



***PIPELINE AND MANHOLE
SPECIFICATIONS***

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SECTION 1 - PURPOSE AND INTRODUCTION

These specifications have been adopted by the Board of Directors of the Cortez Sanitation District (hereafter referred to as the District) for the following purposes:

1. To supplement the rules and regulations of the District.
2. To insure the consistency of design and construction for all sanitary sewers connecting to the District's existing collection and outfall system.
3. To standardize the District's plan submittal, review and acceptance procedures.
Anyone working with this District Manual should be aware that if a variance is required that person can request an appearance before the Board of Directors for discussion.
If additional costs or fees are to be incurred by the District then the party seeking a variance shall be responsible for these costs irrespective of Board approval of such variance.

Developers, contractors and engineers designing and/or constructing a wastewater collection system that will become part of or connect to the District system should be familiar with and must comply with these specifications. Any variation from these specifications shall require prior written approval from the District.

SECTION 2 - SEWER DESIGN AND REVIEW REQUIREMENTS

2.1 GENERAL

The proposed sewer project shall be reviewed by District personnel for compliance with these specifications and compatibility with the District's collection system.

2.2 ENGINEER QUALIFICATIONS

All sewer structures, additions and upgrades to the District's sewer mains shall be designed and stamped by a professional engineer. The engineer shall obtain and use these specifications in the design process of the proposed project.

2.3 DESIGN INFORMATION

All available information regarding other utilities, property lines and physical improvements (existing and proposed) within the area of proposed construction shall be verified and shown on the plans. The location and size of all collector and interceptor sewer mains shall conform to the current sewer master plan as adopted by the District.

All plans submitted shall be in compliance with the standards contained herein and shall meet any and all Special Conditions that may be reasonably required.

2.4 PRE-DESIGN MEETING

Prior to the preparation of preliminary construction drawings, all applicants shall contact the District to obtain locations of existing sewers affected by the proposed construction. The size and approximate location of the proposed improvements will be discussed at this time to determine compatibility with the District's master plan. If a line extension is involved in the design, a line extension agreement will be required before final approval of the design can be given.

2.5 DRAWINGS

2.5.1 TITLE SHEETS

The first sheet of the drawings shall be the title sheet and shall include the following information:

1. Location map, north arrow and numerical and graphic scale.
2. Index to the drawings.
3. General notes.
4. Title block - the title block should include the words "title sheet" and the project name, legal name of project area, recording data (book and page number(s) of all plats or easements used) and a description of the information shown thereon.
5. A title sheet will not be required if the number of drawings is three or less. In this case, the title block information should be included on the first drawing.

2.5.2 PLAN AND PROFILE

1. Scale: scale shall be one used in standard engineering practice. Show scale numerically and graphically. Other scales may be used with prior approval of the District.
2. North arrow.
3. Show center-line of sewer mains and service lines with appropriate ties, angles of deflection, distance between manholes, grade, pipe type, size and profiles.

4. Show right-of-way or easement lines (include date, book number and page number of recording), street center-line, name and number, property lines, curbs, gutters, cross gutters, sidewalks, driveways, paving and other improvements, existing and proposed.
5. Provide details of recorded easements, where required.
6. Show manhole elevations (rim, surface, invert in, invert out) using USGS datum.
7. Use manhole numbers that conform to the District's numbering system.
8. On each sheet of the plan, show a sufficient number of typical sections to give the relative location of surface and underground improvements with respect to the proposed sewer mains. Indicate size, type and other pertinent data for all improvements.
9. Indicate the type, size and ownership of all existing utilities in easements, streets or rights-of way in which the sewers are to be constructed. Tie utilities, sewers and house connections to street or right-of-way center-line or to street property line.
10. Indicate portions of existing utilities that are "to be abandoned" because of sewer construction.
11. Plot crowded intersections in enlarged scale and provide details for other than standard structures.

2.5.3 SUPPORTING DATA

Two complete sets of calculations supporting the design criteria used shall be furnished with the preliminary drawings. Each sheet of calculations shall be dated and have the name or initials of the individual making the calculations. The calculations shall include projected flows, design velocity, slope, maximum population to be served and depth of flow at maximum design flow.

2.6 FINAL DRAWINGS

Two (2) blue-line sets of final drawings and two (2) sets of specifications for the proposed project shall be provided to the District accompanied by two (2) sets of supporting data including documentation that easements and rights-of-way have been acquired shall be included. The title sheet shall provide a space for approval by the District.

2.7 SOILS REPORT

The District reserves the right to require a soils report if deemed necessary in the sole discretion of the District.

2.8 SURVEYS

All surveys must be performed, by a professional land surveyor registered in Colorado, in accordance with recognized good surveying practice. All survey notes must be technically correct, accurate and legible. Notes should include sketches oriented by a north arrow.

2.8.1 HORIZONTAL CONTROL SURVEYS

All property line surveys and location surveys must show authority of points and lines used and/or methods of establishment. Measurements shown on the official survey notes will be accepted provided no error in excess of one part in 5,000 (3rd order) is found. **Control points must be tied down sufficiently to enable the District to find and use them at the time the surveys are submitted and to enable points that may be destroyed prior to construction to be re-established.** All survey monuments shall be shown in notes and tied to surveys. When the location is such that survey monuments must be destroyed by the construction, the monuments must be referenced by a licensed land surveyor and replaced by same after completion of project.

2.8.2 VERTICAL CONTROL SURVEYS

Primary bench mark control levels shall be established and conform to an accuracy of 3rd order. The error of closure in loop or section shall be computed by the formula $e = 0.05 k$ where e is the allowable error in feet and k is the distance in miles between bench mark extremes. This error may be increased by a factor of two in mountainous terrain. The datum used must be based upon USGS mean sea level. A closed level loop shall be used to establish bench mark elevations. Bench marks for construction purposes shall be established at reasonable intervals (not to exceed 1,000 ft.) along the site of proposed construction. Bench marks shall be established in locations where they will not be disturbed by construction. Markers in curbs, headwalls or permanent structures, buried pipes, monuments, etc. are satisfactory. Bench marks in wooden structures, fences and poles and on fire hydrants are not satisfactory. All bench marks shall be completely described in the original notes in such a manner that recovery cannot be in doubt. Bench mark descriptions shall be clear, concise and accurate and submitted to the District along with level notes.

