DESIGN GUIDELINES AND SPECIFICATIONS FOR BRIDGE CROSSINGS OF SALT RIVER PROJECT CANALS

WATER ENGINEERING & TRANSMISSION

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Design Guidelines and Specifications
For
Bridge Crossings
Of Salt River Project Canals

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1 GENERAL

1.1 *Design Guidelines and Specifications for Bridge Crossings of Salt River Project Canals* (herein referred to as "Guidelines") provide general information and design requirements that must be met for bridge crossings of the Salt River Project (herein referred to as "SRP") canal system.

1.2 The Guidelines delineate requirements and guidelines for the operation and maintenance of SRP's canal system only. They do not include any requirements or guidelines from the SRP Power District or any other agency or utility.

1.3 The Bridge Designer shall address all public safety issues in connection with the bridge and associated roadway. Compliance with these Guidelines, and any other SRP requirements, does not relieve the Bridge Designer of this public safety responsibility.

1.4 These guidelines are posted on the web at www.srpnet.com/bridgeguidelines.

2 DEFINITIONS

2.1 BANK FULL CAPACITY – The flow rate at which the canal bank is overtopped in the vicinity of the subject bridge.

2.2 BRIDGE DECK – Top of bridge.

2.3 BRIDGE DESIGNER – The person, firm, corporation, or public agency, or the duly authorized representative responsible for the design of the bridge crossing.

2.4 CONSTRUCTION LICENSE – An SRP license to construct a bridge in the canal right-of-way issued by the SRP Water Engineering Department.

2.5 CONTRACTOR – The person, firm, corporation or public agency responsible for the construction of the bridge crossing.

2.6 ENGINEER – The duly authorized SRP representative.

2.7 CONSTRUCTION CONSULTANT – The SRP representative authorized to issue Field Permits.

2.8 FIELD PERMIT – Form issued by SRP to give permission for minor temporary activities within SRP right-of-way.

2.9 FOREBAY – A portion of a canal between regulating structures.

2.10 LAND USE LICENSE – An SRP license to locate and maintain a bridge in the canal right-of-way issued by the SRP Land Department.

2.11 LICENSEE – The person, firm, corporation, or public agency, or the duly authorized representative, to which a Land Use or Construction License is issued permitting the bridge to be constructed and maintained within SRP right-of-way.

2.12 LOW CHORD – The lowest point of the underside of the bridge within the bridge span.

2.13 OPERATIONAL HIGH WATER ELEVATION – The water level in the canal at its highest normal operating level at the bridge crossing site as established by SRP and approved by the Manager of the WT&C Department. This does not include storm, flood or emergency water levels.

2.14 SRP PLAN REVIEW PORTAL – Plan submittal process for all plan review by SRP. This process is posted on the web at https://srpnet.com/about/land/secure/plansubmittal.aspx

2.15 SRP SPECIFICATION – Reference to SRP Standard Specifications herein shall be interpreted to mean the latest revision.

2.16 WT&C DEPARTMENT – SRP's Water Transmission and Communications Department, the department charged with operating the canal system

3 POLICY

3.1 It is incumbent upon the Bridge Designer and Contractor to conform to the latest version of the Guidelines. If a new version of the Guidelines is published during the design review process, the Bridge Designer and Contractor shall conform to the newer version.

3.2 Bridge Locations

3.2.1 Vehicular – At grade canal bridges will be permitted at section and mid-section lines. Other locations will be considered on a case-by-case basis and subject to approval by SRP. Freeway/expressway crossings at other locations may be allowed if the bridge spans both the entire canal width and the maintenance roads with clearance as defined in Section 5.3.

3.2.2 Pedestrian – The location of at-grade canal bridges for pedestrians, bicycles, golf carts, and/or horses will be considered on a case-by-case basis and subject to approval by SRP.

3.2.3 SRP reserves the right to reject the location of any bridge, and may suggest another suitable location.

3.3 Clearance Requirements

3.3.1 New bridges shall not restrict the Bank Full Capacity of the canal. Modifications to existing bridges will only be allowed if it is hydraulically proven that the modification will not restrict the Bank Full Capacity of the canal.

3.4 The Licensee shall be responsible for any damage caused by heavy equipment to the bridge or bridge approach within the SRP right-of-way in connection with SRP maintenance activity.

3.5 If the bridge design stops during the review process, and no activity occurs for eighteen (18) months, SRP may require that the review process be restarted from the beginning.

3.6 Licensee shall provide as-built information in a form similar to *Figure 5* immediately upon construction completion.

3.7 Canal Dry-up

3.7.1 Canal dry-up dates are scheduled one year in advance and are subject to change.

3.7.2 There is one dry-up scheduled per year, and for only certain canal reaches.

3.7.2.1 For canals south of the Salt River, a dry-up is typically scheduled for a four-week period in the November-December time frame.

3.7.2.2 For canals north of the Salt River, a dry-up is typically scheduled for a four-week period in the January-February timeframe.

3.7.3 It may not be possible to schedule a dry-up that is not in accordance with *The Canal Dry-Up Plan* (*Appendix 3*) and posted on the web at http://www.srpnet.com/water/canals/canaldry.aspx

4 PROCEDURES

4.1 Pre-Design Requirements

4.1.1 The Bridge Designer is encouraged to contact SRP early in the planning stage to confirm that a bridge at the desired location is acceptable to SRP and to discuss scheduling and construction options.

4.1.2 The Bridge Designer shall obtain a copy of SRP's current version of the Guidelines from the Engineer prior to any bridge design or related survey work. An online version can be found at www.srpnet.com/bridgeguidelines.

4.1.3 Determination of Operational High Water Elevation.

4.1.3.1 If data is available, the Engineer will provide the Bridge Designer an estimated Operational High Water Elevation, along with related benchmark information based on SRP datum NGVD 29. If the Engineer or Bridge Designer determines that the freeboard at Operational High Water Elevation is sufficiently close to the minimum clearance required, the Engineer will provide to the Bridge Designer HEC RAS files for the Forebay in which the bridge is located for a more accurate determination of water surface elevation.

4.1.3.2 If data is not available, the Bridge Designer shall conduct a HEC RAS backwater analysis from the downstream control structure to the bridge. This will include obtaining field survey information as necessary. See Section 5.8 for requirements for conducting the HEC RAS analysis. The Engineer will provide starting downstream depth and flow rate.

4.1.4 Once the Bridge Designer provides the general location of the proposed bridge, the Engineer will provide a reference station (SRP Canal System) to the Bridge Designer to use to locate the bridge along the canal using SRP stationing.

4.1.5 Pre-Design Meeting

4.1.5.1 The Bridge Designer shall schedule a meeting with the Engineer at the proposed bridge site. Attendees should include the Bridge Designer, the Engineer and appropriate representatives of SRP's Water and Power operations & maintenance departments.

4.1.5.2 The Bridge Designer shall locate the bridge centerline in the field prior to the pre-design meeting.

4.1.5.3 The purpose of this meeting will be to identify any site-specific items that should be considered in the design.

4.2 **Initial Design Review**

4.2.1 The Bridge Designer shall submit preliminary bridge plans and construction plans checklist (see Section 11.2) in a PDF format for review through the SRP Plan Review Portal (see Section 2.14). Plans should be submitted a minimum of two weeks prior to the Design Review Field Meeting (see Section 4.2.4).

4.2.2 The Bridge Designer shall submit for review all bridge guidelines required information, drawings, notes, sketches, etc. on sequential sheets and independent from the rest of the bridge drawings.

4.2.3 SRP will not perform a thorough detailed review of the plans until a significant portion (at least 75%) of the submittal requirements are complete. See Section 11.2 for the Construction Plans Checklist.

4.2.4 Design Review Field Meeting

4.2.4.1 The Bridge Designer shall schedule a meeting with the Engineer at the proposed bridge site. Attendees should include the Bridge Designer, the Engineer and appropriate representatives of SRP's operations & maintenance departments.

4.2.4.2 Prior to the Design Review Meeting, the Bridge Designer shall stake the following features at the site:

a) Location and deck elevation and Low Chord at the four corners for street bridges, or at the bridge centerlines for pedestrian bridges
b) Location, elevation and extents of abutments
c) Location, elevation and extents of the approach aprons for street bridges
d) Location and top elevation of wing walls and/or retaining walls

4.2.4.3 The purpose of this meeting will be to review the bridge stakes and the design of the bridge.

4.2.5 Upon receipt of the bridge plans after the Design Review Field Meeting, the Engineer will compile and provide SRP's review comments to the Bridge Designer through the SRP Plan Review Portal process, generally within two weeks of plan submittal.

4.2.6 The Bridge Designer shall make corrections, if necessary, and resubmit for approval.

4.3 Intermediate Reviews

4.3.1 Intermediate reviews are not required by SRP, but may be done at the request of the Bridge Designer.

4.3.2 A review will not be done if previous comments have not been addressed.

4.3.3 Prior to the submittal, the Bridge Designer shall contact the Engineer to determine what to submit.

4.4 Final Design Review

4.4.1 The Bridge Designer shall submit signed/sealed final bridge plans and construction plans checklist (see Section 11.2) through the SRP Plan Review Portal. The plans will either be approved or comments will be provided generally within two weeks receipt of the plans. If plans are not approved, corrections shall be made to the plans and resubmitted.

4.4.2 The Bridge Designer shall submit for review all bridge guidelines required information, drawings, notes, sketches, etc. on sequential sheets and independent from the rest of the bridge drawings.

4.4.3 If required, the Bridge Designer shall submit a HEC RAS analysis.

4.4.4 The Bridge Designer shall submit construction scheduling and phasing information as part of the final review if available.

4.5 Land Use License Requirements

4.5.1 The Licensee shall obtain an SRP Land Use License for use of the bridge, new or modified, across the canal right-of-way. License shall be issued upon approval of final plans by the SRP Land department.

4.6 Cultural Clearance Requirements

4.6.1 If any excavation is to be done on USA land, which includes all SRP canals, the Licensee shall obtain a cultural clearance from the U.S.B.R.

4.7 SRP Construction License Requirements

4.7.1 The Construction License is for the express purpose of authorizing the construction, operation and maintenance of improvements within the canal right-of-way.

4.7.2 The Licensee shall obtain a Construction License prior to any on-site construction activities.

4.7.3 A separate Construction License is required for geo-technical borings.

4.7.4 In addition to the requirements of the Land Use License, the following are required before a Construction License is issued:

a) Utilities associated with the bridge must be licensed. (See Section 4.8)

b) If a canal dry-up falling outside of SRP's *Canal Dry-Up Plan* (*Appendix 3*) is requested and approved, an authorization for SRP to bill the responsible agency for the cost of moving fish and other related SRP expenses must be provided.

4.7.5 Typically the Construction License for the bridge is issued with the Land Use License.

4.7.6 All work shall be performed in conformance with the SRP license issued for the project. No work on SRP right-of-way will be allowed without the appropriate SRP license or Field Permit.

4.7.7 If the plans and specifications prepared by the Licensee differ from the SRP specifications, the SRP specifications shall take precedence or whichever is more stringent and approved by the SRP Engineer.

4.7.8 The Construction License requires that construction begin within one year of the issuance of the license.

4.8 Licensing Utilities Associated with the Bridge

4.8.1 The Licensee shall obtain a Construction License for each utility associated with the bridge construction. Typically two weeks are required to process the request.

4.8.2 More than one utility may be included in a single license issued to the owner of the utility.

5 BRIDGE DESIGN CRITERIA

5.1 General Requirements for all Bridges

5.1.1 This section applies to all types of bridge construction, new bridge crossings, bridge widening and replacement, bridge repairs, including roadway, pedestrian, railway and equestrian bridges, whether they be conventional bridges, box culverts or grade separation crossings. (See Section 5.6 for possible exceptions)

5.1.2 A HEC RAS analysis is required for bridges where there is any change in cross section of the canal, or where there is a pier or other obstruction in the canal.

5.1.3 Vertical Clearance Requirements

5.1.3.1 The Low Chord of the bridge shall be no lower than the existing top of the bank, unless a low point exists in the canal bank in the vicinity of the bridge that proves to hydraulically control the Bank Full Capacity, unless in the case of bridge widening or bridge replacement.

5.1.3.2 There must be at least eighteen (18) inches clearance between Operational High Water Elevation and the Low Chord of the bridge.

5.1.3.3 There must be a minimum of eight (8) feet clearance between the canal invert and the bridge Low Chord to allow for maintenance equipment to pass under the bridge. If this is not practicable, the Bridge Designer must obtain approval from SRP for an alternative means to maintain the canal in the vicinity of the bridge, which may require adding access ramp(s) on either side of the proposed bridge at the licensee's expense.

5.1.4 A haunch at each end of the bridge may extend four (4) inches into the eighteen-inch clearance zone for a distance not more than twenty-five (25) percent of the canal top width (see *Figure 1*).

5.1.5 The inside edge of the bridge abutments shall be located at the top of bank.

5.1.6 Bridge abutments and/or piers shall be aligned with the canal so as not to change the direction of water flow.

5.1.7 No ledge shall be allowed under the bridge or along retaining walls (see *Figures 1* and *3*).

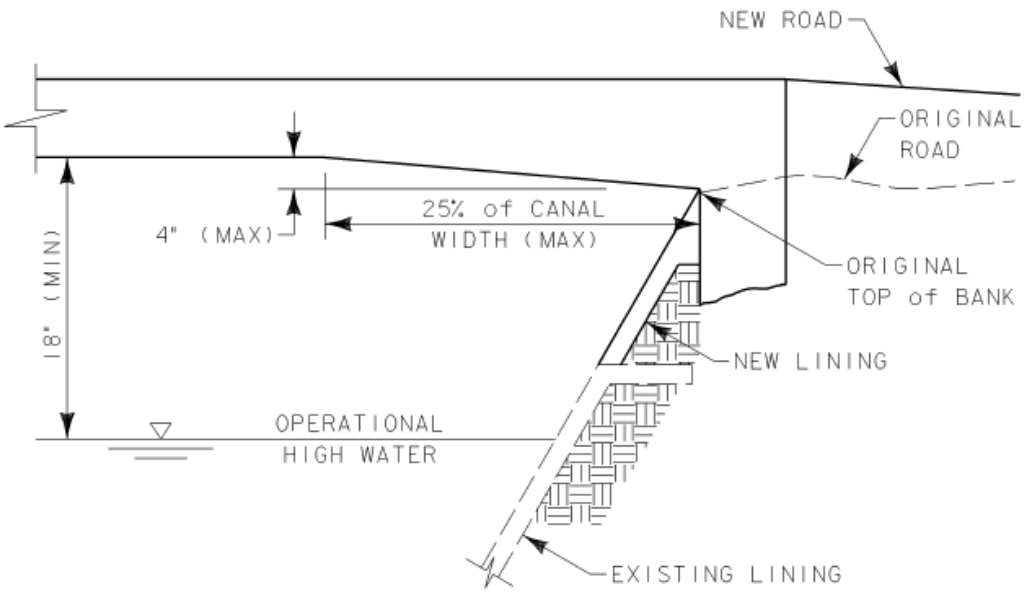


Figure 1
Bridge Clearances and Lining

5.1.8 Landscaping, fencing, walls or any other object shall not restrict the safe site distance necessary for safe transition of vehicles from canal roadway.

5.1.9 Obstructions above the bridges deck elevation, such as dadoes, walkways, bollards, curbs or handrails, shall not extend horizontally beyond the top edge of the canal bank.

5.1.10 Handrails and Fencing

5.1.10.1 Fences and handrails will be reviewed by SRP on a case-by-case basis for compatibility with SRP O&M requirements.

5.1.10.2 Handrails or fencing shall not restrict access to bridge piers for cleaning.

5.1.10.3 Fence sections shall be removable, hinged and lockable to facilitate maintenance of the canal.

5.1.10.4 Handrails on retaining or wings walls shall be removable to facilitate maintenance of the canal.

5.1.10.5 Handrails or fences are not allowed parallel to the canal, except with prior approval, along the SRP right-of-way line, or for pedestrian bridges per Section 5.4.2.

5.1.11 Horizontal Clearances

5.1.11.1 A minimum of twenty (20) feet shall be maintained from the edge of a bridge to the nearest edge of an existing radial canal gate structure

5.1.11.2 A minimum of ten (10) feet shall be maintained from the edge of the bridge to a lateral headgate structure, well outlet, or stilling well.

5.1.12 Surface drainage from the bridge shall not be allowed to enter the canal. Drainage shall be carried beyond the canal right-of-way in a manner that will not cause erosion within SRP right-of-way.

5.1.13 Utilities in SRP Right-of-Way

5.1.13.1 Utility conduits crossing the canal, when allowed, shall either cross underneath the canal per SRP standards, or be located within the bridge structure without extending below the underside of the bridge or being strapped alongside the bridge.

5.1.13.2 Conduits shall extend at least to the SRP right-of-way line on both sides of the bridge. Detailed drawings including the conduit material, trenching, cover and associated structures shall be provided for the entire length of the conduit within the right-of-way.

5.1.13.3 Horizontal and vertical locations of all conduits within SRP right-of-way shall be surveyed as installed. They shall be located relative to some permanent and easily identifiable point on the bridge, such as an abutment corner.

5.1.13.4 Utility crossings for different agencies require separate licenses. All conduits must be licensed before a Construction License will be issued for the bridge. Conduits owned by the Licensee can be included in the Construction License for the bridge.

5.1.13.5 Installation of a conduit for future use by SRP may be required.

a) Conduit should run parallel to the canal ten (10) feet from the canal bank on the operating side of the canal. The operating side of the canal is determined by SRP O&M.

b) Conduit should be three (3) inch PVC

c) Conduit should extend all the way through the disturbed portion of the canal road

d) Cover and fill should conform to MAG standards

e) This conduit(s) shall be surveyed as installed per Section 5.1.13.3

f) These requirements may be modified by the Engineer depending on the site and local conditions.

5.1.13.6 A minimum clearance of thirty-five (35) feet shall be maintained for overhead utilities crossing the canal right-of-way, and a minimum of twenty-two (22) feet for overhead utilities parallel to the canal right-of-way.

5.1.13.7 If wing walls are not used, the bridge abutment walls or cast-in-place concrete retaining walls shall extend a minimum of five (5) feet beyond the bridge to prevent road material from sloughing into the canal. The elevation of these walls shall match the finish grade at the bridge approach aprons and match the finish grade of the canal approach road.

5.2 **Roadway Bridges**

5.2.1 Concrete aprons lining up with the canal maintenance roads shall be installed on both sides of the bridge to permit maintenance equipment to cross without damaging the road surface. The aprons shall extend a minimum of eight (8) feet on each side of the centerline of the canal road, and extend to the edge of the road. These aprons shall be wide enough to provide a minimum of thirty (30) feet unobstructed width.

5.2.2 On divided roadways, a raised median within the canal right-of-way will limit SRP's equipment access from and to the canal roads in all directions, and therefore is not allowed. A rolled concrete curb median may be acceptable on a case-by-case basis and subject to SRP's Engineer's approval. (see *Figure 4*).

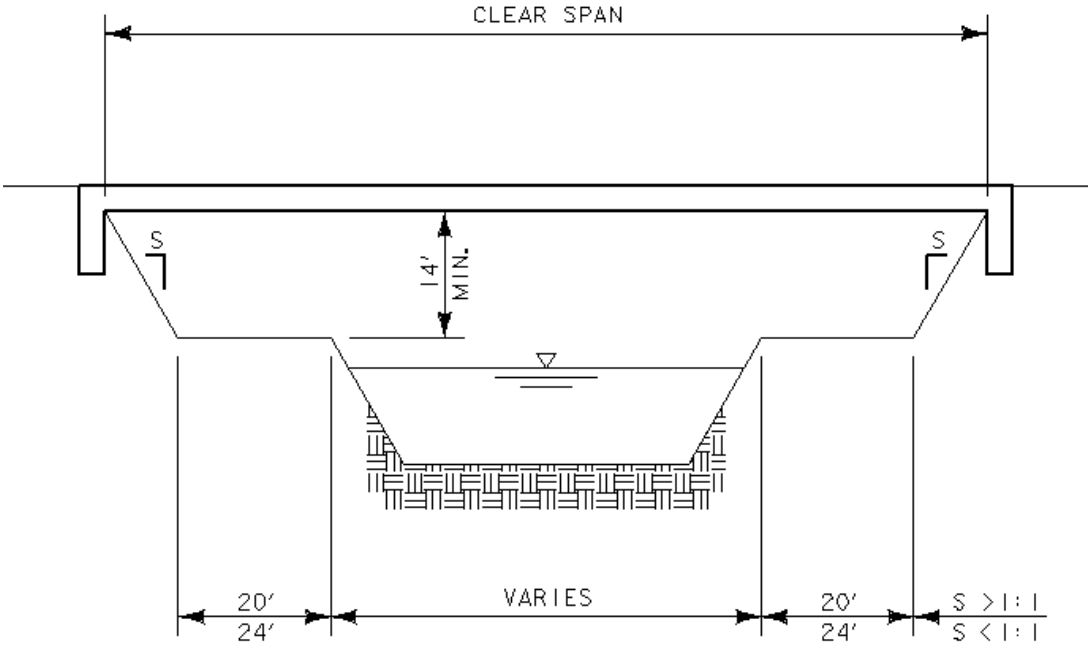
5.2.3 See Section 8.2 for canal road driveway requirements.

5.3 Grade Separation Crossings

5.3.1 A grade separation between freeway/expressway crossings and canal maintenance roads is required.

5.3.2 A grade separation with the roadway undercrossing the canal is preferred.

5.3.3 A grade separation with the roadway over crossing the canal will be allowed on a case-by-case basis. A clear span bridge will be required with the minimum cross-section and vertical clearance as shown on *Figure 2*.



NOTES:

1. SLOPE MAY VARY FROM VERTICAL. A 24 FT. MAINTENANCE ROAD IS REQUIRED FOR SLOPES STEEPER THAN 45° (S < 1:1).
2. CANAL WIDTH DIMENSION AND MAINTENANCE ROAD ELEVATION TO BE DETERMINED BY SRP PRIOR TO DESIGN.

Figure 2
Freeway/Expressway Crossing Above Canal

5.4 Pedestrian Bridges

5.4.1 Any portion of the bridge (deck, approach, aprons, sidewalk, etc.) extending beyond the top of the canal bank into the canal road shall be structurally adequate to carry the loads imposed by canal maintenance vehicles.

5.4.2 Protective fencing parallel to the canal at each corner of the bridge may be permitted, but shall not exceed six (6) feet in length, and shall be subject to the conditions of Section 5.1.10.

5.5 Box Culverts

5.5.1 Box culvert bridges shall have a minimum cross-sectional water area equal to the cross-sectional area of the existing canal, and shall approximate its aspect ratio, so as to minimize head losses.

If the canal is unlined, the floor of a box culvert bridge shall be a minimum of two-tenths (0.2) foot below the bottom of the bed of the upstream canal, or other elevation as specified by the Engineer. If the canal is lined, the floor shall match the existing canal bottom lining.

5.5.2 Nothing shall be installed that will impede the flow into and out of the culvert, such as sediment-catching walls.

5.6 Bridge Widening and Replacement

5.6.1 Existing bridges that do not meet the general guidelines in Section 5.1 can be widened or replaced only if the resulting condition does not decrease the Bank Full Capacity of the canal. In some cases, due to operational requirements, widening or replacement will not be allowed under any circumstances.

