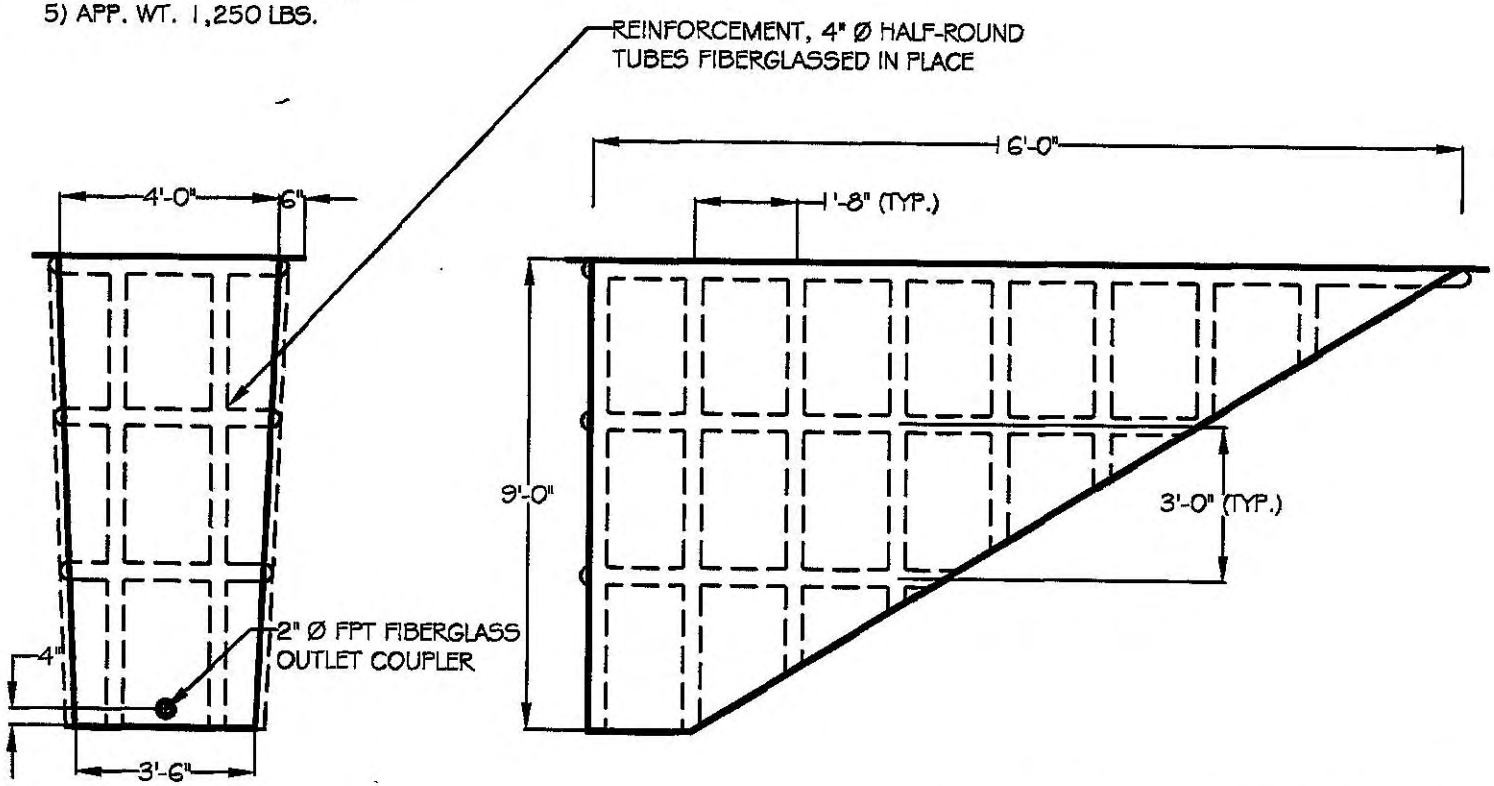


BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	08/30/2004	058	

TITLE: 30" WALK-IN TROUGH

CONSTRUCTION NOTES:
1) LAMINATE FIRST LAYER 3/16" MAX. W/ GUN ROVING & GEN. PURPOSE LAM. RESIN & 1 LAYER 24 OZ. WOVEN ROVING.
2) INST. 4" Ø 1/2 RND. TUBES 24" O.C. & LAM. W/ SECOND LAYER AS FIRST LAYER.
3) INTERIOR SHALL HAVE 2" SQ. F.G RETAINMENT RIBS @ 1' O.C. ACROSS BOTTOM OF TROUGH.
4) 15 mil GREY VINYL ESTER GEL COAT INTERIOR & EXTERIOR.
5) APP. WT. 1,250 LBS.

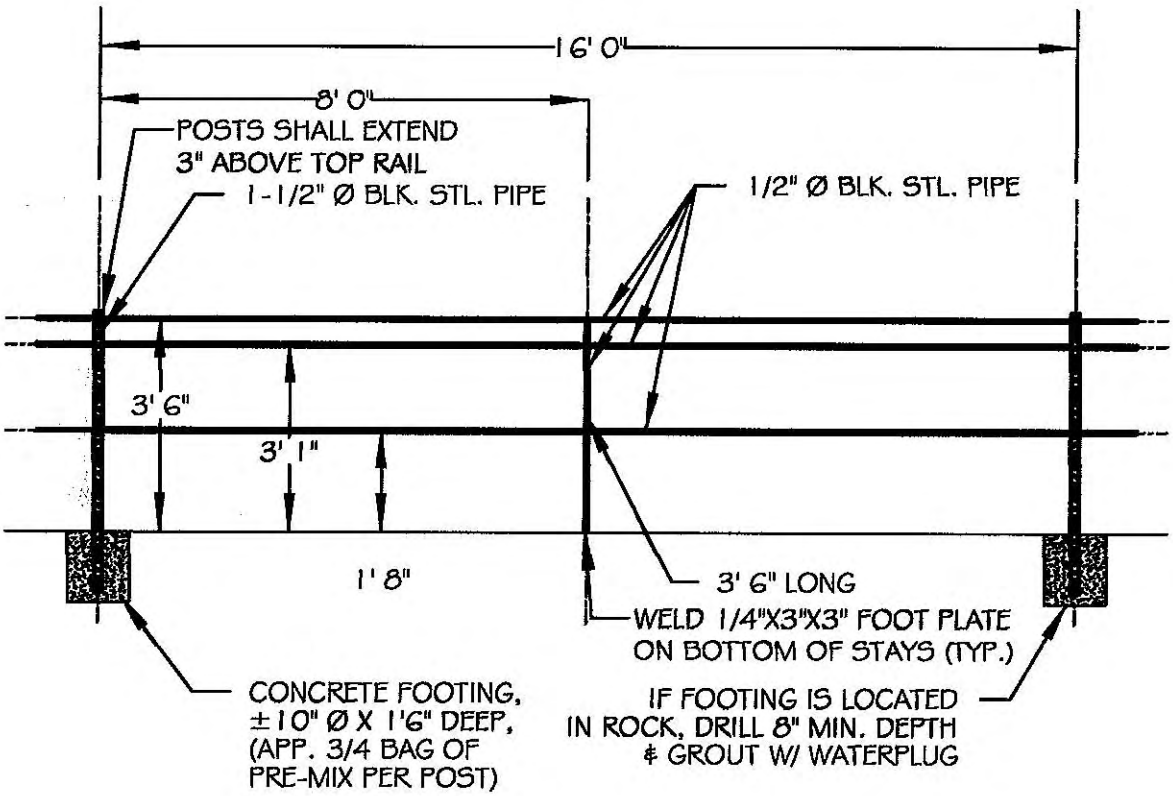




BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	08/30/2004	059	

TITLE: 9' WALK-IN TROUGH

NOTES:
1) ALLOW POSTS TO SET PRIOR TO WELDING RAILS.
2) WELD ALL POSTS AND STAYS TO RAILS.
3) WELD ALL RAILS TO SAME SIDE OF POST (NO OFF-SETS).
4) PRE-CUT 1 1/2" POST TO 63" LENGTH.
5) TOP OF 1/2" STAYS WELDED LEVEL AND SMOOTH TO TOP RAIL.

