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Construction Specification Manual

Salt River Project

Technical Specification Index – April 2022

Division 31

Division	Title	Updated
DIVISION 31:	SITE WORK	
312000	Earth Moving	Revised 04/22
312200	Grading	New 04/22
312300	Excavation and Fill	New 04/22
312300X	Blasting and Vibration Requirements	New 04/22
316239	Drilled Concrete Piers	New 04/22

SECTION 31 20 00

EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, and landscaping.
2. Drainage course for concrete slabs-on-grade.
3. Excavating and backfilling for utility trenches.
4. Excavating and backfilling for buildings and structures.
5. Subbase course for concrete walks and pavements.
6. Subbase and base courses for asphalt paving.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subgrade and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

- G. Rock: Material, including boulders and granite, that cannot be removed by conventional earth moving or ripping equipment and require removal by techniques such as drilling and blasting/splitting or jackhammering. Material is not rock when it is disintegrated, weathered, loose, or fractured to such an extent that it works and handles like soil.
- H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Slurry: Can mean ABC, lime, or cementitious types. See CLSM for engineering term.
- J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below base course or topsoil materials.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 REFERENCES

- A. Uniform Standard Specifications for Public Works Construction from the Maricopa Association of Governments (MAG Specs)

1.4 PREINSTALLATION MEETINGS

- A. Pre-excavation Conference: Conduct a conference at Project site including working foremen of all participating subcontractors and SRP PM.

1.5 FIELD CONDITIONS

- A. Utility Locator Service: Notify "Blue Stake" utility locator service at 602-236-1100 before beginning earth-moving operations.
- B. Maintain underground and overhead utilities in continuous service unless prior approval has been obtained from the Engineer. Locate, safeguard, and maintain conflicting utilities shown on drawings and identified in field. Utility lines identified prior to excavation work, which are damaged by Contractor, shall be repaired at Contractor's expense. Contractor shall identify conflicts by potholing for true depths and is responsible for relocation work needed to resolve conflicts.
- C. Do not commence earth moving operations until plant-protection measures specified in Division 01 are in place.
- D. Provide necessary support systems to meet all federal and state OSHA requirements for maintaining the stability of structures adjacent to excavations and excavation activities, and take necessary precautions to protect buildings, foundations and structures against damage. Contractor shall be liable for all damage.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: As specified in MAG Section 210.
- C. Unsatisfactory Soils: Unsuitable materials include silt and clay soils with moisture content so significantly over optimum they cannot be compacted to the required maximum density. Sod, matted or decayed vegetation, expansive soil, and other deleterious material are also considered unsuitable backfill material and shall be removed from the jobsite.
- D. Base Course: Aggregate Base Course as specified by MAG Section 702.
- E. Engineered Fill: Fill as specified by the engineer on the drawings or within the specifications.
- F. Bedding Course: Bedding shall be native or process material as required by the specifying utility.

2.2 ACCESSORIES

- A. Detectable Underground Location Device: In accordance with ARS 40-360.22, all new and active underground facilities shall be installed with a detectable underground location device unless the facility is capable of being detected from above ground with an electronic locating device. Install acid and alkali resistant, warning tape manufactured for marking and identifying underground utilities. Install a minimum of 6 inches wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; or equivalent products that provide the same detection capability.

2.3 CONTROLLED LOW-STRENGTH MATERIAL (CLSM)

- A. Acceptable CLSM mixtures as specified in MAG Section 728, latest revision.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

- B. Protect and maintain erosion and sedimentation controls during earth moving operations.
- C. Do not pass equipment over any pipe, drain, utility line, duct, or structure before they are adequately protected. Any damage to existing facilities and the costs associated with loss of utility use shall be at the Contractor's expense.
- D. Use excavation shoring, bracing, sheeting, barricading, and plating necessary to perform work and protect excavation and personnel as required for safety and conformance to governing law, including OSHA Construction Standards, Subpart P, and Salt River Project Excavation Safety Resource Manual. Cost of protection systems shall be included in Contractor bid price.

3.2 GENERAL EXCAVATION

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
 - 1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Cut and protect roots.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under sidewalks, walkways, curbs/gutters, and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, tolerances, and elevations with allowances for minimum required bedding width, accommodation of compaction equipment and erection of forms.
- B. Maximum continuous length and time of open trench shall not exceed the requirements of the governing municipality. A trench shall be considered open until backfilled to the top of subgrade on unsurfaced areas and the top of base course on pavements.
- C. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: As indicated in Table 601-1 (from MAG Spec 601) below.

Table 601-1		
Trench Widths		
Size of Pipe (I.D.)	Maximum Width at Top of Pipe Greater Than O.D. of Barrel	Minimum Width at Springline Each Side of Pipe (1)
Less than 18 inches	16 inches	6 inches
18 inches to 24 inches inclusive	19 inches	7 1/2 inches
27 inches to 39 inches inclusive	22 inches	9 inches
42 inches to 60 inches inclusive	1/2 O.D.	12 inches
Over 60 inches	36 inches	12 inches

- D. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.
 - 2. Remove excessive tooth marks or compact level.
- E. Where soil incapable of supporting the utility is encountered, Contractor shall notify the Engineer and a determination will be made as to the depth of over-excavation and the type of engineered fill required.
- F. Berm or otherwise protect trenches from surface drainage or runoff.

3.6 SUBGRADE INSPECTION

- A. Any soft and unstable material shall be removed. The resulting areas and all sections, holes or depressions shall be brought to the required grade and cross-section.
- B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer without additional compensation.
- C. Clean excavation of trash and debris after completion of foundations, removal of forms, and other construction activities.

3.7 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. If approved by the Engineer, backfill unauthorized excavations using 1-½ sack cement CLSM.
 - 1. Fill unauthorized excavations under other construction, pipe, or conduit using aggregate base course compacted to 95% density using ASTM D-6938 or ½ sack CSLM.

3.8 STORAGE OF SOIL MATERIALS

- A. Stockpile borrowed soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations in accordance with OSHA regulations.

3.9 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings to within 18 inches of bottom of footings with satisfactory soil or 1 ½ sack CLSM; fill final 18 inches with concrete to elevation of bottom of footings.
- D. Trenches under Roadways: Unless otherwise specified by the controlling agency, place ½-sack CLSM as backfill in accordance with MAG Section 604.

- E. Backfill material shall be uniformly within 2% of optimum moisture content prior to placement in the trench. Place backfill in level lifts simultaneously on both sides of the conduit, pipe, or structure unless otherwise specified. Backfill operations shall not cause disturbance of the in-place utility.
- F. Backfill from bedding to a point approximately 6 inches above the top of the utility shall be placed in accordance with the specific utility requirements.
- G. Place and compact approved backfill in uniform, level 8-inch thick maximum loose lifts to final subgrade elevation.
- H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.
- I. In projects outside of municipal rights-of-way and approved by the controlling utility, ½-sack cement CLSM per MAG Section 728 may be substituted for bedding and backfill for the convenience of the contractor at no additional cost to Owner.

3.10 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use on-site soils or fill approved by the Engineer.
- C. All other conditions: Use soils as specified in MAG Section 210.

3.11 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 percent of optimum moisture content. Free water shall not appear on the surface during or after compaction. Fill at moisture contents greater than this value shall either be removed and replaced or scarified and air-dried to bring into conformance.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in level lifts not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Fill shall be placed so that, when compacted in a homogenous mass, it is formed free from lenses, pockets, streaks, or layers that differ substantially in texture and gradation from surrounding material. In no instance shall minimum compacted depth of a layer be less than maximum size of aggregate, plus one inch.

- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Place backfill uniformly against structures to prevent eccentric or excessive loading of structures.
- C. Compact soil materials to at least the following percentages of maximum dry unit weight, at or within 3 percent of optimum moisture in accordance with ASTM D 698:
 - 1. Under structures, foundations, and building slabs, scarify the upper 6 inches of existing subgrade. Recompact subgrade and compact subsequent fill lifts to at least 100 percent of maximum dry density.
 - 2. Under steps, sidewalks, walkways, curb/gutter, roadway shoulders, and pavements scarify and recompact the upper 6 inches of existing subgrade. Recompact subgrade and compact subsequent fill lifts to at least 95% of maximum dry density.
 - 3. Unless specified by the controlling agency, utility trench bedding and backfill lifts shall be compacted to no less than the percentages of maximum dry density noted in Table 601-2 of MAG Section 601.

Table 601-2				
Minimum Trench Compaction Densities				
Backfill Type	Location	From Surface to 2 feet Below Surface	From 2 Feet Below Surface to 1 Foot Above Top of Pipe	From 1 Foot Above Top of Pipe to Bottom of Trench
I	Under any existing or proposed pavement curb, gutter, sidewalk, or such construction included in the contract, or when any part of the trench excavation is within 2-feet of the above.	100% for granular 95% for non-granular	90%	90%
II	On any utility easement street, road or alley right-of-way outside limits of jurisdiction.	85%	85%	90%
III	Around any structures or exposed utilities	95% in all cases		

- D. Do not cover lifts before compaction tests are performed. If lifts are covered prior to testing, excavate test pits for making density tests on lower portions of backfill at instruction of the Engineer. Refill and compact test pits in accordance with the specifications. Excavating, refilling, and compacting test pits shall be at Contractor's expense.

- E. Consolidation of backfill by flooding or jetting is permitted only with prior assessment by and written approval of the Engineer.
- F. Mechanical compaction shall not be used within 6 inches of gas lines, electrical cable or plastic conduit.
- G. If in the opinion of the Engineer, any portion of the surface of the backfill becomes so dry or glazed during construction that bond with the succeeding layer to be placed thereon cannot be obtained or should ruts and roadways develop on the backfill, such surface shall be scarified to a minimum depth of 6 inches, re-leveled, moisture conditioned, and re-compacted to the specified density just prior to placing of the succeeding layers at the Contractor's expense.
- H. All compaction equipment shall be of a type and size suitable to perform the required compaction and shall be subject to approval by the Engineer.

3.13 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. The compacted surface shall be graded to a straight grade between finished elevations shown in the plans or to the elevation of the existing ground at the edges of the area to be graded. Variations within the specified tolerance shall be compensating so that the average grade and cross-section specified are met.
- B. Site Rough Grading: Unless otherwise shown on the plans, slope grades to direct water away from buildings and to prevent ponding. Rough subgrades shall not vary to required elevations in accordance with the following tolerances in any 10 feet from the specified grade and cross-section:
 - 1. Turf or Unpaved Areas: ± 1 inch.
 - 2. Sidewalks, driveways, curb/gutter, walkways: ± 1 inch.
 - 3. Pavements: $\pm 3/4$ inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/4-inch when tested with a 10-foot straightedge. Under no circumstances shall overfill reduce minimum foundation thickness.

3.14 BASE COURSE UNDER SLABS, PAVEMENTS, SIDEWALKS AND CURB/GUTTER

- A. Place base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place base course under pavements sidewalks and curbs/gutters as follows:
 - 1. Shape base course to required grades, lines and cross sections shown on the Drawings.
 - 2. Place base course in loose lifts that do not exceed 12 inches in compacted thickness in layers of equal thickness, with no compacted layer less than 3 inches thick.

3. Compact base course within 2% of optimum moisture content to not less than 100 percent of maximum dry unit weight according to ASTM D 698.
4. Finished base course shall be no higher than the specified grade and cross section and no less than ¼-inch below specified grade and cross section. Variations within the above specified tolerance shall be compensating so that the average grade and cross-section specified are met.

3.15 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. Inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.
- D. When subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.
- E. When any structural excavation is complete, notify SRP for an inspection. No materials shall be placed in the excavation prior to an inspection.

3.16 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 22 00

GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparing natural or excavated areas prior to the placement of base or surfacing material.
2. Stripping and disposal of all unsuitable material, including existing pavement and obstructions such as stumps, roots, rocks, etc., from the area to be graded.
3. Compaction to a specified relative density.
4. Chemical treatment specified for the surface.

1.2 REFERENCES

A. The following standards shall be made part of this Specification:

1. ASTM D698 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. (2.48 kg) Rammer and 12-in. (305 mm) Drop (Standard Proctor)
2. ASTM D4318 Liquid Limit, Plastic Limit and Plastic Index of Soils

B. Permission for deviation from these standards or Specifications must be approved in writing by the Engineer prior to award of the Contract.

1.3 TOLERANCES

- A. Subgrade upon which subbase or base material is to be placed shall not vary more than 1/10-foot (30mm) in 10 feet (3m) from the specified grade and cross-section. Variations within the above specified tolerance shall be compensating so that the average grade and cross-section specified are met.
- B. Areas where grade only is called for on the plan shall not vary more than 1/10-foot (30mm) in 10 feet (3m) from the specified grade and cross-section. The surface shall be graded to a straight grade between finished elevations shown in the plans or to the elevation of the existing ground at the edges of the area to be graded.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All subgrade materials shall be stable, meet compaction requirements and be acceptable to the Engineer. Unstable material includes silt and clay soils with a moisture content so significantly over optimum that cannot be compacted to the required maximum density. Sod, matted or decayed vegetation, expansive soil and other deleterious material shall not be suitable subgrade material, and shall be removed from the jobsite.
- B. Suitable fill shall meet the following requirements. A deviation must be approved by the Engineer:
 - 1. Liquid Limit (LL), per ASTM D4318, less than 50 and Plastic Index (PI), per ASTM D4318, less than 15.
 - 2. Contains no rock greater than 4 inches (101.6mm) in diameter.
 - 3. Can be field compacted to at least the specified minimum densities.
 - 4. Shall be sufficiently free of organic material, mica, clay, loam and other deleterious substances

PART 3 - EXECUTION

3.1 STRIPPING

- A. Areas upon which fill is to be placed, and all areas to be surfaced, shall be stripped of sod, matted or decayed vegetable matter, and other deleterious material not suitable for use in subbase or fills to a minimum 6-inch (152mm) depth. Such material shall be hauled from the job immediately and disposed of to a suitable refuse site.
- B. Do not pass equipment over any pipe, drain, utility line, duct, or structure before they are adequately protected. Damage to existing facilities and the costs associated with loss of utility use shall be at the Contractor's expense.

3.2 GRADING & STOCKPILING

- A. Soft and unstable material shall be removed. The resulting areas and all sections, holes or depressions shall be brought to the required grade and cross-section. Suitable excavation material may be used in the fill areas. Material unsuitable for fill, or in excess of requirements, shall be immediately hauled off the job and disposed of, unless noted or specified otherwise.
- B. The existing surface in all areas over which compacted earth fill is to be placed (except cut areas that meet minimum density requirements without additional compactive effort) shall be scarified and loosened to a depth of 6 inches (152mm), then recompact. Unless otherwise noted in the Specifications or Drawings, subgrade cut and fill areas shall be constructed to achieve a uniform soil structure, meeting the specified percent of maximum density within 3 percent of optimum moisture content per ASTM D698.
- C. If required, excavated soils for use as fill shall be stockpiled at locations designated by the Owner. Acceptable fill materials shall be stockpiled separately and shall be placed to provide natural drainage and a stable embankment as directed. Stockpile shall be constructed with a maximum height not exceeding 10 feet (3.1m).