5.7 Piers / Center Walls

5.7.1 Piers or center walls are not allowed when the canal is forty-five (45) feet or less between the tops of the banks.

5.7.2 If the bank-to-bank canal width is greater than forty-five feet, either a bridge with one center pier or a double barrel box culvert may be permitted. If allowed, the following applies:

5.7.2.1 The center pier of a bridge or center wall of a double box culvert shall have a bull or rounded nose and twelve (12) inch maximum width with a continuous surface along the length of the bridge or culvert.

5.7.2.2 The Bridge Designer shall submit a HEC RAS backwater analysis evaluating the effects of the bridge pier or box culvert.

5.7.2.3 The center pier shall extend a minimum of six (6) inches beyond the upstream edge of the bridge, and be accessible for cleaning from the bridge deck.

5.7.2.4 If center pier is constructed at a time prior to bridge construction, the Licensee shall provide a catwalk or other safe access approved by the Engineer to facilitate debris removal from center pier.

5.8 **HEC RAS Analysis**

5.8.1 The analysis shall determine the water surface profile that matches the Operational High Water Elevation for both existing conditions, and for the proposed bridge. The Engineer will provide the location for initiating the analysis, the starting water surface level, the maximum flow rate for the backwater analysis, and, if available, previously developed HEC RAS files[1].

5.8.2 The analysis shall also determine the Bank Full Capacity and associated water surface profile for both the existing bridge and canal, and the proposed modified bridge and canal. The same initial location shall be used, but depths and capacities shall be for bank full conditions.

5.8.3 Energy loss coefficients typically used in the backwater analysis are:

Roughness Coefficients (Manning's n)	Value
Shotcrete/Concrete Lining	0.018
Finished Concrete	0.013
Earth (subject to local conditions)	0.022

Transition Coefficients	Contraction	Expansion
Gradual Transitions (>4:1)	0.1	0.3
Abrupt Transitions (<4:1)	0.6	0.8
Bridge Sections	0.3	0.5

5.8.4 The Bridge Designer shall use the normal bridge routine in the HEC-RAS backwater analysis to simulate flow through the bridge opening.

5.8.5 The Bridge Designer shall submit electronic copies of the data files and a short report of the findings quantifying the water surface elevation differences expected due to the construction of the bridge. This report shall include profile and cross section plots of both existing and proposed conditions, and specific data necessary to support the conclusions of the report.

[1] HEC-RAS geometric data is not guaranteed to be completely accurate, complete, or up to date. Items that should be checked include, but are not limited to, expansion and contraction coefficients, Manning's n values, channel descriptions, ineffective flow areas and overbank flows. **Check the data before using it!**

6 CANAL LINING

6.1 The Licensee may be required to fully line (banks and bottom) the canal under the bridge, extending a minimum of three (3) feet beyond the disturbed portion of the canal, or three (3) feet beyond the end of the bridge, whichever is greater. Existing lining not meeting the specifications shown in *Appendix 1* shall be completely removed and replaced.

6.2 Bank lining shall tie to the bridge wing wall, abutment and retaining walls. No shelves or ledges will be allowed at the top of lining. If a shelf or ledge exists, it shall be filled and concrete lined to match the slope of bank lining. When the additional concrete bank lining extension exceeds six (6) inches, the designer must design the extension and tie-in to the abutment as needed and show the design as a separate detail and submit with regular submittal for review and approval.

7 WING WALLS / RETAINING WALLS

7.1 Wings walls are not required when the bridge width is such that the canal cross-section remains the same under the bridge. If the bridge width changes the canal cross-section under the bridge, wing walls are required and shall extend into the canal banks.

7.2 The wing wall shall be cast-in-place concrete and may be set at up to a forty-five (45) degree angle into the canal bank alignment. The wing walls shall not encroach onto the traveled portion of the canal roadway.

7.3 The location of the wing walls and/or retaining walls shall be shown on the plans, but the exact length and alignment of the wing walls and/or retaining walls will be determined in the field by the Engineer at the time of construction.

7.4 Retaining walls are required on the edge of the canal if the proposed elevation difference between the bridge approach apron and the canal road is greater than one (1) foot.

7.5 Retaining walls shall be located as close to the top edge of the canal lining/bank as possible. The top of concrete at the bridge end of the wall shall match the bridge approach apron and extend at a slope to match the finish surface of the canal road.

7.6 Retaining walls shall extend to a point where there is no more than a 6-inch difference between the existing and the proposed road elevation.

7.7 A retaining wall on the outside edge of the canal road (away from the canal) is required if it creates a drop-off of three (3) feet or more.

7.8 When bridge abutment walls are extended and tied directly to the wing walls of a canal structure, or to retaining walls, appropriate water stops or other similar material shall be used to prevent leakage.

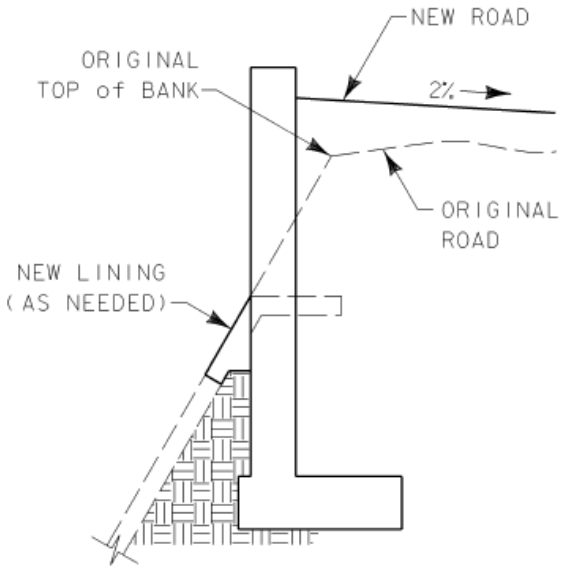


Figure 3
Retaining Wall with New Canal Lining

8 CANAL MAINTENANCE ROADS

8.1 The canal maintenance roads shall continue in a straight line on both sides of the canal across the roadway or pathway or under/over grade separated bridges. There shall be nothing in the roads that will obstruct canal maintenance road traffic.

8.2 Sidewalks and Driveways

8.2.1 On roadways having curb and gutter, fully depressed curbs thirty (30) feet wide (minimum) are required at entrances to the canal roads. If sidewalks are provided, it may be necessary to taper a portion of the sidewalk adjacent to the canal road as well as widening the maintenance road in order to accomplish a smooth turning movement.

8.2.2 Where the bridge is skewed, and where there is curb and gutter, the driveway width shall be extended so that the depressed curb measures thirty (30) feet in a direction perpendicular to the canal. See *Figure 4* in Section 11.2.

8.3 Canal Maintenance Road Width

8.3.1 Roadway bridges

8.3.1.1 The taper from the thirty (30) foot driveway to the approach ramp shall be no greater than forty-five (45) degrees.

8.3.1.2 The minimum width of the approach ramp shall be twenty-four (24) feet or the width of the existing road, whichever is greater.

8.3.1.3 The approach ramp width shall extend a minimum of twenty-five (25) feet beyond the back of driveway or the edge of the bridge structure, before being allowed to taper to the existing road width.

8.3.1.4 The taper from the approach ramp to the existing canal road shall be no greater than sixty (60) degrees.

8.3.1.5 If conditions will not allow for a twenty-four (24) foot approach ramp, the width shall be determined by the Engineer.

8.3.2 For pedestrian bridges, the existing canal road width shall be maintained. In cases where there is an asphalt strip along the canal road, and bridge construction activities disturb that asphalt strip, it shall be replaced in kind. (Note: the asphalt strip is not the canal road, the canal road includes the entire drivable surface within the canal right-of-way.)

8.3.3 Grade-separated bridges

8.3.3.1 For roadways going under the canal (*i.e.* in cases where the canal bridges the road), the minimum canal road width shall be twenty (20) feet or the width of the existing road, whichever is greater, and shall extend a minimum of twenty-five (25) feet beyond the end of the bridge. The tapering to the existing canal road shall not exceed 60 degrees.

8.3.3.2 For roadway overpasses with embankment slopes shallower than 45 degrees, the minimum canal road width shall be twenty (20) feet or the width of the existing canal road, whichever is greater. For overpasses with embankment slopes steeper than forty-five (45) degrees, the minimum canal road width shall be twenty-four (24) feet or the width of the existing canal road, whichever is greater. See *Figure 2*.

8.4 The longitudinal slope of the canal road shall not exceed four (4) percent.

8.5 The canal road shall be graded at a two (2) percent cross slope away from the canal to facilitate drainage.

8.6 Canal Road Surface Material

8.6.1 For roadway bridges, asphalt surface shall be installed for a minimum of twenty-five (25) feet from the bridge, or to the extent that the canal road is disturbed, whichever is greater. The surface material shall be applied to the full width of the canal road.

8.6.2 For pedestrian bridges, a well-graded aggregate base, as specified in Section 10.3.1, shall be installed to the extent that the canal road is disturbed. The surface material shall be applied to the full width of the canal road. In cases where there is an asphalt strip along the canal road, and bridge construction activities disturb that asphalt strip, it shall be replaced in kind. (Note: an asphalt strip does not constitute the entire width of the canal road; the canal road includes the entire drivable surface within the canal right-of-way.)

8.7 Canal Road Gates

8.7.1 When a bridge is planned so that the existing canal gate will be less than seventy-five (75) feet from the closest edge of the new bridge, the Licensee shall relocate the gate, unless otherwise specified by the Engineer.

8.7.2 The Licensee may be required to install additional canal road gates to limit vehicular access to the canal road based on local conditions, *e.g.*, a new bridge in a reach that has gates at existing upstream and downstream bridges.

8.8 Canal Maintenance Road Undercrossings

8.8.1 A minimum of a sixteen (16) foot width and a fourteen (14) foot height shall be maintained throughout the undercrossing.

8.8.2 Slopes into, through and out of the undercrossing shall not exceed four percent (4%).

8.8.3 A twenty-two (22) foot apron just outside each end of an underpass shall be at the same grade as the underpass, i.e. if the underpass is flat, the apron shall be flat; if the underpass is at 1%, the apron shall be at 1%, etc.

8.8.4 If the slope up to or down to the original maintenance road begins less than twenty-two (22) feet from the end of the underpass, the height of the underpass shall be raised to accommodate a vehicle twenty-two (22) feet long and thirteen (13) feet-six (6) inches high.

8.8.5 Drainage of the underpass shall be provided. This drainage shall not be allowed to enter the canal.

9 NON-DRY UP CONSTRUCTION REQUIREMENTS

9.1 Construction of the bridge from the canal banks and bridge deck is permitted with water in the canal if the bridge design and construction meet the conditions described below in addition to the other conditions of these Guidelines.

9.1.1 The bridge deck shall be designed so that regardless of the abutment location, obstructions above the deck shall not extend past the edge of the canal bank (see Section 5.1.9).

9.1.2 The bridge abutments shall be no closer than three (3) inches to the turndown for the canal lining and shall not be within the canal prism.

9.1.3 The bridge shall be clear span unless the pier was constructed during a previous canal dry up.

9.1.4 If center pier is constructed at a time prior to bridge construction, the Licensee shall provide a catwalk or other safe access approved by the Engineer to facilitate debris removal from center pier.

9.2 Construction within the canal cross section during wet conditions may be permitted with approval of SRP. Conditions which might be imposed by SRP include the following:

9.2.1 Cofferdams or dikes at the outer limits of bridge construction site.

9.2.2 Temporary pipe culvert between cofferdams or dikes in order to accommodate water deliveries during construction. These flows will be established by SRP. This does not include storm flows.

9.2.3 Canal fish removal and relocation, or herding away from the site by SRP, at the expense of the Licensee.

10 CONSTRUCTION NOTES

10.1 For all bridges, the Bridge Designer shall include the following items on construction plans, in the contract specifications or in the special provisions.

10.1.1 No concrete shall be placed without prior approval of the SRP Engineer.

10.1.2 All concrete, plaster, or headwalls shall be sprayed with a white pigment curing compound immediately after finishing or form removal.

10.1.3 Any abandoned structures found within the zone of construction shall be completely removed to the SRP Engineer’s satisfaction.

10.1.4 Any material placed in the canal or in the canal right-of-way shall be completely removed to the SRP Engineer's satisfaction.

10.1.5 All backfill shall be carefully placed in eight (8) inch uncompacted lifts and compacted to a minimum of 95 percent standard Proctor density, ASTM D698.

10.1.6 All damage to SRP facilities shall be repaired by the Licensee or his contractor to the SRP Engineer's satisfaction. If emergency repair work is necessary or the Licensee fails to complete all work covered by this License in a reasonable time as determined by the SRP Engineer, the work may be performed by SRP forces, and the Licensee shall pay the full cost of said work.

10.1.7 Through traffic on both canal roads, or on detours approved by SRP, shall be provided and maintained by Licensee at all times for the full duration of bridge construction for SRP operations and maintenance equipment.

10.1.8 The contractor is responsible for handling storm flows, return flows and other nuisance water in the canals.

10.2 If the bridge is a roadway bridge, the Bridge Designer shall also include the following item on construction plans, in the contract specifications or in the special provisions.

10.2.1 The approach ramp material shall be asphalt placed in accordance with MAG Specifications Section 321. The material will conform to the 19 mm mix in MAG Specifications Section 710.

10.3 If the bridge is a pedestrian bridge, the Bridge Designer shall also include the following item on construction plans, in the contract specifications or in the special provisions.

10.3.1 The approach ramp material shall consist of a well-graded aggregate base in accordance with MAG Specifications Section 702, or a similar material approved by the SRP Engineer, thoroughly mixed with a minimum of 20 percent to a maximum of 40 percent fines (material that will pass that #200 sieve).

10.4 If the bridge includes wingwalls, the Bridge Designer shall also include the following items on construction plans, in the contract specifications or in the special provisions.

10.4.1 Realignment of the canal bank from the existing canal bank to the tie-in to the wing wall of the bridge shall not exceed a 4 to 1 taper.

10.5 If the bridge includes retaining walls, the Bridge Designer shall also include the following items on construction plans, in the contract specifications or in the special provisions.

10.5.1 The exact length and alignment of retaining walls or wing walls will be determined in the field at the time of construction by the SRP Engineer prior to setting the forms.

10.6 If the bridge and/or associated structures (e.g. retaining walls) are located in a lined portion of the canal system, the Bridge Designer shall also include the following items on construction plans, in the contract specifications or in the special provisions.

10.6.1 If the canal lining is disturbed during installation of the bridge or associated structures, it shall be reshaped, compacted, and lined, as directed by the SRP Engineer in accordance with the following SRP Standard Drawings and Specifications:

- WES-FRCANLNG – "Standard Drawing for Fiber-Reinforced Canal Lining Section"
- CE 02.490 – "Standard Specification for Preparation of Subgrade For Canal Lining"
- CE 03.361 – "Standard Specification for Placement of Canal Bottom Concrete"
- SRP 03300 – "Standard Specification for Concrete"
- SRP 03364 – "Standard Specification for Fiber Reinforced Shotcrete for Canal Bank Lining"

10.6.2 If the existing bottom and bank lining does not meet the above requirements, it shall be removed and replaced as specified herein. All bottom and bank preparation shall conform to the minimum standards as stipulated in SRP Standard Drawings and Specifications above.

10.7 If the bridge and/or associated structures (e.g. retaining walls) are located in an unlined portion of the canal system, the Bridge Designer may be required to include the following items on construction plans, in the contract specifications or in the special provisions.

10.7.1 Canal bottom and bank lining shall be shaped, compacted, and lined, as directed by the SRP Engineer in accordance with the following SRP Standard Drawings and Specifications:

- WES-FRCANLNG – "Standard Drawing for Fiber-Reinforced Canal Lining Section"
- CE 02.490 – "Standard Specification for Preparation of Subgrade For Canal Lining"

- CE 03.361 – "Standard Specification for Placement of Canal Bottom Concrete"
- SRP 03300 – "Standard Specification for Concrete"
- SRP 03364 – "Standard Specification for Fiber Reinforced Shotcrete for Canal Bank Lining"

10.7.2 The bank and bottom lining shall extend three (3) feet beyond the disturbed portion of the bottom, or three (3) feet beyond the end of the bridge, whichever is greater.

10.8 If the bridge is to be constructed during a non-dry up period, the Bridge Designer shall also include the following items on construction plans, in the contract specifications or in the special provisions.

10.8.1 Any damage done to the lining as a result of construction shall be the responsibility of the Licensee. If any repairs or modifications to the canal lining are required, the work shall be performed as soon as possible by, and at the expense of, the Licensee.

10.8.2 At no time will any obstruction to the flow of the canal be allowed. This includes deck support timbers, and any soil or rubble that may enter the canal. If material does enter the canal, the contractor shall remove it at his expense immediately. If the contractor does not remove the material when notified, SRP may remove the debris at the Licensee's expense.

10.8.3 No excavation will be permitted across the full width of the canal bank and maintenance road, which would, at bank-to-bank flow, create a conduit for flow out of the canal, or across the maintenance roads.

10.9 Copies of SRP Water Group Standard Drawings and Specifications applicable to work associated with bridge crossings are included in *Appendix 1*.

11 CHECKLISTS

11.1 Procedural Checklist

SRP	Designer	*Before Design:*	*Section*
		Determine if the location is acceptable to SRP	4.1.1
		Obtain latest version of Guidelines	4.1.2
		Obtain high water elevation	4.1.3
		Start cultural clearance process	4.6.1
		Set up pre-design meeting	4.1.5

		Initial Design Review:	*Section*
		Check plans against checklist	11.2
		Submit plans/specs in PDF format thru SRP Plans Review Portal	4.2.1, 2
		Set up Design Review Meeting	4.2.4

		Intermediate and Final Design Reviews:	*Section*
		Address all comments from previous reviews	4.2.6
		Submit final set of signed/sealed plans thru SRP Plans Review Portal	4.4.1
		All bridge drawings per bridge guidelines are independent from rest of project and sequential	4.4.2
		If applicable, submit HEC RAS analysis	4.4.3
		Submit construction phasing information	4.4.4

		Before Construction:	*Section*
		If applicable, obtain approval of construction phasing plan	4.4.4
		Obtain Land Use License	4.5
		Obtain Cultural Clearance	4.6
		Obtain Construction License	4.7.2
		If applicable, obtain Construction License for geo-technical borings	4.7.3
		If applicable, obtain licenses for utilities using bridge conduits	4.7.4

		As-built Information Provided to SRP After Construction:	*Section*
		Provide as-built information per Figure 5 of the Bridge Guidelines	11.2

11.2 **Construction Plans Checklist (Submit with Plan Review)**

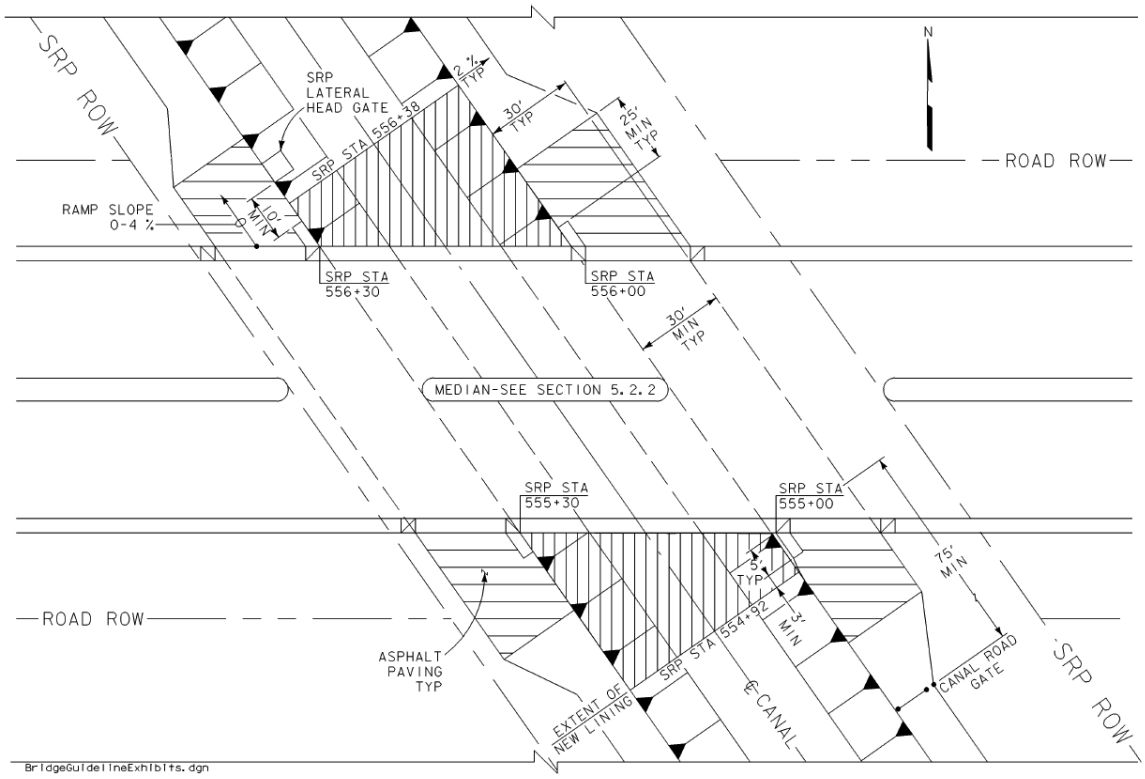
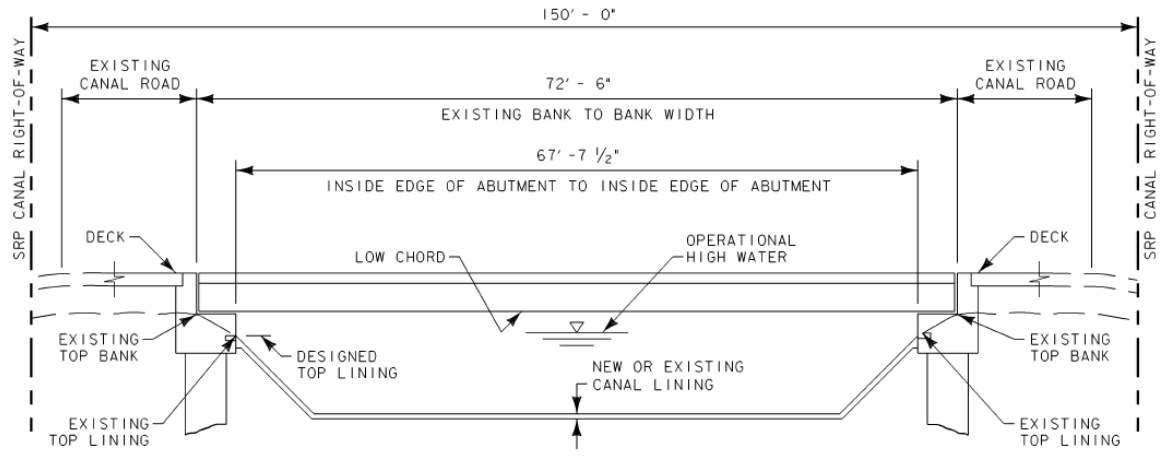


Figure 4
Sample Plan



ELEVATIONS ARE NGVD29 DATUM

		CANAL				BRIDGE			CLEARANCE (FT)	
CORNER	SRP STATION	INVERT	EXISTING TOP LINING	EXISTING TOP BANK	OPERATIONAL HIGH WATER	DESIGNED TOP LINING	LOW CHORD	DECK	CHORD INVERT	OHW CHORD
NW	556+30	1196.2	1201.8	1202.4	1200.22	1201.8	1202.6	1206.72	6.4	2.38
NE	556+00	1196.2	1201.9	1202.8	1200.22	1201.8	1202.6	1206.87	6.4	2.38
SW	555+30	1196.1	1201.9	1202.6	1200.19	1201.8	1202.4	1206.72	6.3	2.21
SE	555+00	1196.1	1202.0	1202.9	1200.19	1201.8	1202.4	1206.87	6.3	2.21

BridgeGuidelineExhibits.dgn

Figure 5
Sample Cross Section

Construction Plans Checklist (Submit with Plan Review)

SRP	Designer	*Notes and Specifications:*
		The bridge conforms to the latest version of *Design Guidelines and Specifications for Bridge Crossings of Salt River Project Canals.*
		SRP's standard drawing for canal lining is included in the plan set.
		All notes in Section 10 have been included on either the construction plans or in the contact specifications/special provisions.