2.9 REVIEW REQUIREMENTS

2.9.1 PRELIMINARY REVIEW

Two (2) sets of blueline prints and specifications for the proposed project accompanied by three (3) sets of supporting data shall be submitted to the staff of the District for review. Incomplete submittals will be returned for compliance prior to review. Upon review and approval by the Manager of the District, notice of said approval shall be transmitted to the Applicant along with any required modifications. Such approval of preliminary plans shall permit the applicant to prepare final construction drawings in accordance with these specifications and incorporate any modifications required by the District.

The purpose of the District review of plans is to insure compliance with the District's rules and regulations and with these specifications. Approval by the District is not intended and shall not be interpreted as guaranteeing the design of the facility.

2.9.2 FINAL REVIEW

- A. Two (2) blueline sets of final drawings and two (2) sets of specifications for the proposed project accompanied by two (2) sets of supporting data, including documentation that easements and rights-of-way have been obtained and recorded shall be submitted to the staff of the District at least ten (10) days prior to a regular meeting of the Board of Directors of the District. The final drawings and specifications for the proposed project shall be reviewed by the District. When the plans and specifications are found to be in compliance with these specifications approval will be given by the District.
- B. Upon approval of the final plans by the District one (1) approved copy of the plans and specifications shall be transmitted to the Applicant.
- C. If the final drawings and specifications are found not to be in compliance with the District's specifications and previously requested modifications, the District Manager shall disapprove the plans and return them to the Applicant.
- D. No sewer or service line may be connected to the District system without prior approval of the drawings and specifications.
- E. After final approval by Cortez Sanitation District is given, any revisions to the plans must be re-submitted to Cortez Sanitation District for review and approval before construction.
- F. The construction shall commence within twelve (12) months of the approval date or the plans must be re-submitted for review.

2.9.3 REVIEW FEES

The District has incurred and will incur legal, engineering and inspection costs associated with the Project. Before commencement of construction of the Project, the Developer shall deliver to the District, in cash or certified funds, a legal, engineering and inspection fee in an amount equal to \$3.00 per foot for the first 2000 feet, or portion thereof, of sewer line proposed to be installed as part of the Project. Upon initiation of the project, actual costs incurred by the District in excess of this initial charge will be assessed to the developer and shall be paid in full prior to acceptance of the project by the District. If the costs are less than this initial charge the excess will be refunded to the Developer after the Project has been accepted.

SECTION 3 - SEWER DESIGN

3.1 INTERCEPTOR/COLLECTOR SEWERS

New sewers shall be designed on the basis of the projected peak flow at ultimate build out. The projected peak flow is calculated by multiplying the estimated average flow in gallons per minute by a peaking factor. A peaking factor of 4.0 shall be used for the peak occupancy season and all design flows. The District recognizes one single family equivalent (SFE) as a flow of 243 gallons per day. **The minimum acceptable interceptor/collector pipe size shall be 8 inches.**

3.2 DESIGN VELOCITIES

The acceptable flow velocity range is between 2.0 FPS (feet per second) and 15.0 FPS. Where velocities greater than 15.0 FPS are attained, special provisions shall be utilized to stabilize the pipe and manholes against erosion and displacement.

Care shall be exercised to avoid velocity conditions which will allow debris (floating or otherwise) to build up in pipes and structures.

3.3 DESIGN SLOPES

The following are minimum slopes which shall be provided; however, slopes greater than these are desirable.

TABLE 1 MINIMUM PIPE SLOPES

<u>SEWER SIZE</u>	<u>MINIMUM SLOPE INCHES/100 FT.</u>	
8"	6.0	0.50
10"	6.0	0.50
12"	2.6	0.22
15"	1.8	0.15
18"	1.4	0.12
21"	1.2	0.10
24"	1.0	0.08

3.4 SEWER SIZING

3.4.1 SIZE OF INTERCEPTOR/COLLECTOR SEWERS

Design conditions shall provide for maximum depth of flow at peak hour flow rate of no more than 80 percent of the internal pipe diameter (i.e., d/D). full pipe design conditions shall not be allowed, except for siphons which require full pipe flow.

Sewers 15 inches in diameter and smaller shall be designed to flow not more than half full when carrying peak design flow. Sewers 16 inches and larger shall be designed to flow not more than three quarters full using peak design flows.

3.4.2 CALCULATION OF PIPE SIZE

Interceptor/collector pipe sizes shall be computed by using the Manning equation.

3.5 SEWER ALIGNMENT AND LOCATION

Sewers shall be laid with straight alignment between manholes. Sewers must be located in Public rights-of-way or permanent utility easements. In general, sewers should be designed deep enough to allow for the connection of basements and to prevent freezing. Sewers must have a minimum of three (3) feet of ground cover over the top of pipe. Sewer services less than 8" in diameter shall not be installed less than 10ft. from the manhole and shall have a minimum separation of 5ft.

SECTION 4 - PIPE MATERIALS

4.1 GENERAL

All materials used shall be new and the best available and shall conform to the latest standards of the American Water Works Association (AWWA), the American National Standards Institute (ANSI) and the American Society of Testing and Materials (ASTM).

4.2 PVC GRAVITY SEWER PIPE

4.2.1 SCOPE

This specification covers the requirements for Polyvinyl Chloride (PVC) Gravity Sewer Pipe and Fittings in sizes 4" through 27", SDR 35, 4" - 15", SDR 26.

4.2.2 CONFORMANCE

Pipe and Fittings shall meet the requirements of:

ASTM D 3034 "Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings", SDR 35, and SDR 26 in sizes 4" - 15".

ASTM F 679 "Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings" T-1 Wall, (SDR 35) sizes 18" - 27".