- D. Stockpiled backfill material shall be moisture conditioned as far as practicable by sprinkling, aerating, harrowing, discing, draining, or other approved means in order to obtain uniform moisture distribution such that the specified density may be obtained. Sprinkling shall be by sprinkler trucks equipped with pressure spray bars and valves to give a uniform and even application of water to the dry areas and a positive control of the rate of water application at all times. Free water shall not appear on surface during or after compaction operations.

3.3 BACKFILLING AND COMPACTING

- A. Fill materials to be placed as shown on Drawings shall be placed on prepared sub-grade. The placing method shall be such as to prevent segregation of the materials.
- B. Backfill material shall be satisfactorily placed and spread in the fill having moisture content uniformly distributed throughout the fill ranging within 3% of optimum. Material shall be compacted by rollers, power tampers, or vibratory compactors. Materials shall be placed so that, when compacted in a homogenous mass, it is formed free from lenses, pockets, streaks, or layers that differ substantially in texture and gradation from surrounding material. All roller trips shall be made in parallel paths and in a systematic manner. A rolling pass shall consist of one entire coverage of the area by a roller. In order to assure complete coverage of the area to be rolled, each trip of the roller shall overlap the adjacent trip by not less than 2 feet (0.6m). Where there is sufficient area, dumping, spreading, sprinkling, discing, harrowing, and compacting may be performed at the same time at different points of the backfill surface.
- C. All backfill materials shall be placed in successive uniform layers with uncompacted thickness not to exceed 12 inches (300mm). Actual uncompacted layer thickness shall be appropriate for type of compaction equipment to be used. All layers shall be placed in horizontal lifts, except on the interior side slopes where they shall be placed parallel to the slope. Material shall be compacted by rolling and or tamping as noted in this Specification, and on the Drawings.
- D. To place material in uncompacted lift depths greater than 12 inches (300mm), place a minimum 10 foot (3.1m) wide by 20 foot (6.2m) long test strip at start of compaction operation using proposed equipment and technique to demonstrate ability to achieve uniform specified compaction at the proposed uncompacted lift depth. Should compaction results not meet specification requirements, maximum uncompacted lift depth shall be reduced until uniform, specified compaction can be achieved. Do not exceed maximum uncompacted lift depth determined by this test. The Contractor shall not be permitted to charge to Owner additional costs due to reduced maximum uncompacted lift depth.
- E. In no instance shall minimum compacted depth of a layer be less than maximum allowable size of aggregate, plus one inch. When compacted depth requires uncompacted lift depths in excess of 12 inches (300mm), material shall be placed in layers of equal depth. Each layer shall be compacted as hereinafter specified.
- F. Sections of backfill containing material which is too wet or too dry to achieve required densities shall not be compacted until the moisture content meets the limits specified, or

the material shall be removed and replaced with material having a moisture within acceptable limits at the Contractor's expense.

- G. Should in the opinion of the Owner, a portion of the surface of the backfill become so dry or glazed during construction that bond with the succeeding layer to be placed thereon cannot be obtained or should ruts and roadways develop on the backfill, such surface shall be scarified to a minimum depth of 6 inches, re-leveled, moisture conditioned, and re-compacted to the specified density just prior to placing of the succeeding layers at the Contractor's expense.
- H. If unsuitable material is placed in any part of the backfill, all such material shall be removed and replaced with suitable materials at the Contractor's expense.
- I. Compaction equipment shall be of a type and size suitable to perform the required compaction and shall be approved by the Owner. The equipment shall be maintained in satisfactory operating condition at all times.
- J. Unless otherwise specified, dike or embankment backfill not accessible to roller compaction shall be compacted by power tampers or vibratory compactors to the specified compaction. Power tampers for use in restricted areas shall be a type and size suitable to perform the required compaction and shall be approved by Owner. The tampers shall be capable of delivering impulses of at least one ton per square foot.
- K. Inspection and compaction tests are required on backfills and subgrade except where cement-stabilized flowable backfills and/or retention basin rock fill are used. Do not cover lifts before compaction tests are performed. If lifts are covered prior to testing, excavate pits for making density tests on lower lifts as instructed by the Engineer. Test pits shall be backfilled and compacted in accordance with the Specifications and at the Contractor's expense.

3.4 SOIL STERILIZATION

- A. Soil sterilization shall be used only on subgrades when noted in the Specifications or Drawings.
- B. The soil sterilant and rate of application must be approved in writing by the Engineer prior to application.
- C. Prevent contamination of adjacent areas with sterilant, and for the protection of personnel.
- D. Certification shall be furnished to the Engineer, showing the purchase receipt and rate of application of the sterilant.

3.5 TERMITE CONTROL

- A. Termite control will be used only on subgrade surface when noted in the Specifications or Drawings.

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- B. Termite control shall be done by a licensed and bonded exterminating company, using only those chemicals approved by state and federal agencies.

END OF SECTION

GRADING
31 22 00 - 5

Last Updated:

April 2022

SECTION 31 23 00
EXCAVATION AND FILL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes structure excavation, backfilling and related items.

1.2 REFERENCES

- A. The following standards shall be made part of this Specification:
 - 1. ASTM D698 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. (2.48 kg) Rammer and 12-in. (305 mm) Drop (Standard Proctor)
- B. Permission for deviation from these standards or Specifications shall be approved in writing by the Engineer prior to award of the Contract.

1.3 DEFINITION OF ROCK

- A. Rock shall be defined as materials, including boulders and granite, that cannot be removed by conventional earth moving or ripping equipment and require removal by techniques such as drilling and blasting/splitting or jackhammering.
- B. Material shall not be considered rock when it is disintegrated, weathered, loose or fractured to such an extent that it works and handles like soil.
- C. Rock encountered during construction shall be determined and agreed on by Contractor and the Engineer. Contractor shall note location of rock encountered during excavation on installation record drawings.
- D. **Bluestake and Clearances:** Maintain underground and overhead utilities in continuous service unless prior approval has been obtained from the Engineer. Locate, safeguard, and maintain conflicting utilities shown on Drawings and identified in field. Comply with state and local Blue Stake requirements for locating all utilities, including private lines. Utility lines identified prior to excavation work which are damaged shall be repaired at Contractor's expense. Identify conflicts by potholing for true depths and is responsible for relocation work needed to resolve conflicts.
- E. **Protection of Structures:** Take necessary precautions to protect buildings, foundations, and structures against damage. Contractor shall be liable for all damage.
- F. Provide necessary support systems to meet all federal and state OSHA requirements for maintaining the stability of structures adjacent to excavations and excavation activities.

PART 2 - PRODUCTS

2.1 FILL AND BACKFILL MATERIAL

- A. Fill and backfill material shall be as specified on the Drawings and Specifications.
- B. Unsuitable materials include silt and clay soils with a moisture content so significantly over optimum they cannot be compacted to the required maximum density. Sod, matted or decayed vegetation, expansive soil, and other deleterious material are also considered unsuitable backfill material and shall be removed from the jobsite.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Use excavation shoring, bracing, sheeting, barricading and plating necessary to perform work and protect excavation and personnel as required for safety and conformance to governing law, including OSHA Construction Standards, Subpart P, and Salt River Project Excavation Safety Resource Manual. Cost of protection systems shall be included in Contractor bid price.
- B. Excavations for foundations and footings shall conform to dimensions, elevations, grades, and tolerances indicated, with allowance for erection of forms, shoring, waterproofing and inspection. Excavation shall be kept free of loose material.
- C. Predetermined elevations or depths for bottoms of footings are shown on Drawings. Should site conditions require excavation beyond predetermined depths, work shall be suspended. Contractor shall notify the Engineer requesting an evaluation and written authorization to continue excavating. Authorized additional excavating will be compensated in accordance with provisions of Specification.
- D. If excavation is carried beyond dimensions, elevations or grades indicated on Drawings without the Engineer's approval, over-excavated area shall be cleaned of all loose material and backfilled at Contractor's expense. Backfill material shall be LMB 1-½ sack (SRP Stock Code No. 00-0106) or aggregate base or select material approved by Owner compacted to at least 100% of maximum density within 2% of optimum moisture content in accordance with ASTM D698.
- E. Material to be excavated shall be non-classified and shall include all earth or other materials encountered in excavating. Price quoted shall cover removal of all such materials to depth and extent indicated or specified.
- F. Use of explosives is generally not permitted. If explosives are to be used, a controlled blasting plan that meets the requirements of Appendix A must be submitted and approved by the Engineer prior to such use. Comply with applicable ordinances and regulations, and state in bid proposal if bid is based on use of explosives. Contractor shall be responsible for any damages occurring due to use of controlled blasting.