Plan View:

		Plan view is drawn to scale
		Plan includes entire SRP right-of-way and boundaries are shown.
		Plan extends to at least ten feet beyond at each end of disturbed portion of canal and canal roads.
		Existing and proposed easement and license limit boundaries are shown.
		Plan shows bridge, retaining walls and all associated structures
		Out-to-out bridge width is shown
		Location of existing toe of slope is shown, both sides.
		Location of both banks is shown.
		Location of canal road boundaries on all four corners is shown.
		SRP stationing is shown at the upstream and downstream sides of the bridge. Stationing for all four corners is shown if bridge is skewed
		Extent of new lining is shown
	If the canal cross section changes underneath the bridge, then wing walls:	
		• are at 45 degrees or less to the canal bank
		• do not extend into canal road
		If there are no wing walls or retaining walls, the abutment walls extend five feet (min) beyond the bridge.
		Bridge is at least 20 feet from any radial gate structure.
		Bridge is at least 10 feet the edge of any lateral headgate structure and/or a stilling well.
		There is no surface drainage from the bridge or associated structures into the canal
		Bollards are on the bridge, off the canal road.

Construction Plans Checklist (Submit with Plan Review)

SRP	Designer	*Cross Section View*
		Cross section is drawn to scale.
		Vertical datum is NGVD 29.
		Cross section is perpendicular to the flow in the canal and is taken through the bridge.
		High water elevation is shown.
		Both existing and proposed canal road elevations are shown.
		Width of bridge between abutment faces is shown.
		Faces of abutments are as close as possible to top-of-lining if the canal is lined, or as close as possible to the edge of the bank if the canal is unlined.
		Width of existing canal between banks is shown.
		Distance of encroachment into the canal roads is shown.
		At least 18 inches between low chord and high water.
		At or above low bank elevation.
		Meets equipment height requirements.
Elevation Table (four corners):		
		• Low chord
		• Deck
		• Invert
		• Existing Top-of-Lining
		• Proposed Top-of-Lining
		• Existing Top-of-Bank
For a box culvert:		
		• Span and height of culvert (open area) is shown.
		• Box culvert is superimposed on existing canal cross section.
		• Cross sectional area under the water surface in box culvert is at least that of the canal cross section in the vicinity.
		• Culvert meets ADOT structural standards
		• If canal is unlined, invert elevations (upstream and downstream) of culvert meet requirements provided by Engineer
		• If canal is lined, invert elevations (upstream and downstream) match the existing canal bottom lining
If the design calls for haunches:		
		• Haunch extends no more than 25% of the canal width
		• Haunch is no more than 4 inches below low chord at abutment

Construction Plans Checklist (Submit with Plan Review)

SRP	Designer	***Bridge Pier or Culvert Center Wall:***
		Canal is more than 45 feet wide bank to bank (otherwise, pier/center wall not allowed).
		Pier/wall is no more than 12 inches wide.
		Pier/wall has bull or rounded nose.
		Pier/wall has continuous surface.
		Pier/wall extends six inches (min) beyond upstream edge of bridge.
If HEC RAS analysis required:		
		• Available cross sections from upstream of bridge to downstream control point obtained from the Engineer
		• High operating level and maximum flow rate obtained from Engineer
		• Roughness and transition coefficients approved by Engineer
		• If other than standard step method is used, method has been approved Engineer
		• Cross sections in the vicinity of the bridge added as appropriate
		• Backwaters run for both existing and proposed conditions
		• Results approved by Engineer

		Retaining Walls:
		If deck is more than one foot above the existing canal road, there are retaining walls included.
		Retaining walls are located as close to the edge of the bank as possible.
		Top of walls follow the same slope as the finished canal roads.
		There is between zero and six inches between the top of wall and the finished canal road.
		If retaining wall connects directly to an existing structure, appropriate water stops are included.
		If handrails are used, they are removable.
		Design doesn't threaten integrity of canal slope or lining.

Construction Plans Checklist (Submit with Plan Review)

SRP	Designer	*Canal Roads:*
		Profiles, drawn to scale, are shown for the canal roads at all four corners for a minimum of 25 feet or the length of the disturbed portion, whichever is greater.
		Vertical datum is NGVD 29.
		If the bridge is a **roadway** bridge, the width of the canal road approach ramp is 30 feet and extends beyond the end of the bridge structures and wing walls before it tapers back to the original canal road width.
		If the bridge is a **pedestrian** bridge, the width of the canal road is maintained.
		If the bridge is a grade separated **overpass,** the widths of the canal roads are 20 feet for embankment slopes less than 45 degrees, or 24 feet for embankment slopes steeper than 45 degrees.
		If the roadway is a grade separated **undercrossing,** the widths of the canal roads are at least 20 ft and extend at least 25 ft beyond the end of the bridge.
		The slope of the disturbed portion of the canal road is no more than 4% along the road.
		The slope of the disturbed portion of the canal road is 2% across the road away from the canal.
		If the bridge is a roadway bridge, asphalt paving is called out for the disturbed portion of the canal road, or for 25 feet from the bridge, whichever is greater.
		If the bridge is a pedestrian bridge, an aggregate base approved by SRP is called out for the disturbed portion of the canal road, or for 25 feet from the bridge, whichever is greater.
Concrete aprons on each end of a roadway bridge:		
		• line up with the canal roads
		• are at least 16 feet wide
		• extend from the bridge to at least 8 feet beyond the ctrline of the canal road
		At each corner where there is curb and gutter, there is a 30-foot wide (min) fully-depressed curb at the entrance to the canal road. (Note: if the bridge is skewed, a greater width may be required.)
		At each corner where there is a sidewalk, there are tapered sections adjacent to the canal road sufficient to accomplish smooth turning.
		If there is a concrete curb median, there is a 30-foot wide opening (min) aligned with the concrete apron and the canal roads on either side.
		Safe site distance from the canal roads is not restricted.
		Canal road gates less than 75 feet from the bridge are relocated.
		New canal road gates required by SRP are included.

Construction Plans Checklist (Submit with Plan Review)

SRP	Designer	***Canal Road Undercrossings:***
		Dimensions are 16 feet (min) wide and 14 feet (min) high
		Slopes into and out of the undercrossing are no more than 4%.
		Apron is either 22 feet long on either end and is at the same grade as the undercrossing, or height of undercrossing is adjusted to accommodate a 22 feet long, 13.5 feet high vehicle.
		There is adequate drainage of the undercrossing.

		Canal Lining:
		For new canal lining, both on bottom and sides extends 3 feet (min) beyond the disturbed portion of canal or 3 feet (min) beyond end of bridge, whichever is greater.
		For new canal lining, each end of the lining is perpendicular to the canal banks
		Existing lining that does not meet specifications is called out to be removed and replaced.
		Shotcrete lining is extended to abutment faces, wing walls, and retaining walls.
		There is no shelf at the top of lining.
		Lining extension detail.

		Utility Conduits Attached to the Bridge:
		Conduit locations are shown in both the plan and the cross section.
		Conduits are located within the bridge structure.
		Conduits extend to the edge of SRP right-of-way on both banks.
		Conduit drawings include conduit material, trenching, cover and associated structures.
		Appropriate parallel conduits are included.

		Handrails and Fencing:
		All handrails and fencing locations have been approved by Engineer.
		There are no obstructions above the bridge deck that extend beyond the canal bank.
		All handrails are removable.
		Access to bridge piers is not restricted.

DESIGN GUIDELINES AND SPECIFICATIONS FOR BRIDGE CROSSINGS OF SALT RIVER PROJECT CANALS

WATER ENGINEERING & TRANSMISSION

APPENDICES

APPENDIX 1

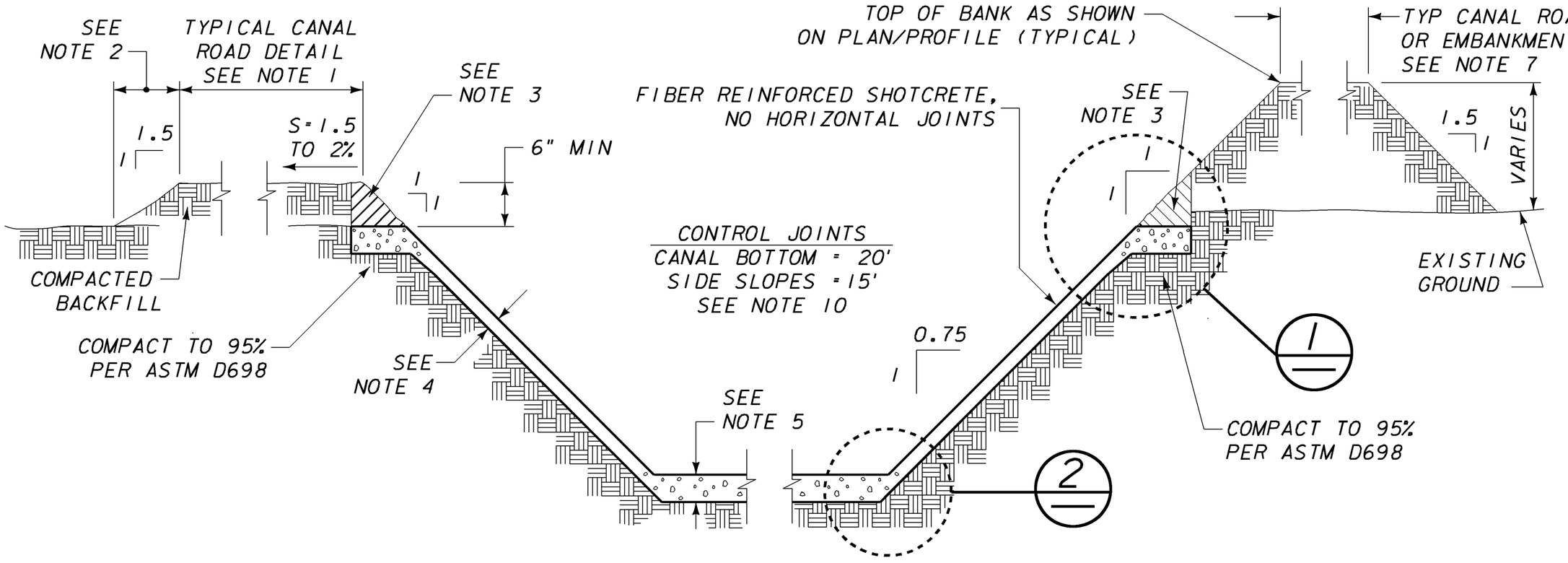
SRP Standard Drawings and Specifications

Standard Drawings:

WES-FRCANLNG	Fiber-Reinforced Canal Lining Section
WES-30100-001	Safety Ladder for Concrete Lined Canals
WES-30100-002	Partially Lined Canal Undercrossing
WES-30100-007	Lined Canal Undercrossing
WES-30100-009	Canal Access Ramp
WES-30100-010	Unlined Canal Undercrossing

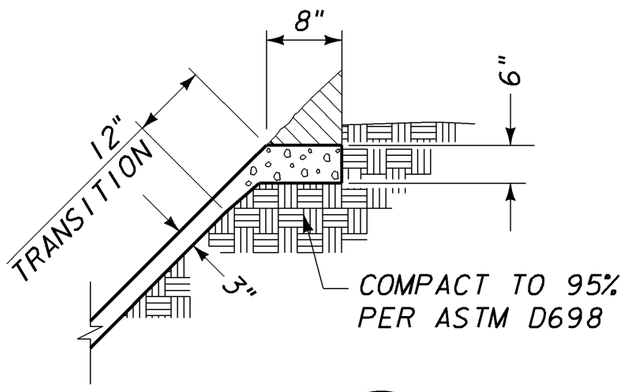
Standard Specifications:

CE 02.490	Preparation of Subgrade for Canal Lining
CE 03.212	Canal Bank Reinforcement
CE 03.361	Placement of Canal Bottom Concrete
SRP 03300	Concrete
SRP 03364	Fiber-Reinforced Shotcrete for Canal Bank Lining



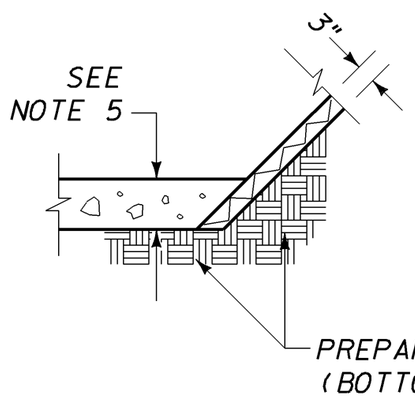
TYPICAL CANAL SECTION

SEE DETAIL (3) AND (4) FOR TIE-IN TO EXISTING LINING

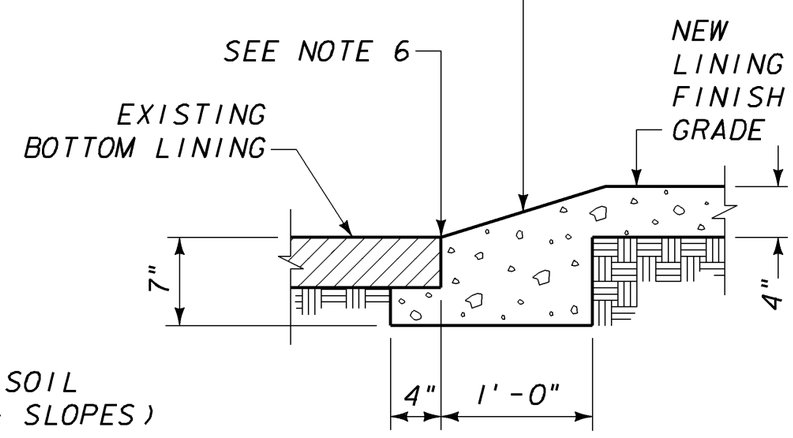


DETAIL 1

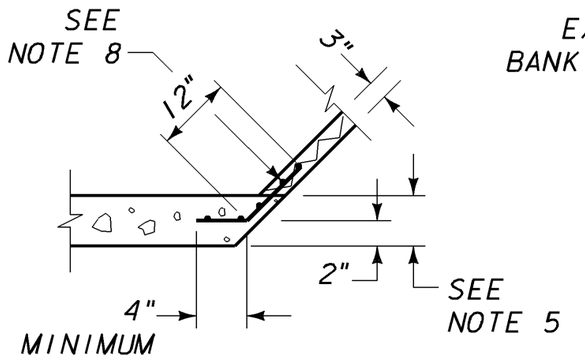
TRANSITION THE CANAL BOTTOM LINING AT A 4:1 MAXIMUM SLOPE FROM THE EXISTING LINING ELEVATION TO THE NEW LINING FINISH GRADE ELEVATION



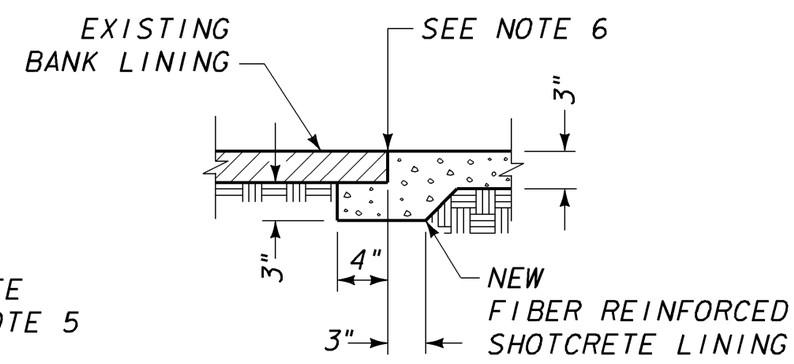
DETAIL 2
OPTION 1



DETAIL 3
SEE NOTE 6



DETAIL 2
OPTION 2



DETAIL 4
SEE NOTE 6

NOTES

1. WIDTH OF CANAL ROAD TO BE 20' MINIMUM UNLESS OTHERWISE SPECIFIED. STRIP ROADWAY OF ALL VEGETATION AND LOOSE MATERIAL WITHIN THE LIMITS OF CONSTRUCTION, AND MOISTEN PRIOR TO PLACEMENT OF SUITABLE FILL MATERIAL. FILL SHALL BE PLACED IN 8 INCH MAXIMUM UNCOMPACTED LIFTS AT +2% TO -4% OF THE OPTIMUM MOISTURE CONTENT AND COMPACTED TO A MINIMUM OF 90% PER ASTM D698. SLOPE AWAY FROM CANAL AT 1.5% TO 2%.
2. TOE OF SLOPE TO BE WITHIN THE RIGHT-OF-WAY OR OTHER PRESCRIBED LIMITS OF CONSTRUCTION.
3. TOP OF EXISTING BANKS TO BE STRIPPED OF ALL VEGETATION AND LOOSE MATERIAL. BACKFILL WITH MOISTENED COHESIVE MATERIAL. STABILIZE TO PREVENT SLOUGHING.
4. MINIMUM 3 INCH THICK PNEUMATICALLY PLACED FIBER REINFORCED SHOTCRETE BANK LINING PER SPECIFICATION SRP 03364. FIBER REINFORCEMENT SHALL COMPLY WITH THE REQUIRMENTS OF ASTM C1116.
5. CANAL BOTTOM TO BE MINIMUM 4 INCHES THICK NON-REINFORCED CONCRETE (3000 PSI).
6. CUT EXISTING LINING TO A NEAT VERTICAL EDGE. REMOVE ANY LOOSE OR FOREIGN MATERIAL. APPLY BONDING AGENT SIKADUR 32 OR APPROVED EQUAL.
7. WHERE CANAL HAS ONLY EMBANKMENT ON ONE SIDE, MINIMUM TOP WIDTH OF EMBANKMENT SHALL BE 18".
8. GALVANIZED 4 X 4-WO.5 X WO.5 WELDED WIRE FABRIC CONTINUOUS CENTERED IN LINING.
9. DETAIL 2 (OPTION 2) IS PREFERRED BY ENGINEER.
10. CONTROL JOINT SHALL BE 1/4" WIDE AND 1/2" DEEP, AND BE TOOLED OR SAW CUT WITHIN 4 HOURS OF CONCRETE PLACEMENT. MAXIMUM SPACING BETWEEN CONTROL JOINTS SHALL BE 20' ON CANAL BOTTOM AND 15' ON SIDE SLOPES, UNLESS OTHERWISE SHOWN ON THE DRAWINGS OR DIRECTED IN WRITING BY THE ENGINEER.
11. IF THERE ARE CONFLICTS WITH THIS DETAIL, PLANS AND SPECIFICATIONS AND LOCAL GOVERNING REQUIREMENTS, THE MOST STRINGENT REQUIREMENT SHALL APPLY, AS DETERMINED BY THE SRP ENGINEER.

REFERENCES

STANDARD SPEC FOR PREPARATION OF SUBGRADE FOR CANAL LINING	CE 02.490
STANDARD SPEC FOR CANAL BANK REINFORCEMENT	CE 03.212
STANDARD SPECIFICATION FOR CONCRETE	SRP 03300
STANDARD SPEC FOR PLACEMENT OF CANAL BOTTOM CONCRETE	CE 03.361
STANDARD SPEC FOR FIBER REINFORCED SHOTCRETE FOR CANAL BANK LINING	SRP 03364
SAFETY LADDER FOR CONCRETE LINED CANALS	WES-30100-001
CANAL LINING STRUCTURE TIE DETAIL	WES-30100-008

REVISIONS

REV NO.	DFTR	DSGN	ENGR CHK	ISSUE AUTH	DATE
REVISED CONTROL JOINT SPACING ON SIDE SLOPE TO 15' ON SECTION/NOTE 10. ADDED NOTE 11 & JOINT WIDTH/DEPTH TO NOTE 10.					
5	JWS	HAS	HAS	REL	02/22/19
	JWS	HAS	HAS	REL	
INITIAL ISSUE.					
0	JWS	RSG	CWT	REL	01/31/00
	JWS	RSG	CWT	REL	

SALT RIVER PROJECT
WATER ENGINEERING STANDARD

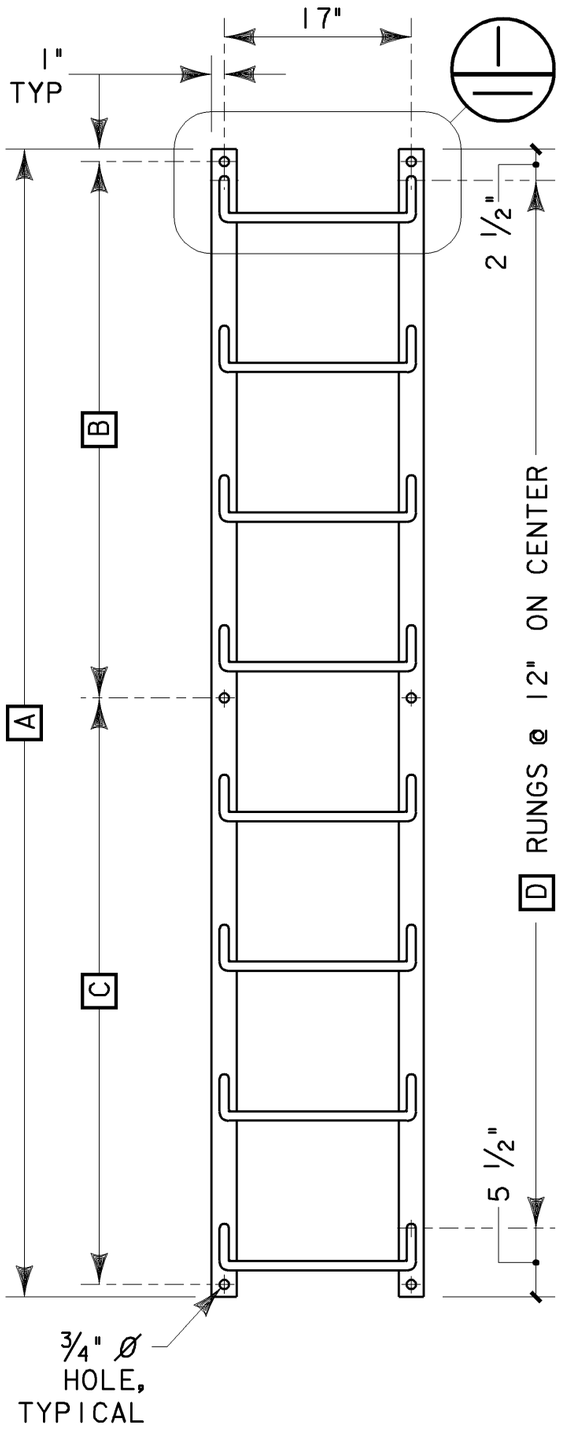
FIBER REINFORCED CANAL LINING SECTION

SCALE: NOT TO SCALE | FRCANLNG.WES

DWG SIZE: 22X17

WES-FRCANLNG

THIS DRAWING REPLACES WES-30100-006

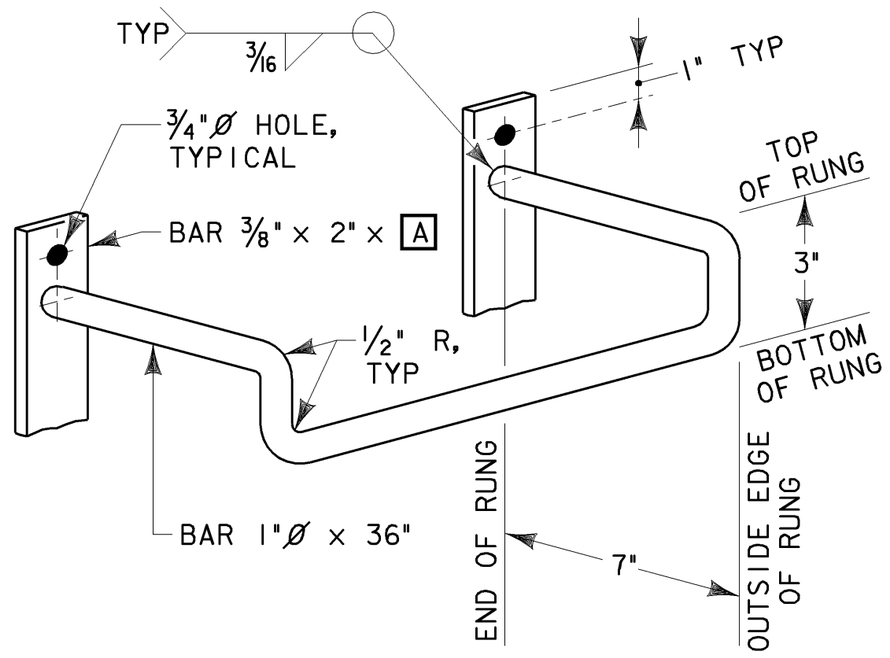


PLAN VIEW

SEE TABLE FOR VARIOUS LENGTHS
(7' -8" LADDER SHOWN)