4.3 C-900 PIPE

Where required by the District PVC C-900 pipe shall be used. This pipe shall meet the requirements of AWWA C-900 "PVC pressure pipe". The PVC C-900 pipe shall be Class 150, SDR 18 or better. The bell shall consist of an integral wall section with a solid cross-section elastomeric ring width which meets the requirements of ASTM D1869 and E-477. The bell section shall be designed to be at least as strong as the pipe wall.

4.4 COUPLINGS

RUBBER COUPLINGS - Fernco or similar rubber couplings shall not be used for pipe connections unless approved by District personnel.

MECHANICAL COUPLINGS - Whenever it is necessary to join together pipe with different O.D. dimensions or material, mechanical couplings with transition gaskets shall be used and shall be in accordance with the specifications set forth in Standard Drawing 4 in Appendix 1. **Shear Guard Couplings** (combination rubber and PVC coupler) are another preferred coupling that may be used in making repairs to District Sewer Lines.

PLASTIC COUPLINGS - Plastic, solid sleeve couplings shall be used for pipe repairs for all plastic pipe of the same diameter.

4.5 CONCRETE PIPE

Concrete pipe may be used only with special approval of the District.

4.6 MANHOLE DESIGN AND LOCATION

Manholes shall be installed at the end of each line; at all changes in grade, size or alignment; at all intersections; and at distances not greater than 400 feet for sewers 15 inches or less, and 500 feet for sewers 18 inches to 30 inches. Cleanouts shall not be used in public sewer systems to replace manholes. When possible, manholes shall be located in streets, either in the center of the street or the center of a driving lane. Manholes shall not be located in curbs, pans, drainage and/or borrow ditches, or any locations where water can collect, pool and infiltrate into the sewer system.

DROP TYPE - An outside drop pipe should be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert should be filleted to prevent solids deposition. See Standard Drawings 12 and 13 in Appendix 1.

DIAMETER - The minimum inside diameter of manholes shall be 48 inches. For sewer lines with a diameter of 15" and greater the minimum inside diameter of manholes shall be 60 inches. See Standard Drawing 6 in Appendix 1.

FLOW CHANNEL - The flow channel through manholes should be made to conform in shape and slope to that of the sewers. The sewer pipe should lay through the manhole when alignment allows.

WATERTIGHTNESS - Manholes must pass a vacuum test before acceptance by Cortez Sanitation District. Manholes must be coated with two coats of conseal 55 or equivalent water proofing.

4.6.1 MANHOLE

All manholes shall be constructed of precast concrete barrels and bases unless otherwise approved, in writing, by Cortez Sanitation District. See Standard Drawing 5 in Appendix 1. They shall have a four (4) foot minimum inside diameter and conform to ASTM specification C478. The top section shall be a precast cone or flat top with 24 inch opening. The top of the base shall be at least 12 inches above the top of the pipe. All pipe connections to the manhole base shall be made by coring and using a Kor-N-Seal boot or approved equal inserted and held in place by an expanding clamp. See Standard Drawings 5-13 in Appendix 1.

Poured in place manhole bases shall require written approval by the District. Poured in place manhole bases shall be constructed in accordance with Standard Drawing 9 in Appendix 1.

New Main lines or service lines to be tied into existing manholes shall not be used unless they consist of PVC pipe with a minimum diameter of eight inches and is connected to the manhole base by a Kor-N-Seal boot or approved equal inserted and held in place by an expanding clamp.

4.6.2 MANHOLE FRAMES AND COVERS

The frame and cover shall be cast iron. Castings shall be tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and all defects, and shall conform to ASTM A48, Class 30B. Plane or grind bearing surfaces to ensure flat, true surfaces. Covers shall be true and seat within ring at all points. All covers shall be marked "SEWER" and be 24 inch in diameter. See Standard Drawing 13 in Appendix 1.

4.6.3 ADAPTER RINGS

Manhole adapter rings may be used to adjust manhole elevations for street paving. A maximum of 12 inches of rings for existing manhole adjustments and a maximum of 8-10 inches may be used per manhole for new construction or replacement installation.

4.6.4 GROUT

Non-Shrink Grout or approved sealant shall be used.

4.7 BEDDING MATERIAL

All embedment material (bedding, haunching & initial backfill) for pipe and manhole installations shall be Class 6 Roadbase or better. (3/4" minus in size) Or as approved by qualified District personnel. Native soil may be used for backfill in approved areas only after initial 1 foot of required bedding material is compacted and in place a minimum of 1 foot above the pipe.

SECTION 5 - CONSTRUCTION OF COLLECTOR/INTERCEPTOR SEWERS

5.1 GENERAL

All pipe shall be laid true to line and grade with the spigots pointing in the direction of flow. Preparatory to making pipe joints, all surfaces of the portions to be joined shall be clean and dry. Lubricants shall be used as recommended by the pipe or joint manufacturer's specifications. Pipe shall be pushed to the manufactures recommended depth (**usually to the black line**). Trenches shall be kept water-free and dry during laying, jointing and bedding operations. Under no circumstances shall water be allowed to rise in unbackfilled trenches after the pipe has been placed. **All trenches shall be properly sloped or shored to prevent caving and injury to the pipe layers. The protection of the workers is the responsibility of the contractor. If District personnel witnesses' unsafe acts the Job may be SHUT DOWN until safe measures are taken.** District personnel will not enter excavations they determine to be unsafe. Required inspections to be performed by District personnel will not be performed until potentially unsafe conditions are remedied to District personnel satisfaction. All trenches and excavations shall be backfilled **A.S.A.P.** after the pipe has been laid and inspected unless other protection for the pipe is provided.

5.2 CONSTRUCTION OF SEWER PIPELINES

5.2.1 PLANS

A District approved copy of the project plans and specifications shall be kept on the job site at all times during construction. Engineer shall keep a current record of information required for as-built plans.

5.2.2 CONSTRUCTION STAKING

Three days Prior to construction, the sewer lines shall be staked by the engineer and the District notified 10 working days before construction starts to enable a field route inspection to be conducted and the location verified. To be paid by owner.