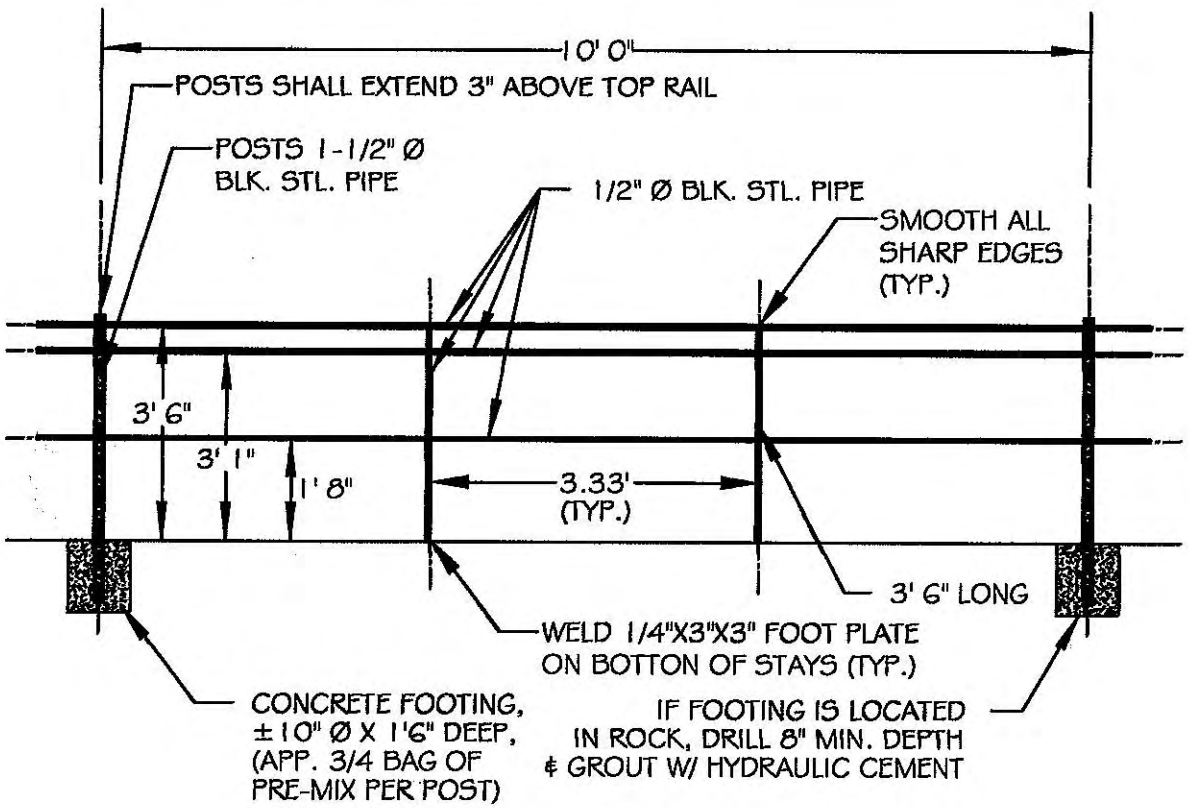


LIGHT DUTY PIPE RAIL EXCLOSURE FENCE

DATE: JULY 7, 1999

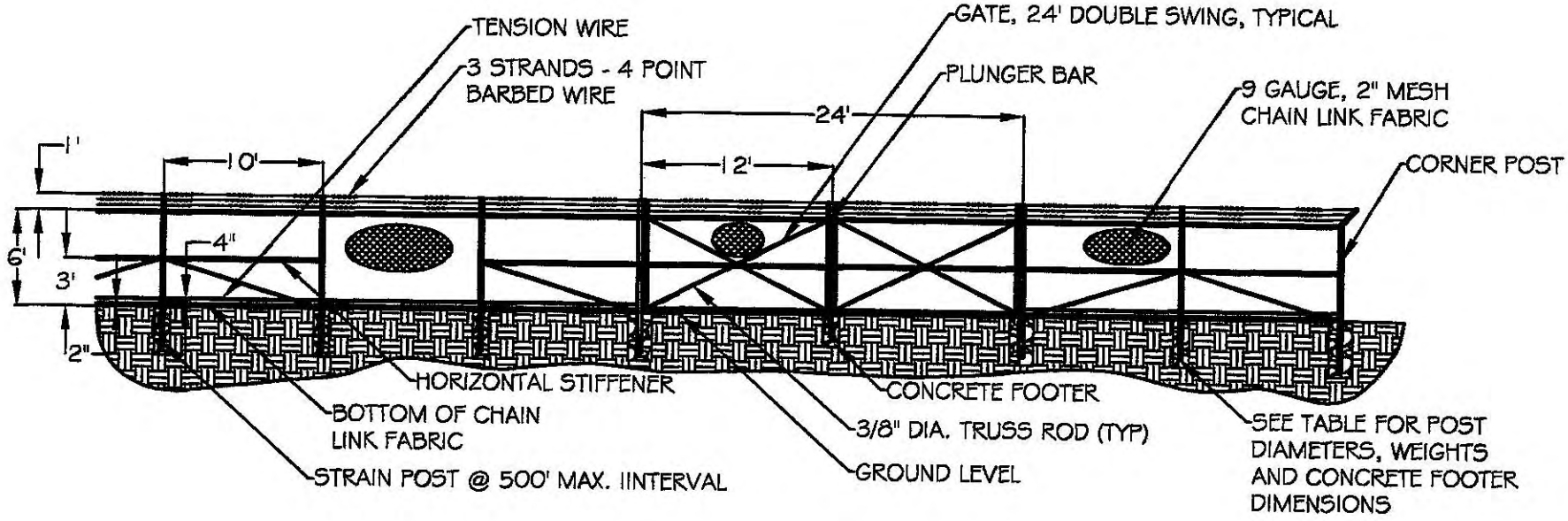
BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	7/7/1999	071	
TITLE	STANDARD PIPE-RAIL FENCE		

NOTES:
1) ALLOW POSTS TO SET PRIOR TO WELDING RAILS.
2) WELD ALL POSTS AND STAYS TO RAILS.
3) WELD ALL RAILS TO SAME SIDE OF POST (NO OFF-SETS).
4) PRE-CUT 1 1/2" POST TO 63" LENGTH.
5) TOP OF 1/2" STAYS WELDED LEVEL AND SMOOTH TO TOP RAIL.



HEAVY DUTY PIPE RAIL EXCLOSURE FENCE

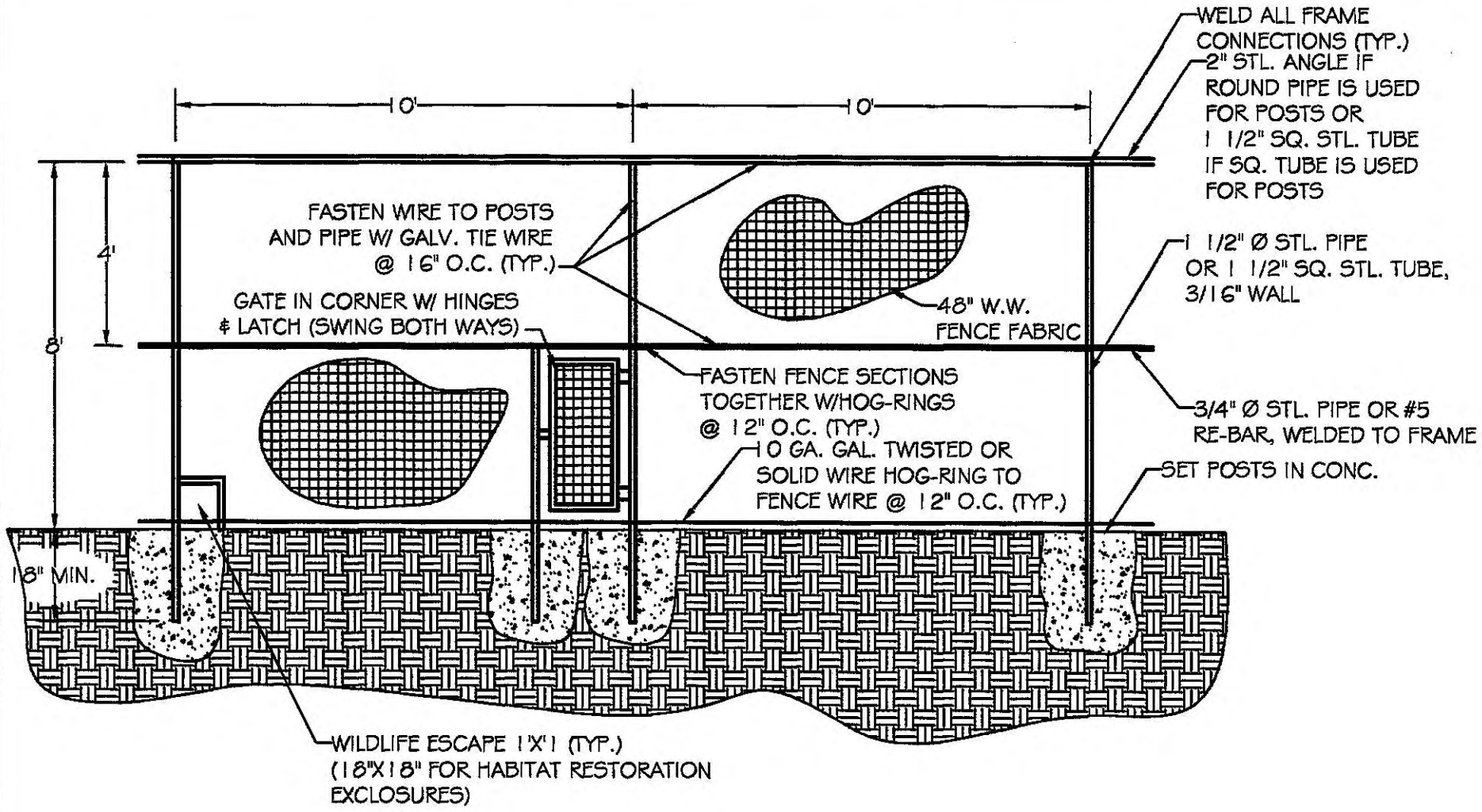
BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	9/17/2003	072	
TITLE	HEAVY DUTY PIPE-RAIL EXCLOSURE FENCE		



MEMBER	AISC SIZE	OUTSIDE DIAMETER (IN.)	WEIGHT (LB./FT.)	FOOTER DIMENSIONS (MAG CLASS "C")
CORNER POST	2 1/2"	2.875"	3.65	1'-4" Ø X 3'-6"
LINE POST	1 1/2"	1.900"	2.72	1' Ø X 2'-6"
STRAIN POST	1 1/2"	1.900"	3.65	1'-4" Ø X 3'-6"
BRACE	1 1/4"	1.666"	2.27	
STRETCH BAR	3/16"X3/4"	FLAT		
GATE POST	3 1/2"	4.000"	9.11	1'-4" Ø X 3'-6"
TOP RAIL	1 1/4"	1.666"	2.27	

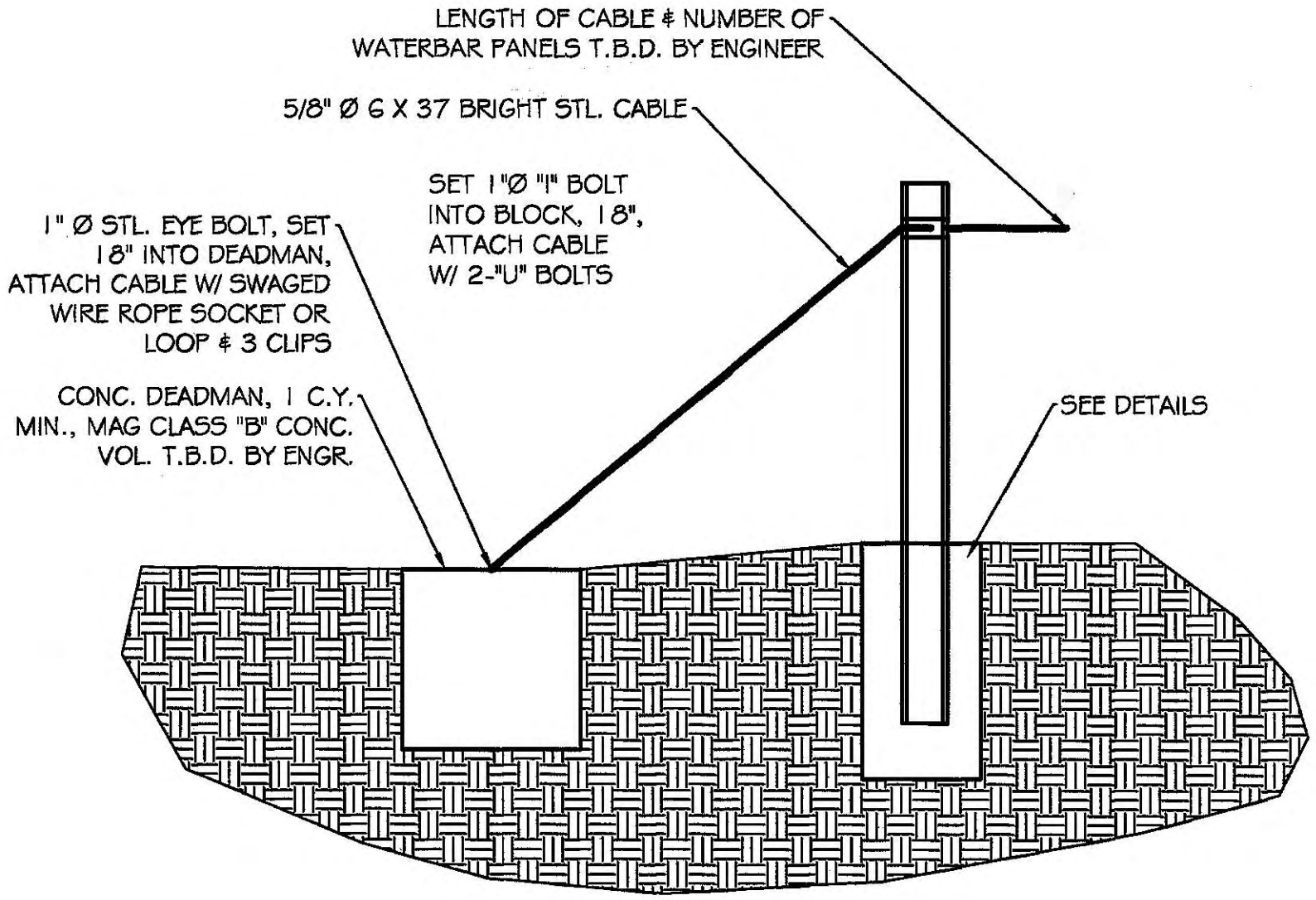
BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	21 JUL 08	073	