TABLE

A	B	C	D	STOCK CODE NUMBER
3' -8"	-	-	4	
4' -8"	1' -7"	2' -11"	5	
5' -8"	2' -7"	2' -11"	6	
6' -8"	2' -7"	3' -11"	7	
7' -8"	3' -7"	3' -11"	8	5077692
8' -8"	3' -7"	4' -11"	9	
9' -8"	4' -7"	4' -11"	10	
10' -8"	4' -7"	5' -11"	11	
11' -8"	5' -7"	5' -11"	12	
12' -8"	5' -7"	6' -11"	13	



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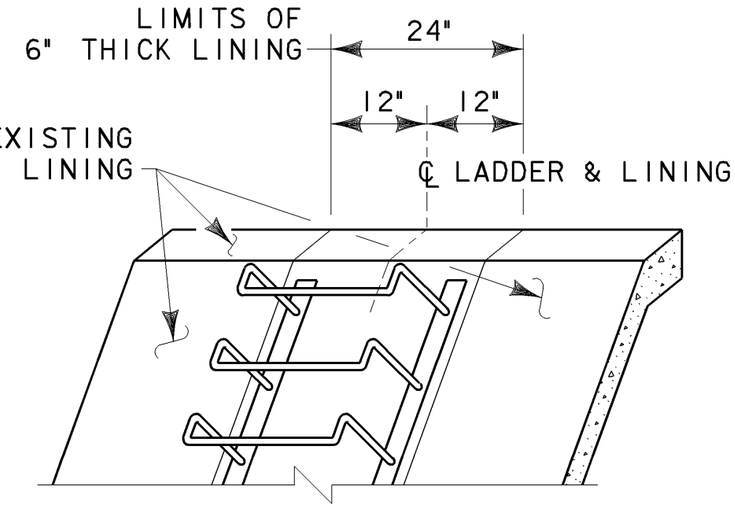
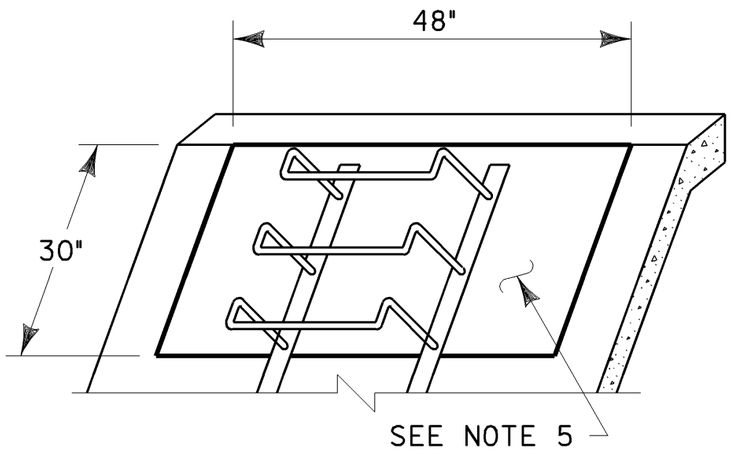


BANK DETAIL 2



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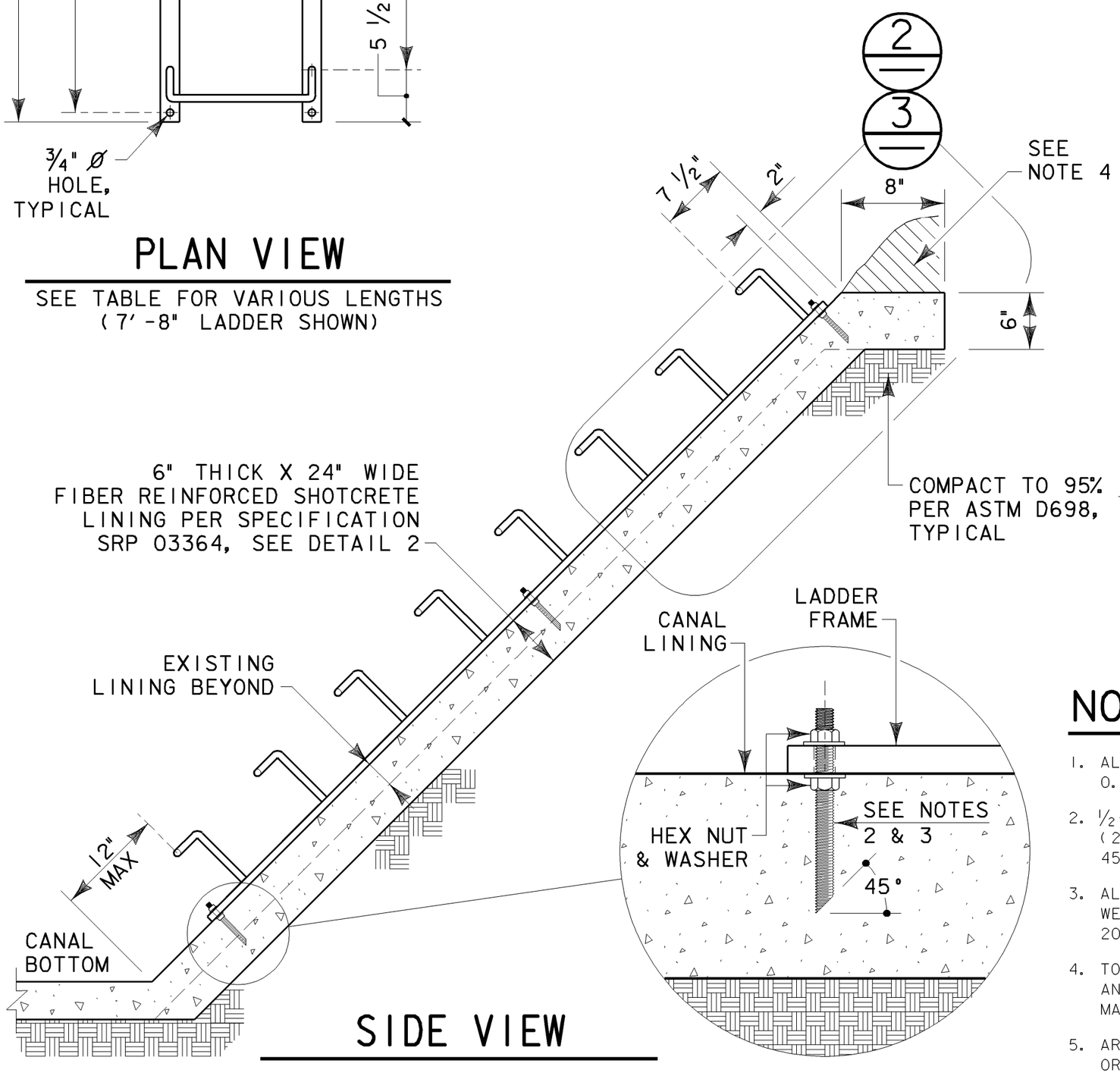


SIDE VIEW

NOTES

1. ALL STEEL TO BE ASTM A36. SANDBLAST AND METAL SPRAY TO 0.005" MINIMUM THICKNESS, AFTER FABRICATION.
2. 1/2-13 (UNC) STAINLESS STEEL ALL THREAD 6" LENGTH WITH (2) STAINLESS STEEL HEX NUTS AND WASHERS. CUT EMBED END 45 DEGREES.
3. ALTERNATE OPTION: 1/2" DIAMETER X 2" STAINLESS STEEL WEJ-IT. USE WITH EXISTING CONCRETE THAT HAS ACHIEVED 2000 PSI (14 DAY) MINIMUM STRENGTH.
4. TOP OF EXISTING BANK TO BE STRIPPED OF ALL VEGETATION AND LOOSE MATERIAL. BACKFILL WITH MOISTENED COHESIVE MATERIAL. STABILIZE TO PREVENT SLOUGHING.
5. AREA IS TO BE PAINTED WITH YELLOW TRAFFIC STRIPE PAINT OR EQUAL. IF THIS AREA IS NEW CONCRETE - OMIT CURING COMPOUND AND CURE WITH SHEET PLASTIC.

REFERENCES

STANDARD SPECIFICATION FOR FIBER REINFORCED SHOTCRETE FOR CANAL BANK LINING	SRP 03364
STANDARD SPECIFICATION FOR STRUCTURAL STEEL	SRP 05100
STANDARD SPECIFICATION FOR METALLIZING STRUCTURAL STEEL	GE 05920
FIBER REINFORCED CANAL LINING SECTION	WES-FRCANLNG

REVISIONS

REV NO.	DFTR	DSGN	ENGR CHK	ISSUE AUTH	DATE
REVISED PLAN VIEW TOP DIM FROM 2" TO 2 1/2". BOTTOM DIM FROM 6" TO 5 1/2", & SIDE VIEW TOP DIM FROM 7" TO 7 1/2".					
7	JWS	HAS	HAS	REL	12/16/15
	JWS	HAS	HAS	REL	
INITIAL ISSUE.					
0	JWS	-	CWT	REL	09/06/04
	JWS	-	CWT	REL	

SALT RIVER PROJECT
WATER ENGINEERING STANDARD

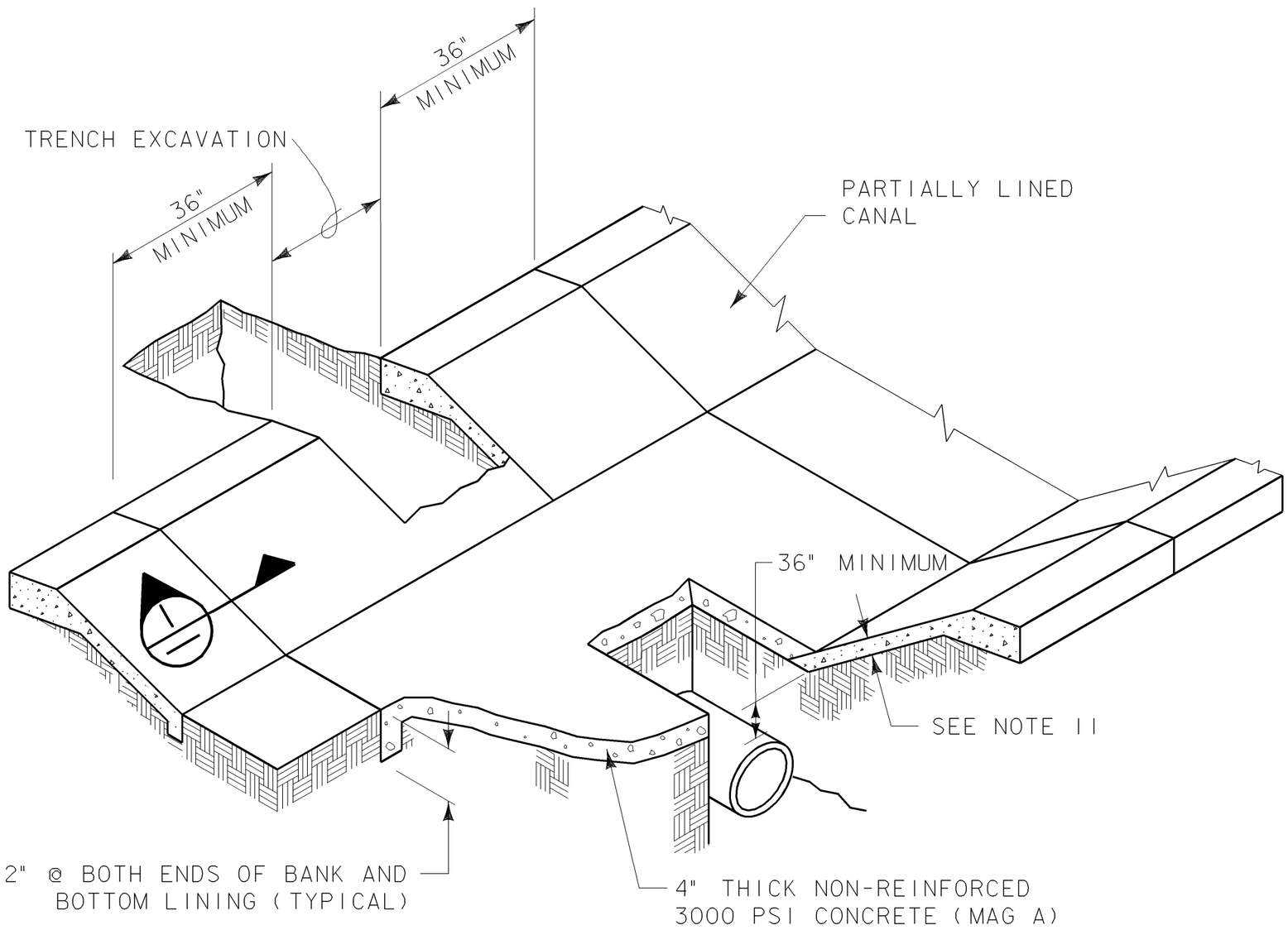
SAFETY LADDER FOR CONCRETE LINED CANALS

SCALE: NONE | 30100001.WES

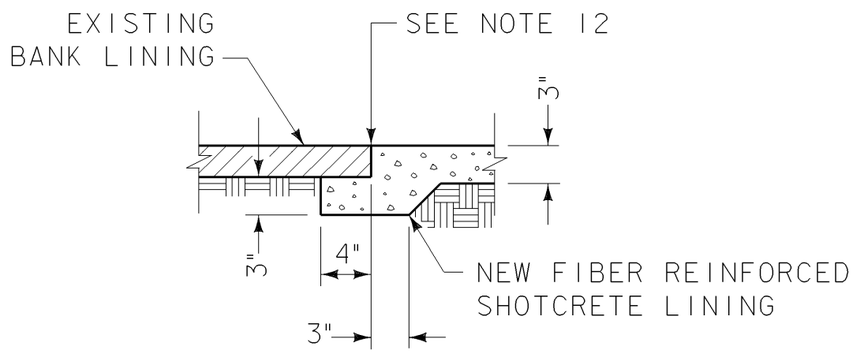
DWG SIZE 22X17

WES-30100-001

THIS DRAWING REPLACES CES-30100-001,
WHICH SUPERCEDED DRAWING B-54-267



PARTIALLY LINED CANAL UNDERCROSSING



BANK LINING TIE DETAIL 1

NOTES

1. NO MANHOLES, RISERS, VALVES OR OTHER SIMILAR FACILITIES ARE TO BE PLACED IN ANY PORTION OF SRP RIGHT-OF-WAY WITHOUT SPECIFIC AUTHORIZATION IN AN SRP LICENSE.
2. TOP OF PIPE, CONDUIT, CABLE OR ENCASEMENT IN SRP RIGHT-OF-WAY IS TO BE A MINIMUM OF 36 INCHES BELOW GRADE OR ROAD SURFACE.
3. ALL AFFECTED PORTIONS OF SRP RIGHT-OF-WAY, INCLUDING ROAD SURFACES, SHALL BE RESTORED TO THEIR ORIGINAL CONDITION OR BETTER.
4. SRP FACILITIES DAMAGED OR DESTROYED SHALL BE REPAIRED OR REPLACED TO THE SATISFACTION OF THE SRP ENGINEER.
5. COMPLETELY REMOVE ALL DIRT AND DEBRIS AFTER COMPLETION OF CROSSING CONSTRUCTION.
6. REMOVE UNSUITABLE/DELETERIOUS MATERIAL TO A MINIMUM TWO FOOT DEPTH AND REPLACE WITH APPROVED BACKFILL.
7. BACKFILL SHALL BE CLEAN, COHESIVE NATIVE MATERIAL AS APPROVED BY THE SRP ENGINEER OR MAG 728 1-SACK CLSM (CONTROLLED LOW STRENGTH MATERIAL).
8. PLACE COHESIVE BACKFILL AT OPTIMUM MOISTURE CONTENT IN 6 INCH LIFTS AND COMPACT TO 90 % OF MAXIMUM PROCTOR DENSITY (ASTM D698 STANDARD PROCTOR).
9. ELEVATIONS AND SLOPES SHALL BE AS DETERMINED BY THE SRP ENGINEER.
10. APPLY WHITE PIGMENTED CURING COMPOUND WITHIN ONE HOUR AFTER PLACING/FINISHING CONCRETE.
11. 3 INCH THICK HAND OR PNEUMATICALLY PLACED 3000 PSI CONCRETE. FIBER REINFORCED CONCRETE SHALL COMPLY WITH REQUIREMENTS OF SRP STANDARD SPECIFICATION SRP 03364. WWF REINFORCED CONCRETE SHALL BE MAG A WITH ASTM C33 #8 COARSE AGGREGATE AND A MAXIMUM AGGREGATE SIZE OF 3/8". WWF SHALL BE 4x4-W0.5xW0.5 OR 4x4-10 GAUGE x 10 GAUGE. EXTEND WWF MINIMUM 4" INTO BOTTOM LINING.
12. EXISTING BANK LINING SHALL BE SAWCUT OR MECHANICALLY SCORED AND REMOVED 36 INCHES (EACH SIDE) FROM THE EDGE OF EXCAVATION TO A NEAT VERTICAL EDGE. REMOVE ANY LOOSE OR FOREIGN MATERIAL.
13. BOTTOM LINING IS TO BE INSTALLED ON UNDISTURBED CANAL BOTTOM MATERIAL AND KEYED IN WITH A 12 INCH MINIMUM TURNDOWN ALONG THE EDGE.

REFERENCES

STD SPEC FOR PREPARATION OF SUBGRADE FOR CANAL LINING	CE 02.490
STD SPECIFICATION FOR CONCRETE	SRP 03300
STD SPEC FOR PLACEMENT OF CANAL BOTTOM CONCRETE	CE 03.361
STD SPEC FOR FIBER REINFORCED SHOTCRETE FOR CANAL BANK LINING	SRP 03364

REVISIONS

REV NO.	DFTR	DSGN	ENGR CHK	ISSUE AUTH	DATE
UPDATED THE FIBER REINFORCED SHOTCRETE SPEC FROM WTR 03364 TO SRP 03664.					
2	JWS	-	-	REL	11/12/15
	JWS	-	-	REL	
INITIAL ISSUE.					
0	MOD	CWT	CWT	REL	01/20/98
	MOD	CWT	CWT	REL	