5.2.3 TRENCH EXCAVATION

GENERAL - Excavate trenches to insure that sides will be stable under all working conditions. Slope trench walls or provide supports in conformance with all local and national safety codes. Only as much trench as can safely be maintained by available equipment should be opened. Trenches should be backfilled as soon as is practical, but not later than the end of each workday when working in improved areas. All excavations should comply with applicable OSHA requirements.

Trenches should be excavated to the alignment and elevations as indicated on the drawings with any deviations approved by the piping system design engineer and Cortez Sanitation District. Appurtenances should be located and installed in accordance with design requirements. Excavated material should be stockpiled in a manner that will not endanger the work. Hydrants under pressure, water and gas valves, manhole covers, fire and police call boxes and other utilities and controls should be left unobstructed and accessible until work is completed. Gutters should be kept open or other satisfactory provisions should be made for street drainage. Unless otherwise approved, stockpiles should not obstruct adjacent streets, walks or driveways.

MINIMUM TRENCH WIDTH - Where trench walls are stable, provide a width sufficient, but no greater than necessary, to insure working room too properly and safely place and compact haunching and other embedment materials. The space between the pipe and trench wall must be wider than the compaction equipment used in the pipe zone. Minimum widths are not less than 6"-9" clearance on each side of the pipe for 8" and larger size pipe.

Minimum trench widths are intended to provide adequate spacing between pipe and trench all for proper placing and compaction of haunching material and may vary somewhat depending on construction procedures being used.

These minimum trench widths are based on the use of free flowing granular material Class 6 Roadbase.

5.2.4 MOVABLE SHEETING, TRENCH BOXES OR SHIELDS

When using movable trench support, care should be exercised not to disturb the pipe location, jointing or embedment. For this reason, movable trench supports should only be used in either wide trench construction where supports extend below the top of the pipe, or on a shelf above the pipe with the pipe installed in a narrow, vertical-wall subditch. Any void left in the embedment material by support removal should be carefully filled with granular material which is adequately compacted. Removal of bracing between sheeting should only be done where backfilling proceeds and bracing is removed in a manner that does not relax trench support. When advancing trench boxes or shields, prevent longitudinal pipe movement or disjointing.

5.2.5 DEWATERING

Where conditions are such that running or standing water occurs in the trench bottom, or the soil in the trench bottom displays a “quick” tendency, the water should be removed by pumps or other suitable means such as well points or pervious underdrain bedding, until the pipe has been installed and the backfill has been placed to a sufficient height to prevent pipe flotation. Care should be taken that any underdrain is of proper gradation and thickness to prevent migration of material between the underdrain, pipe embedment and native soils in the trench below and at the sides of the pipe.

5.2.6 PREPARATION OF THE TRENCH BOTTOM

The trench bottom should be constructed to provide a firm, stable and uniform support for the full length of the pipe. Bell holes should be provided at each joint to permit proper joint assembly and alignment. Any part of the trench bottom excavated below grade should be backfilled to grade and should be compacted as required to provide firm pipe support. When an unstable subgrade condition is encountered which will provide inadequate pipe support, additional trench depth

should be excavated and refilled with suitable foundation material as specified by the Engineer and/or Cortez Sanitation District. In severe conditions special foundations may be required to maintain grade and will be specified by the Engineer and/or Cortez Sanitation District. A cushion of acceptable bedding material should always be provided between any hard foundation and the pipe.

EXCAVATION IN POOR SOIL AND/OR ROCK – Unless otherwise stated in the project specific contract/specifications, Rock and/or poor soil conditions are considered completely **INCIDENTIAL and must be accounted for during the bid process.** In these areas the District will require the excavation and removal of the unsuitable material. Before the pipe is laid, the subgrade shall be returned to the proper level with bedding material. In areas where the trench bottom is composed of coarse gravel and boulders, all boulders 3” or larger in diameter shall be removed and replaced with bedding material. In solid rock areas, the trench shall be excavated 6” below grade and brought back to grade with bedding material.

BOULDERS - No boulders over 6” in diameter shall be allowed in the top 12” of the trench. Further, all backfill shall be carefully placed so that no damage will be done to the pipeline. No backfill material shall have boulders larger than 12” in diameter. Boulders larger than 8” in diameter shall be carefully lowered into trench until the backfill is 4’ over the top of the pipe.

5.2.7 PVC PIPE INSTALLATION AND HANDLING

When a load of pipe arrives at the job site it is the contractor’s responsibility to inspect the pipe for defects or damage. While unloading the pipe use reasonable care, **DO NOT DROP THE PIPE.** Store it on level

ground and do not stack over 8' in height. Damaged or defective pipe will not be accepted by Cortez Sanitation District.

The pipe installation shall be in strict compliance with ASTM D2321, "Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications" or the "Uni-Bell Handbook of PVC Pipe" latest edition.

5.2.8 PIPE LAYING

GENERAL - Proper implements, tools and equipment should be used for placement of the pipe in the trench to prevent damage. In no case should pipe or accessories be dropped into the trench. Pipe laying generally should commence at the lowest elevation and terminate at manholes. Pipe bells shall be laid upstream. Whenever pipe laying is interrupted, the open ends of installed pipe should be closed to prevent entrance of trench water, mud and foreign matter.

LINE & GRADE CONTROL - An in-pipe laser shall be used during construction to control the alignment and grade of the pipe. Grade shall be held to a tolerance of plus or minus one tenth (0.1) foot per 400 feet of line. Alignment shall be held to a minimum of a **full moon per lamp test**.

FREQUENCY OF SIEVE ANALYSIS and COMPACTION TESTS ON EMBEDMENT

MATERIAL – the contractor shall provide sieve analysis results on every two hundred cubic yards of embedment material delivered to the job site. Each analysis shall contain the name and signature of the individual conducting the analysis, date of analysis, description of material, and percent by weight passing each sieve size. Two compaction tests shall be run for every 200 lineal feet of pipe layed and 2 vertical feet of trench backfill. These analyses shall be provided to the District.