- G. Where non-blast related construction activities have the capability to cause vibrations of sufficient intensity to damage structures, meet vibration requirements of Appendix A.
- H. Remove unsuitable material and material in excess of job requirements from jobsite and dispose of at an approved municipal disposal site at Contractor's expense unless noted otherwise.
- I. Berm or otherwise protect excavations from surface drainage or runoff.

3.2 SUBGRADE PREPARATION

- A. Subgrade shall be scarified to a depth of 6 inches (152 mm) (except cut areas that meet minimum density requirements without additional compactive effort), prepared to grade indicated on Drawings and compacted to specified density prior to placement of fill material or concrete.

3.3 UNDER-SLAB/FOOTING FILL PLACEMENT

- A. Under-slab/footing fill shall be placed in level layers (lifts) to grade indicated on Drawings and compacted to specified density, with a tolerance for final grade of plus zero inches to minus one inch (25 mm).
- B. Lift depths (loose, uncompacted) of native fill material shall not exceeding eight inches (203 mm) and of aggregate base or select fill material shall not exceed twelve inches.
- C. LMB 1-½ sack (SRP Stock Code No. 00-0106) may be used as fill to within four inches (102 mm) below bottom of slab/footing. Final four inches (102 mm) of fill above LMB shall be compacted aggregate base material.
- D. Do not place fill or backfill material on surfaces that are muddy, frozen or contain frost or ice.

3.4 BACKFILL PLACEMENT ADJACENT TO STRUCTURES

- A. Clean excavation of trash and debris after completion of foundations, removal of forms, and other construction activities.
- B. Place backfill uniformly against structures to prevent eccentric or excessive loading of structures.
- C. Unless otherwise specified or prior approved by the Engineer, lift depths (loose, uncompacted) of native fill material shall not exceeding eight inches (203 mm) and of aggregate base or select fill material shall not exceed twelve inches (305 mm).
- D. The Engineer may allow Contractor to exceed specified lift depth limits where Contractor demonstrates the ability to meet compaction requirements with proposed equipment and methods. Lift thicknesses shall not exceed that which can be effectively compacted by type of equipment and method used.

- E. LMB ½ sack (SRP Stock Code No. 00-0104) may be placed adjacent to structures in maximum three foot 914 mm) thick lifts, or as specified by the Engineer.

3.5 COMPACTION

- A. Subgrade below slabs and footings, and under-slab/footing fill and backfill shall be compacted to at least 95% of maximum density within 2% of optimum moisture content in accordance with ASTM D698, unless noted otherwise in Specifications or on Drawings.
- B. Consult with Engineer for any special precautions or modified compaction requirements necessary when compacting behind retaining walls to prevent structure overload.
- C. Where subgrade or fill material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or fill material and work water into soil to produce uniform moisture content throughout. Free water shall not appear on surface during or after compaction operations. Moisture condition backfill prior to placement.
- D. Consolidation of backfill by flooding or jetting is permitted only with prior assessment by and written approval of the Engineer.

3.6 FIELD QUALITY CONTROL

- A. Inspection and compaction tests are required on excavation backfills and subgrade unless LMB slurries are used.
- B. Density and moisture content will be verified during construction by the Engineer at no cost to Contractor. Test will be made at the discretion of the Engineer. Retesting for non-compliance shall be at Contractor's expense.
- C. Do not cover lifts before compaction tests are performed. If lifts are covered prior to testing, excavate test pits for making density tests on lower portions of backfill at instruction of the Engineer. Refill and compact test pits in accordance with the specifications. Excavating, refilling, and compacting test pits shall be at Contractor's expense.

3.7 ATTACHMENTS

- A. Appendix No. 1: SRP Blasting and Vibration Requirements.

END OF SECTION

SECTION 31 23 00 – EXCAVATION AND FILL
APPENDIX No. 1

SALT RIVER PROJECT
BLASTING AND VIBRATION REQUIREMENTS
(SRP 02220)

1.0 GENERAL

- 1.1 This Supplemental Specification augments the requirements for controlled blasting and monitoring of vibration.

2.0 SUBMITTALS

- 2.0.1 Submit the following items to the Engineer for review prior to blasting:
- a. Blasting contractor name, contact person and telephone number.
 - b. Blasting plan (include methods, dates, area of blast, etc.).
 - c. Maximum weight of explosives per delay and anticipated blast wave frequency.
 - d. Measured distance from nearest explosion to structures (including poles, building foundations, slabs, paved streets, canals, etc.).

3.0 PRE-BLAST SURVEY

- 3.0.1 Make a pre-blast survey of structures within 300 feet (91 m) of the blast site and provide the Engineer with a survey report a minimum of ten days prior to commencement of blasting. Report shall contain the following:
- a. List of properties and owners of record within 300 feet (91 m) of blast site.
 - b. List of property owners contacted, date, and method of contact.
 - c. Drawings, photographs, and other documentation of existing cracks and damage to structures on listed properties.
 - d. List of properties not inspected and reason(s) for not performing inspections.

4.0 MONITORING AND PRACTICES

- 4.0.1 Monitor blasting using minimum of two on-site seismographs as detailed in paragraph 25.C.04 of "The Blasting Guidance Manual," prepared by the Office of Surface Mining Reclamation and Enforcement, United States Department of the Interior (dated 10/1/87).
- 4.0.2 Energy ratio recorded by a three-component seismograph shall not exceed 1.00

and peak particle velocity shall not exceed 2.00 inches per second (50.8 mm/s).

- 4.0.3 Allow enough time between tests and production blasting to make adjustments in weight per delay of explosives used.
- 4.0.4 Use blasting practices which ensure that no flyrock reaches structures. Do not use metal blasting mats within 200 feet (61 m) of electric power lines.
- 4.0.5 Monitor other construction vibrations which may be of sufficient intensity to cause damage to buildings or structures in accordance with the requirements of this appendix.

END OF DOCUMENT

SECTION 31 62 39

DRILLED CONCRETE PIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes drilled pier foundations, such as those used for single shaft pole and H-frame electric distribution or transmission structures.

1.2 REFERENCES

- A. The following standards shall be made a part of this Specification:
1. ACI 304R Guide for Measuring, Mixing, Transporting and Placing Concrete
 2. ACI 305R Hot Weather Concreting
 3. ACI 306R Cold Weather Concreting
 4. ACI 309R Guide for Consolidation of Concrete
 5. ACI 315 Manual for Standard Practice for Detailing Reinforced Concrete Structures
 6. ACI 318 Building Code Requirements for Reinforced Concrete Buildings
 7. ASTM A615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
 8. ASTM C31 Standard Practices for Making and Curing Concrete Test Specimens in the Field
 9. ASTM C33 Standard Specification for Concrete Aggregates
 10. ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 11. ASTM C39 Standard Test Method for Compressive Strength of Molded Concrete Cylinders
 12. ASTM C143 Standard Test Method for Slump of Portland Cement Concrete
 13. ASTM C172 Standard Practices for Sampling Freshly Mixed Concrete
 14. ASTM C192 Standard Practices for Making and Curing Concrete Test Specimens in the Laboratory
 15. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 16. ASTM C1064 Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
 17. Division 03 Section 03 33 00 "Cast in Place Concrete."
- B. Permission for deviation must be approved in writing by the Engineer prior to the award of the Contract.