SALT RIVER PROJECT
WATER ENGINEERING STANDARD

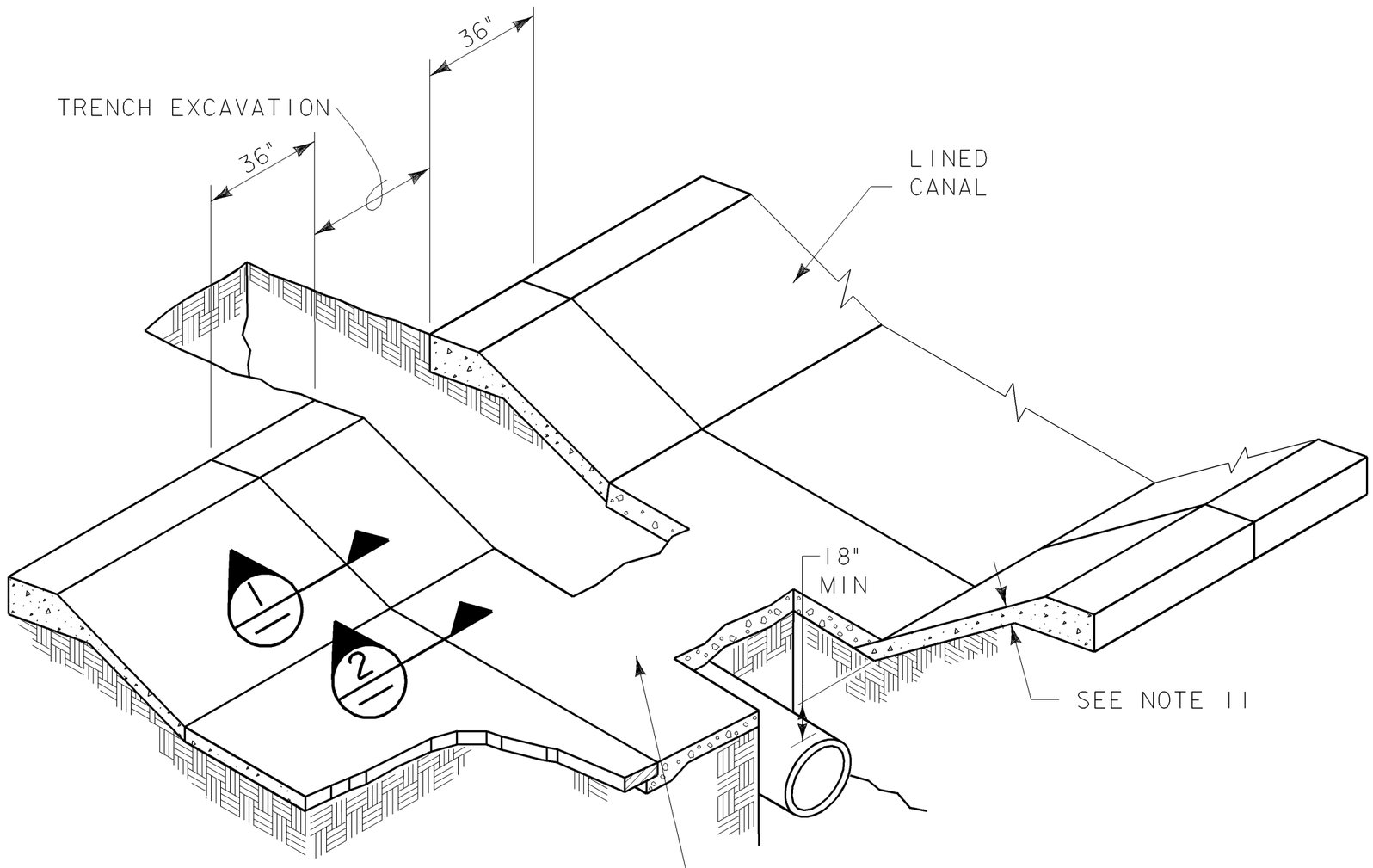
PARTIALLY LINED CANAL UNDERCROSSING

SCALE: NONE | 30100002.WES

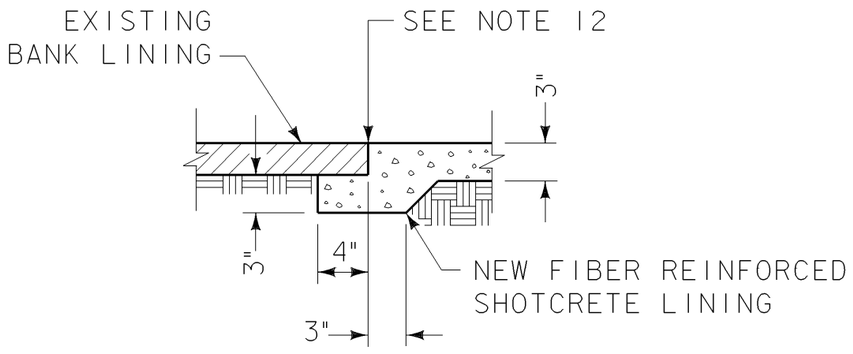
DWG SIZE: 22X17

WES-30100-002

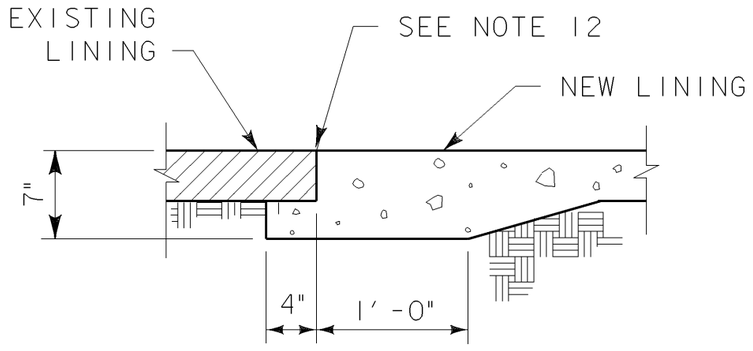
THIS DRAWING REPLACES B-54-58



LINED CANAL UNDERCROSSING



BANK LINING TIE DETAIL 1



BOTTOM LINING TIE DETAIL 2

NOTES

1. NO MANHOLES, RISERS, VALVES OR OTHER SIMILAR FACILITIES ARE TO BE PLACED IN ANY PORTION OF SRP RIGHT-OF-WAY WITHOUT SPECIFIC AUTHORIZATION IN AN SRP LICENSE.
2. TOP OF PIPE, CONDUIT, CABLE OR ENCASEMENT IN SRP RIGHT-OF-WAY IS TO BE A MINIMUM OF 36 INCHES BELOW GRADE OR ROAD SURFACE.
3. ALL AFFECTED PORTIONS OF SRP RIGHT-OF-WAY, INCLUDING ROAD SURFACES, SHALL BE RESTORED TO THEIR ORIGINAL CONDITION OR BETTER.
4. SRP FACILITIES DAMAGED OR DESTROYED SHALL BE REPAIRED OR REPLACED TO THE SATISFACTION OF THE SRP ENGINEER.
5. COMPLETELY REMOVE ALL DIRT AND DEBRIS AFTER COMPLETION OF CROSSING CONSTRUCTION.
6. REMOVE UNSUITABLE/DELETERIOUS MATERIAL TO A MINIMUM TWO FOOT DEPTH AND REPLACE WITH APPROVED BACKFILL.
7. BACKFILL SHALL BE CLEAN, COHESIVE NATIVE MATERIAL AS APPROVED BY THE SRP ENGINEER OR MAG 728 1-SACK CLSM (CONTROLLED LOW STRENGTH MATERIAL).
8. PLACE COHESIVE BACKFILL AT OPTIMUM MOISTURE CONTENT IN 6 INCH LIFTS AND COMPACT TO 90 % OF MAXIMUM PROCTOR DENSITY (ASTM D698 STANDARD PROCTOR).
9. ELEVATIONS AND SLOPES SHALL BE AS DETERMINED BY THE SRP ENGINEER.
10. APPLY WHITE PIGMENTED CURING COMPOUND WITHIN ONE HOUR AFTER PLACING/FINISHING CONCRETE.
11. 3 INCH THICK HAND OR PNEUMATICALLY PLACED 3000 PSI CONCRETE. FIBER REINFORCED CONCRETE SHALL COMPLY WITH REQUIREMENTS OF SRP STANDARD SPECIFICATION SRP 03364. WWF REINFORCED CONCRETE SHALL BE MAG A WITH ASTM C33 #8 COARSE AGGREGATE AND A MAXIMUM AGGREGATE SIZE OF 3/8". WWF SHALL BE 4x4-W0.5xW0.5 OR 4x4-10 GAUGE x 10 GAUGE. EXTEND WWF MINIMUM 4" INTO BOTTOM LINING.
12. EXISTING BANK AND BOTTOM LINING SHALL BE SAWCUT OR MECHANICALLY SCORED AND REMOVED 36 INCHES (EACH SIDE) FROM THE EDGE OF EXCAVATION TO A NEAT VERTICAL EDGE. REMOVE ANY LOOSE OR FOREIGN MATERIAL.
13. THE TOP OF PIPE AND/OR CONCRETE ENCASEMENT WITHIN THE CANAL SECTION IS TO BE A MINIMUM OF 18 INCHES BELOW THE BOTTOM OF THE CANAL BOTTOM CONCRETE.

REFERENCES

STD SPEC FOR PREPARATION OF SUBGRADE FOR CANAL LINING	CE 02.490
STD SPECIFICATION FOR CONCRETE	SRP 03300
STD SPEC FOR PLACEMENT OF CANAL BOTTOM CONCRETE	CE 03.361
STD SPEC FOR FIBER REINFORCED SHOTCRETE FOR CANAL BANK LINING	SRP 03364

REVISIONS

REV NO.	DFTR	DSGN	ENGR CHK	ISSUE AUTH	DATE
UPDATED THE FIBER REINFORCED SHOTCRETE SPEC FROM WTR 03364 TO SRP 03664.					
2	JWS	-	-	REL	11/12/15
	JWS	-	-	REL	
INITIAL ISSUE.					
0	MOD	CWT	CWT	REL	01/20/98
	MOD	CWT	CWT	REL	

SALT RIVER PROJECT
WATER ENGINEERING STANDARD

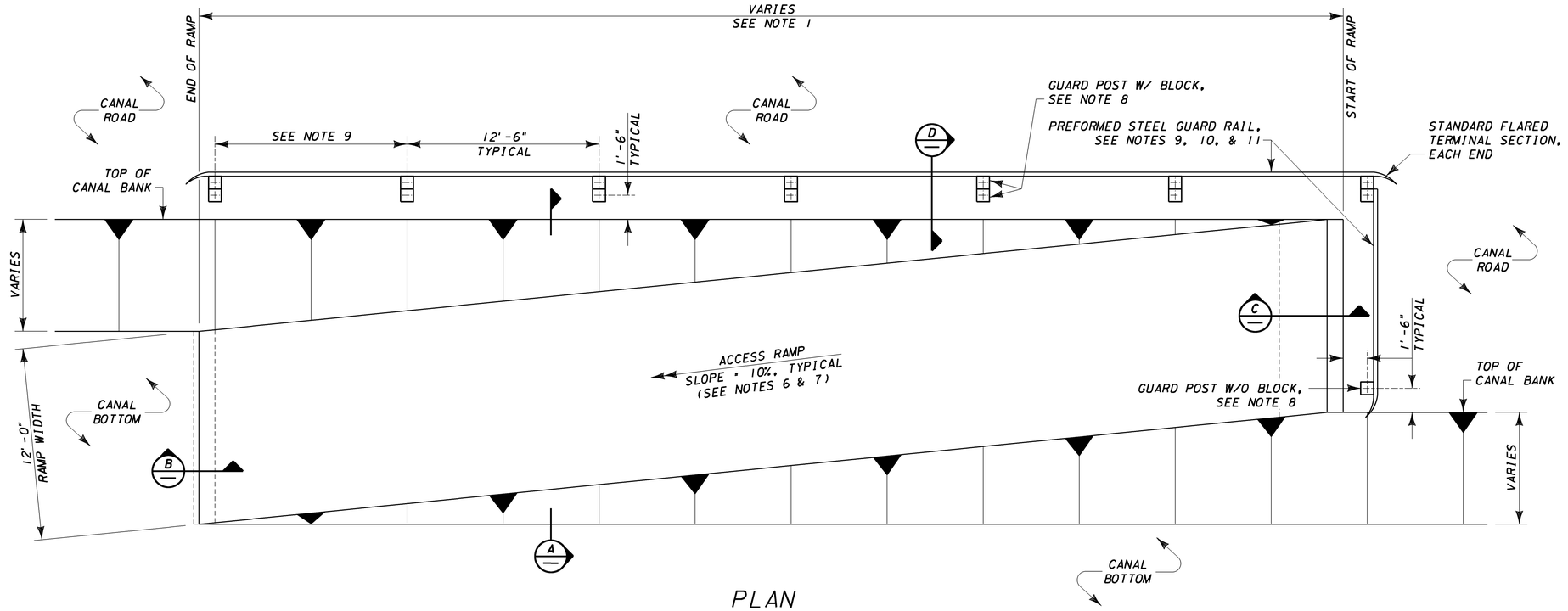
LINED CANAL UNDERCROSSING

SCALE: NONE | 30100007.WES

DWG SIZE 22X17

WES-30100-007

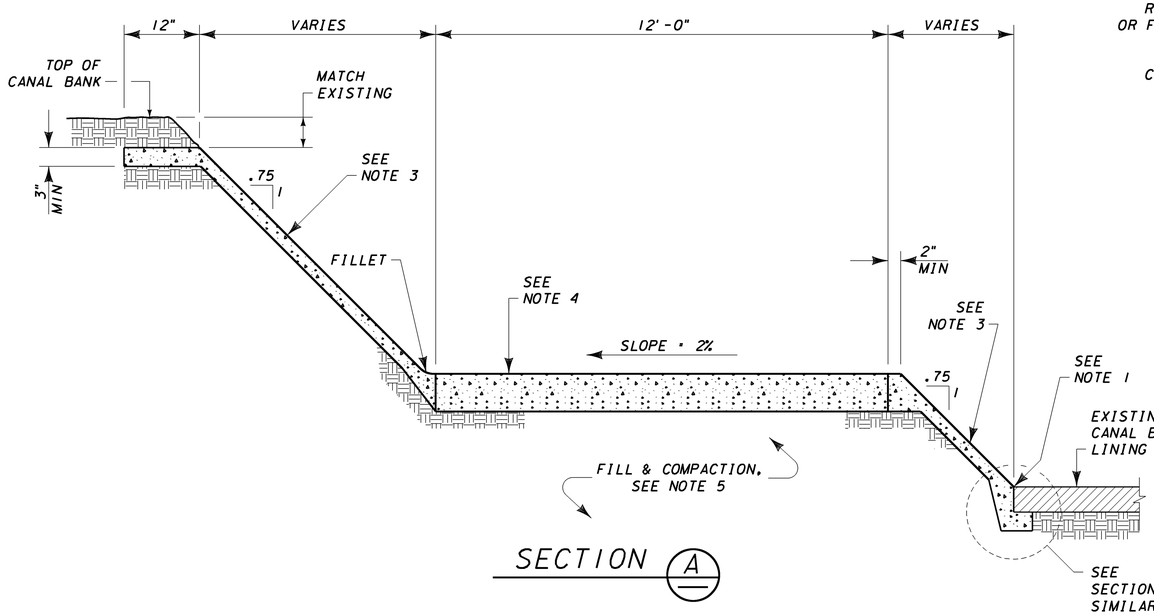
THIS DRAWING REPLACES B-54-225



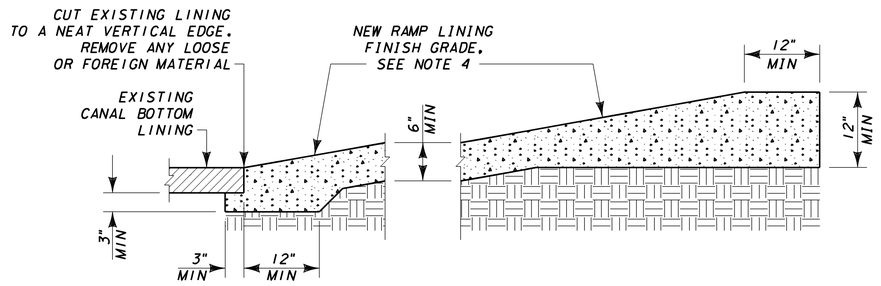
PLAN

NOTES

1. LIMITS OF LINING REMOVAL TO BE DETERMINED IN THE FIELD. CUT OR BREAK EXISTING LINING TO NEAT (VERTICAL) EDGE AND PROPERLY BOND WITH NEW.
2. DESIGN OF TOP OF LINING MAY VARY. SEE PROJECT SPECIFIC DRAWINGS AND FIBER REINFORCED CANAL LINING SECTION DRAWING WES-FRCANLNG.
3. MINIMUM 3 INCH THICK PNEUMATICALLY PLACED FIBER-REINFORCED SHOTCRETE BANK LINING PER SPECIFICATION SRP 03364.
4. MINIMUM 6 INCH THICK 3000 PSI CONCRETE (MAG A) PER SRP 03300. COMPACT AND SHAPE RAMP; DO NOT VIBRATE. FINISH TO BE TRANSVERSE ROUGH TAMP ONLY.
5. FILL SHALL BE PLACED IN 8" MAXIMUM UNCOMPACTED LIFTS AT +2% TO -4% OF THE OPTIMUM MOISTURE CONTENT AND COMPACTED TO A MINUMUM OF 90% PER ASTM D698.
6. RAMP SLOPE MAY VARY BASED ON LOCAL CONDITIONS.
7. RAMP SLOPE TO PROJECT DOWNSTREAM. ALIGNMENT TO BE DETERMINED BY O&M, CONSTRUCTION AND ADC REPRESENTATIVES.
8. GUARD POST SHALL BE 8"x 8"x 5'-4" AND BLOCK 8"x 8"x 14" PRESSURE TREATED PINE WOOD OR APPROVED EQUAL. SEE SECTION D.
9. GUARD RAIL LENGTH IS SUBJECT TO SITE REQUIREMENTS. GUARD RAIL EXTENDS TO END OF RAMP OR BEYOND. MAINTAIN STANDARD 12'-6" SPACING FOR END POST.
10. ALL GUARD RAIL PLATE, FITTINGS AND HARDWARE SHALL BE GALVANIZED.
11. GUARD RAIL TO BE STRIPED WITH REFLECTIVE TAPE.

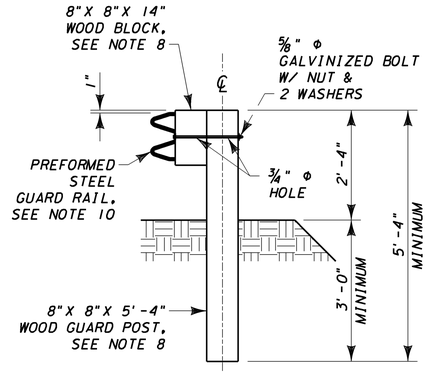


SECTION A



SECTION B

SECTION C



SECTION D

REFERENCES

STANDARD SPEC FOR SLURRY BACKFILL MATERIALS	SRP 02227
STANDARD SPEC FOR CONCRETE	SRP 03300
STANDARD SPEC FOR FIBER REINF SHOTCRETE FOR CANAL BANK LINING	SRP 03364
FIBER REINFORCED CANAL LINING SECTION	WES-FRCANLNG

REVISIONS

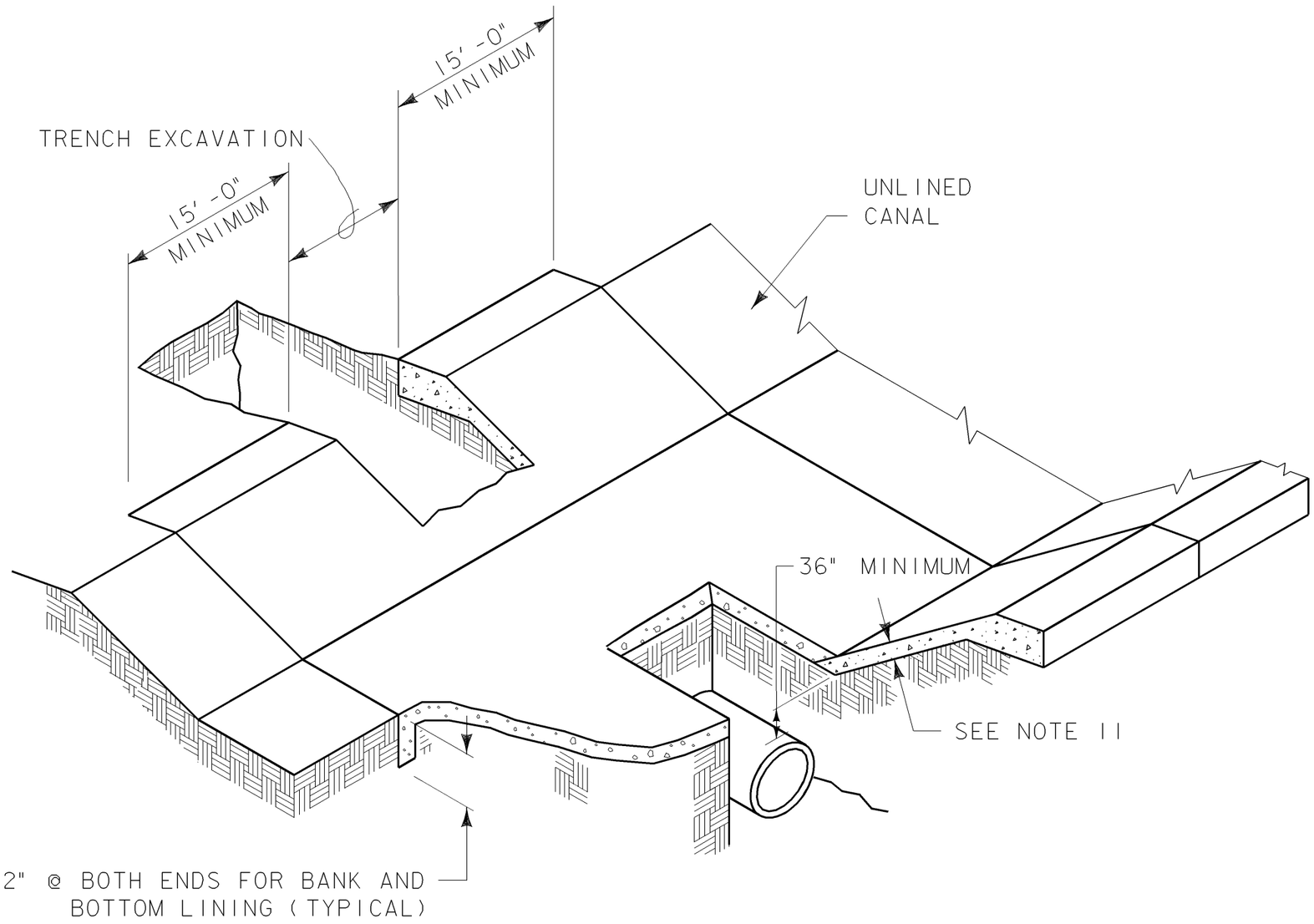
REV NO.	DFTR	DSGN	ENGR CHK	ISSUE AUTH	DATE
PLAN DETAIL AND SECTION D REDRAWN WITH NOTES 3 & 8 REVISED.					
4	JWS	HAS	HAS	REL	02/22/19
	JWS	HAS	HAS	REL	
INITIAL ISSUE.					
0	MOD	CWT	CWT	REL	12/01/98
	MOD	CWT	CWT	REL	

SALT RIVER PROJECT
WATER ENGINEERING STANDARD

CANAL ACCESS RAMP

SCALE: NONE
30100009.WES
DWG SIZE 22X34

WES-30100-009



UNLINED CANAL UNDERCROSSING

NOTES

1. NO MANHOLES, RISERS, VALVES OR OTHER SIMILAR FACILITIES ARE TO BE PLACED IN ANY PORTION OF SRP RIGHT-OF-WAY WITHOUT SPECIFIC AUTHORIZATION IN AN SRP LICENSE.
2. TOP OF PIPE, CONDUIT, CABLE OR ENCASEMENT IN SRP RIGHT-OF-WAY IS TO BE A MINIMUM OF 36 INCHES BELOW GRADE OR ROAD SURFACE.
3. ALL AFFECTED PORTIONS OF SRP RIGHT-OF-WAY, INCLUDING ROAD SURFACES, SHALL BE RESTORED TO THEIR ORIGINAL CONDITION OR BETTER.
4. SRP FACILITIES DAMAGED OR DESTROYED SHALL BE REPAIRED OR REPLACED TO THE SATISFACTION OF THE SRP ENGINEER.
5. COMPLETELY REMOVE ALL DIRT AND DEBRIS AFTER COMPLETION OF CROSSING CONSTRUCTION.
6. REMOVE UNSUITABLE/DELETERIOUS MATERIAL TO A MINIMUM TWO FOOT DEPTH AND REPLACE WITH APPROVED BACKFILL.
7. BACKFILL SHALL BE CLEAN, COHESIVE NATIVE MATERIAL AS APPROVED BY THE SRP ENGINEER OR MAG 728 1-SACK CLSM (CONTROLLED LOW STRENGTH MATERIAL).
8. PLACE COHESIVE BACKFILL AT OPTIMUM MOISTURE CONTENT IN 6 INCH LIFTS AND COMPACT TO 90 % OF MAXIMUM PROCTOR DENSITY (ASTM D698 STANDARD PROCTOR).
9. ELEVATIONS AND SLOPES SHALL BE AS DETERMINED BY THE SRP ENGINEER.
10. APPLY WHITE PIGMENTED CURING COMPOUND WITHIN ONE HOUR AFTER PLACING/FINISHING CONCRETE.
11. 3 INCH THICK HAND OR PNEUMATICALLY PLACED 3000 PSI CONCRETE. FIBER REINFORCED CONCRETE SHALL COMPLY WITH REQUIREMENTS OF SRP STANDARD SPECIFICATION SRP 03364. WWF REINFORCED CONCRETE SHALL BE MAG A WITH ASTM C33 #8 COARSE AGGREGATE AND A MAXIMUM AGGREGATE SIZE OF 3/8". WWF SHALL BE 4×4-W0.5×W0.5 OR 4×4-10 GAUGE × 10 GAUGE. EXTEND WWF MINIMUM 4" INTO BOTTOM LINING.
12. THE UNLINED CANAL BANK SURFACES SHALL BE SHAPED TO A SLOPE DETERMINED BY THE SRP ENGINEER. THE SLOPE SPECIFIED WILL NOT BE STEEPER THAN 3/4 TO 1 AND WILL NOT NECESSARILY MATCH THE EXISTING BANK SLOPES. TRANSITION FROM THE EXISTING UNLINED BOTTOM AND BANKS TO THE NEW LINING AT A MAXIMUM 4 TO 1 SLOPE.