BEDDING - Bedding is required primarily to bring the trench bottom up to grade. Bedding materials should be placed to provide uniform and adequate longitudinal support under the pipe. Blocking shall not be used to bring the pipe to grade. Bell holes at each joint shall be provided to permit the joint to be assembled properly while maintaining uniform pipe support. A compacted depth of 4"-6" is sufficient bedding thickness.

HAUNCHING - The most important factor affecting pipe performance and deflection is the haunching material and its density. Material should be placed and consolidated under the pipe haunch to provide adequate side support to the pipe while avoiding both vertical and lateral displacement of the pipe from proper alignment. Haunching is placed up to the pipe springline.

INITIAL BACKFILL - Initial backfill is that portion of the pipe embedment beginning at the springline of the pipe and extending 12" over the top of the pipe. Since little or no additional side support is gained above the springline, bedding may be used without special compaction efforts.

WARNING TAPE REQUIRED - A warning tape shall be installed in the trench 18" above the pipe. This tape shall be six (6) inches wide, plastic, colored green and have the word "SEWER" printed on the tape.

5.2.9 DIKES

In high ground water areas the bedding shall be interrupted by concrete dikes keyed into undisturbed ground. The concrete dikes shall be spaced every 100' or as directed by the District. The concrete dikes shall be constructed to the same dimensions as the bedding except they shall extend 18" above the top of the pipe. Excavated materials shall not be used as bedding material above or below the pipe unless approved by the District. It is the contractor's responsibility to identify the situation and bring it to the attention of the District. The District will approve plans for corrective measures.

5.2.10 MIGRATION

When coarse and open-graded material is placed adjacent to a finer material, fines may migrate into the coarser material under the action of hydraulic gradient from ground water flow. The gradation and relative size of the embedment and adjacent materials must be compatible in order to minimize migration. In general, where significant ground water flow is anticipated, avoid placing coarse, open-graded materials, such as Class IA, above, below or adjacent to finer materials, unless methods are employed to impede migration such as the use of an appropriate stone filter or filter fabric along the boundary of the incompatible materials.

5.2.11 FINAL BACKFILL

The moisture content of backfill materials should be maintained within suitable limits to permit placement and compaction to required levels. For non-free draining material, such as Class III and IV-A, moisture content should be held close to optimum. In applications where water exists in the trench, free draining backfill materials are generally more suitable because they are more readily densified while saturated.

When using mechanical compactors, avoid contact with the pipe. When compacting over the pipe crown, maintain a minimum of 12" of cover when using small mechanical compactors. When using larger compactors, maintain minimum clearances as required by the Engineer and/or Cortez Sanitation District. This decision will be based on the depth of influence of the specific compaction equipment being used. For compaction by heavy wheel loading or hydro hammer methods, a minimum distance of 30" over the crown may be required. Heavy wheel loading and hydro hammer methods of compaction should not be used for compacting where total cover is less than the influence zone of the compaction device.

All backfill above the bedded pipe shall be carefully placed and compacted. Compaction shall be in 8" maximum loose lifts. No flooding or puddling of trenches will be permitted. All material which is saturated (or more than 5% over optimum moisture) shall be dried out to an acceptable moisture level before use as backfill. All compaction within public ROW's shall be 95% of maximum dry density or equal to governing body requirements. All other compaction should be at 90% standard proctor density. Compaction testing will normally be required at a rate of two tests every 200 linear feet of pipe laid and every 2 vertical feet of trench backfill. All compaction tests shall be performed in accordance with ASTM specification D698-70 method C (or latest revision) and shall be arranged and paid for by the contractor. The contractor shall provide one copy of all soils testing logs to the District. Compaction test results shall be provided to the District on the same day as the tests are conducted. All failing areas shall be recompacted and retested. Material which cannot be compacted to specification shall be removed and discarded. The District may require a different test frequency than specified above if the compaction effort provides consistent satisfactory results or inconsistent results.

Montezuma County, the City of Cortez and the State of Colorado may require specific material for backfill in various areas. It shall be the contractor's responsibility to determine if this shall be required.

MAINTENANCE OF BACKFILL - All backfill shall be maintained in a satisfactory condition and all places showing signs of settlement shall be filled and maintained during the life of the contract and for a **period of two (2) years** following the date of final acceptance of all work performed under the contract. When the contractor is notified by the District that any backfill is hazardous due to settlement, he shall correct such hazardous conditions at once. Any utilities and road surfacing damaged by settlement shall be repaired by the contractor to the satisfaction of the County, City, State or the District. In addition, the contractor shall be responsible for costs to the District for claims for damages and for court actions brought against the District for, and on account of, such damage.

5.2.12 SEWERS ON STEEP SLOPES

It is necessary that sewers on slopes of 20 percent (approximately 11.5 degrees) or greater, and where shallow bury and/or poorly consolidated soil conditions exist, should be anchored securely with concrete collars or other appropriate abutments immediately downhill from bells to prevent downhill movement of the pipe.

5.2.13 TEE BRANCHES

Tee branches or Y's) shall be installed at all locations indicated on the approved plans for future service connections. Addition or deletion of tee branches during construction must be approved by the District. Tee branches shall be positioned 30 degrees above the horizontal and connected to the service line stub using a 22 ½ degree vertical bend. Tee branches shall be marked using a vertical 4" x 4" post which shall terminate one foot above the ground surface if conditions permit. Marker posts in other areas shall terminate within one foot of the ground surface. All tee branches shall be accurately located on the record drawings by "swing ties" to permanent objects. All tee branches reserved for future use shall be plugged with a removable water tight plug. Sewer services shall not be installed less than 10ft. from the manhole and shall have a minimum separation of 5ft.

5.2.14 CONCRETE ENCASEMENT

Concrete encasement will be required on some stream crossings. The encasements shall be made in accordance with the engineer's specifications. All pipe to be encased shall be anchored sufficiently to prevent displacement of the pipe during encasement operations. The use of concrete around any sewer pipe shall require written approval by Cortez Sanitation District.