TITLE: CHAIN LINK FENCE



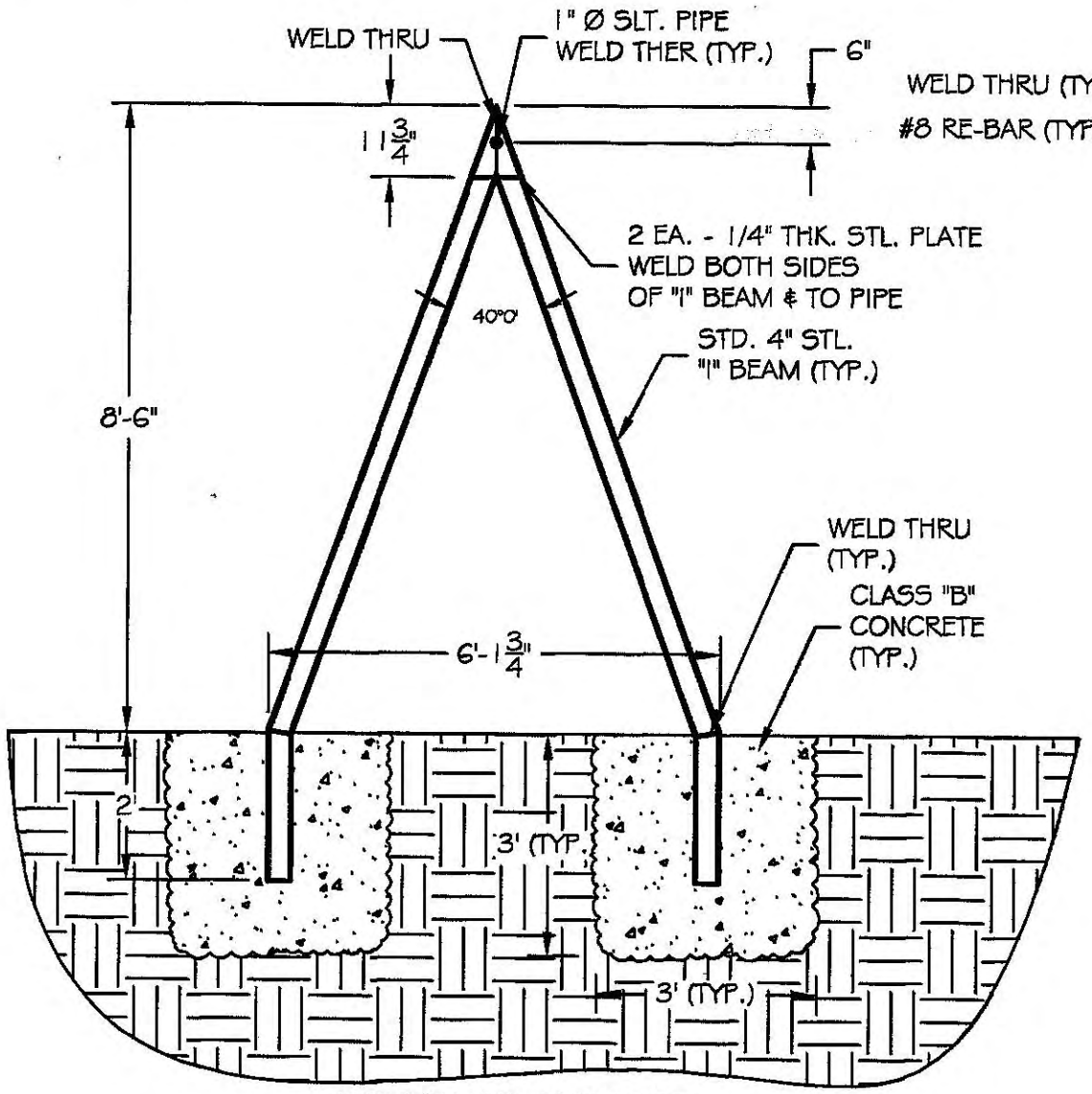
BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	5/6/ 2004	074	

TITLE: ELK EXCLOSURE FENCE

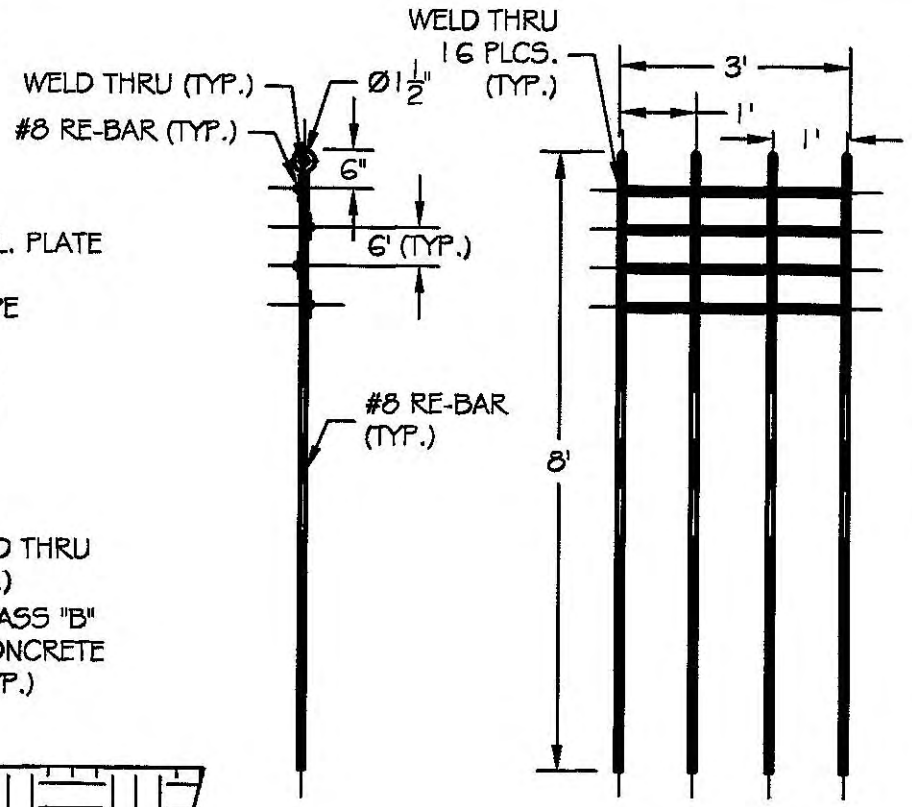


BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	15 FEB 07	075	0

TITLE: STANDARD WATERBAR



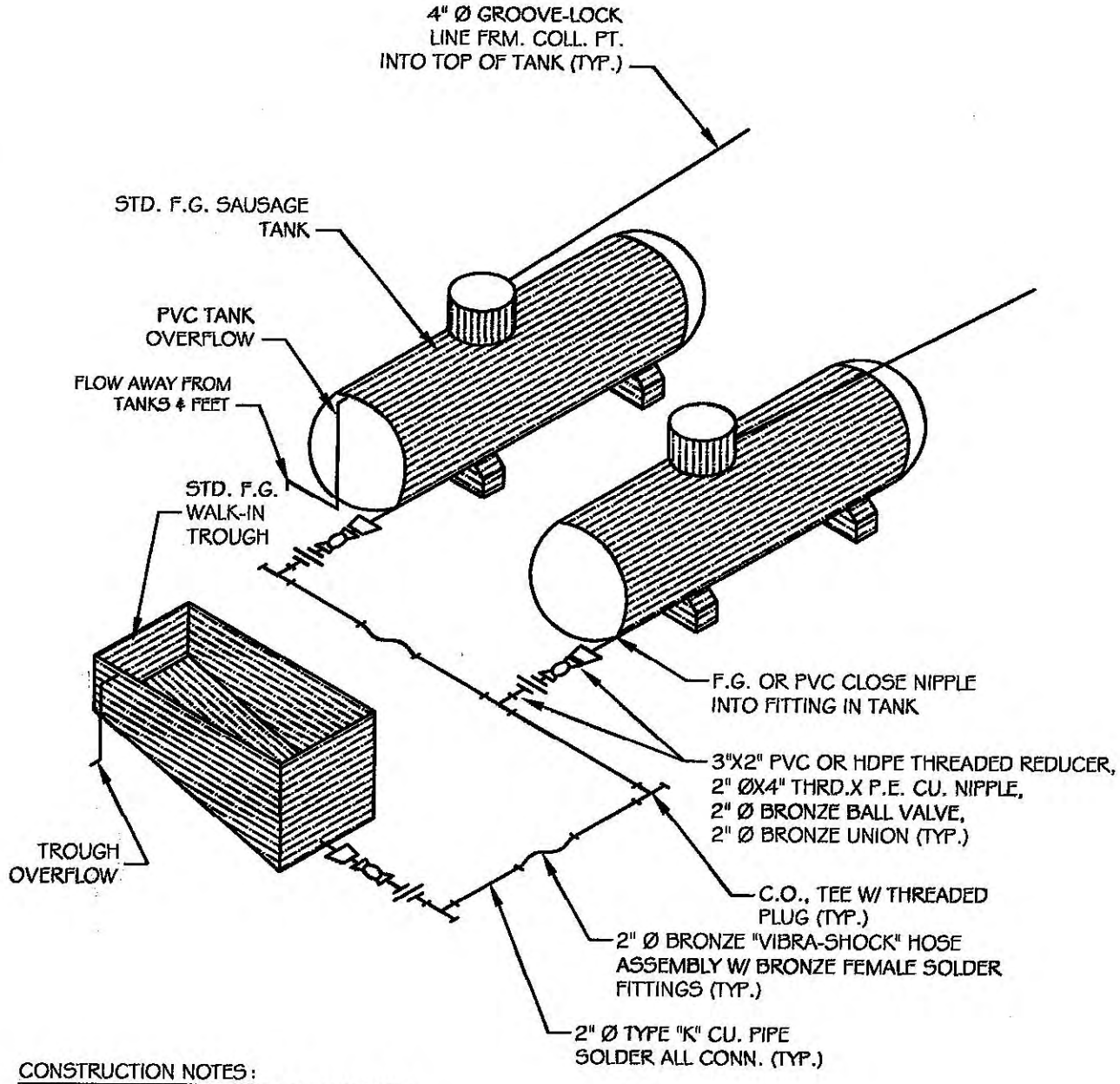
WATERBAR SUPPORT



WATERBAR PANEL

BY:	DATE:	DETAIL NO.	REV. NO.
G.M	15 FEB 07	076	

TITLE: STANDARD WATERBAR PANEL & SUPPORT DETAILS



CONSTRUCTION NOTES:

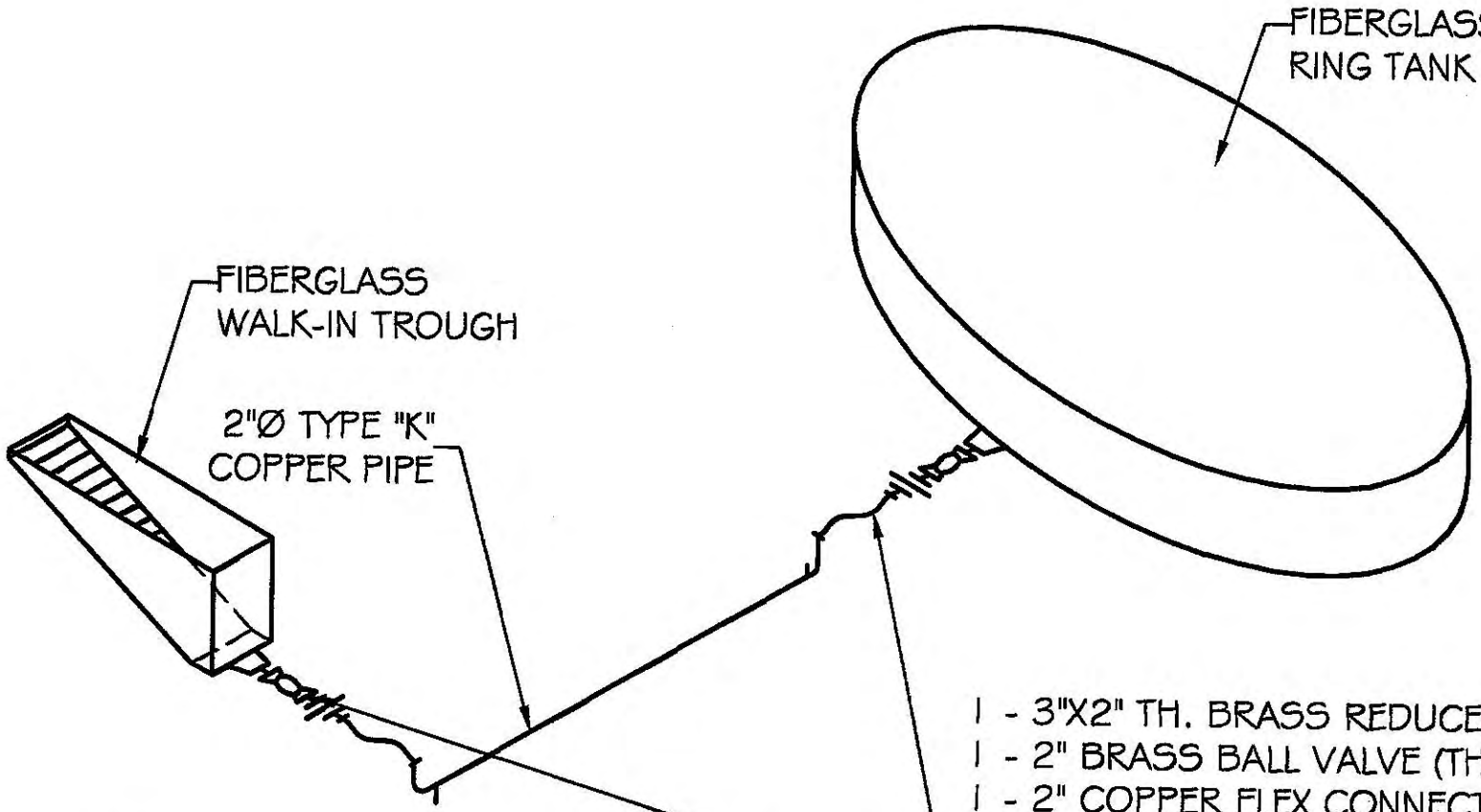
1) USE LIBERAL QUANTITIES OF SILICONE PIPE SEALANT AND/OR TEFLON TAPE ON ALL THREADED CONNECTIONS.
2) USE LEAD-FREE SOLDER ON ALL SOLDERED JOINTS.
3) USE EXTREME CAUTION WHEN INSTALLING BUSHING IN F.G. TANK, DO NOT OVER-TORQUE.
4) USE EXTREME CAUTION AND AVOID APPLYING ANY BENDING MOMENT TO NIPPLE SCREWED IN TO F.G. BULKHEAD.
5) BOTTOM OUTLETS OF BOTH TANKS AND TROUGH SHALL BE SET AT SAME ELEVATION.

FIBERGLASS SAUSAGE TANK, PLUMBING ISOMETRIC (TYPICAL)

JUNE 10, 2002

BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	6/10/2002	081	

TITLE: SAUSAGE TANK PLUMBING ISOMETRIC



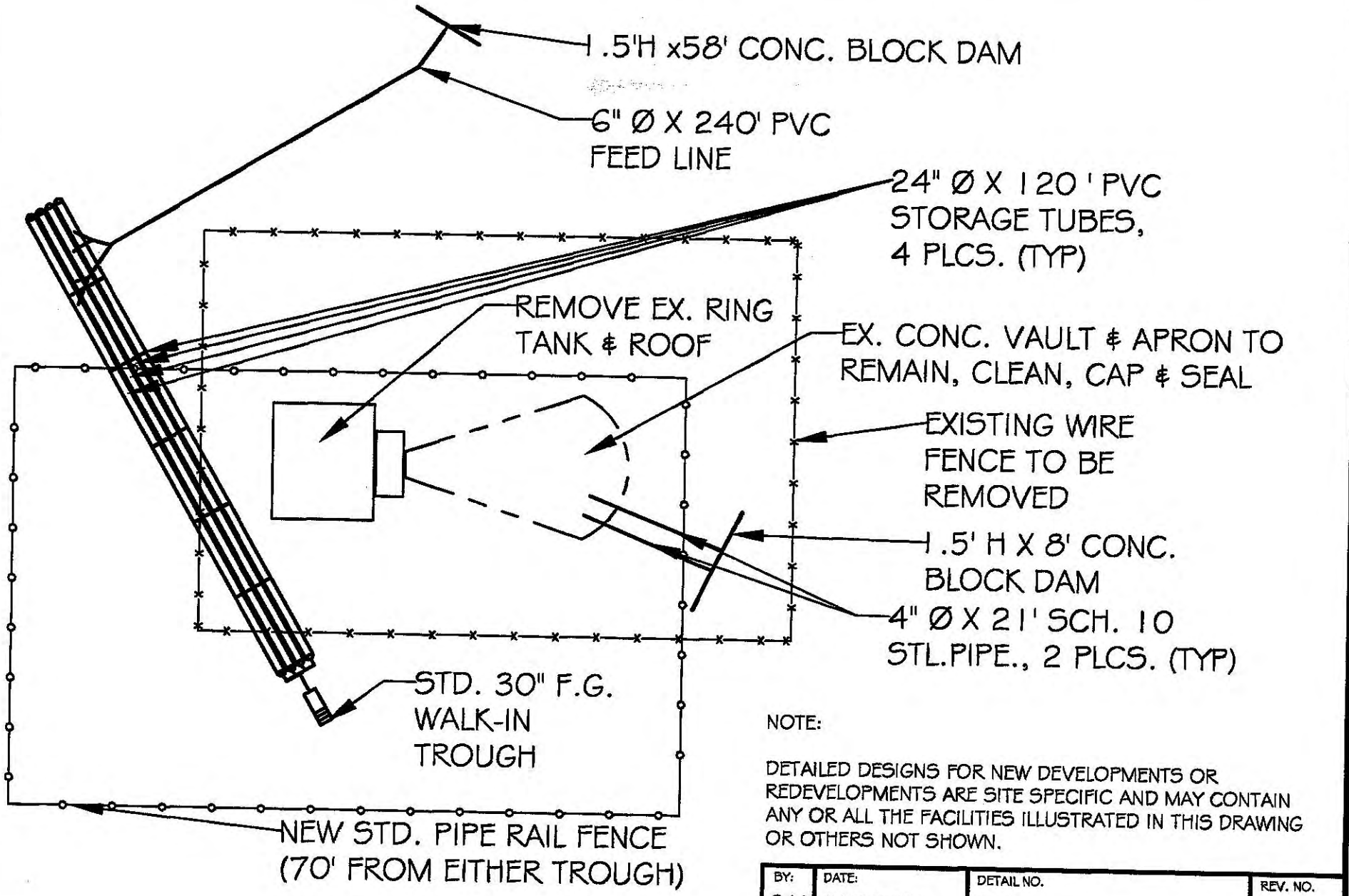
NOTES:

1) USE SILICONE SEALANT ON ALL F.G. TO METAL JOINTS.
2) WRAP ALL CU. PIPE W/ BLACK TAPE.
3) USE TEFLON PIPE TAPE ON ALL SCREWED METAL JOINTS.

1 - 3"X2" TH. BRASS REDUCER BUSHING
1 - 2" BRASS BALL VALVE (TH X TH)
1 - 2" COPPER FLEX CONNECTOR
1 - 2" COPPER "TEE"
1 - 2" FEMALE ADAPTER (TH X SL)
1 - 2" BRASS TH. PLUG (SQ. HD.)
2 - 2" COPPER 90° ELL
2 - 2" Ø X 3" BRASS CLOSE NIPPLE
1 - 2" Ø MALE ADAPTERS (TH X SL)
1 - 2" Ø TH. UNION

BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	6/23/2004	082	

TITLE: RING TANK PLUMBING ISOMETRIC

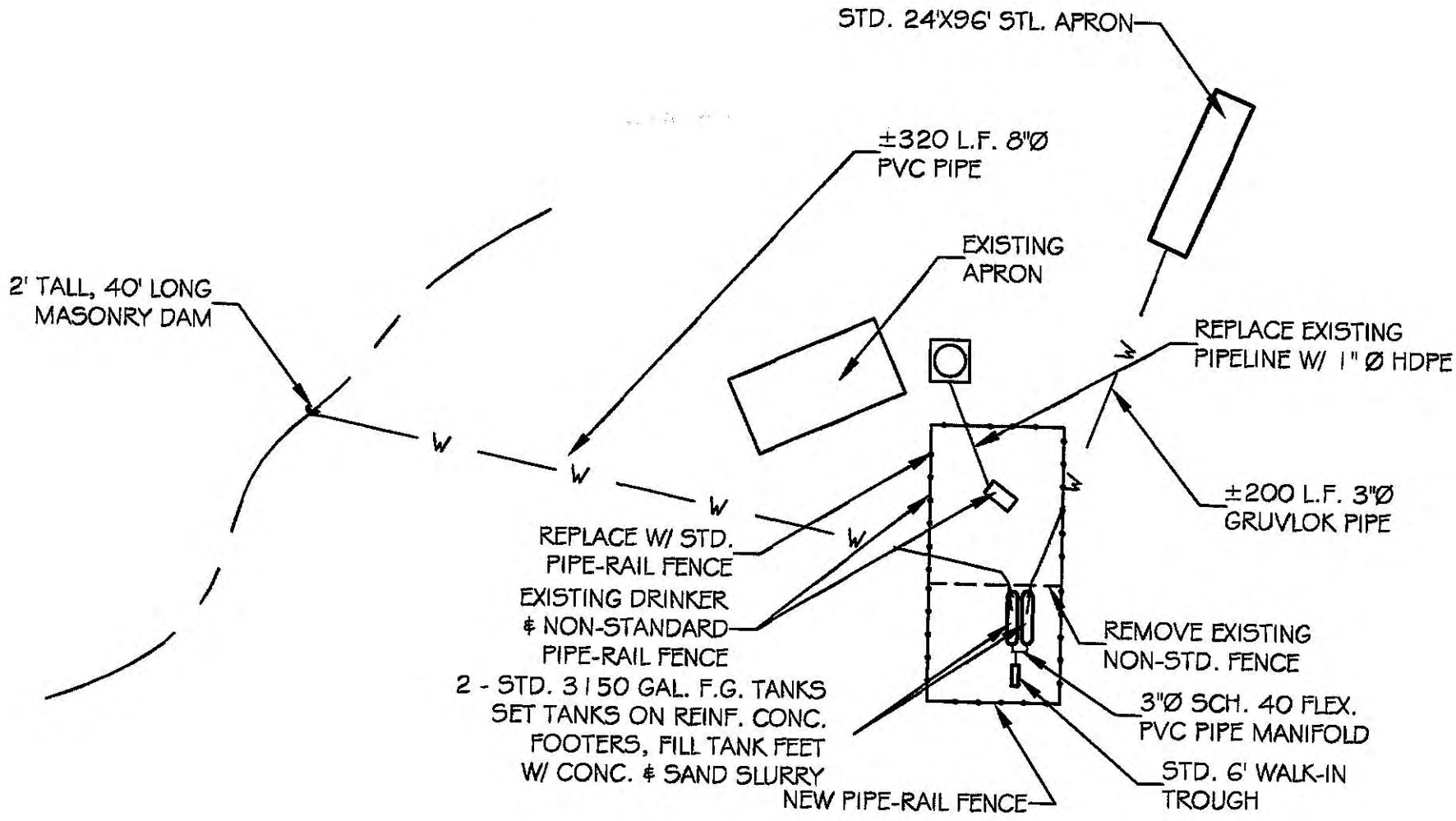


NOTE:

DETAILED DESIGNS FOR NEW DEVELOPMENTS OR REDEVELOPMENTS ARE SITE SPECIFIC AND MAY CONTAIN ANY OR ALL THE FACILITIES ILLUSTRATED IN THIS DRAWING OR OTHERS NOT SHOWN.

BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	8/10/2004	083	

TITLE: EXAMPLE OF UNDERGROUND REDEVELOPMENT

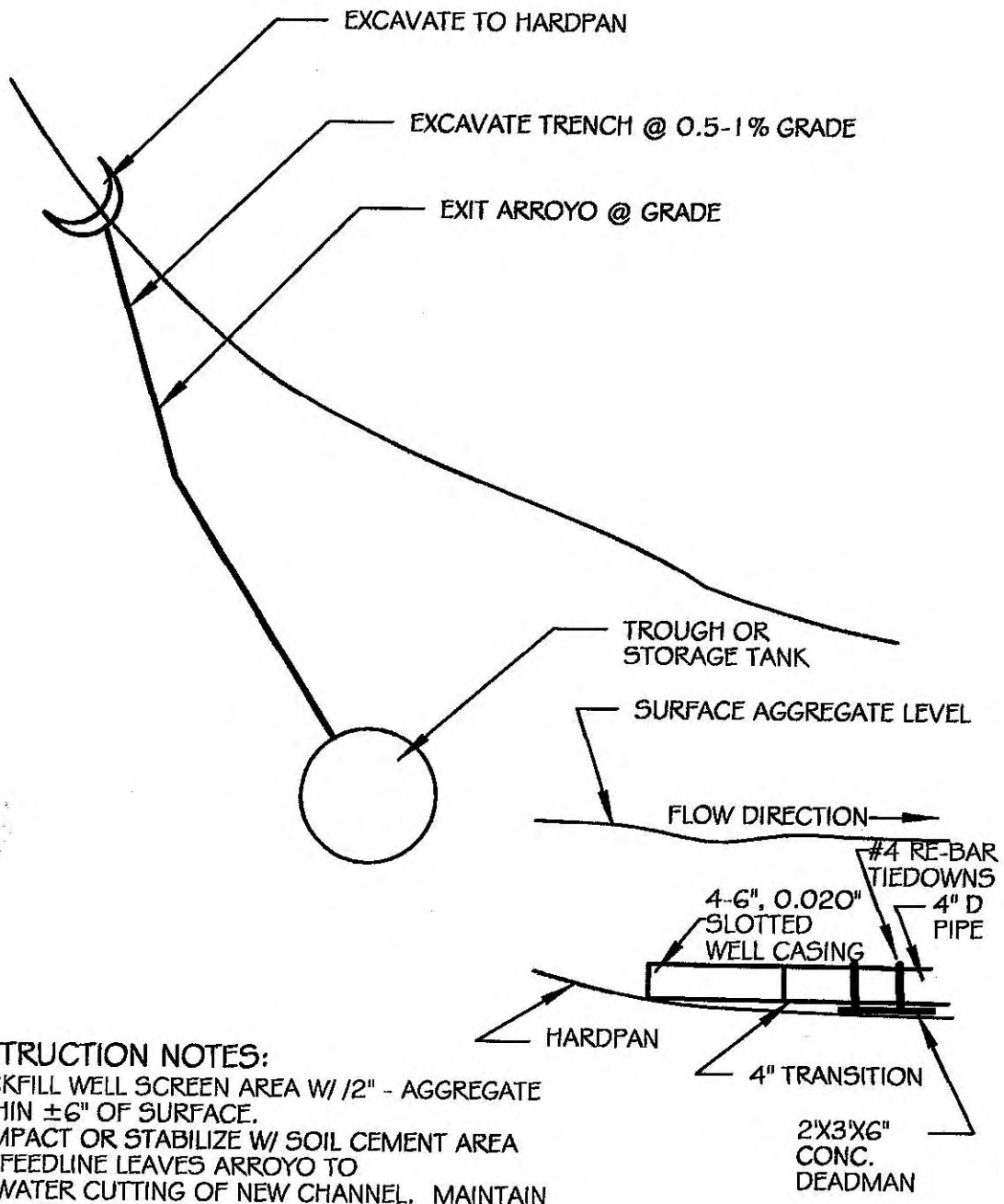


NOTE:

DETAILED DESIGNS FOR NEW DEVELOPMENTS OR REDEVELOPMENTS ARE SITE SPECIFIC AND MAY CONTAIN ANY OR ALL THE FACILITIES ILLUSTRATED IN THIS DRAWING OR OTHERS NOT SHOWN.

BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	3/22/2004	084	

TITLE: EXAMPLE OF ABOVE GROUND REDEVELOPMENT

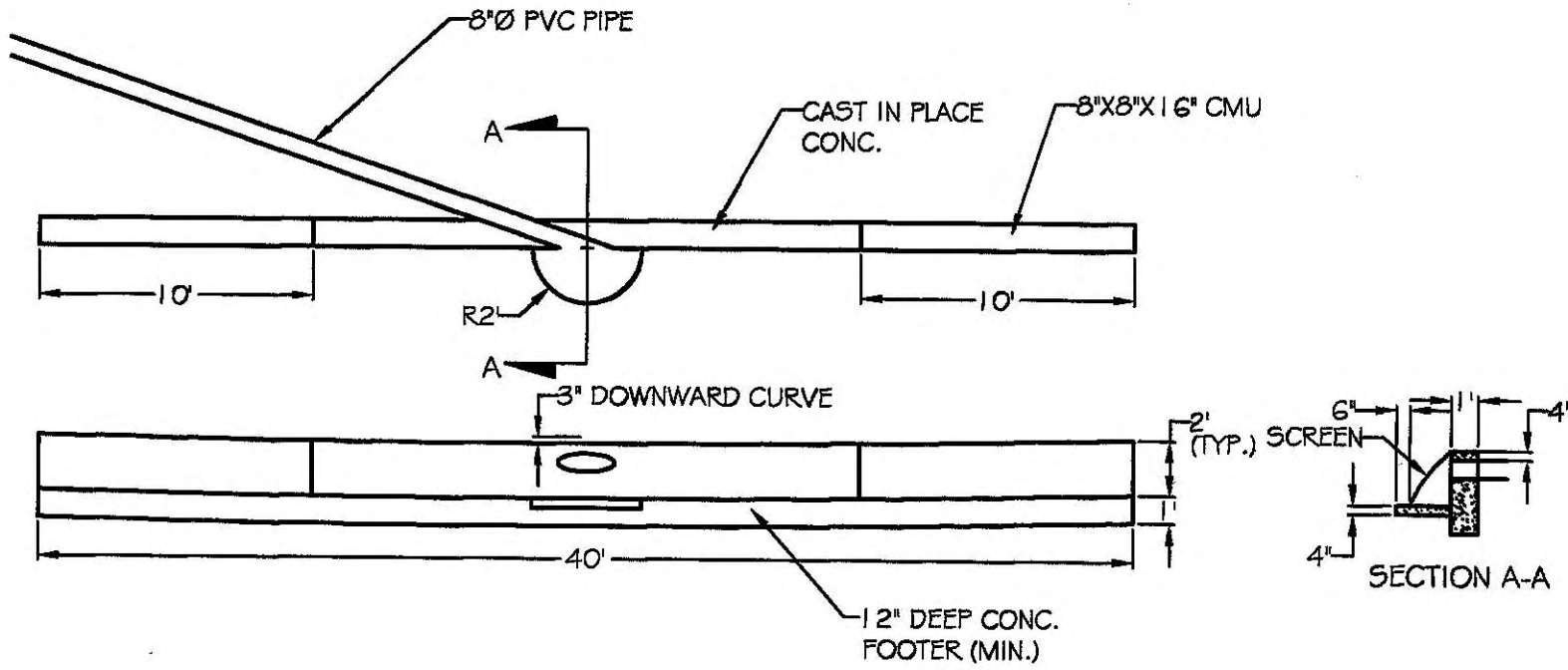


CONSTRUCTION NOTES:

1) BACKFILL WELL SCREEN AREA W/ /2" - AGGREGATE TO WITHIN ±6" OF SURFACE.
2) COMPACT OR STABILIZE W/ SOIL CEMENT AREA WHERE FEEDLINE LEAVES ARROYO TO AVOID WATER CUTTING OF NEW CHANNEL. MAINTAIN FLAT GRADE IN THIS AREA.

BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	7/30/1998	085	

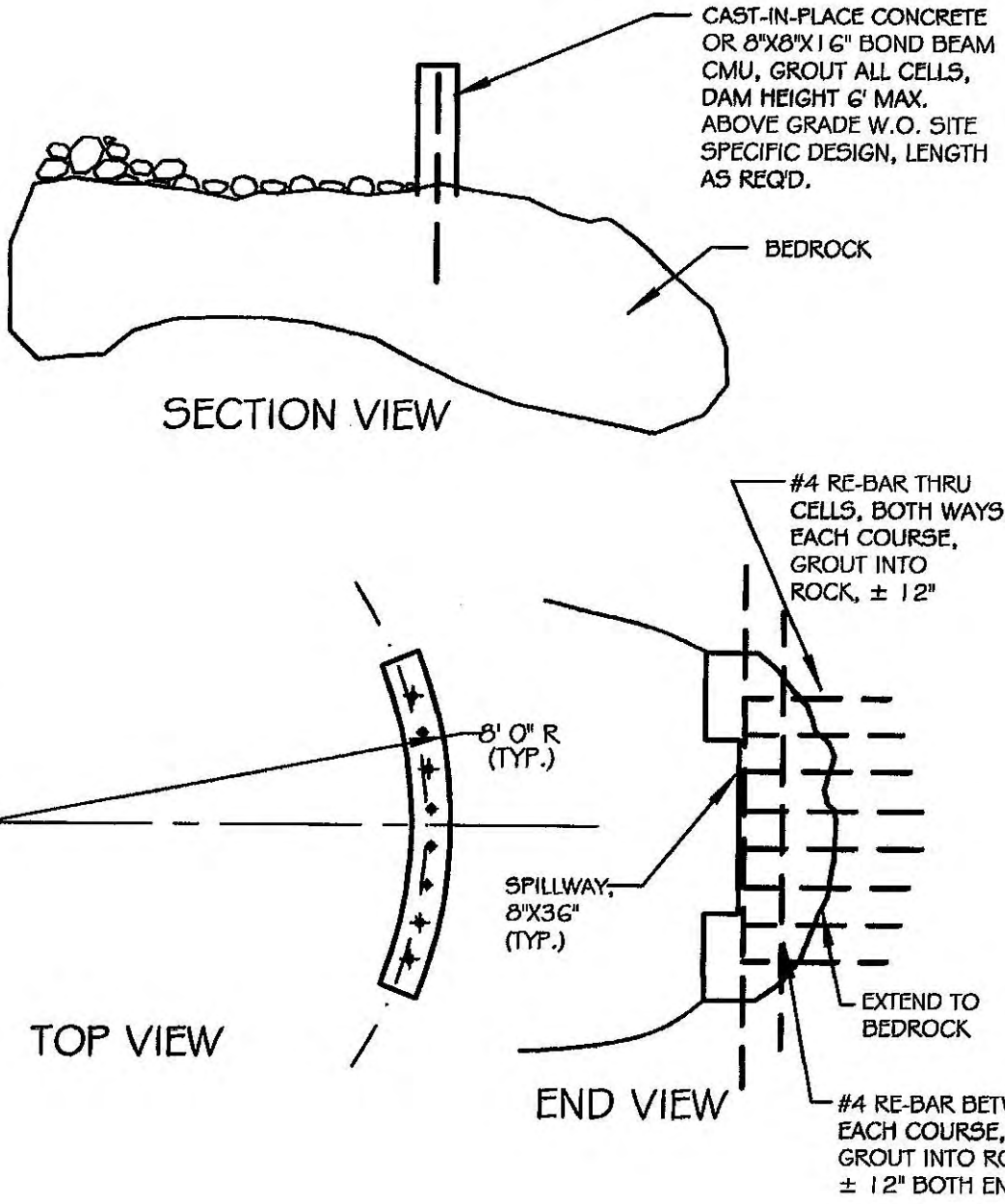
TITLE: SUB-SURFACE COLLECTION POINT SCHEMATIC



BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	3/22/2004	086	

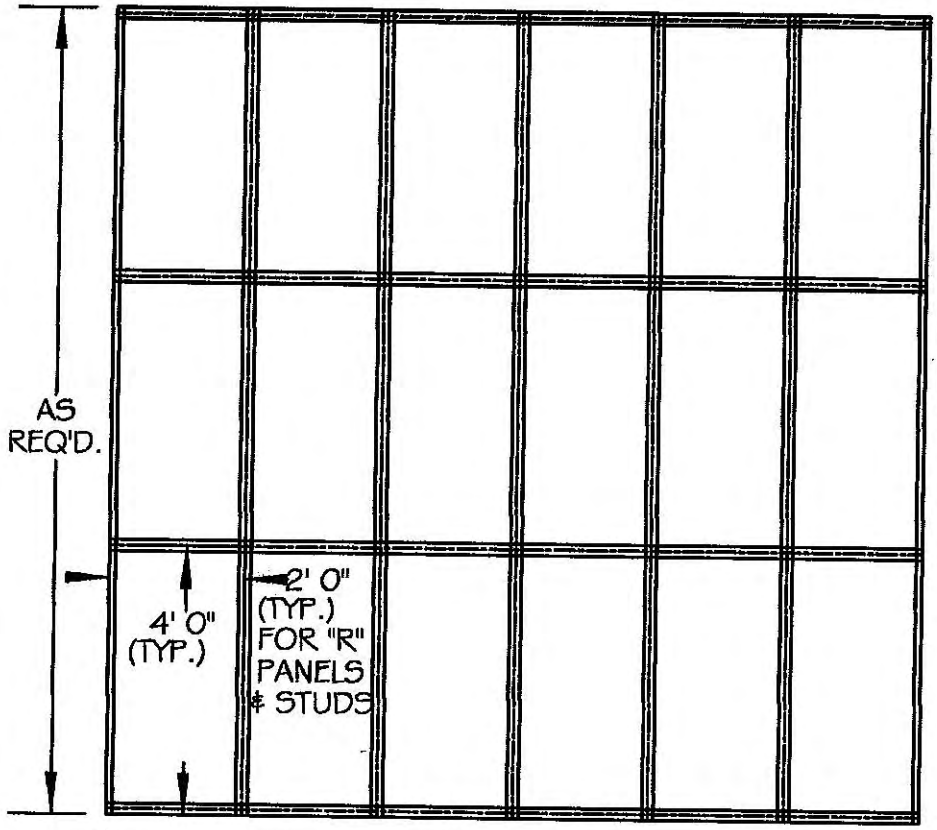
TITLE: TYPICAL DIVERSION DAM DETAIL

NOTES:
1) DIMENSIONS AND RADIUS OF CURVATURE MAY VARY DEPENDING ON FIELD CONDITIONS.
2) DAM SHALL BE FACED ON UPSTREAM SIDEW/ APPROVED WATERPROOFING MATERIAL.
3) MAXIMUM ALLOWED HEIGHT 6' WITHOUT SEALED, DETAILED ENGINEERING DESIGN.

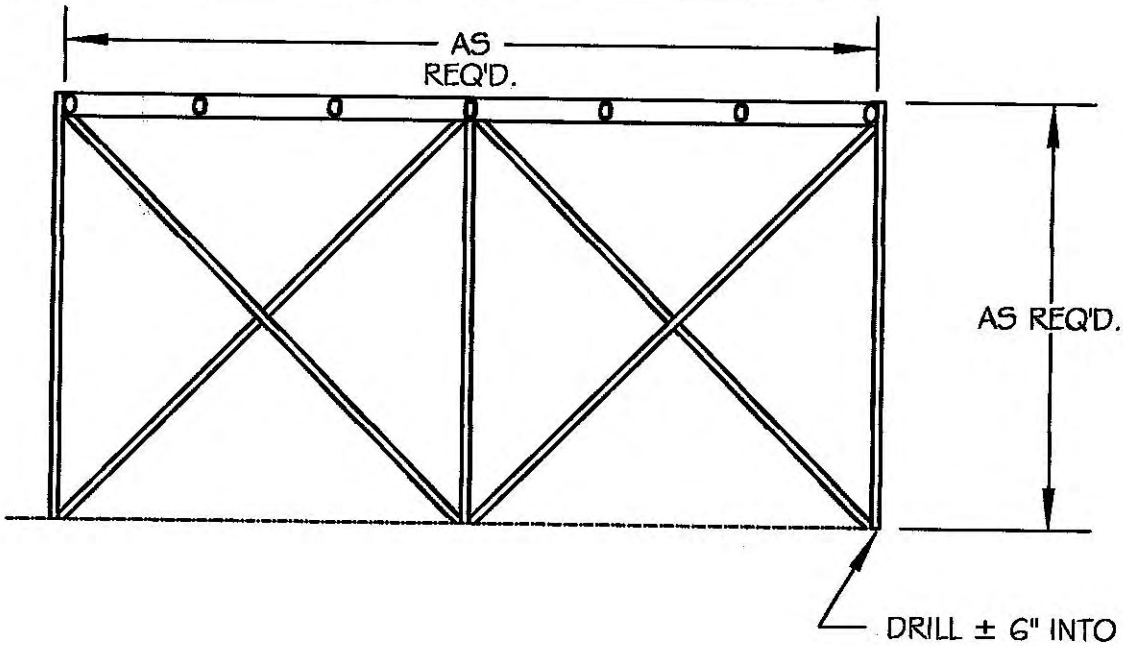


BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	4/8/1998	088	

TITLE: STANDARD "TINAJA" DAM SCHEMATIC

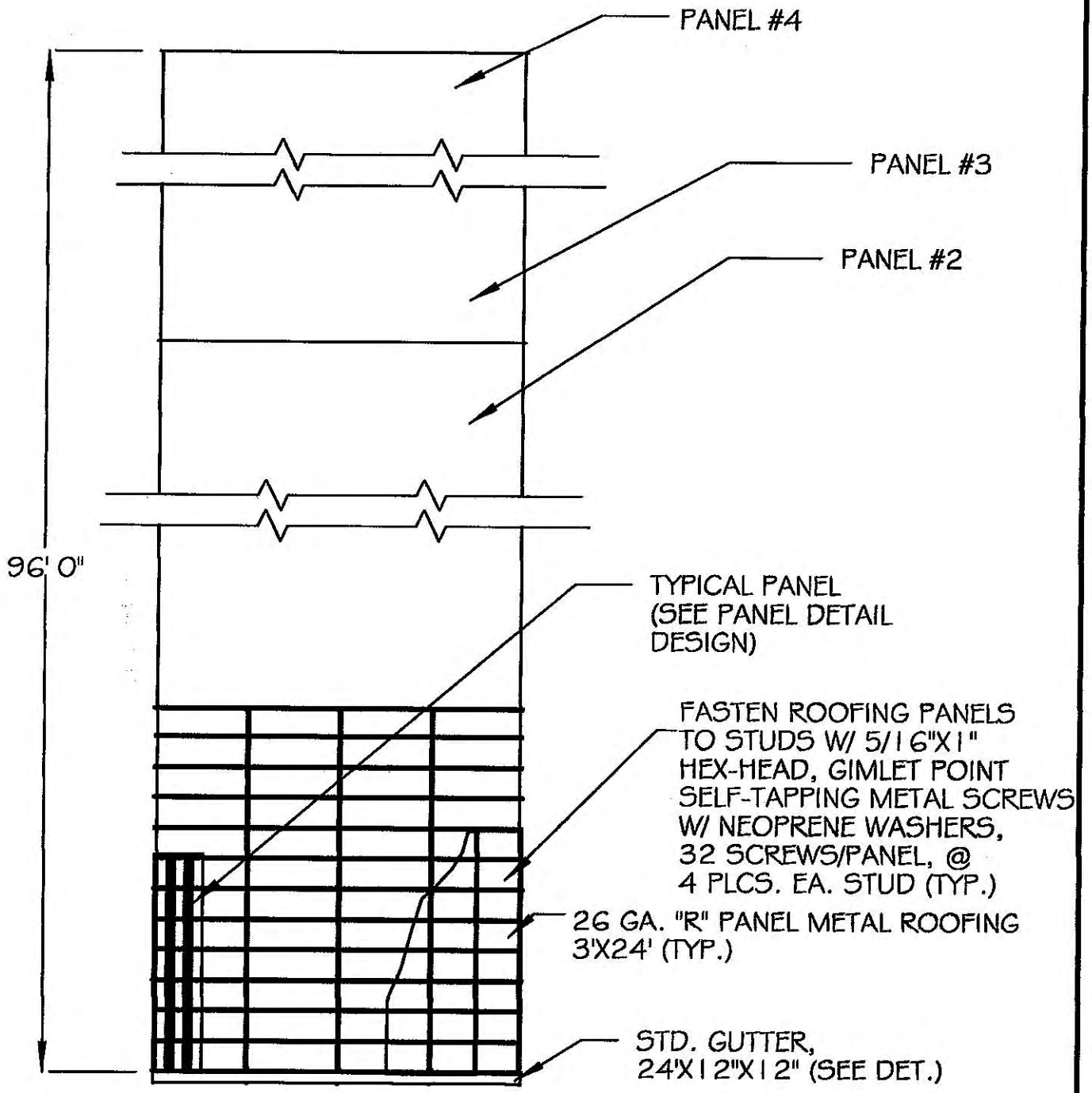


CONSTRUCTION NOTES:
1) SHADE STRUCTURE SHALL BE CONSTRUCTED OF 16 GA. STL. STUDS & CHANNEL & 26 GA. STL. "R" PANELS.
2) SHADE SUPPORTS SHALL BE CONSTRUCTED FROM 1-1/2" SQ. STL. TUBING.
3) 20-30 PSF. CAMO. LOAD