REFERENCES

STD SPEC FOR PREPARATION OF SUBGRADE FOR CANAL LINING	CE 02.490
STD SPECIFICATION FOR CONCRETE	SRP 03300
STD SPEC FOR PLACEMENT OF CANAL BOTTOM CONCRETE	CE 03.361
STD SPEC FOR FIBER REINFORCED SHOTCRETE FOR CANAL BANK LINING	SRP 03364

REVISIONS

REV NO.	DFTR	DSGN	ENGR CHK	ISSUE AUTH	DATE
UPDATED THE FIBER REINFORCED SHOTCRETE SPEC FROM WTR 03364 TO SRP 03664.					
2	JWS	-	-	REL	11/12/15
	JWS	-	-	REL	
INITIAL ISSUE.					
0	MOD	CWT	CWT	REL	01/20/98
	MOD	CWT	CWT	REL	

SALT RIVER PROJECT
WATER ENGINEERING STANDARD

UNLINED CANAL UNDERCROSSING

SCALE: NONE | 30100010.WES

DWG SIZE: 22X17

WES-30100-010

SALT RIVER PROJECT

WATER GROUP
STANDARD SPECIFICATION
FOR
PREPARATION OF SUBGRADE FOR CANAL LINING
(CE 02.490)

TABLE OF CONTENTS

PREPARED: J. STUDTS APPROVED: H. ELSAAD

SALT RIVER PROJECT

WATER GROUP
STANDARD SPECIFICATION
FOR
PREPARING OF SUBGRADE FOR CANAL LINING
(CE 02.490)

1.0 GENERAL

1.1 SCOPE OF WORK

1.1.1 This specification covers all labor and services required for the preparation of the canal bank and bed lining subgrade.

1.2 STANDARD SPECIFICATIONS

1.2.1 Reference to standard specifications herein shall be interpreted to mean the latest revisions. The following abbreviations appear in the specifications:

ASTM – American Society for Testing and Materials

1.2.2 Permission for deviation from any requirements mentioned herein or from the aforementioned standards shall be obtained from the Engineer in writing.

1.3 TESTING

1.3.1 Soil moisture and compaction tests may be performed at the discretion of the Engineer, to insure compliance with that specified herein.

1.3.1 Testing performed by the Engineer shall be at the expense of the Purchaser.

2.0 PRODUCT

2.1 UNSUITABLE SOIL MATERIAL

2.1.1 Unsuitable soil material is material that contains organic matter, is saturated with a moisture content exceeding 5% over optimum, or contains other matter of such a nature that compaction to the specified density is unobtainable.

2.2 SUITABLE FILL MATERIAL

2.2.1 Suitable fill material is material that is free of any organic material, debris, and other objectionable material as determined by the Engineer. If import material is to be used, the source must be approved by the Engineer prior to the beginning of construction.

3.0 EXECUTION

3.1 CANAL PRISM CLEARING

3.1.1 All concrete, mortar, vegetation, debris, excess silt and unsuitable soil material, as determined by the Engineer, shall be removed from the canal. Reasonable care shall be exercised in the removal and cleaning operations so as to minimize damage to, or removal of, sound subgrade material.

3.1.2 The material removed shall be disposed of in a safe manner to a state approved disposal site or as directed by the Engineer.

3.2 MOISTURE CONTROL AND COMPACTION

3.2.1 The subgrade material shall be moistened to obtain the optimum soil moisture content, within ± 2%, and compacted to a minimum of 95% of maximum proctor density (ASTM D698).

3.3 TREATMENT OF EXISTING SUBGRADE SOILS

3.3.1 Existing lining subgrade found to be overly saturated, with a moisture content of 2% or 5% over optimum, shall be treated by aeration or other means to reduce the moisture content of the material.

3.3.2 Saturated soils with a moisture content exceeding 5% over optimum, and materials otherwise deemed unsuitable by the Engineer as subgrade material for the canal lining, shall be removed and disposed of in accordance with section 3.1.2, and replaced with suitable fill material. The fill material shall be placed and compacted in accordance with Section 3.2.1 in six inch maximum lifts.

3.4 TOP OF LINING TIE TO EMBANKMENT

3.4.1 Where the existing canal embankment is lower than the design grade for the top of lining, additional suitable fill material shall be placed to the prescribed construction limits indicated on the drawings. The canal embankment shall be cleared of all vegetation and loose material within the prescribed limits and moistened prior to placement of the fill material. The fill material shall be placed in six inch maximum lifts and compacted in accordance with Section 3.2.1.

3.5 TRIMMING FOR LINING

3.5.1 The bottom and side slopes, including the surfaces of compacted embankment over which the lining is to be placed, shall be uniformly trimmed to the required side slope, bottom width and bottom grade indicated on the drawings. The finished tolerances shall be within 1.0 feet from the design bottom width and within 0.1 feet from the design bottom grade indicated on the drawings, or as directed by the Engineer.

3.5.2 The top of the canal embankment shall be uniformly trimmed to the top of lining grade indicated on the drawings with a finished tolerance within 0.1 feet, or as directed by the Engineer.

3.5.3 A cut-off lip shall be excavated in accordance with the drawings to an approximate straight line parallel with the top edge of the embankment.

3.5.4 The top of the canal embankment shall be maintained at a minimum of 95% of the maximum proctor density (ASTM D698) following the excavation of the cut-off lip.

3.5.5 Benching may be required at the top of the bank to allow for the preparation of the cut-off lip.

3.5.6 The canal side slopes shall be trimmed to provide a firm foundation for the shotcrete lining. The subgrade surface shall be free of loose material, large rocks, organics, and voids to provide a smooth, compacted surface.

3.5.7 Any material excavated beyond the specified limits and grades of the canal lining subgrade, shall be refilled in horizontal layers with suitable fill material. The fill material shall be placed and compacted in six inch maximum lifts in accordance with Section 3.2.1. When placing and compacting material on a sloping subgrade, the layers shall be placed parallel and keyed into the surface of the subgrade provided that it can be compacted as specified in Section 3.2.1. If the sloping subgrade cannot be properly compacted, the area shall be overbuilt, compacted in six inch maximum lifts in accordance with Section 3.2.1, and trimmed to the required subgrade limits.

3.5.8 If at any point the subgrade materials are disturbed or loosened prior to installation of the lining, the disturbed material shall be thoroughly compacted by tamping, rolling or other approved methods in accordance with Section 3.2.1.

3.6 MOISTURE CONTROL PRIOR TO LINING INSTALLATION

3.6.1 The canal bank and bottom lining subgrade surfaces shall be kept in a moist condition, within 2% of the optimum moisture content, at all times prior to the installation of the concrete lining, for dust abatement and to prevent premature drying and cracking of the concrete lining upon installation.

3.6.2 The water shall be applied through the use of a nozzle or spray bar to provide an even spray distribution and to prevent erosion of the subgrade surface.

3.6.3 The equipment necessary to obtain the required moisture content shall be kept available on the job site throughout the construction.

SALT RIVER PROJECT

WATER GROUP
STANDARD SPECIFICATION
FOR
CANAL BANK REINFORCEMENT
(CE 03.212)

TABLE OF CONTENTS

PREPARED: J. STUDTS APPROVED: H. ELSAAD

SALT RIVER PROJECT

WATER GROUP
STANDARD SPECIFICATION
FOR
CANAL BANK REINFORCEMENT
(CE 03.212)

1.0 GENERAL

1.1 SCOPE OF WORK

1.1.1 This specification covers all labor, equipment, and services necessary for the installation of the canal bank lining welded wire fabric reinforcement.

1.2 STANDARD SPECIFICATIONS

1.2.1 Reference to standard specifications herein shall be interpreted to mean the latest revisions. The following abbreviation appears in the specifications:

ASTM – American Society for Testing and Materials

1.2.2 Permission for deviation from any requirements mentioned herein or from the aforementioned standards shall be obtained from the Engineer in writing.

2.0 PRODUCT

2.1 WELDED WIRE FABRIC

2.1.1 The welded wire fabric shall be in accordance with the “Standard Specification for Steel Welded Wire Fabric”, ASTM A185, and shall be galvanized in accordance with the “Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire”, ASTM A641.

2.1.2 The welded wire fabric shall be 4 x 4 W0.5 x W0.5 (4 inch by 4 inch mesh with 14 gage wire).

2.1.3 The width of the roll shall not be less than 5 feet.

2.2 WELDED WIRE FABRIC PINS

2.2.1 The welded wire fabric pins shall be equivalent to a J-hook, a minimum of 6 inches in length with a 1 inch hook. The pins shall be fabricated from 9 gage wire, or equivalent, to provide sufficient strength to allow them to be driven into the canal bank subgrade.

2.2.2 A sample pin shall be provided to the Engineer for approval prior to the beginning of construction.

3.0 EXECUTION

3.1 WELDED WIRE FABRIC PLACEMENT

3.1.1 Prior to placement, the welded wire fabric shall be cleaned of all dirt, grease or other foreign substances, to the satisfaction of the Engineer.

3.1.2 The welded wire fabric shall be completely installed over a properly prepared canal bank subgrade in accordance with Salt River Project's "Standard Specification for Preparation of Subgrade for Canal Lining", CE 02.490, prior to placing the canal bottom lining, unless otherwise approved by the Engineer.

3.1.3 The welded wire fabric shall be cut and fit as required to allow the fabric to be placed flat, without bulging.

3.1.4 The welded wire fabric shall be placed parallel to the canal bank. The longitudinal joints shall be lapped a minimum of 4 inches, up to a maximum of 25 percent of the width of the roll to minimize longitudinal cutting. The end joints shall be lapped a minimum of 4 inches, and staggered.

3.1.5 The welded wire fabric shall be embedded a minimum of 4 inches into the canal bottom lining and extend to the bottom of the cut-off lip at the top of the bank.

3.1.6 The welded wire fabric shall be accurately and securely placed in position with pins embedded in the banks. The pins shall be installed at a maximum spacing of every 4 feet vertically and every 8 feet horizontally to prevent displacement during the placement of the concrete.

3.1.7 After being placed, the welded wire fabric shall be maintained in a clean condition until completely embedded in the concrete. Special care shall be exercised to prevent any disturbance to welded wire fabric that has already been embedded in concrete.

3.1.8 One ladder on each bank, for access into and out of the canal, shall be located at each area where work is being performed. Climbing on the prepared canal bank subgrade or welded wire fabric will not be permitted.

SALT RIVER PROJECT

WATER GROUP
STANDARD SPECIFICATION
FOR
PLACEMENT OF CANAL BOTTOM CONCRETE
(CE 03.361)

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PREPARED: J. STUDTS APPROVED: H. ELSAAD

SALT RIVER PROJECT

WATER GROUP
STANDARD SPECIFICATION
FOR
PLACEMENT OF CANAL BOTTOM CONCRETE
(CE 03.361)

1.0 GENERAL

1.1 SCOPE OF WORK

1.1.1 This specification covers all labor, equipment and services necessary for the installation of the canal bottom concrete lining.

1.2 STANDARD SPECIFICATIONS

1.2.1 Reference to standard specifications herein shall be interpreted to mean the latest revisions. The following abbreviations appear in the specifications:

ASTM – American Society for Testing and Materials
ACI – American Concrete Institute

1.2.2 Permission for deviation from any requirements mentioned herein or from the aforementioned standards shall be obtained from the Engineer in writing.

2.0 PRODUCT

2.1 CANAL BOTTOM CONCRETE

2.1.1 The concrete for the canal bottom lining shall be in accordance with the requirements of “Standard Specification for Concrete”, SRP 03300, mix design SRP Stock Code No. 00-00220 (SRP SAP No. 5075320).

2.2 CURING COMPOUND

2.2.1 The curing compound shall be a white-pigmented compound in accordance with the requirements of the “Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete”, ASTM C309, for a Type 2, class A compound.

3.0 EXECUTION

3.1 PLACEMENT

3.1.1 Upon completion of the canal bottom and bank subgrade preparation as specified in Salt River Project’s “Standard Specification for Preparation of Subgrade for Canal Lining”, CE 02.490, and installation of the canal bank

reinforcement as specified in Salt River Project's "Standard Specification for Canal Bank Reinforcement", CE 03.212, the concrete bottom lining may be constructed.

3.1.2 The concrete shall not be placed until the Engineer has approved the canal preparation and the canal bank reinforcement installation.

3.1.3 Prior to placement, all absorptive surfaces against which the concrete is to be placed shall be uniformly moistened, and maintained in that condition, as specified in Salt River Project's "Standard Specification for Preparation of Subgrade for Canal Lining", CE 02.490, Section 3.6. Caution shall be taken to prevent over-saturation of the subgrade surface during the moistening process. Failure to comply shall result in a temporary shutdown of the concrete placement until the requirements are met to the satisfaction of the Engineer.

3.1.4 At the time of application, there shall be no free water on the surface upon which the concrete is to be placed.

3.1.5 Any disturbance to the prepared bottom subgrade surface during the concrete placement shall be repaired to the satisfaction of the Engineer prior to installing the bottom concrete.

3.1.6 The bottom concrete shall be placed only in the presence of the Engineer.

3.1.7 The concrete bottom lining shall be placed to a 4-inch minimum finished thickness, with a finished tolerance within 0.1 feet from the design elevation indicated on the drawings.

3.1.8 The concrete shall be compacted with a hand tamper, vibrator or other device approved by the Engineer to remove air voids and draw the aggregate below the surface.

3.1.9 Concrete bottom lining placements which are stopped for the day, interrupted because of breakdown, or delayed by other causes shall have a temporary bulkhead installed at all free edges of the placement to a vertical surface. When placing operations are resumed, the surface of the hardened concrete shall be cleaned of all loose and foreign material and coated with a sand/cement mixture. The joint shall be thickened by excavating under the edge of the previously placed concrete lining, as shown on the drawings.

3.1.10 One ladder on each canal bank, for access into and out of the canal, shall be located at each area where work is being performed. Climbing on the prepared canal bank subgrade or welded wire fabric will not be permitted.

3.2 FINISHING

3.2.1 The concrete surface shall be finished to achieve a level, skid resistant surface free from ridges or other projections.

3.3 CURING

3.3.1 As the concrete placement progresses, the bottom concrete lining placed shall be cured by membrane curing. Membrane curing shall consist of the application of a white-pigmented curing compound as specified in Section 2.2.1.

3.3.2 The curing compound shall be applied immediately after all free water has left the concrete surface.

3.3.3 The curing compound shall be sprayed in a single application to provide a continuous, uniform, white membrane over the entire bottom concrete surface excluding a 12-inch wide strip along each bank for the tie-in of the canal bank lining.

3.3.4 The application rate shall be at the minimum rate of one gallon per 100 square feet, and may be increased as directed by the Engineer to obtain the required continuous membrane.

3.3.5 The curing compound shall be kept mixed to a uniform consistency by moderate stirring or agitation throughout the application process.

3.4 HOT WEATHER CONCRETING

3.4.1 The concrete shall be placed and cured in accordance with the requirements of “Hot Weather Concreting”, ACI 305R, when the temperature is 90°F or above, or is likely to rise above 90°F within the 24 hour period after placing.

3.5 COLD WEATHER CONCRETING

3.5.1 The concrete shall be placed and cured in accordance with the requirements of “Cold Weather Concreting”, ACI 306R, when the temperature is below 40°F or is likely to fall below 40°F during the 24 hour period after placing.

3.5.2 The concrete shall be protected from exposure to carbon monoxide or carbon dioxide fumes from heaters or engines.

SALT RIVER PROJECT
STANDARD SPECIFICATION
FOR
CONCRETE
(SRP 03300)

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REVISED: J. ADAMS APPROVED: K. L. CHHIBBER

STANDARD SPECIFICATION FOR CONCRETE (SRP 03300)

1.0 GENERAL

1.1 Work Specified

This specification covers the furnishing of all plant, labor, materials and equipment necessary for designing, mixing, and delivering normal and light weight Portland cement concrete ready for placement.

1.2 Work Performed by Concrete Supplier

Concrete Supplier is defined as the concrete supplier responsible for designing, proportioning, mixing, and delivering Portland cement concrete. Concrete will be requested either by the Buyer, or by the Contractor retained by the Buyer.

1.3 Standard Units

English units are the standard.

1.4 Reference Standards

1.4.1 Reference to standards or specifications shall be interpreted to mean the latest revision unless noted otherwise.

1.4.2 The following abbreviations appear in this Specification:

ACI	American Concrete Institute
ADEQ	Arizona Department of Environmental Quality
ARPA	Arizona Rock Products Association
ASTM	American Society for Testing and Materials
EPA	U.S. Environmental Protection Agency
ICC	International Code Council
MAG	Maricopa Association of Governments
NRMCA	National Ready-Mixed Concrete Association

SRP	Salt River Project

1.4.3 The following standards and reports shall be made a part of this Specification:

ACI 212.3R	Report on Chemical Admixtures for Concrete
ACI 304R	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 318	Building Code Requirements for Reinforced Concrete
ASTM C31	Standard Practice for Making and Curing Test Specimens in the Field
ASTM C25	Standard Test Method for Chemical Analysis of Limestone, Quicklime and Hydrated Lime
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	Standard Test Method for Organic Impurities in Fine Aggregate for Concrete
ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C117	Standard Test Method for Materials Finer than (75-µm (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C123	Standard Test Method for Lightweight Particles in Aggregate
ASTM C127	Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
ASTM C128	Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138	Standard Test Method for Unit Weight, Yield, and Air Contents (Gravimetric) of Concrete
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C233	Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C403	Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete
ASTM C937	Standard Specification for Grout Fluidifer for Preplaced-Aggregate Concrete
ASTM C1064	Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
ASTM C1097	Standard Specification for Hydrated Lime for Use in Asphalt Cement or Bituminous Paving Mixtures
ASTM C1116	Standard Specification for Fiber Reinforced Concrete
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM C1603	Standard Test Method for Measurement of Solids in Water
ASTM D512	Standard Test Methods for Chloride Ion in Water
ASTM D516	Standard Test Method for Sulfate Ion in Water
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D5821	Standard Test Method for Determining Percentage of Fractured Particles in Coarse Aggregate

ASTM D7508	Standard Specification for Polyolefin Chopped Strands for Use in Concrete
ICC AC32	Acceptance Criteria for Concrete with Synthetic Fibers
MAG Section 725	Portland Cement Concrete

1.4.4 Exceptions to this specification must be approved in writing by the Buyer prior to beginning the affected Work.

1.5 Submittals

1.5.1 Concrete Supplier shall submit the following items for each batch plant (Plant) and mix to be supplied. All submittals must be current, and signed by person responsible for testing and/or certification. Expired and unsigned submittals may be rejected. Testing, sampling, and certification must be performed by a qualified, independent laboratory, agency, engineer, and/or oversight group:

a. Plant Certification. A plant certification is required for each Plant proposed by Concrete Supplier to provide material. Certification to consist of ARPA Certification of Performance for Concrete Production Facilities, or NRMCA Plant Certification.

b. Portland Cement Certification and Mill Test Report. Manufacturers certification is required from each source of Portland cement used in proposed mixes. Certification to include Certification of Test for Portland cement Type II/V Low Alkali meeting requirements of ASTM C150. Certification of Test to be dated within 1-year of submittal date, and must include source of Portland cement.

c. Fly Ash Certification. Pozzolan Test Report is required from each source of fly ash used in proposed mixes. Test Report shall meet requirements of ASTM C618. Sampling and testing shall meet requirements of ASTM C311. Test Report to be dated within 1-year of submittal date, and must include source of fly ash.

d. Hydrated Lime Certification. Certificate of Analysis is required from each source of hydrated lime used in proposed mixes. Certification shall meet requirements of ASTM C1097. Certification to be dated within 1-year of submittal date, and must include source of hydrated lime.

e. Source of Water and Water Certification. Water used for the concrete mix and washing aggregate to meet requirements of ASTM C1602. State source of water for each proposed Plant as either City or "Other." City water does not require a submittal. Submit chemical analysis of "Other" water performed by an independent, qualified laboratory certifying suitability in accordance with ASTM C114 and ASTM C1603 for each proposed plant that uses "Other" water. Water analysis methods must meet ADEQ Accepted Laboratory Methods, and, as a minimum, should include the following:

- Alkalies (calculated)
- Chloride Content (EPA SM 4500-Cl C)
- Sulfate Content (EPA SM 4500-SO4 D)
- Total Potassium (EPA 200.7)
- Total Sodium (EPA 200.7)
- Total Solids (EPA SM 2540 B)

Water certification must be dated within 1-year of submittal date. Report to include sample source, sample date, and sample time.

f. Scale Certification. Documents of Certification are required for all scales used to weigh aggregates, cement, and admixtures. Certifications are required for every scale that may be used at each proposed plant. Date of certification must be within 1-year of submittal date.

g. Fine Aggregate Certification. Fine aggregates to meet requirements of ASTM C33. Submit testing results of fine aggregates to be used within proposed mixes for each proposed plant. Where a single stockpile provides material for more than one plant, this stockpile requires only one certification with statement of which proposed plants the stockpile provides material. Date of certification must be within 1-year of submittal date. Testing, as a minimum, should include the following:

- Sieve Analysis of Fine and Coarse Aggregates (ASTM C136)
- Amount of Material Finer Than #200 Sieve (ASTM C117)
- Fineness Modulus (ASTM C136)
- Liquid Limit, Plastic Limit and Plasticity Index of Soils (ASTM D4318)
- Sand Equivalent Value for Soils and Fine Aggregate (ASTM D2419)
- Specific Gravity and Absorption of Coarse Aggregate (ASTM C128)
- Soundness of Aggregate by use of Sodium Sulfate (ASTM C88)

- Lightweight Particles in Aggregate (ASTM C123)
- Clay Lumps and Friable Particles in Aggregate (ASTM C142)
- Organic Impurities in Fine Aggregates for Concrete (ASTM C40)

h. Coarse Aggregate Certification. Coarse aggregates to meet requirements of ASTM C33. Submit testing results of all single size and blended coarse aggregates used within proposed mixes for each proposed plant. Where a single stockpile provides material for more than one proposed plant, this stockpile requires only one certification with statement of which proposed plants the stockpile provides material. Date of certification must be within 1-year of submittal date. Testing, as a minimum, should include the following:

- Sieve Analysis of Fine and Coarse Aggregates (ASTM C136)
- Amount of Material Finer Than #200 Sieve (ASTM C117)
- Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine (ASTM C131)
- Clay Lumps and Friable Particles in Aggregate (ASTM C142)
- Lightweight Pieces in Aggregate (ASTM C123)
- Specific Gravity and Absorption of Coarse Aggregate (ASTM C127)
- Soundness of Aggregate by use of Sodium Sulfate (ASTM C88)
- Percentage of Crushed Particle in Mineral Aggregate (ASTM D5821)
- Potential Alkali Silica Reaction (ASTM C1260/C1567)

i. Admixture Certification. Submit manufacturer certifications for proposed admixtures to be used in proposed mixes. Admixtures requiring certification, as a minimum, may include the following:

- Normal Water Reducing Admixture (NWRA)
- Mid-Range Water Reducing Admixture (MRWRA)
- High-Range Water Reducing Admixtures (HRWRA)
- Air Entraining Admixture (AEA)
- Hydration Stabilizer Admixture “Retarder” (HSA)
- Accelerator Admixture (Acc)
- Micro and Macro-Fiber Admixture
- Permeability Reducing Admixture for Concrete Subject to Hydrostatic Conditions (PRAH)

j. Mix Designs. Provide sealed mix design for each proposed mix from each proposed plant. Mix designs that are used at more than one proposed plant require only a single submittal with comment on which proposed plants the mix design applies. Mix design to

include SRP stock code no., SRP SAP material item no., SRP product name, Concrete Supplier product code no., and Concrete Supplier product name. SRP stock code no. is currently used by Concrete Supplier and SRP in ordering material. The new SRP SAP material item no. is not presently used by Concrete Supplier and SRP, but will eventually be phased in. Mix design to include the applicable proportions, weights, and quantities of individual materials incorporated into the mix including the size of aggregates, type cement and fly ash, and the brand and designation of admixtures.