5.2.15 HIGHWAY CROSSING/STREET CUTS

Prior to start of construction, the required permits or licenses shall be obtained from the appropriate authority(s) by the contractor. Streets cut within City, County or State ROW must meet permit requirements (cut 12" wider than the original trench on each side). All street cuts must be a **straight/neat** line. The District will not be responsible for additional pavement removed outside the Neat line and will only pay for minimum trench width. See drawing 16 example in appendix 1

When open cuts are permitted, only one-half the traveled way shall be closed at one time, thus allowing traffic to precede on the other half.

Boring shall be performed by experienced boring contractors only. Bores shall be constructed to the lines and grades shown on the approved drawings. Backfill and surface replacement shall be performed to the specifications of the appropriate authority and all requirements of the permit or license shall be met.

5.3 MANHOLE CONSTRUCTION

5.3.1 GENERAL

The distance between manholes shall not be greater than 400 feet for sewers 15 inches in diameter or less. Spacing may be increased to 500 feet for sewers 18 to 30 inches in diameter. Manholes shall be installed at the end of each line, at all grade changes, pipe size changes or change in alignment. Manholes shall be used at all collector/interceptor sewer intersections. No manholes shall be placed in borrow ditches or in water courses. Precast manhole bases are required unless poured-in-place bases have been approved by the Cortez Sanitation District. See Standard Drawing 14 in Appendix 1.

5.3.2 HANDLING

Precast concrete sections shall be handled carefully and shall not be bumped or dropped. Chains, cables and hooks shall not come in contact with joint surfaces. Precast concrete sections will be inspected before installation. All cracked or otherwise defective or substandard units will be marked rejected and removed from the construction site.

5.3.3 INSTALLATION

Manhole bases shall be placed on level compacted subgrade consisting of 4 inches of bedding material (95% standard proctor density) to the grade and alignment shown on the construction drawings. Pipes shall be connected by use of waterstops as shown in Standard Drawing 9&12 in Appendix 1. Inverts or holes for field connections shall be carefully cored or drilled. In no case shall holes be made in manholes with pneumatic hammers or similar devices.

5.3.4 INVERTS

Inverts shall be carefully poured and troweled into the shape of the pipes through the manhole. The inverts shall be constructed of 4,000 psi concrete using type II cement. Side branches shall be connected on as large a radius curve as practical. Inverts may be formed by continuing the pipe through the manhole and removing the top half of the pipe. The space underneath the pipe and to the top edge of the pipe formed channel shall be filled with 4,000 psi concrete. All inverts shall be troweled to a smooth clean surface. Inverts shall be required in top end manholes.

5.3.5 GRADE RINGS

Precast grade rings shall be installed between the top of the cone and the manhole casting on all manholes. The rings shall be sealed with two strips of joint mastic between each layer. A maximum of 8-10 inches of grade rings will be allowed.

5.3.6 FINAL GRADE OF MANHOLE COVERS

NON-TRAVELED AREAS - Manhole covers shall be 4 to 8 inches above finished grade.

NON-PAVED TRAVELED AREAS - Manhole cover shall be 4 inches below finished grade.

PAVED AREAS - Manhole covers shall be ¼ to ¾ inch below grade to accommodate for snow plowing.

5.3.7 DROP MANHOLES

An outside drop manhole shall be constructed at all manholes where the incoming pipe invert is twenty-four (24) inches or more above the exit pipe invert. Drop manholes shall be constructed in accordance with the details. No inside drop manholes will be allowed. See Standard Drawings 12, 13 and 14 in Appendix 1.

5.3.8 MODIFYING EXISTING MANHOLES

All new holes required in existing manholes to facilitate installation of additional pipes or replacement of existing pipes shall be cored in the manhole walls. The pipe shall be sealed with a Kor-N-Seal rubber boot or approved equal. All connections must be inspected and approved by the District. In the event the

existing manhole is in a condition that does not allow coring, the District and the developer will enter into a cost share agreement to replace the manhole.

Whenever possible, the core should continue through the invert bench to form a new flow channel.

5.3.9 COATING

Two (2) coats of the specified bitumastic material shall be applied to all exterior manhole walls. This material shall be allowed to dry between coats according to the manufacturer's instructions. Do not backfill until coating has cured according to the manufacturer's instructions. All damage to the bitumastic material shall be repaired. All coatings are to be applied according to the manufacturer's instructions. In high ground water areas a bitumastic wrap shall also be applied to the entire manhole, as specified in Section 6.3.10. Con-seal CS55 is an acceptable manhole sealant.

5.3.10 EXTERNAL MANHOLE SEALING IN HIGH GROUND WATER AREAS

In high ground water areas the adjusting rings and manholes shall be sealed with an external sealing sleeve as manufactured by Infi-Shield or Grace Construction Products or an approved equivalent. The rubberized asphalt sheet membrane waterproofing system shall have a minimum thickness of 60 mils and the low temperature flexibility shall be unaffected to -45 degrees Fahrenheit per ASTM D1970. The material shall be installed in strict compliance with the manufacture's recommendations.

5.3.11 HORIZONTAL JOINTS

Flexible plastic joint sealing compound in accordance with these Specifications shall be applied to all manhole joints. The application of priming compound and the sealing compound shall be accomplished in strict conformance with the manufacture's instructions. The joint materials shall conform to the approximate manufactured shape at the time of installation. Any materials not conforming shall be rejected and not used. The joint materials shall not be stretched or in any other way distorted. See Standard Drawings 10 and 11 in Appendix 1. The sealing compound shall be heated before installation when the ambient temperature is below 40 degrees Fahrenheit.

5.3.12 TESTING

All manholes will be vacuum tested by the District. The test shall be in compliance with ASTM C1244-11 "Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill". See Appendix 2 for complete test requirements. **The third test after two failures of any manhole will be charged to the contractor.** The manhole will not be accepted by the District until it passes the vacuum test.

5.3.13 BEDDING MATERIAL

All embedment material for pipe (bedding, haunching & initial backfill) and bedding material for manhole installations shall be Class 6 Roadbase or better. (3/4" minus in size) As approved by qualified District personnel. Native soil may be used for backfill in approved areas only after initial compacted bedding is in place.