1.3 GEOTECHNICAL REPORT

- A. A geotechnical report or boring log for the site may be included with the project documents at time of bid. It is for informational purposes only. The data presented represents subsurface conditions only at the specific test locations at the time designated. The data may not represent conditions at other locations and/or times, including water table elevation. Contractor is fully responsible for interpretations or conclusions drawn from the geotechnical data.

1.4 SUBMITTALS

- A. Provide submittals described in this Specification. In addition, submit material information for Owner's approval when choosing an alternative to that listed on the Contract Drawings (where "or approved equal" is identified).
- B. Submit the following at least ten (10) working days prior to first placement of concrete:
 - 1. Concrete mix design and historical test data for the specified design mix per Division 03 Section 03 33 00 Cast in Place Concrete.
 - 2. Current plant certification for concrete ready-mix batch plant.
 - 3. Certified mill test reports for cement and steel reinforcement.
- C. Submit with the bid proposal a Detailed Installation Plan
- D. If using an Owner approved concrete mix from an Owner approved vendor, submit with the bid the name of the vendor and the vendor's Owner approved mix designation.

1.5 SURVEY AND STAKING

- A. The Contractor shall be responsible for measurements that may be required for execution of the work to the exact position and elevation as prescribed in the Contract Drawings and Specifications. Furnish personnel, equipment and materials required to make such surveys as are necessary. All control necessary for the work, except as identified in the Specific Conditions, is the responsibility of the Contractor.
- B. Conduct survey work and layout as required.
- C. Owner's drawings identify coordinate and elevation benchmarks to use as reference points.
- D. Drawing discrepancies in distances, elevations or coordinates shall be brought to the attention of the Owner when the discrepancy is discovered and shall be resolved before the start of the work.
- E. Survey or layout work performed by the Contractor found to be in error shall be immediately corrected. If such error requires facilities to be relocated proceed immediately with the necessary work as directed by the Owner at no additional cost to the Owner.

- F. Preserve and maintain benchmarks and reference points established by Owner. If benchmarks or reference points are removed or destroyed during the course of work, the cost of re-establishing these benchmarks or reference points will be paid by the Contractor.
- G. Establish the centerlines, elevations and off-sets required for the complete installation of all foundations and foundation anchor bolts.
- H. Layout tolerances for foundation locations and elevations shall be within 0.10 foot laterally and 0.05 foot vertically of drawing dimensions.

1.6 INSTALLATION PLAN

- A. Provide an Installation Plan of the procedures to be employed for all anticipated subsurface conditions, including normal drilled pier construction, procedures to be employed if groundwater is encountered or when hole stabilization is needed, and procedures to be employed if rock is encountered.
- B. Identify Subcontractors to be used for the major elements of drilled pier foundation construction, including shaft drilling, shaft stabilization, reinforcing and/or anchor bolt cage fabrication, and concrete placement.
- C. Contractors or Subcontractors who are performing the major elements of drilled pier foundation construction must have at least five (5) years of experience serving as either a primary contractor or subcontractor for performance of the job function identified.
- D. Submit a list containing at least three (3) projects completed in the last five (5) years on which the Contractor or Subcontractor has installed drilled shafts of a diameter and length similar to those shown on the plans and in similar subsurface conditions (rock drilling, use of casing, use of slurry stabilization, etc.). The list of projects shall contain names and phone numbers of owner's representatives who can verify the Contractor's or Subcontractor's participation on those projects.
- E. The Installation Plan shall be of sufficient detail to outline the Contractor's intended overall construction sequence and methods of excavation for the drilled shafts, including (but not limited to) the following:
 - 1. Name and experience record of the driller and drilled shaft superintendent. Include the same information if multiple drillers or superintendents are to be used for the job.
 - 2. List of proposed equipment to be used including cranes, drills, augers, bailing buckets, rock core barrels, downhole hammers, grooving equipment, scouring equipment, final cleaning equipment, tremies or concrete pumps, casing, slurry equipment, airlift pumps, etc.
 - 3. Details of overall construction operation sequence and the sequence of shaft construction for all anticipated subsurface conditions. Include an emergency construction joint method.

4. Details of shaft excavation methods for all anticipated subsurface conditions. Include details of methods to clean the shaft excavation, including air lift methods and spin bucket methods as applicable.
 5. Details of casing (both permanent and temporary) and forms to be used, including installation and removal (if applicable). Note length, depth, diameter and thickness of all casing. If applicable, including calculations showing the ability of the casing to withstand anticipated hydraulic and earth pressures, and to withstand stresses due to installation without undue deformation. These details shall include methods for casing handling, splicing, straightening and out-of-round correction. Calculations included in the Installation Plan shall be signed and sealed by a registered professional engineer licensed to practice in the State of Arizona. All cased construction methods shall be in accordance with approved by Owner.
 6. Use of slurry (if applicable): Details of the type and methods to mix, circulate, desand, test, and dispose of slurry (if applicable). If polymer slurry is proposed, submit data on load transfer and manufacturers requirements for slurry control. Slurry methods shall be approved by Owner.
 7. Details of reinforcement and anchor bolt placement including lifting, support and cage centering methods.
 8. Reinforcing steel cage splicing method, if proposed, including details of dimensions, installation, splice location, support and cage centering methods, and estimated time required for splicing.
 9. Details of concrete placement including procedures for tremie or pumping methods, method to prevent slurry intrusion at the discharge end, and methods to prevent spoil intrusion at the end or throughout the length of the drilled shaft.
 10. Concrete: Details of concrete delivery to the site and placement of concrete in a continuous pour, including operational procedures for tremie or pump, and methods to prevent and handle delays in concrete batching and delivery to the site. Include any modifications in the concrete mix required for the specific job conditions or placement methods.
 11. Details of methods to control cuttings, water, slurry, etc. with adjacent traffic conditions (vehicular or railroad) or adjacent properties.
 12. Details of final discharge of concrete at top of shaft, of removing contaminated concrete, and verifying concrete uniformity for site specific conditions.
 13. Details of integrity testing (Crosshole Sonic Log testing) access tubes if slurry-assisted drilling is proposed. Note location and attachment methods of tubes. Integrity testing requirements shall be approved by Owner.
 14. If applicable, include an evaluation to determine the effect or impact of drilled shaft work on adjacent structures (buildings, roads, railroads, power poles, etc.).
- F. The Installation Plan shall include diagrams, photographs and drawings as necessary to accurately describe the proposed methods.