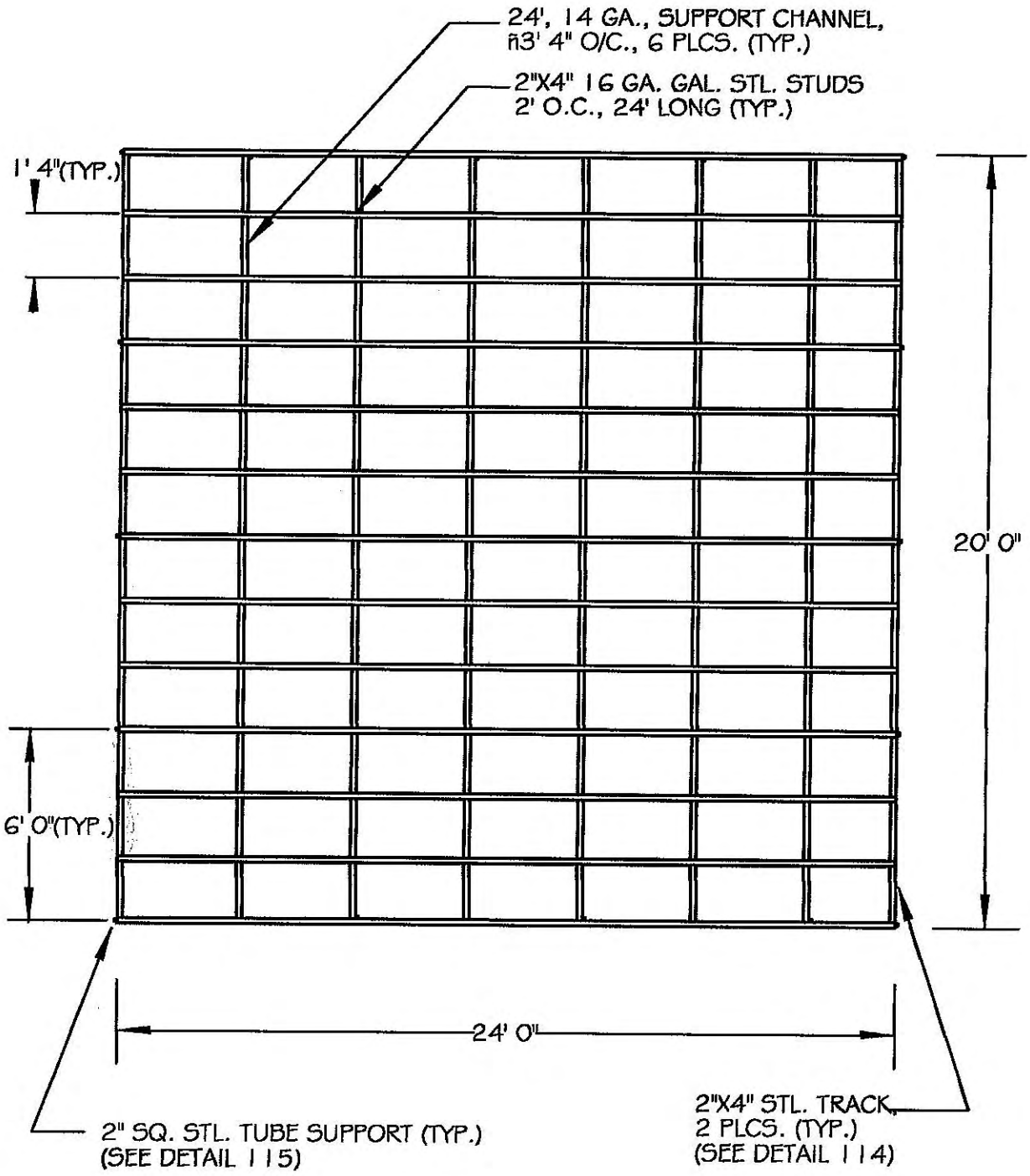
BY:	DATE:	DETAIL NO.	REV. NO.
GM	7/30/1998	111	
TITLE	SUN SHADE		

NOTE:
COMPLETE APRON CONSISTS OF MULTIPLE PANELS FASTENED END TO END WITH A SINGLE STANDARD GUTTER ATTACHED. ROOFING PANELS SHALL BE LAID CONTINUOUSLY ACROSS PANELS. APRON GRADE SHALL BE SET TO FALL TO GUTTER. AS AN ALTERNATE, APRON MAY BE CONSTRUCTED AS A 48'X48' SQUARE WITH DOUBLE GUTTERS PLACED ALONG THE LOW SIDE.

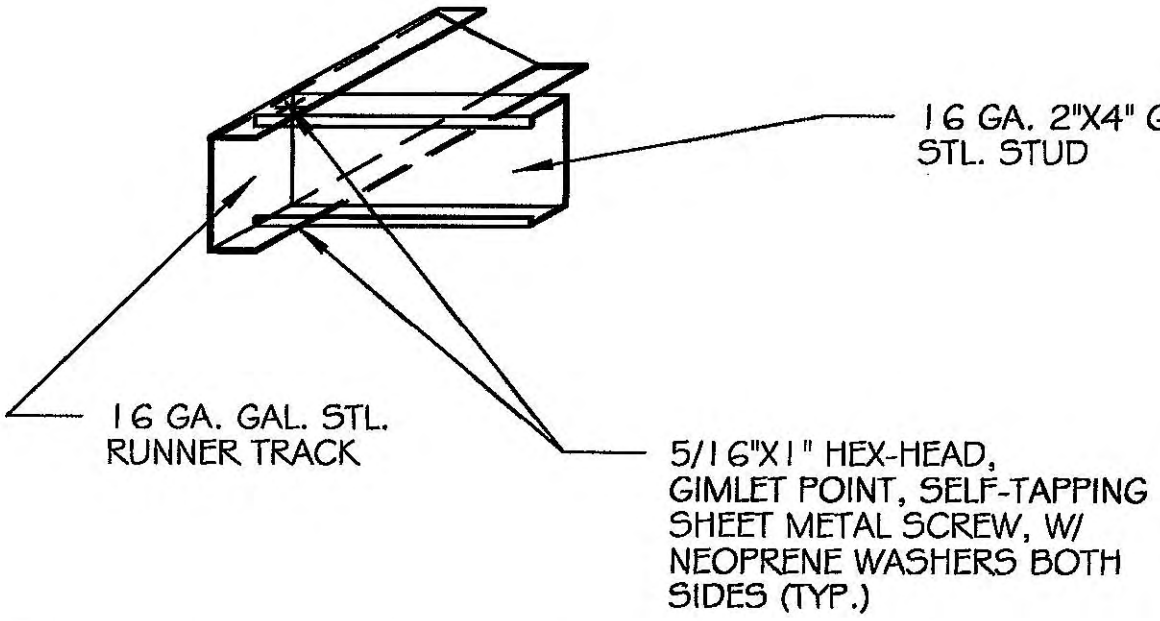


NO SCALE

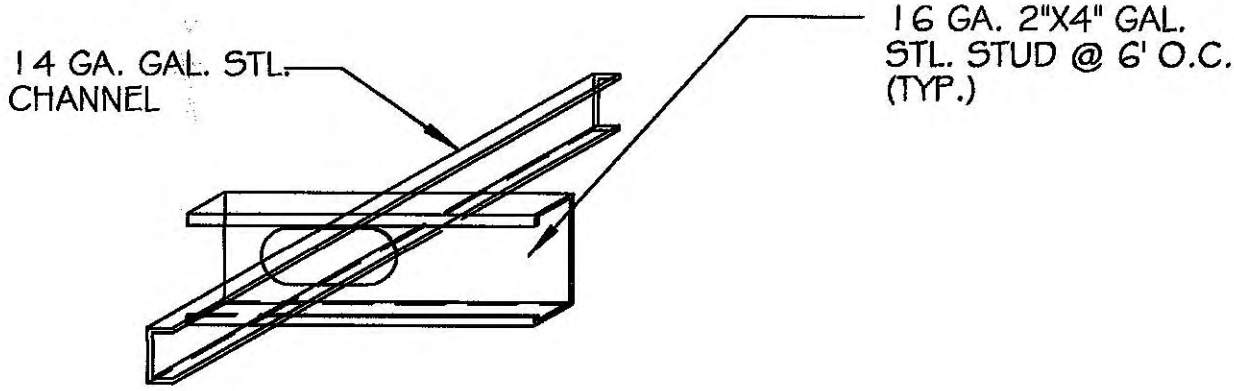
BY:	DATE:	DETAIL NO.	REV. NO.
GM	11/6/1997	112	1
TITLE	STANDARD APRON LAYOUT		