SECTION 6 - SURFACE RESTORATION

6.1 GENERAL

Where pavement, curb and gutter, sidewalks or other improved surfaces have been removed during the course of the work, such items shall be restored to a condition equal or better than prior to removal. The sub-grade for all restored surfaces shall be thoroughly compacted by mechanical or hand tampers, or vibratory rollers, or by other means of compaction acceptable to the District.

6.2 STREET IMPROVEMENTS

Paving, signs, curb and gutter, sidewalks or other street improvements destroyed, removed or damaged during construction shall be replaced with the same type and dimensions of units removed and shall be equal to and consistent with the undisturbed portions of the improvements existing prior to the trench excavation.

All concrete used in the restoration work shall be equal to the requirements of the street or highway department having jurisdiction. The thickness of all paving shall be the same as the adjacent undisturbed paving, but shall not be less than 3 inches. The top 8 inches of backfill material within street pavement driveways or street curbing areas shall be Class 6 Road Base as specified in the Colorado Department of Highways Specification.

6.3 FINISH GRADING AND CLEANUP

The contractor shall grade the trench line to a smooth grade to affect a neat and workmanlike appearance of the trench line. Boulders which cannot be placed in the trench backfill shall be collected and hauled to a dump site selected by the contractor, off the District’s property, easements and rights-of-way.

Excess excavated material, if any, shall be similarly hauled away, to a site selected by the contractor, off the District’s property, easements and rights-of-way. All tools, equipment of the work, barricades and temporary structures shall be removed from the site by the contractor. All excess dirt and rubbish shall be removed and the construction site left clean.

6.4 CONTRACTOR’S RESPONSIBILITY

6.4.1 GENERAL

Local police, fire departments and affected home/land owners shall be notified by the contractor prior to closing any street, road or property access and similar notification shall be given upon reopening.

6.4.2 PROTECTION/MAINTENANCE OF PUBLIC AND PRIVATE PROPERTIES

The contractor will comply with all applicable laws, ordinances, rules, regulations and orders of any public body having jurisdiction. The contractor will erect and maintain, as required by the conditions and progress of the work, all necessary safeguards. The contractor will notify owners of other utilities when progression of the work may affect them. The contractor will remedy all damage, injury or loss to any property caused, directly or indirectly, in whole or in part, by the contractor or anyone directly or indirectly employed by him or anyone for whose acts he is liable.

The contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient red lights, danger signals and detour and other signs, provide a sufficient number of flagmen, and take all necessary precautions for the protection of work safety and the public. Roadways closed to traffic shall be protected by effective barricades, and obstructions shall be illuminated at night.

All traffic control shall be in conformance with State Highway Specifications, Montezuma County and City of Cortez requirements. It will be the responsibility of the contractor to provide access to properties affected by temporary street closures and to notify all affected property owners, police and fire departments of the time and duration of street closures at least 72 hours prior to closure.

When the need for any barricade or sign no longer exists, it shall be removed. Upon completion of all work, all remaining construction signs and barricades shall be removed.

In accordance with generally accepted construction practices, the contractor will be solely and completely responsible for conditions of the job site, including safety of all persons and property during the performance of the work. This requirement will apply continuously and not be limited to normal working hours. The District's review of the construction is not intended to include review of the adequacy of the contractor's safety measures in, on or near the construction site.

The contractor shall take, use, provide and maintain all necessary precautions, safeguards and protection to prevent accidents or injury to persons or property on, about or adjacent to the site of the work. The contractor shall post danger signs warning against any hazards created by the work. The contractor shall designate a responsible member of his organization on the job site, whose duty shall be the prevention of accidents, and the name of the person so designated shall be reported to the District in writing. In an emergency affecting the safety of life or of the work or adjoining property, the contractor, without special instruction or authorization from the District, is hereby permitted to act, at his discretion, to prevent such threatened loss or injury, and he must take such action if so instructed by the District.

All natural drainages and road ditches shall be restored to their original condition. This should be done immediately behind the backfill operations in order to prevent surface drainage from damaging the surrounding properties or the construction work.

6.4.3 PROTECTION OF SEWER DURING CONSTRUCTION

During construction special precautions shall be taken to prevent earth, rocks and other deleterious substances from entering the pipeline. The end of the pipeline shall be securely plugged each time construction is suspended. Introduction of foreign materials such as mud, sand, debris groundwater, construction materials and any other material considered to be foreign to a domestic wastewater system shall not be allowed in any Cortez Sanitation District owned facility. In the event of introduction of such foreign substance, the District reserves the right to collect from the person or persons responsible, all costs associated with handling the foreign substance. Such costs shall include, but are not limited to, costs associated with removing and cleaning and/or repair of facilities, treatment costs and incidental costs such as engineering and legal fees.

6.4.4 SAFETY

The safety of all workers and the public shall be the responsibility of the contractor or applicant. The contractor or applicant shall take all prudent precautions to protect the public from harm at all times. The contractor shall conduct all work in accordance with all applicable safety standards, including OSHA and local regulations. Excavations which are deemed unsafe by District personnel shall have the unsafe conditions corrected before District personnel will enter the excavations for inspections, connections or other work.

6.4.5 PERMITS

Permits and licenses of a temporary nature necessary for the progression of the work shall be secured and paid for by the contractor. Copies of all permits and licenses obtained by the contractor shall be provided to the District. The contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the work as drawn or specified.

6.4.6 AS-BUILTS

It shall be the responsibility of the owner to obtain as-built drawings which provide accurate measurements to and depths of all pipe and appurtenant facilities and crossings of other utilities. The as-built drawings shall be prepared and certified as to accuracy by a registered engineer. No backfilling shall be performed before the required measurements are taken. In the event that any of the aforementioned items are backfilled without being properly referenced, it shall be the responsibility of the contractor to re-expose said items. Two (2) blue-line sets of final drawings on paper and electronically (ESRI GIS ARCVIEW) with X, Y and Z coordinates are required. **The District will not accept the project until acceptable as-built information is furnished.**

6.4.7 SERVICE INTERRUPTIONS

Interruptions of service may be necessary at certain times during construction. The number and length of interruptions shall be kept to a minimum. Interruptions of service shall be limited to the period between 8:00 A.M. and 5:00 P.M. Monday through Friday, excluding holidays. The contractor shall notify all persons affected by the service interruptions not less than 24 hours in advance either by posting prominent and easily read signs or by distribution of handbill notices or both.