PART 2 - PRODUCT

2.1 EXCAVATION TOLERANCES

- A. Where foundations are structurally connected or where equipment is supported by more than one foundation (i.e. transformer pier group, switches, bus support and line dead end foundations), foundation elevation tolerances shall be 0.03 foot (9mm) with respect to each other. The center of each structure shall be within 0.08 foot (25mm) of its theoretical position in both directions.
- B. For all other foundations, the center of each structure shall be within 0.25 foot (76mm) of its theoretical position across the line and within 1 foot (305mm) along the line. Horizontal variation of the holes for each structure shall be a maximum of 2 inches (51mm).
- C. Drilled shafts for foundations shall be plumb within a tolerance of one percent of the shaft length to a maximum of 6 inches (152mm). The plumbness of the shaft shall be measured by the Contractor by the use of an inclinometer on the Kelly bar or another technique approved by the Engineer.
- D. The depth of excavation shall be at least to the depth indicated on the foundation drawing, measured from the lowest point within 2 feet (0.6m) of the edge of the excavation. Any overexcavation beyond depths shown on the drawings or authorized by the Engineer shall be at the Contractor's expense.
- E. The diameter of the excavation shall be at least the diameter specified on the foundation drawing. Minimum auger size shall be 1½ inches (38mm) less than the specified nominal pier diameter. Use of auger diameters larger than required may be acceptable, but shall be at the Contractor's expense. Use of larger diameter augers shall be subject to prior approval by the Engineer. Augers subject to wear shall be periodically checked and replaced or built up when the diameter becomes one-half inch less than the specified nominal diameter.

2.2 REINFORCEMENT CAGE TOLERANCES

- A. Circular ties shall be placed within a vertical tolerance of 1 inch (25mm).
- B. Vertical reinforcement bars shall be placed within a tolerance of ½ inch (13mm), laterally and vertically.
- C. The reinforcement cage shall be plumb within a tolerance of one percent of the foundation length from top of concrete with a maximum of 6 inches (305mm).

2.3 ANCHOR BOLTS OR EMBEDMENT SLEEVE TOLERANCES

- A. The top template of the anchor bolt cage or an embedment sleeve shall be leveled within a tolerance of 0.01 foot (3mm) across the pier diameter.

- B. The elevation of top of concrete shall be within +½ inch (13mm) to -3/8 inch (10 mm) of the computed elevation.
- C. For steel base plated poles, the transverse axis of each pole shall not deviate from the bisector of the interior line angle by more than 12 minutes of arc.

2.4 CONCRETE

- A. Concrete shall be in conformance with the requirements of Division 03 Section 03 33 00 "Cast in Place Concrete," Mix 00-0230, concrete f'c of 3000 psi - normal consistency (Metric Mix 00-0230, concrete f'c of 20MPa).

2.5 REINFORCEMENT STEEL

- A. Reinforcement shall be deformed bar and conform to ASTM A615, Grade 60. All reinforcing bar shall be new billet steel and comply with the physical requirements of ASTM A615.
- B. Reinforcing steel shall be fabricated in accordance with the standards set forth in ACI 315.
- C. Reinforcing steel shall be clean, free of rust, flaws, cracks, excessive mill scale, oil, grease and all other deleterious coatings that would impair bonding or cause improper construction.

2.6 CONTROLLED LOW-STRENGTH MATERIAL (CLSM)

- A. CLSM shall be in accordance with Maricopa Association of Governments (MAG) Standard Specification for Public Works Construction 728 (latest revision). Unless otherwise specified, ½-sack CLSM shall be used for general purposes.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Perform excavations through whatever material is encountered to the dimensions and elevations specified on the foundation drawings and foundation schedule unless otherwise directed by the Engineer in writing. The contractor's methods and equipment shall be suitable for the intended purpose and for whatever material is encountered.
- B. Excavation, as defined herein, shall be the removal of all materials of whatever nature encountered, regardless of the manner in which they must be removed. Excavation includes the removal of cobbles, boulders, and rock, and the advancement of holes through hardpan, caliche, cemented and rock-like soils, dense materials, unstable materials, and groundwater.

- C. Excavations required for shafts shall be completed in a continuous operation. Ensure the stability of the shaft excavation and the surrounding soil. When obstructions, either expected or unexpected, are encountered, notify the Engineer promptly. Either dry methods, wet methods, temporary casing methods, permanent casing methods (if specified), rock excavation methods, or combinations, as necessary, shall be used to produce sound, durable concrete drilled shafts free of defects. The permanent casing method shall be used only when required or pre-approved by the contract documents. Explosives shall not be used in advancing the pier excavations. When a rock socket is required, the Engineer will be the sole judge as to what constitutes the top of sound rock. The Engineer may order in writing additional depths of rock socket below the top of sound rock as considered necessary to improve the foundation. If the top surface of the sound rock is found to be inclined across the width of the shaft, immediately notify the Engineer. All attempts shall be made to excavate foundations to the specified nominal size and diameter. Trench-type foundation excavation is not permitted.
- D. The Contractor is responsible for problems associated with sloughing, raveling and caving. If raveling and/or caving becomes a problem, stabilization methods may have to be used to advance the drilled pier to required depths. The maintenance of the shaft stability shall be the Contractor's responsibility. Overruns in excavation and concrete quantity where sloughing occurs shall be at the Contractor's expense, unless otherwise specified in the Specific Conditions.
- E. At the end of each working day and/or completion of an excavation, unattended holes shall be protected for the purposes of public safe by any method which will properly secure the excavation. Unless stabilization methods are used, cover the hole with proper material to prevent moisture loss and desiccation due to exposure.
- F. In general, spoils from drilling may be uniformly broadcast across the site and graded to conform with the natural contours of the terrain, unless otherwise specified in the Specific Conditions.
- G. Provide equipment capable of constructing shafts to a depth equal to the deepest shaft tip elevation shown on the plans plus 15 feet or as otherwise specified in the contract documents. When a rock socket is identified on the plans at a shaft location, the definition of "shaft tip elevation", for the purposes of this subsection, shall be taken to refer to the bottom of the rock socket.

3.2 CLEANING OF EXCAVATION

- A. No brush, trash, vegetation, wood, organic material, loose soil, or other debris shall be allowed to be embedded in the bottom or sides of the pier excavation.
- B. The bottom of excavations upon which concrete is to be placed shall be machine cleaned. After reaching the required depth, clean the bottom of the hole by placing the auger back in the hole and making two additional passes at high rotational speed with no additional downpressure. If needed, a small amount of water may be added to assist hole cleaning if approved by the Engineer.

- C. If sloughing occurs or debris collects in the bottom of the excavation before reinforcing steel is placed, the Contractor may be required to re-machine clean the excavation. This cleaning shall occur just prior to the installation of the reinforcing cage.
- D. If erosion and wall or bottom softening is produced by water infiltration or other means before concreting, the shaft shall be redrilled to greater diameters and depths to remove weakened soils as directed by the Engineer.
- E. The sides of foundations shall be cleaned so that loose, disturbed soil resulting from drilling operations are removed. This criteria applies specifically to foundations that are drilled in cemented soils and soft rock conditions.

3.3 GRADING

- A. Grading in the vicinity of the foundations shall be controlled to prevent surface water from running into excavated areas.
- B. Where piers are required on side slopes (such as along river banks), the Contractor may excavate or fill as required to build a temporary working level or platform. The side slopes shall be returned to the original contours.

3.4 WATER IN EXCAVATIONS

- A. In the event groundwater is encountered in any excavation, the Engineer shall be notified in immediately.
- B. Accumulated water, including groundwater, will be the responsibility of the Contractor.
- C. When water is present in an excavation and the water cannot be pumped to provide a "dry hole", concrete shall be place by tremie pipe. Concrete mix designs shall be modified as noted in the supplemental specifications so that they are pumpable and self-consolidating. No free fall of concrete into water shall be allowed.
- D. Placement of concrete below water using tremie pipe techniques shall conform to the requirements of the supplemental specifications.

3.5 PLACEMENT OF REINFORCING STEEL

- A. Supply and install all reinforcing steel required for foundations, including all ties, as shown on the foundation drawings.
- B. The reinforcement shall be placed as detailed on the Drawings.
- C. The Drawings show only the minimum amount of steel required for structural design. The Contractor may, at his own expense and with prior written approval by the Engineer, increase the number and size of ties and/or main bars or reinforcement to facilitate construction.