Mix design must be sealed within 1-year of the submittal date by an Arizona-registered professional engineer responsible for the mix. Preliminary submittals may use mix designs that are not sealed; however, final submittal of mix design must be sealed.

k. Mix Design Performance and/or Trial Batch History. Provide performance history (including results of trial batches when available) for each proposed mix. Performance history includes items such as slump, compressive strength, time of set, delayed time of set with hydration stabilizer admixture, flow rate, thermal resistivity (rho), etc. If performance data is not available so state.

1.5.2 Concrete Supplier shall use SRP mix stock code numbers, SRP SAP material item nos., and SRP product names to refer to mixes, but may assign Concrete Supplier product code numbers and Concrete Supplier product names in addition to SRP mix stock code numbers and product names specified in Table 1. SRP SAP material item nos. are currently not used by Concrete Supplier and SRP, but will be eventually phased in.

1.5.3 Mixes and plants that have already been submitted to and approved by Buyer, and are current, do not require re-submittal. Re-submittal will be required at end of term of any agreements, or at any time determined by the Buyer.

1.5.4 In addition to specified materials and mixes, Concrete Supplier may submit alternative mix designs or deviations to the specifications for review and approval. Buyer may request additional test and/or certification documentation before approving alternatives.

1.6 Quality Assurance

1.6.1 Each batch plant from which Concrete Supplier intends to provide materials governed by this specification must have current NRMCA, ARPA, or equivalent certification.

1.6.2 Concrete Supplier shall provide access to batch plant to Buyer and Buyer's Representative for sampling/inspection of materials and equipment as required by the Buyer.

1.7 Storage and Handling

1.7.1 Materials shall be stored and handled in a manner that prevents deterioration, segregation, or intrusion of foreign matter.
1.7.2 Storage of aggregate on natural ground surface will be permitted if bottom six inches of pile is not used in batching.

2.0 PRODUCT

2.1 Cement

Cement: Portland Cement, Type II/V, low alkali, moderate heat of hydration, ASTM C150. Equivalent alkali content shall not exceed 0.60 percent, per Table 2, ASTM C150.

2.2 Aggregate

Coarse and fine aggregate: ASTM C33. Fine aggregate shall be sized as noted in Table 1 of ASTM C33. Coarse aggregate shall be sized as presented in Table 3 of ASTM C33.

2.3 Water

Water for washing aggregate and for mixing concrete shall be potable. If potable water is not used, chemical analysis of water shall be performed certifying suitability in accordance with ASTM C94, ASTM C1602, ASTM C1603, ASTM D512, and ASTM D516 by a qualified, independent testing laboratory. Testing will be at Concrete Supplier's expense.

2.4 Admixtures

2.4.1 Admixtures must be certified by manufacturer and shall be approved by the Buyer prior to use. Admixtures shall be added at the plant at the time of batching, unless otherwise noted. Admixtures shall contain not more than 0.1 percent water-soluble chloride ions by mass and shall be compatible with other admixtures. Do not use admixtures containing calcium chloride. Superplasticizer may be added at batch plant or at Jobsite.

2.4.2 Air-Entraining Admixtures

a. Air-entraining admixtures: ASTM C260.

b. Testing of air-entraining admixtures: ASTM C233.

c. Air content (unless specified otherwise): ASTM 94, Section 6.1.4, 1, moderate exposure. Tolerance for air content as delivered ± 1.5 percent.

2.4.3 Water-Reducing, Hydration Stabilizing (Retarding), and Accelerating Admixtures

a. Water-reducing admixtures: ASTM C494, Type A.

b. Water-reducing and retarding admixtures: ASTM C494, Type B & D.

c. Accelerating Admixtures: ASTM C494, Type C.

d. Water-reducing and accelerating admixture: ASTM C494, Type E.

e. Water-reducing, high range admixtures (superplasticizers): ASTM C494, Type F.

f. Water-reducing, high range, and retarding admixtures: ASTM C494, Type G.

2.4.4 Fiber Admixtures

a. Macro-fiber, micro-fiber, and macro/micro fiber blend admixtures: ASTM C1116.

b. Steel Fiber-Reinforced Concrete: ASTM C1116, Type I.

c. Glass Fiber-Reinforced Concrete: ASTM C1116, Type II.

d. Synthetic Fiber-Reinforced Concrete: ASTM C1116, Type III, ASTM D7508, and ICC AC32.

e. Natural Fiber-Reinforced Concrete: ASTM C1116, Type IV.

f. Fiber may be ordered per ASTM C1116, Section 6, Option A where Buyer assumes responsibility for mixture proportioning and dictates type and dosage of fiber admixtures. Fiber reinforcement ordered by the Buyer will be synthetic macro-fiber, polypropylene copolymer, 2-inches long, unless otherwise requested. Synthetic micro-fiber, or blend of macro/micro fibers may be requested by the Buyer.

g. Fiber may be ordered per ASTM C1116, Section 6, Option B where Buyer specifies required flexural performance and requires Concrete Supplier to assume full responsibility for fiber type and mixture proportioning. Fiber of Option B may be ASTM Type I, II, III, or IV.

h. Fiber may be ordered per ASTM C1116, Section 6, Option C where Buyer specifies minimum allowable cement content and required flexural performance, and requires Concrete Supplier to assume responsibility for fiber type and mixture proportioning. Fiber of Option C may be ASTM Type I, II, III, or IV.

i. Dosage of fiber admixture shall be in pounds per cubic yard of concrete.

2.4.5 Grout Fluidifers

Grout Fluidifers: ASTM C937.

2.4.6 Permeability Reducing Admixtures

Permeability reducing admixtures must be hydrophilic crystalline product for concrete subject to hydrostatic conditions (PRAH): ACI 212.3R.

2.5 Fly Ash

2.5.1 Fly ash: ASTM C618, Class F.

2.5.2 Fly ash shall be used in all proposed mixes, unless noted otherwise in Table 1.

2.5.3 Fly ash shall be compatible with cement and shall not react deleteriously with alkalis in cement.

2.5.4 Maximum fly ash replacement ratio of cementitious material within mixes shall be as specified within MAG Section 725 “Portland Cement Concrete,” unless otherwise specified by the Buyer. Concrete Supplier shall be responsible to determine replacement ratio for each pound of replaced cement to maintain specified compressive strength f'c and specified performance.

2.6 Proportioning of Mix

2.6.1 Proportioning of Mix: ASTM C94.

Option A: Buyer specifies requirement for compressive strength and Concrete Supplier to assume full responsibility for the selection of proportions for the concrete mixture.

Option B: Buyer assumes responsibility for the proportioning of the mixture.

Option C: Buyer specifies minimum allowable cement content and Concrete Supplier to assume responsibility for the selection of the proportions for the mix.

2.6.2 Minimum cementitious material content shall be as recommended in Table 725-1 of MAG Section 725.

Minimum Cementitious Material Content by Concrete Class (Table 725-1, Section 725 of MAG).

Class of Concrete	Minimum Cementitious Materials Content (lbs./CY)	Minimum Compressive Strength at 28-Days (psi)
AA	600	4000
A	520	3000
B	470	2500
C	420	2000

2.6.3 Proportioning of ingredients shall produce a consistent, durable, and workable product that meets specified compressive strength, slump, properties per referenced standards in Section 1.4, requirements of Table 1, and other performance properties as required by the application. Mix shall be homogeneous, readily placeable, and sufficiently and uniformly workable.

2.6.4 Source, character or gradation of materials shall not be changed without notification of the Buyer. New mix design and possible performance verification must be submitted to the Buyer for approval when modifications to the mix are categorized in MAG Section 725 as "Modifications that require a new mix design submittal/approval and may require performance verification."

2.7 Measuring Materials

Measuring of materials: ASTM C94

2.8 Mixing

2.8.1 Mixing: ASTM C94.

2.8.2 Concrete to be central-mixed or truck-mixed with all ingredients added to the mix at the batch plant, unless otherwise noted.

2.8.3 Truck-mixed concrete shall be mixed per Section 12.5 of ASTM C94. Per the standard, the batch shall be mixed for 70 to 100 revolutions at mixing speed designated by the manufacturer to produce uniformity of concrete (typically 6 to 18 rpm).

2.8.4 High range water reducing admixtures (superplasticizers) may be added at batch plant or at Jobsite.

2.8.5 Fibers shall be added to the mix per manufacturer's recommendations and at a rate that insures proper distribution throughout the mix (no clumping).

2.8.6 Fly ash and cement shall be added in a manner and at a rate as to minimize presence of incomplete mixed nodules. Dry nodules over 1-inch diameter are not allowed. Concrete containing non-uniform material exceeding 1% of the total volume may be rejected by the Buyer with full cost the responsibility of the Concrete Supplier.

2.8.7 Retarding admixtures may be added to concrete to meet slump requirements and compensate for travel time to specific Jobsites. Volume of retarding agent added is responsibility of Concrete Supplier. Type and volume must be approved by the Buyer prior to batching.

2.9 Delivery and Batch Ticket

2.9.1 Delivery: Section 12 of ASTM C94.

2.9.2 Batch/Delivery Ticket: Section 14 of ASTM C94.

2.9.3 Copy of delivery ticket is to be given to the Buyer at time of delivery. Batch out time of truck shall be machine-stamped on delivery ticket at Concrete Supplier's Plant. Concrete deliveries without machine-stamped batch out time on delivery ticket may be rejected by the Buyer.

2.9.4 **Delivery ticket must include SRP Mix Stock Code No., SRP SAP Material Item No., SRP Product Name, Concrete Supplier Product Code No., and Concrete Supplier Product Name.** Material delivered with a delivery ticket that does not include these items may be rejected by the Buyer. SRP SAP material item no. is currently not used by Concrete Supplier and SRP, but will eventually be phased in.

2.9.5 Concrete shall be delivered within 30 minutes of requested delivery time. Time lapse between successive deliveries shall not vary by more than

20 minutes from that requested. The Buyer may reject any batch not meeting these requirements.

2.10 Hot Weather Concreting

2.10.1 Hot weather concreting: ACI 305.1.

2.10.2 Concrete temperature shall not exceed 90˚F during mixing, delivery, and discharging.

2.10.3 During conditions of high temperature, low relative humidity, or wind which might impair quality of concrete, setting time shall be delayed by using proper admixtures upon approval by the Buyer.

2.11 Cold Weather Concreting

2.11.1 Cold weather concreting: ACI 306.1.

2.11.2 Required concrete temperatures shall be as recommended in Table 3.2.1 of ACI 306.1. Concrete temperature during mixing, delivery, and discharge shall not be less than 55˚F.

2.12 Direct and Indirect Costs

Direct and indirect costs incurred by Buyer due to failure to meet requirements of this specification shall be paid by Concrete Supplier and/or Contractor.

3.0 EXECUTION

3.1 Placement

3.1.1 Placement of concrete and cementitious materials: Section 26.5.2 of ACI 318, ACI 304R, and Section 12 of ASTM C94.

3.1.2 Unless a different allowable temperature range is pre-approved by the Buyer, temperature of concrete during production, delivery, and discharge shall never be outside the temperature range of 55˚F (13˚C) to 90˚F (32˚C). Concrete that is outside the temperature range of 55^{o}F to 90 ^{o}F, concrete that has become unworkable, or concrete that has attained its initial set, as determined by the Buyer, may be rejected at the Concrete Supplier’s and/or Contractor's cost. Buyer may waive these limitations if slump, workability, and temperature is such that concrete can be placed as specified without the addition of water.

3.1.3 Unless designed using pre-approved set delay additives, concrete shall be discharged within 1-1/2 hours after initial mixing water has been added to cement and aggregate. This limitation may be waived by the Buyer if the concrete is of such slump, workability, and temperature after 1-1/2 hours that it can be placed, without addition of water to the mix. In hot weather, or under conditions contributing to rapid stiffening of the concrete, a time less than 1-1/2 hours may be specified by the Buyer.

3.1.4 Concrete Supplier shall be responsible to make corrections to bring mix to specified slump. Buyer's preference is that no water be added at the Jobsite. Addition of water at Jobsite requires Buyer's approval. When approved, additional water added at the Jobsite must be in accordance with Paragraph 12.7 of ASTM C94. Slump after such water addition must not exceed the maximum allowed by the Mix Design, and the water/cementitious material ratio must not exceed that specified by the Mix Design. All water additions are to be completed within 15 minutes from the start of first water addition. Added water must be mixed into the batch for a minimum of 30 additional revolutions at mixing speed (typically 6 to 18 rpm). Mix not meeting slump requirements may be rejected by the Buyer at the Concrete Supplier's cost.

3.1.5 Material shall be placed at a rate so as to provide adequate supply at the location of placement, at a rate at all times so material retains sufficient workability and can be self-consolidated or consolidated by external method, material remains homogeneous without segregation or loss of material, without interruptions between successive placements that may result in cold joints, and deposited near its final location to avoid segregation due to rehandling or flowing.

3.1.6 Cementitious material is prohibited to be in contact with aluminum, copper, or brass. No aluminum, copper, or brass conduits and tremies shall be used to pump or place cementitious material.

3.1.7 Masonry filler units that will be in contact with concrete shall be pre-wetted prior to placing concrete.

3.1.8 Free-fall height greater than 5-feet is prohibited, unless otherwise approved by the Buyer.

3.2 Testing, Strength Compliance, and Acceptance of Concrete

3.2.1 Testing

a. Concrete samples will be taken directly from discharge of ready-mix transit truck. Sampling and testing will be in accordance with the following standards:

ASTM C138	Unit Weight & Yield
ASTM C143	Slump
ASTM C172	Sampling
ASTM C231	Air
ASTM C1064	Temperature

b. Frequency for sampling concrete for strength compliance: Section 17 of ASTM C94 with the exception that Buyer standard requires one test per minimum 50 CY, or as otherwise specified by the Buyer.

c. Frequency for sampling and testing for slump, air-content, and temperature compliance: Section 17 of ASTM C94, or as otherwise specified by the Buyer. Buyer requires, as a minimum, that this testing be performed when strength specimens are made. Testing of air content only required for batches that include an air-entraining admixture, unless otherwise directed by the Buyer.

d. Standard set of cylindrical concrete samples for compressive strength testing to consist of 1 at 7-days, 2 at 28-days, and 1-hold cylinder, unless otherwise specified by the Buyer.

e. Making and curing of concrete strength specimens: ASTM C31. Test specimens 4” diameter by 8” tall cylinders.

f. Compressive strength testing of cylindrical concrete specimens: ASTM C39.

3.2.2 Testing specified in subsection 3.2.1 will be performed by the Buyer at no cost to Concrete Supplier or Contractor unless otherwise stated in the contract documents.

3.2.3 Compliance With Compressive Strength Provisions

Compressive strength will be considered satisfactory if test results meet the following requirements and Section 18 of ASTM C94, unless otherwise specified by the Buyer. Where requirement differs from ASTM C94, the requirement stated herein would have precedence. A set of strength tests consists of minimum two (2) 28-day test cylinders, 6” diameter by 12” tall, or 4” diameter by 8” tall, unless otherwise required by the Buyer:

a. (This requirement has been added by the Buyer and is not included within ASTM C94). 7-day average compressive strength of one cylinder equals or exceeds 70-percent of the specified compressive strength f’c. When more than one cylinder is available for testing, the average of the tested cylinders equals or exceeds 70-percent of the specified compressive strength and the compressive strength of a

single cylinder test is not less than 65-percent of the specified compressive strength.

b. 28-day average compressive strength of any three consecutive sets of strength tests equals or exceeds specified compressive strength f'c.

c. (This requirement has been added by the Buyer and deviates from ASTM C94). When three consecutive strength tests (minimum two cylinders per test) is not available for testing, the average compressive strength of any consecutive cylinder sets tested (one or two sets) equals or exceeds the specified compressive strength.

d. For specified compressive strength of 5,000 psi or less, no individual set of strength test (average of minimum two cylinder tests) falls more than 500 psi below specified compressive strength f'c when at least three sets of strength tests are made. When less than three sets of strength tests are made, no individual cylinder strength falls below specified compressive strength f'c.

e. For specified compressive strength greater than 5,000 psi, no set of strength test (average of minimum two cylinder tests) shall be less than 0.90 f'c. When less than three sets of strength tests are made, no individual cylinder strength falls below specified compressive strength f'c.

3.2.4 Failure to Meet Compliance Requirements

a. Failure to meet requirements of subsection 3.2.3a indicates that potentially low-strength concrete has been delivered. Concrete Supplier and Contractor will be notified of potential problem for remedial action.

b. Failure to meet requirements of subsections 3.2.3b or 3.2.3c or 3.2.3d or 3.2.3e shall be basis for investigation of low-strength concrete per subsection 3.2.5.

3.2.5 Investigation of Low-Strength Concrete

a. A set of three cores representing each strength test shall be taken.

b. Cores shall be taken within 72 hours of testing for 28-day compressive strength, or as specified by the Buyer, in accordance with ASTM C42 and tested in accordance with ASTM C39.

c. Concrete Supplier and/or Contractor shall be responsible for costs associated with investigation of low-strength concrete. However,

Concrete Supplier's and Contractor's cost will be reimbursed if requirements of subsection 3.2.6 have been satisfied.

3.2.6 Acceptance of Low-Strength Concrete

Concrete in an area represented by core tests will be considered acceptable if the average of three cores is minimum 85 percent of specified compressive strength f'c and no single core is less than 75 percent of specified compressive strength f'c.
When low-strength concrete is accepted by the Buyer on the basis of test results of less than 100% of the required minimum compressive strength, an adjustment in the concrete unit price may be made for the quantity of concrete represented by such strength tests in accordance with Table 725-2 of MAG Section 725.

Table 725-2 of MAG Section 725			
Class AA and Class A		Class B and Class C	
Percent of Specified Minimum 28-day Compressive Strength Attained (Nearest 1%)	Percent of Concrete Unit Price Allowed	Percent of Specified Minimum 28-day Compressive Strength Attained (Nearest 1%)	Percent of Concrete Unit Price Allowed
100% or greater	100	100% or greater	100
98-99	90	95-99	95
96-97	85	90-94	90
95	80	85-89	85

3.2.7 Rejection of Low-Strength Concrete

Concrete failing to meet acceptance requirements of subsection 3.2.6 will be rejected. Concrete Supplier and/or Contractor shall be responsible for direct and indirect costs of removal and replacement of rejected concrete.

SRP SAP NUMBER	SRP STOCK CODE NUMBER	Description	Specified Min. Compressive Strength @ 28-Days f'c (psi)	Coarse Aggregate Max. Size, ASTM C33 Table 2 (in)	Slump Range (in)	Air Content (+/- 1.5%) (%)	Min. Cementitious Material (#/CY)	Max. Water/ Cementitious Material Ratio (by Wt.)	Remarks
5075320	00-00220	MAG C - 1"	2,000	1" (#57)	3 to 5	1.5	420	N/A	Can use as Canal Bottom
5079391	00-00222	ASTM C-476 Grout for Masonry (Coarse) - 3/8" w/Fly Ash		3/8" (#8)	8 to 11	1.5	PMD	0.55	Mix Per ASTM C476. 1-Part C+P, 0-0.10 Part Lime, Fine Agg 1.25-3 Times C+P, Coarse Agg 1-2 Times C+P (By Volume)
5075323	00-00230	MAG A - 1" or SRP Normal 3000 Mix	3,000	1" (#57)	3 to 5	1.5	520	0.58	Can Use as Canal Bottom
5079409	00-00231	MAG A - 1" Flowable			5 to 8				Use Superplasticizer, Can Use as Canal Bottom
	00-00232	MAG A - 1/2" w/Air or SRP Slipform		1/2" (#7)	2 to 4	5.5			
5075324	00-00233	MAG A - 1/2" or SRP Cable Trench			3 to 5	1.5			
5079319	00-00234	SRP 3000 Shotcrete - 3/8" w/5# Fiber		3/8" (#8)	2 to 4	5.5	PMD	0.50	75 to 85% Coarse Aggregate Passing 3/8" Sieve
5079345	00-00235	MAG A - 3/8" w/Air or SRP Ditchmix			3 to 5	6.0	520	0.58	
	00-00236	SRP 3000 Shotcrete - 3/8" No Fiber			2 to 4	5.5	PMD	0.50	75 to 85% Coarse Aggregate Passing 3/8" Sieve
	00-00237	MAG A - 1/2" Flowable		1/2" (#7)	5 to 8	1.5	520	0.58	Use Superplasticizer
	00-00238	MAG A - 1/2" Pumpable			3 to 5				Max 40% Coarse Agg
	00-00239	MAG A - 1/2" Flowable & Pumpable			5 to 8				Max 40% Coarse Agg. Use Superplasticizer, B3050
5079320	00-00240	MAG AA - 1" or SRP Normal 4000 Mix	4,000	1" (#57)	3 to 5	1.5	600	0.50	
5079326	00-00241	MAG AA - 1" w/Air				5.0			
5079336	00-00242	MAG AA - 1" Flowable			5 to 8	1.5			Use Superplasticizer
5079321	00-00243	MAG AA - 1" Flowable w/Air				5.0			
5079368	00-00244	SRP 4000 1/2" Precast - No Fly Ash		1/2" (#7)	3 to 5	1.5			
	00-00245	SRP 4000 Pumpable - 1/2"			3 to 6				Max 40% Coarse Agg
5079341	00-00250	SRP 5000 - 1" Normal	5,000	1" (#57)	3 to 5	1.5	660	0.45	
5079369	00-00251	SRP 5000 - 1" w/Air				5.0			
5079362	00-00252	SRP 5000 - 1" Flowable			5 to 8	1.5			Use Superplasticizer
5079348	00-00253	SRP 5000 - 1" Flowable w/Air				5.0			
5079349	00-00254	SRP 5000 - 1" No Fly Ash			3 to 5	1.5			
5079350	00-00255	SRP 5000 - 1/2"		1/2" (#7)					
5079351	00-00256	SRP 5000 - 1/2" No Fly Ash							
	00-00257	SRP 3000@24-Hrs 5000@28-Days - 1"		1" (#57)			PMD	0.40	

Notes:

1) Fiber Admixture may be added to any mix. Either Buyer dictates type and amount of fiber per ASTM C1116 Order Information Option A; or Buyer provides minimum flexural strength and Concrete Supplier determines mix proportions including fiber type and dosage. Fiber may consist of Macro, Micro, or Macro/Micro blend meeting requirements of ASTM C1116 "Fiber-Reinforced Concrete."
2) Hydration stabilizer admixtures (HSA, retarders) can be added to any mix. Buyer to either dictate dosage rate of HSA, or Buyer to dictate required extension in initial set of product (extending workability of product) and Concrete Supplier to determine admixture type and dosage.
3) Permeability reducing admixtures for concrete subject to hydrostatic conditions (PRAH) may be added to any mix. Buyer to either dictate PRAH type and dosage rate, or Buyer to dictate required specification and Concrete Supplier to determine type and dosage.