BY:	DATE:	DETAIL NO.	REV. NO.
GM	11/6/1997	113	
TITLE	STANDARD APRON PANEL		

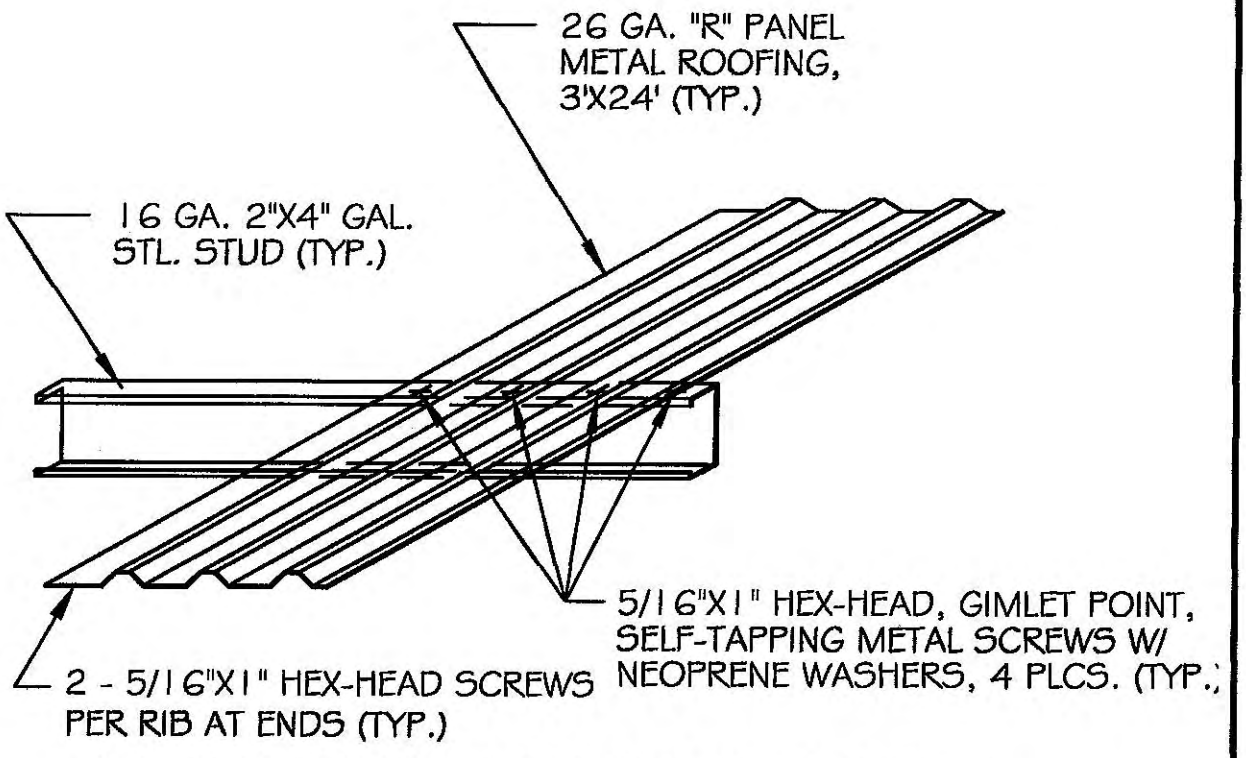


STUD TO TRACK FASTENING DETAIL

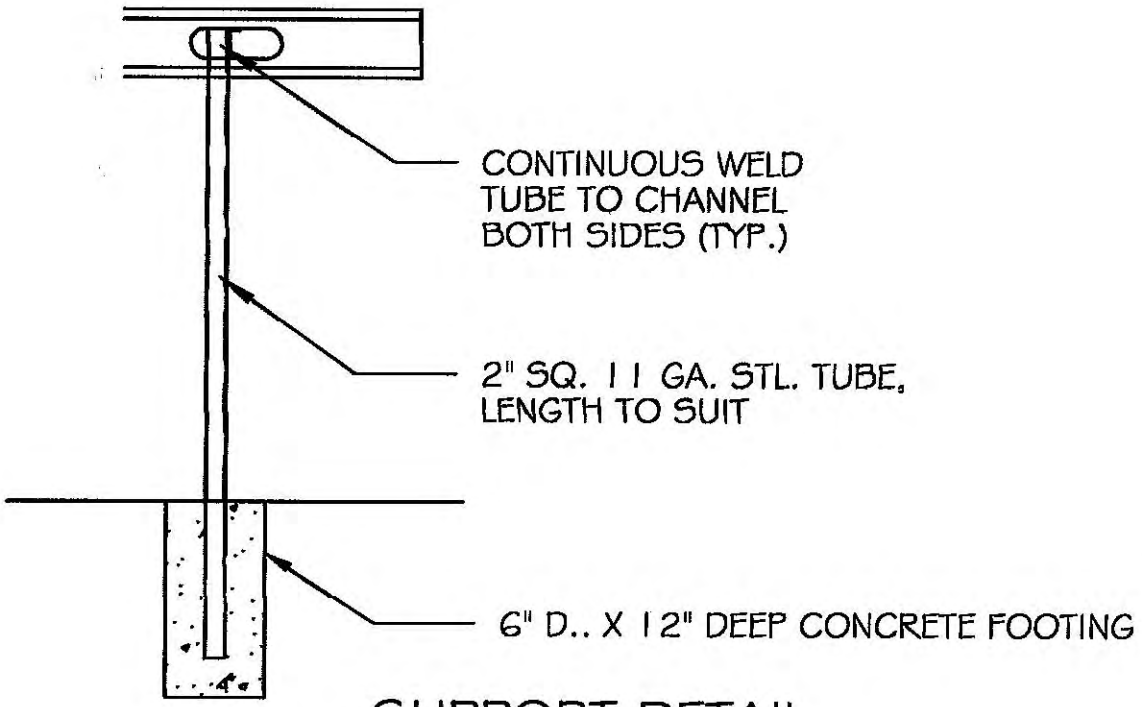


STUD TO CHANNEL FASTENING DETAIL

BY:	DATE:	DETAIL NO.	REV. NO.
GM	11/19/1997	114	
TITLE	STANDARD APRON CONSTRUCTION DETAILS - 1		

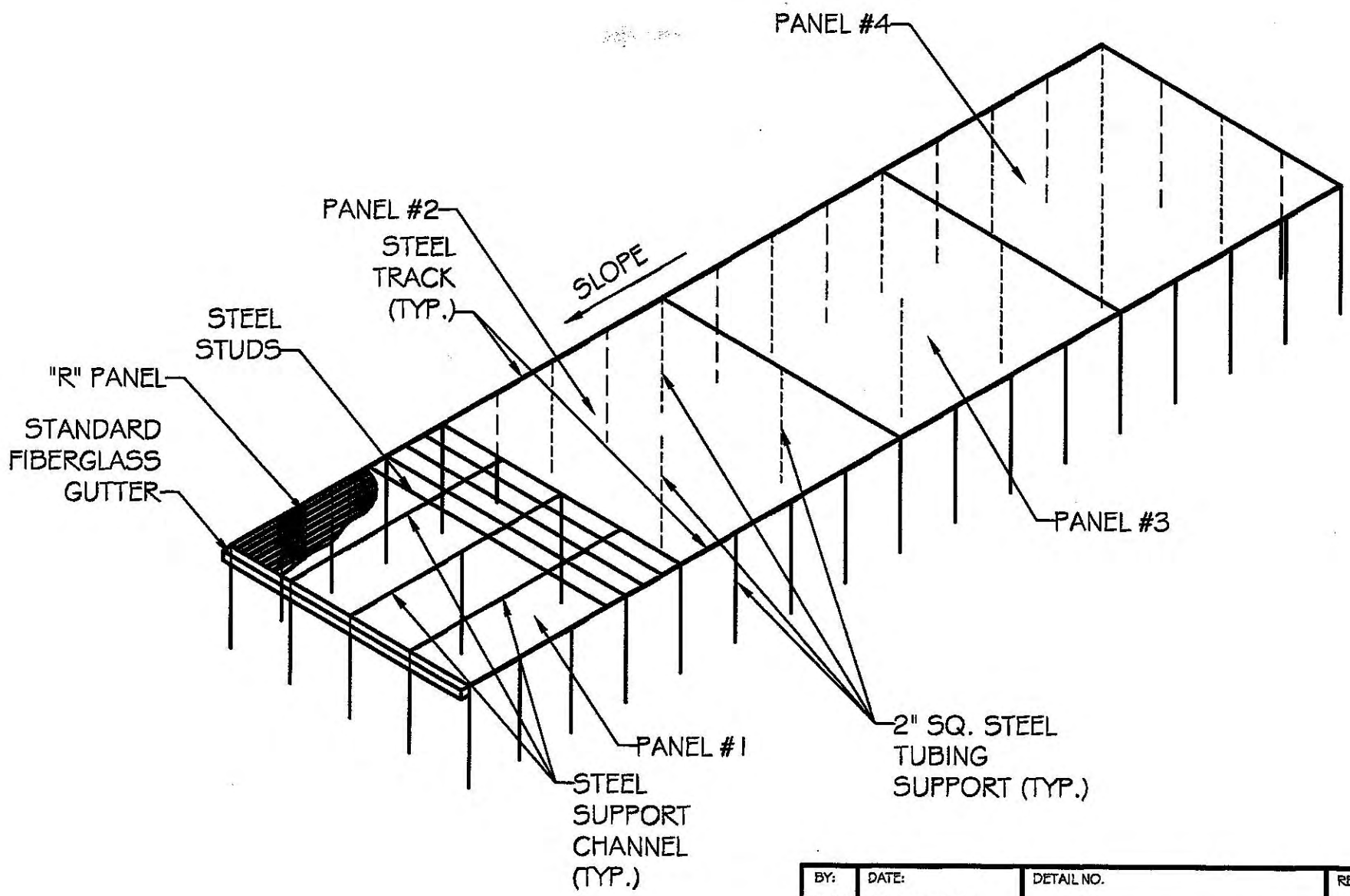


APRON PANEL ATTACHMENT DETAIL



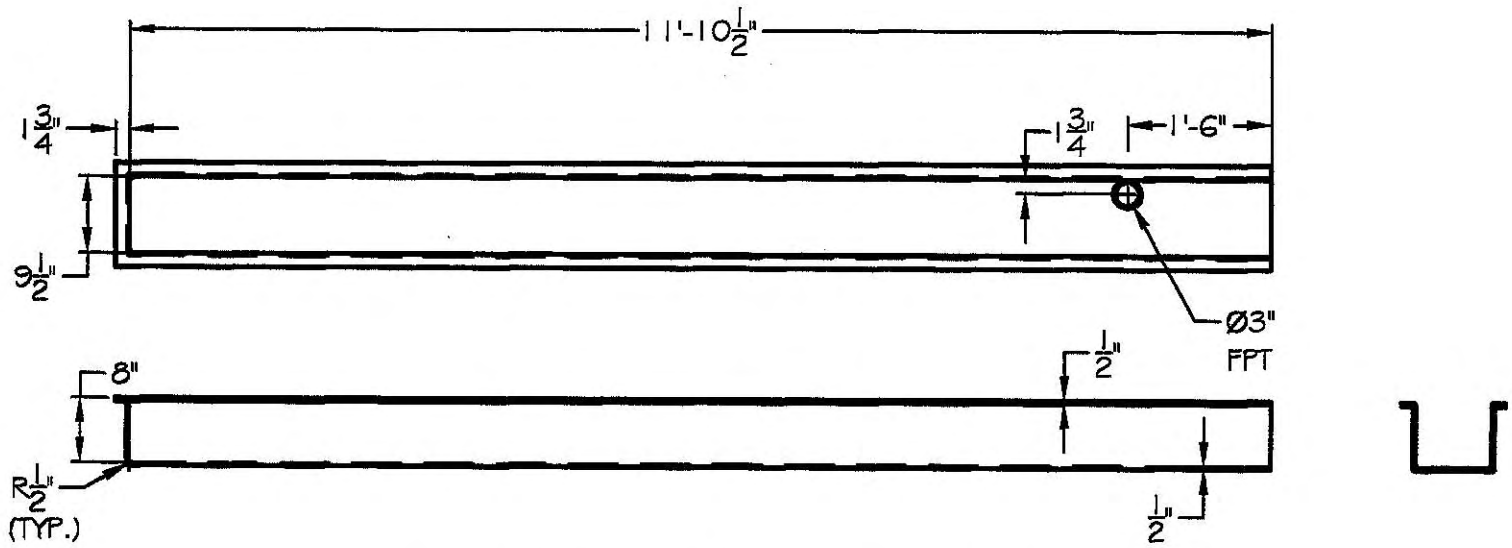
SUPPORT DETAIL

BY:	DATE:	DETAIL NO.	REV. NO.
GM	11/19/1997	115	
TITLE	STANDARD APRON DETAILS - 2		



BY:	DATE:	DETAIL NO.	REV. NO.
G.M.	6/23/2004	116	

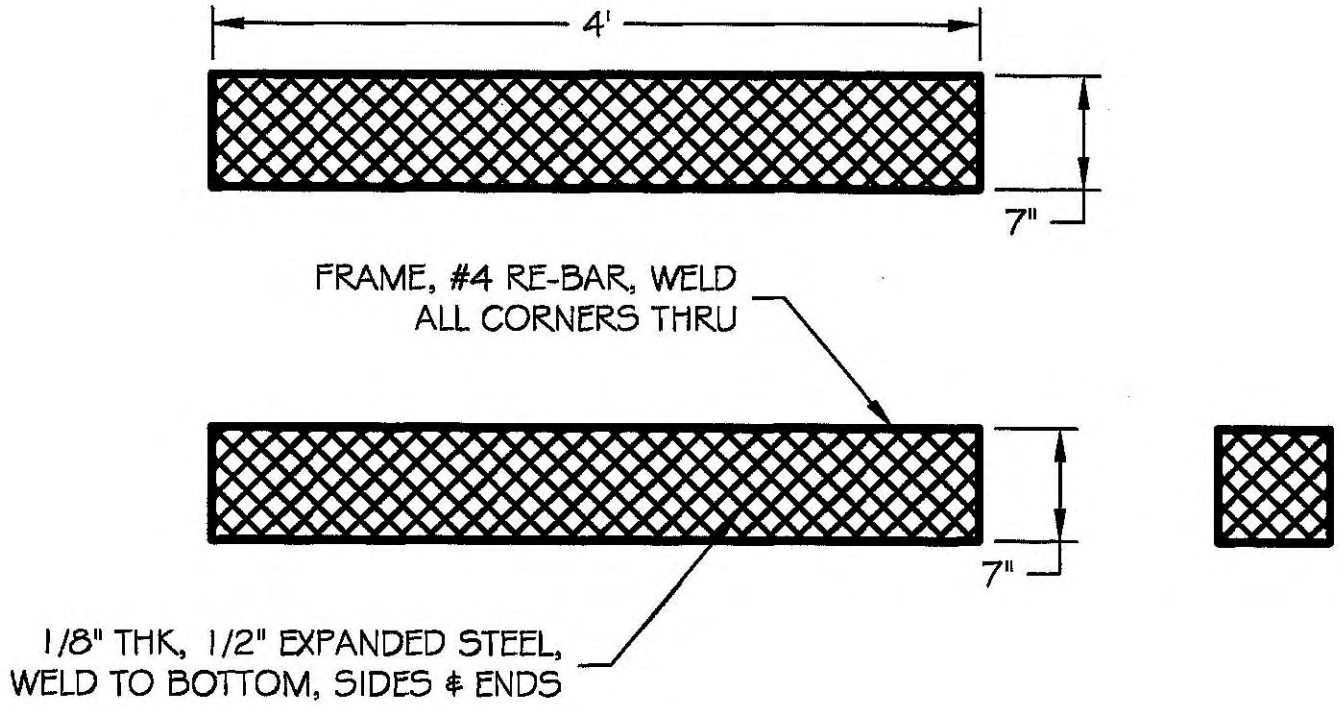
TITLE: TYPICAL APRON INSTALLATION ISOMETRIC



LEFT HALF OF GUTTER SHOWN, RIGHT HALF IS MIRROR IMAGE

BY:	DATE:	DETAIL NO.	REV. NO.
G.M	16 JAN 07	117	

TITLE: STANDARD FIBERGLASS GUTTER



BY:	DATE:	DETAIL NO.	REV. NO.
G.M	16 JAN 07	118	

TITLE: STANDARD STEEL GUTTER BASKET

MISSION

To conserve, enhance and restore Arizona's diverse wildlife resources and habitats through aggressive protection and management programs and to provide wildlife resources and safe watercraft and off-highway vehicle recreation for the enjoyment, appreciation and use by present and future generations