- D. Ties shall be a closed tie, the ends of which are spliced by overlapping a minimum length as shown on the foundation drawings. Tie bar lap splice locations shall be rotated 90 degrees in a clockwise rotation with adjacent tie bars.
- E. Reinforcement shall be prefabricated in assembled cages and braced internally (if required) to prevent cage distortion during lifting operations. Braces required to stabilize the cage shall be at the Contractor's expense.
- F. Reinforcement bars shall be tied at all intersections with no less than No. 14 gage (2mm) annealed wire. No tack or arc welding of reinforcement (including bracing or diaphragm members) shall be permitted without prior written approval by the Engineer.
- G. Steel reinforcement, before being positioned, shall be wire brushed and thoroughly cleaned of any coatings that destroy or reduce bond. Where there is delay in placing concrete, reinforcement shall be reinspected and, when needed, cleaned. Firm rust will be permitted, but rust which is loose or flaky shall be cleaned off.
- H. Placement and handling of assembled reinforcing steel shall be done so that the bars are not displaced or overstressed. Lifting beams (spreader bars) or stiffbacks and multiple picking points are required for anchor bolt cages and all but very short reinforcing cages to protect cages from excessive bending. Cages shall be lowered in one continuous operation with crane of sufficient capacity.
- I. Placement of reinforcing within the hole or immured sections shall be within tolerances given in ACI 318 and the publication "CRSI Recommended Practice for Placing Reinforcing Bars."
- J. Reinforcing steel shall have, as a minimum, the cover specified on the foundation drawings.
- K. Reinforcement shall be effectively supported, accurately positioned and properly secured against displacement during placing and vibrating of concrete.

3.6 ANCHOR BOLT CAGES

- A. The Engineer shall furnish the anchor bolts and templates as shown on the foundation drawings. The anchor bolts will be furnished loose and it shall be the Contractor's responsibility to assemble the cages in the field.
- B. The anchor bolts will be furnished with at least one bottom and one top template for each foundation. The bottom template shall be tack-welded to the anchor bolts as shown on the foundation drawings. The top template and any intermediate templates shall not be welded to the anchor bolt cluster. The top template may be removed from the foundation 72 hours after concrete placement is complete.
- C. Anchor bolts will be furnished with two nuts per bolt.

- D. The top template will have two 1-inch (25mm) long weld beads at two places on the transverse axis of the pole. These weld beads shall always be placed on the bisector of the line.
- E. Before assembly and installation, all rust, mud, oil, grease or any deleterious material shall be removed from the anchor bolts.

3.7 PLACEMENT OF CONCRETE

- A. Cage assemblies and embedment sleeves shall be supported from the top by a ground surface frame or other positive means during complete concrete placement in order to ensure plumbness and to minimize downward slumping. The support system shall be concentric with the apparatus to prevent racking and distortion of the steel. Cranes shall not be used to support anchor bolt cages, but may be used to hold separate reinforcing steel cages if pre-approved by the Engineer.
- B. Time delay between shaft drilling and concrete placement shall be minimized. In potentially unstable deposits, complete concrete placement shall be accomplished on the same day or the day following the drilling. In other soils, shafts shall be covered until concrete is placed. Concrete placement shall take place within 48 hours after drilling is completed provided no sloughing and/or caving occurs. Under all circumstances, the maintenance of shaft stability between drilling and concrete placement shall be the Contractor's responsibility.
- C. The Contractor shall notify the Engineer at least 24 hours in advance of all proposed concrete placements. Anchor bolts, reinforcing steel, embedded sleeves, immured sections and any forms shall be installed sufficiently in advance of concrete placement to provide the Engineer reasonable time for inspection.
- D. Concrete placement, unless specifically waved, shall be done in the presence of the Engineer and shall not commence until he has authorized the work to proceed.
- E. Concrete placement shall comply with ACI 304R.
- F. Bonding surfaces shall be clean and free of foreign materials. Surfaces against which concrete will be placed shall be sprinkled with cool water just prior to placement of concrete to prevent absorption and loss of moisture from the concrete.
- G. Concrete shall be placed against undisturbed soil, unless otherwise approved by the Engineer. All ice, snow or frost shall be completely removed. Concrete shall not be placed against frozen subgrade or one that contains frozen materials.
- H. Concrete shall be conveyed from the mixer and deposited in place by methods which prevent segregation or loss of materials. Where placement exceeds fifty feet in a horizontal direction, concrete shall be pumped.
- I. Equipment for chuting, pumping and pneumatically conveying concrete shall be of such size and design as to provide a practically continuous flow of concrete at the delivery end. Aluminum or magnesium alloy conveying equipment shall not be used.

- J. In general, concrete shall be placed continuously such that no cold joints will form (excluding the joint between foundation caps and immured sections). However, if practical and approved by the Engineer in writing, the Contractor may be permitted to make a construction joint, provided the joint is located at least five feet below the bottom of anchor bolts. At all construction joints, the surface of the previously placed and hardened concrete shall be thoroughly cleaned of laitance and foreign matter. Hardened concrete shall be properly roughened to expose aggregate and the rebar wire brushed to ensure proper bonding. Procedures for cleaning and preparing construction joints shall be submitted to the Engineer for approval.
- K. Concrete shall be placed through a hopper or other device so it is channeled in a manner to free fall and clear the walls of the excavation and reinforcing steel until it strikes the bottom. Adequate compaction will be achieved by free fall on the concrete below the top 5 feet (1.5m). The top 5 feet (1.5m) of concrete shall be mechanically consolidated by vibration to achieve proper compaction.
- L. Wherever practical, free water shall be removed from the hole prior to placing concrete. Dewater in a manner that will not create subsidence and ground loss that might adversely affect the construction and existing adjacent structures/property. If concrete must be placed under water, the placement requirements in the supplemental specifications shall be utilized.
- M. Under no circumstance shall free fall concrete be allowed through water or slurry.
- N. Forms shall be designed to withstand the pressure of concrete, the effects of vibration as the concrete is being placed and all loads incidental to the construction operations without distortions or displacements.
- O. Reusable forms shall be maintained at all times and kept in good condition as to the accuracy of shape, strength, rigidity, water-tightness and smoothness of surface. Forms unsatisfactory in any respect shall not be used.
- P. Mud or foreign matter shall be prevented from entering the concrete or forms during placement operations.
- Q. Failure to demonstrate the adequacy of concrete placement methods or equipment during construction shafts will be cause for the engineer to require appropriate alterations in equipment or methods to eliminate unsatisfactory results. Drilled shafts that are completed, but do not meet the concrete placement requirements, will be unacceptable. Correct all unacceptable completed shafts to the satisfaction of the Engineer at the Contractor's expense.

3.8 CONSOLIDATION OF CONCRETE

- A. Concrete shall be consolidated as recommended by ACI 309R. Characteristics and applications of concrete vibrators shall be as set forth in Table 5.1.5 (of ACI 309R).

- B. Concrete shall be thoroughly settled and compacted into a dense homogeneous mass throughout the full depth of each layer being consolidated. If free fall placement does not provide adequate consolidation, then internal vibrators having a speed of not less than 6,000 rpm shall be used. Excessive vibration shall be avoided.
- C. An adequate number of vibrators (with standby supply) of sufficient capacity shall be provided to keep up with the maximum rate of concrete placement.
- D. Vibrate concrete only until the mass is thoroughly consolidated and the voids filled as evidenced by the leveled appearance of the concrete at the exposed surface and the embedment of the surface aggregate.
- E. Insert internal vibrators vertically to the full depth of the layer being placed and into the previous layer. Do not drag the vibrator through the concrete. Insert and withdraw vibrator slowly with the vibrator running continuously so that no hole will be left in the concrete. Avoid flow of concrete from one location to another by use of the vibrator.