PMD - Per Mix Design

SALT RIVER PROJECT

WATER GROUP
STANDARD SPECIFICATION
FOR FIBER REINFORCED SHOTCRETE
FOR CANAL BANK LINING
(SRP 03364)

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SALT RIVER PROJECT

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STANDARD SPECIFICATION
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FOR CANAL BANK LINING
(SRP 03364)

1.0 GENERAL

1.1 Work Specified

This specification covers the furnishing of all plant, labor, materials, tools and equipment necessary for mixing, delivering and placement of fiber reinforced shotcrete for canal bank lining.

1.2 Work Performed by Purchaser

1.2.1 Prior to canal bank lining work by the Contractor, the Purchaser will install concrete canal bottom lining and shape the canal banks. Generally, the Contractor will be able to begin work within two weeks after the beginning of canal dry-up. The Purchaser will make every effort not to impede the Contractor's work, and the Contractor shall in turn accommodate the Purchaser's work when required.

1.2.2 The Purchaser will spray the bank with water to maintain optimum soil moisture content during bank preparation and for a period ending 24 hours after Purchaser's notice to Contractor to shotcrete a specified section of canal bank. The Contractor shall be responsible to maintain optimum soil moisture content thereafter until completion of shotcreting the specified section of canal bank.

1.3 Standard Units

When both English and SI (metric) units are stated, the English units are the standard. The SI units are approximations listed for information only.

1.4 Reference Standards

1.4.1 Reference to standards or specifications shall be interpreted to mean the latest revision unless noted otherwise.

1.4.2 The following abbreviations appear in this Specification:

ACI	American Concrete Institute
ARPA	Arizona Rock Products Association
ASTM	American Society for Testing and Materials
NRMCA	National Ready-Mixed Concrete Association
SRP	Salt River Project (Purchaser)

1.4.3 The following standards shall be made a part of this Specification:

ACI 305R	Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 318/318M	Building Code Requirements for Reinforced Concrete
ACI 506R	Guide to Shotcrete
ACI 506.2	Specification for Materials, Proportioning, and Application of Shotcrete
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C138	Standard Test Method for Unit Weight, Yield, and Air Contents (Gravimetric) of Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Standard Specification for Portland Cement

ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C233	Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C1064	Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
ASTM C1116	Standard Specification for Fiber-Reinforced Concrete and Shotcrete
ASTM D512	Standard Test Methods for Chloride Ion in Water
ASTM D516	Standard Test Method for Sulfate Ion in Water
SRP 03300	SRP Standard Specification for Concrete

1.4.4 Exceptions to this specification must be approved in writing by the Engineer prior to beginning the affected work.

1.5 Submittals

1.5.1 Contractor/concrete supplier shall submit the following items for each mix to be supplied:

a. Plant certification

b. Mix design

c. Mix design performance/trial batch data

d. Source and gradation of fine and coarse aggregate

e. Cement certification and mill test report

f. Fly ash certification

g. Fly ash replacement ratio

h. Admixture brand and certification

i. Source of water and certification

1.5.2 Mix designs shall be submitted to the Engineer for approval a minimum of one week prior to the beginning of work.

1.5.3 In lieu of the submittals required per Sections 1.5.1 and 1.5.2, Contractor/concrete supplier may use pre-approved mix design for shotcrete, SRP Stock Code No. 0000234 per Specification SRP 03300, with fiber added.

1.6 Quality Assurance

1.6.1 Each batch plant from which concrete supplier intends to provide concrete must have current NRMCA, ARPA or equivalent laboratory certification.

1.6.2 Concrete supplier shall provide documentation that an Arizona-registered professional engineer has reviewed mix designs and other submittals prior to submitting to the Purchaser for approval.

1.6.3 Concrete supplier shall provide access to batch plant for sampling/inspection of materials and equipment.

1.7 Storage and Handling

1.7.1 Materials shall be stored and handled in a manner that prevents deterioration, segregation, or intrusion of foreign matter.

1.7.2 Storage of aggregate on natural ground surface will be permitted if bottom six inches of pile is not used in batching.

1.8 Emergency Releases

1.8.1 SRP will provide a minimum of 2 hours advance warning of emergency water releases into the canal. The Contractor shall store materials and equipment in a safe location, and SRP will not be responsible for loss of materials or equipment resulting from emergency releases. The loss of completed construction or immovable materials will be paid by the Purchaser at the unit cost bid.

1.8.2 The Contractor will not be paid for any portion of the work not completed before the scheduled end of canal dry-up and which work is damaged by water releases into the canal.

1.9 Access

Suitable roadways for construction traffic exist along both sides of the canal in most locations. The Bidder should review all sites to determine actual conditions. Access to the canal roadways exists at major road crossings of the canal.

1.10 Protection of Existing Structures

The Contractor shall take the necessary precautions to protect existing bridges and canal structures. Damage to any existing structures shall be repaired to the satisfaction of the Engineer at the expense of the Contractor.

2.0 PRODUCT

2.1 Cement

Cement shall be Portland cement, Type II, low alkali, moderate heat of hydration, conforming to ASTM C150. Equivalent alkali content shall not exceed 0.6 percent, per Table 2, ASTM C150.

2.2 Aggregate

Coarse and fine aggregate shall conform to ASTM C33.

2.3 Water

Water for washing aggregate and for mixing concrete shall be potable or shall meet requirements of ASTM C94. If potable water is not used, concrete supplier shall have independent testing laboratory perform chemical analysis of water certifying suitability in accordance with ASTM D512 and ASTM D516.

2.4 Admixtures

2.4.1 Admixtures for the mix design shall not be substituted without prior written approval of the Engineer.

2.4.2 Air-Entraining Admixtures

a. Air-entraining admixtures shall conform to ASTM C260.

b. Air-entraining admistures shall be tested in accordance with ASTM C233.

c. Air content, unless specified otherwise, shall conform to ACI 318, Table 4.2.1, moderate exposure. Tolerance for air content as delivered shall be $\pm$ 1.5 percent.

2.4.3 Water-Reducing, Retarding, and Accelerating Admixtures

a. Water-reducng, retarding, and accelerating admixtures shall conform to ASTM C494.

b. Chloride admixtures shall not be used.

2.4.4 Superplasticizers

Superplasticizers shall conform to ASTM C494, Type F or G.

2.5 Fly Ash

2.5.1 Fly ash shall be used in all mix designs.

2.5.2 Fly ash shall conform to ASTM C618, Class F.

2.5.3 Fly ash shall be compatible with cement and shall not react deleteriously with alkalis in cement. Concrete supplier shall have fly ash sampled and tested in accordance with ASTM C311.

2.5.4 Maximum 25 percent of weight of cement required for mix design may be replaced with fly ash. Concrete supplier shall be responsible to determine

replacement ratio for each pound of replaced cement to maintain specified compressive strength f'c.

2.6 Fiber Reinforcement

2.6.1 Fiber reinforcement shall be Euclid Chemical Company TUF-STRAND SF Synthetic Macro-Fiber, polypropylene/polyethylene copolymer, 2 inch long; or SRP approved equivalent. Fibers shall comply with the material specifications and performance requirements of ASTM C1116.

2.6.2 Total amount of fibers in the mix shall be 5 pounds per cubic yard of concrete.

2.6.3 Fiber will be the only reinforcing used in the shotcrete for canal bank lining.

2.7 Proportioning of Mix

2.7.1 Source, character or gradation of materials shall not be changed without prior written approval of the Engineer.

2.7.2 Mix shall be homogeneous, readily placeable and uniformly workable. Proportioning of ingredients shall produce consistency, durability, workability, specified compressive strength f'c, and other properties as required per reference standards in Section 1.4.

2.7.3 Mix shall develop compressive strength f'c of 3000 psi at 28 days. Mix shall have a maximum water/cementicious material ratio of 0.47 by weight.

2.8 Measurement of Materials

Material shall be measured in accordance with ASTM C94.

2.9 Mixing

2.9.1 Mixing shall follow the procedures in accordance with ASTM C94.

2.9.2 All ingredients shall be added to the mix at the batch plant. Fibers shall be added to the mix per manufacturer's recommendations and at a rate that avoids clumping of fibers in the mix. Minimum mixing time after introduction of fibers shall be five minutes at high rpm.

2.9.3 Design slump at the discharge end of the nozzle shall be 3" (± 1").

2.10 Delivery

2.10.1 Ready-mix concrete shall be produced and delivered in accordance with ASTM C94. Concrete that is outside the temperature range of 55° F to 90° F, or has attained its initial set upon arrival at jobsite, as determined by the Engineer, will be rejected at concrete supplier's cost. Engineer may waive these limitations if slump is such that concrete can be placed without addition of water.

Concrete shall be discharged within 1-1/2 hours after initial mixing water has been added to cement and aggregate.

2.10.2 Concrete supplier shall be responsible to make corrections to bring mix to specified slump. Only one addition of water to bring mix to specified slump shall be allowed. Mix not meeting slump requirements will be rejected.

2.10.3 Batch out time of truck shall be machine-stamped on delivery ticket at concrete supplier's plant. A copy of delivery ticket having machine-stamped batch out time shall be given to the Engineer at time of delivery. Concrete deliveries without machine-stamped batch out time on delivery ticket will be rejected.

2.10.4 Concrete shall be delivered within 30 minutes of requested delivery time. Time lapse between successive deliveries shall not vary by more than 20 minutes from that requested. The Engineer may reject any batch not meeting these requirements.

2.11 Hot Weather Concreting

2.11.1 Hot weather concreting shall be in accordance with ACI 305R. The concrete temperature during discharge shall not exceed 90° F.

2.11.2 During conditions of high temperature, low relative humidity or wind which might impair quality of concrete, setting time shall be delayed by using proper admixtures.

2.12 Cold Weather Concreting

Cold weather concreting shall be in accordance with ACI 306.1. Concrete temperature during discharge shall not be less than 55° F.

2.13 Curing Compound

The curing compound shall be a white pigmented compound in accordance with the requirements of ASTM C309 for a Type 2, Class A compound.

3.0 EXECUTION

3.1 Testing, Strength Compliance, and Acceptance of Concrete

3.1.1 Testing

a. Frequency for sampling concrete for strength compliance will be in accordance with ACI 318 or as specified by the Engineer.

b. Concrete samples shall be taken directly from transit mix truck, unless specified otherwise. Sampling and testing will be in accordance with the following standards:

ASTM C138	Unit Weight & Yield
ASTM C143	Slump (sample from nozzle)
ASTM C172	Sampling
ASTM C231	Air
ASTM C1064	Temperature

c. Concrete strength specimens shall be made in accordance with ASTM C31. Test specimens shall be 4 inch diameter by 8 inch long cylinders.

Test cylinders shall be tested in accordance with ASTM C39.

e. The Engineer will install forms for producing 24-inch square test panels. The test panels shall be filled during the shotcrete placement and removed immediately thereafter by the Contractor. The panel voids shall be refilled immediately following removal of the forms.

3.1.2 Testing specified in Section 3.1.1 will be performed by the Engineer at no cost to Contractor.

3.1.3 Compliance with Compressive Strength Provisions

Compressive strength will be considered satisfactory if test results meet following requirements:

a. 7-day average compressive strength, per strength test (average of two cylinders) equals or exceeds 70 percent specified compressive strength f'c.

b. 28-day average compressive strength of all sets of three consecutive strength tests equals or exceeds specified compressive strength f'c.

c. No individual strength test (average of two cylinders) falls more than 500 psi below specified compressive strength f'c when at least three strength tests are made.

d. When less than three strength tests are made, no individual cylinder strength falls below specified compressive strength f'c.

3.1.4 Failure to Meet Compliance Requirements

a. Failure to meet requirements of Section 3.1.3a indicates that potentially low-strength concrete has been delivered. Contractor will be notified of potential problem for remedial action.

b. Failure to meet requirements of Section 3.1.3b or Section 3.1.3c shall be the basis for investigation of low-strength concrete per Subsection 3.1.5.

c. Failure to meet requirements of Section 3.1.3d will be the basis for investigation of low-strength concrete per Section 3.1.5.

3.1.5 Investigation of Low-Strength Concrete

a. A set of three cores or sawcut prisms representing each strength test shall be taken.

b. Cores or prisms shall be taken within 72 hours of testing for 28-day compressive strength or as specified by the Engineer, in accordance with ASTM C42 and tested in accordance with ASTM C39.

c. Contractor shall be responsible for costs associated with investigation of low-strength concrete. However, Contractor's cost will be reimbursed if requirements of Section 3.1.6 have been satisfied.

3.1.6 Acceptance of Low-Strength Concrete

Concrete in an area represented by core or prism tests will be considered acceptable if the average of three tests is minimum 85 percent specified compressive strength f'c and no single test is less than 75 percent specified compressive strength f'c.

3.1.7 Rejection of Low-Strength Concrete

Concrete failing to meet acceptance requirements of Section 3.1.6 will be rejected. Contractor shall be responsible for direct and indirect costs of removal and replacement of rejected concrete.

3.2 Placement

3.2.1 Placement of canal bank shotcrete shall be in accordance with ACI 506R and ACI 506.2.

3.2.2 The canal bank shotcrete lining shall be placed after completion of the canal bottom concrete placement.

3.2.3 The shotcrete shall not be placed until the Engineer has approved the canal bank preparation.

3.2.4 All absorptive surfaces against which the shotcrete is to be placed shall be uniformly moistened and maintained within 2% of the optimum moisture content at all times prior to placement of the bank lining. Caution shall be taken to prevent erosion or over-saturation of the subgrade surface during the moistening process. The water shall be applied through the use of a nozzle or spray bar to provide an even spray distribution and to prevent erosion of the subgrade surface. The equipment necessary to obtain the required moisture content shall be approved by the Engineer and kept available on the jobsite throughout the construction. Failure to comply with these requirements shall result in a temporary shutdown of the shotcrete placement until the requirements are met to the satisfaction of the Engineer.

3.2.5 At the time of application, there shall be no free water on the surface upon which the shotcrete is to be placed.

3.2.6 The bank subgrade, top cut-off key, and the edge of the canal bottom concrete shall be free of any loose or spoil material prior to installation of the shotcrete.

3.2.7 Any disturbance to the prepared bank subgrade surface shall be repaired to the satisfaction of the Engineer prior to placing the shotcrete.

3.2.8 The Contractor shall notify the Engineer of the shotcrete placement schedule prior to any shotcrete operations.

3.2.9 The canal bottom concrete at the edge of the bank shall be thoroughly cleaned of all foreign matter and shall be free of surface water. The area to be

cleaned shall be the entire surface where shotcrete will join the canal bottom lining.

3.2.10 The Contractor shall be responsible for providing all equipment necessary to place the shotcrete in accordance with this specification. Special equipment may be required where the vertical lining height is 7 feet or greater.

3.2.11 The shotcrete for the top of the lining section and the cut-off key shall be installed from the top of the canal bank.

3.2.12 The canal bank shotcrete lining shall be placed with a minimum thickness of 3 inches, unless otherwise shown on the drawings or directed in writing by the Engineer. Tolerance shall be +1/2", -0".

3.2.13 The grade at top of shotcrete canal bank lining shall be finished at design grade (± 0.1 foot).

3.2.14 Shotcrete application shall begin at the bottom of the canal bank and continue to the top. The nozzle shall be held at a distance of 4 to 6 feet from and directed perpendicular to the canal bank surface. The nozzle shall be rotated steadily in a series of small oval or circular patterns. Angle shooting will only be allowed when no other suitable alternative exists.

3.2.15 Rebound material left on the soil bank for more than 30 minutes shall be removed and discarded prior to continuing shotcrete application.

3.2.16 When work is to be suspended at the end of the day or otherwise for a period exceeding 30 minutes, the end of the shotcrete placement shall be sloped to a thin edge. Prior to resuming work, the surface of the shotcrete upon or against which fresh shotcrete is to be placed shall be prepared for continuation of shotcrete placement. The bonding area shall be thoroughly cleaned, moistened, roughened, and when deemed necessary by the Engineer, a suitable bonding agent shall be applied to ensure thorough bonding of the fresh shotcrete to the previously placed shotcrete.

3.2.17 Longitudinal cold joints in the concrete shall not be permitted, and the maximum length of each longitudinal placement shall be determined by the Engineer, but in no case shall exceed 50 feet in length. Shotcrete shall be placed in a staggered pattern.

3.2.18 Precautions shall be taken, as deemed necessary by the Engineer, to avoid or minimize accumulations of rebound. Any excess rebound shall be removed at the time of placement to prevent excessive buildup on the canal bottom.

3.3 Finishing

3.3.1 The finished surface shall be smooth, uniform and even and shall be finished with a wet, fine-bristled broom immediately following the application of the shotcrete. The broom finish shall be applied by directing the broom in the upward direction only, over the surface of the shotcrete lining.

3.3.2 The finished surface shall be free of any rock pockets or surface voids. Fresh overspray onto freshly finished shotcrete shall be refinished as specified above.

3.3.3 Water containers for immersing the finishing broom shall be provided to facilitate obtaining the specified finish.

3.3.4 Extension handles for the finishing tools may be required as deemed necessary by the Engineer, depending on the vertical height of the shotcrete lining.

3.4 Joints

3.4.1 Tooled vertical control joints shall be installed immediately following broom finishing.

3.4.2 Control joints shall extend full height of the sloped shotcrete lining, including the cut-off key at the top of the lining.

3.4.3 Tooled control joints shall be 3/4-inch deep.

3.4.4 Maximum spacing between control joints shall be 10 feet unless otherwise shown on the drawings or directed by the Engineer..

3.5 Curing

3.5.1 As the shotcrete placement progresses, the shotcrete lining placed shall be cured by membrane curing. Membrane curing shall consist of the application of a white-pigmented curing compound as specified in Section 2.13.

3.5.2 The curing compound shall be applied immediately after all free water has left the shotcrete surface.

3.5.3 The curing compound shall be sprayed in a single application to provide a continuous, uniform, white membrane over the entire shotcrete surface and extending a minimum of one foot onto the canal bottom concrete.

3.5.4 The application rate shall be at the minimum rate of one gallon per 100 square feet, and may be increased as directed by the Engineer to obtain the required continuous membrane.

3.5.5 The curing compound shall be thoroughly mixed to a uniform consistency by stirring or agitation with an automatic mixer prior to and throughout the application process, as approved by the Engineer.

3.5.6 The canal safety steps drawings shall not be sprayed with curing compound in areas noted on the drawings to be painted by the Purchaser. Contractor shall cover such areas with plastic sheet for curing.

3.5.7 The concrete shall be protected from exposure to carbon monoxide or carbon dioxide fumes from heaters or engines.

3.6 Equipment

3.6.1 All equipment and the method of operation of the equipment shall be in accordance with accepted practice for this type of work, and shall be subject to the approval of the Engineer.

3.6.2 The shotcrete equipment shall include a boom capable of extending out over the canal bank, sufficient in strength to support the weight of the discharge and air hoses, and long enough to prevent the hoses from dragging on the canal bank.

3.6.3 Aluminum pipe shall not be used for pumping.

3.6.4 The production capacity of all equipment shall be adequate for proper performance of the work and to meet the Purchaser's schedule.

3.6.5 Placement may be temporarily halted, at the discretion of the Engineer, due to any equipment failure or slowdown.

3.6.6 Air pressure fed to the nozzle shall be maintained at a uniform pressure of not less than 80 pounds per square inch.

3.6.7 A 300 gallon minimum capacity water tank for each shotcrete rig plus an additional backup tank of the same capacity shall be on the job site during the shotcrete lining placement, unless otherwise approved by the Engineer.

3.6.8 The backup tank shall be available to prevent temporary shutdowns caused while refilling the water tanks. The tanks shall be equipped with a pump and nozzle or spray bar capable of discharging water with adequate pressure to maintain the required bank subgrade moisture, as specified in Section 3.2.3, prior to installing the shotcrete lining.

3.6.9 For access into and out of the canal, provide one ladder on each bank at each area where work is being performed. Climbing on the prepared canal bank subgrade will not be permitted.

3.7 Direct and Indirect Costs

Direct and indirect costs incurred by Purchaser due to failure to meet requirements of this specification shall be paid by Contractor.

APPENDIX 2

SRP Heavy Equipment Loadings

Mobile Substation # 3: 4' axle spacing, 10' wide and 4 tires per axle, each axle each 28,875 pounds.

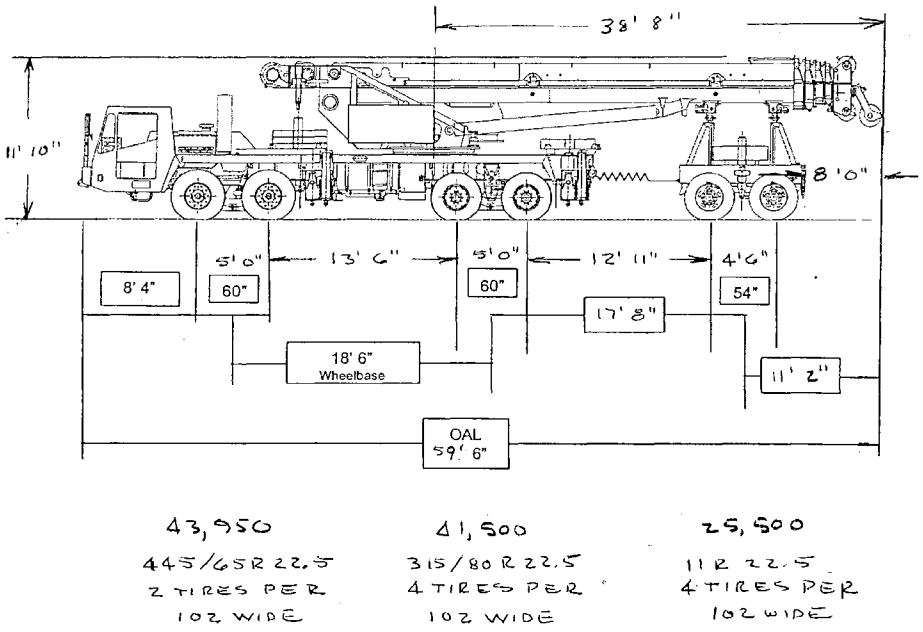
Cat 318 Excavator: 28' axle spacing, 8' 6" wide and 4 tires per axle, each 28,000 pounds.

Cat Grader: 5' axle spacing, 10' 6" wide and 2 tires per axle, each 29,531 pounds.

Link Belt 70-ton Crane: 4' 2" axle spacing 8' 6" wide and 2 tires per axle, each 23,188 pounds.

Grove 90-ton Crane: Per drawing below.

Weights and Dimensions (Trailing Boom)



APPENDIX 3

Canal Dry-up Plan