3.9 CURING OF CONCRETE

- A. All formed and exposed concrete surfaces shall be cured by one of the following methods:
 - 1. Formed surfaces may be cured by leaving forms in place a minimum of seven days. Form work shall be kept wet to prevent drying of concrete surfaces.
 - 2. Formed and exposed surfaces may be cured by use of saturated bats, soaker hoses or sprinklers for a minimum of seven days. Concrete shall be kept continuously wet.
 - 3. Formed and exposed surfaces may be cured by using white polyethylene sheets applied in full contact with surfaces and maintained in an approved manner for a minimum of seven days.
 - 4. Formed and exposed surfaces may be cured by applying one coat of a pigmented liquid membrane curing compound conforming to ASTM C309, Type II. Curing Compounds shall be applied to all unformed concrete surfaces within four hours after finishing and formed concrete surfaces within one hour after stripping of forms. The curing compound shall be applied by spraying for uniform coverage, as will be indicated by an evenly colored concrete surface after application.
- B. The curing methods recommended in ACI 305R and ACI 306R shall be followed for concrete placement during hot or cold weather.
- C. Wind breaks for all placement with large surface areas shall be used at items prior to curing with pigment. Heat reflecting plastic membrane shall be used when wind velocity exceeds 15 MPH (24 km/hr).
- D. If cold joints tend to form, if surfaces set and dry too rapidly or if plastic shrinkage cracks tend to appear, the concrete shall be kept moist by means of fog sprays, wet burlap cotton mats or other means.

- E. Insulating blankets or heated enclosures may be used to protect concrete after placing in cold weather. Insulation requirement guidelines are set forth in ACI 306R, Tables 7.3.1, 7.3.2, 7.3.3 and 7.3.4. Fresh concrete shall not be exposed to carbon monoxide or carbon dioxide fumes from heaters or engines.

3.10 CONCRETE FINISH

- A. Concrete for foundations shall be finished in such a manner that free water will not collect on top of foundations.
- B. Threads on anchor bolts shall be protected from concrete buildup and/or splatter. Threads shall be clean so that nuts spin freely without interference due to cement paste or cemented aggregate.
- C. Exposed unformed concrete surfaces shall have a wood float and then a light broom finish.
- D. Exposed concrete above the ground surface shall be free from irregularities, fins, rock pockets or other imperfections.
- E. A $\frac{3}{4}$ -inch (19mm) chamfer shall be made at all corners and edges of concrete forms above grade. Rounded foundations may be chamfered with a concrete edging trowel.

3.11 DEFECTIVE SURFACES

- A. Defective surfaces are defined as any concrete surface showing misalignment, rock pockets, poor joints, holes from ties, voids, honeycomb or other defective area. The Repair defective surfaces in the following manner:
 1. Chip surface back to a minimum depth of $\frac{1}{2}$ -inch (13mm) beyond the imperfection. Chip edges perpendicular to surface. Pre-wet depression and brush with neat cement immediately before patching.
 2. Patch defective surface using mortar with same sand-cement ratio as original concrete and with minimum water for placing. Use approximately 20 percent white cement to match concrete color.
 3. Apply mortar to tie holes with hammer and ramming rod and strike flush at surface.
 4. Moist cure for three days or use curing compound.

3.12 INSPECTION AND TESTING

- A. Material shall be subject to inspection by the Engineer. When material furnished by the Contractor fails to fulfill specification requirements, the Engineer shall reject it and inform the Contractor. Inspection may be waived by the Engineer, but shall not be interpreted as releasing the Contractor from his responsibilities for delivery of materials which meet the requirements of this Specification.

- B. The cost of making all chemical analysis and physical tests and of furnishing the certified copies of the reports of test and analysis for cement, rebar, water and aggregate in conformance with the Specifications shall be borne by the Contractor.
- C. Furnish at least two (2) weeks prior to installation of steel, three (3) certified copies of reinforcing steel Mill Test reports to Owner. Mill Test reports shall contain all information required by the ASTM such as chemistry, tensile and yield strength, elongation and heat treatment. Mill Test reports shall be based on a heat number basis.
- D. On the basis of field or laboratory tests, the Engineer may require modifications of materials. Such modifications shall be made by the Contractor at his expense. Material which has been rejected for non-conformance with the Specifications shall not be used. Freshly mixed concrete which has been rejected for non-conformance shall be wasted or otherwise disposed of as directed by the Engineer.
- E. The Engineer shall perform sampling and testing of concrete. Frequency for sampling concrete for strength compliance shall be at least one per day, every 50 cubic yards (38 m³), every deadend structure, when there is a change in concrete consistency or at the discretion of the Engineer.
- F. Concrete samples will be taken directly from the transit mix truck and shall be sampled and tested as noted in Division 03 Section 03 33 00 "Cast in Place Concrete." A set of six test specimens shall be made for each sampling.
- G. Cylinders shall be tested at 7 days (2) and at 28 days (3), with one kept on hold by the testing laboratory. Compressive strength results will be evaluated per the requirements in Division 03 Section 03 33 00 "Cast in Place Concrete."
- H. Potentially low-strength concrete shall remain accessible with no other work performed that relates to or depends upon the questionable concrete until further testing is performed.
- I. In the event that results are low from a misfabricated cylinder, the Engineer may test the "hold" cylinder. The results from this test shall then be substituted for the misfabricated cylinder.
- J. In addition to the methods noted in Division 03 Section 03 33 00 "Cast in Place Concrete," low-strength concrete will be considered acceptable if the 56-day compressive strength test of the "hold" cylinder that equals or exceed the specified compressive strength.
- K. Excavations which are rejected by the Engineer for non-conformance with these Specifications shall, at the Contractor's expense, be corrected to the Engineers satisfaction. Excavations that cannot be corrected shall be properly filled and compacted, with the natural grade restored. A new excavation shall be made as directed by the Engineer to meet the original design dimensions and specification requirements. All work associated with the relocation of a rejected excavation shall be at the Contractor's expense.

- L. Reinforcing steel not meeting the requirements of this Specification shall be rejected by the Owner and replaced by the Contractor at no extra cost to the Owner. Steel may be rejected at the Supplier's plant or at the jobsite.
- M. Completed shafts shall be subjected to the specified testing methods to determine the extent of any defects that may be present. Work and material required for testing shall be furnished by the Contractor and will be paid for in accordance with the contract documents. If testing reveals voids or discontinuities in the concrete that, as determined by the Engineer, indicate that the shaft is not structurally adequate, the shaft will be rejected. The construction of additional drilled shafts shall be discontinued until the Contractor demonstrates the adequacy of the shaft construction method to the satisfaction of the Engineer. Any additional work required by the Contractor as a result of shaft defects will be noncompensable and any effect on time of performance nonexcusable.
- N. Foundations which are rejected by the Engineer for non-conformance with these Specifications shall, at the Contractor's expense, be corrected to the Engineers satisfaction. Foundations that cannot be corrected shall be removed to at least 2 feet (0.6m) below ground surface or as directed by the Engineer and fill added and compacted to restore natural grade. The new required foundations shall be constructed at the Contractor's expense.

3.13 FOUNDATION EVALUATION

- A. The Contractor may be required to demonstrate the quality of the foundation with respect to voids, honey-combing and soil-concrete interface layer by excavating and exposing the top five (5) feet of one of the first foundations constructed.
- B. The excavation of the finished foundation, if required by the Owner, will be accomplished 48 hours after the initial set of the concrete.
- C. The Contractor shall be responsible for placement of a one (1) sack CLSM in place of the excavated material.

3.14 CLEAN UP

- A. After completion of the foundations, other construction and removal of forms clean the area around foundations of trash and debris that is a result of the construction work.

END OF SECTION