6.4.8 INDEMNIFICATION

The contractor will indemnify and hold harmless the District and its agents and employees from and against all claims, damages, losses and expenses including attorney fees arising out of or resulting from the performance of the work, provided that any such claims, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property including the loss of use resulting therefrom; and as caused in whole or in part by any negligent or willful act or omission of the contractor, or anyone directly or indirectly employed by him or anyone for whose act any of the may be liable.

SECTION 7 - PUMP STATION SPECIFICATIONS

7.1 INTRODUCTION

The following specifications provide a design basis for main line sewage pump stations that will be constructed within the Cortez Sanitation District service area.

The specifications will provide the design engineer with guidelines for the design of sewage pump stations and cover the different types of pump stations that can be used in various applications. The specifications cover the selection and design of mechanical equipment, piping system layout, hydraulics, electrical design, and structural and architectural considerations. The design engineer shall be responsible for addressing other items that are unique to each application and for the proper design and construction of the facility for each specific location.

- These specifications cover the following types of pump stations:
- Wet Well Mounted (Vacuum Primed) pumps
- Submersible pumps

Pump stations shall be of the non-submersible, non-clog sewage pump type, unless otherwise approved by the District.

7.2 GENERAL

7.2.1 DEFINITIONS

District: The Cortez Sanitation District and those areas served by the District.

Engineer: The developer's consultant or other representative responsible for technical decisions concerning the project.

Force Main: The discharge piping from the pump station, which conveys wastewater under pressure, to the connection with the gravity sewer.

Pump Station: A structure specifically designed to accept wastewater flow and pump that flow to a gravity sewer at a higher elevation.

7.2.2 ABBREVIATIONS

ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
AWWA	American Water Works Association
CDH	Colorado Department of Health
CRSI	Concrete Reinforcing Steel Institute
DIP	Ductile Iron Pipe
EPA	Environmental Protection Agency
NEMA	National Electric Manufacturer's Association
PVC	Poly Vinyl Chloride
OSHA	Occupational Safety and Health Act
UBC	Uniform Building Code

7.2.3 CODES

The design and construction of pump stations, wet wells and associated structures shall conform to all applicable local, state and federal regulations, including but not limited to:

- National Electric Code (NEC)
- National Fire Protection Association (NFPA)
- Occupational Safety and Health Act (OSHA)
- Uniform Building Code

7.2.4 DEVIATION FROM SPECIFICATIONS

Unusual site conditions may require an exception to these specifications. When an exception is necessary, application shall be made to the District in writing requesting the exception. The District shall have sole authority to determine if the exception will be granted and will respond in writing within 20 days of receipt of the request.

7.2.5 REVISION OF SPECIFICATIONS

These specifications may be revised at any time by the District.

7.2.6 SUBMITTALS

The design engineer shall prepare a design report, drawings and specifications for each pump station and shall submit these items to the District for review. All reports, drawings and specifications shall be submitted at least 20 days prior to the date upon which action by the District is desired. All documents submitted for review shall bear the seal of a professional engineer, licensed in the State of Colorado, in responsible charge for the design of the pump station. Preliminary reports must be presented to the District for consultation prior to the preparation of final drawings. A letter of transmittal shall be submitted which includes any requests for variances and the estimated total project cost. All submittals must have the approval of the Colorado Department of Health and Environment.

7.2.7 ENGINEER'S REPORT

The purpose of the report is to record the controlling assumptions made and factors used in the functional design of the sewage pump station as a whole and each of the components. The report shall include, but not be limited to:

- A brief description of the project
- The purpose of the project
- Project location
- Topographical information
- Population and flow estimates
- Basis of design
- Field survey data

The field survey data shall include information regarding sewage flows, sewage composition (i.e. industrial and commercial loadings), soils investigations, test borings and flooding risk. The engineer's report shall also include a description of existing and proposed sewers, including determination of available capacity.

7.2.8 DRAWINGS

Drawings shall be prepared for each pump station showing the location and extent of the tributary area, any municipal boundaries and the location of the pump station and force main, including pertinent elevations. The following detailed drawings shall also be prepared and submitted for review:

- A contour map of the property being served, including the pump station site
- Pump station construction, including provisions for future expansion
- Test borings and groundwater elevations
- Force main plan and profile drawings, including connection to the existing gravity sewer system

7.2.9 SPECIFICATIONS

Complete technical specifications for the construction of sewers, pump stations, force mains and all appurtenances shall accompany the drawings. Specifications must address the method for maintaining existing sewer service during construction.

7.2.10 REVISIONS

Any deviations from reviewed drawings or specifications affecting capacity, flow or operation of the pump station shall be submitted in writing and approved by the District before such changes are made. The District may require resubmittal of the engineer's report, drawings or specifications prior to construction.

7.2.11 SHOP DRAWINGS

The engineer shall submit 3 sets of shop drawings to the District for review and acceptance prior to construction. Submittals shall include piping, fittings, hatches, pumps, motors, controls and all manufactured components contained in the pump station. Details showing electric power, control sequences, telemetry and alarms, installation details and layouts shall be included in each submittal.

7.2.12 AS-BUILT DRAWINGS

Upon completion of the construction, the design engineer shall submit as-built drawings of the installation to the District showing the location and elevations of the pump station and force main.

7.2.13 TESTING

Testing and inspection shall be performed by the manufacturer's quality control personnel in conformance with applicable specifications. Testing shall be witnessed by the District or an approved independent testing laboratory. Three copies of certified test results shall be submitted to the District.

A manufacturer's representative shall conduct on site performance testing using wastewater under design conditions. Performance testing shall be witnessed by the District.

7.2.14 WARRANTY

All pump station installations, including equipment, shall be warranted for a minimum of 1 year, beginning from the time of acceptance by the District.

7.3 DESIGN CRITERIA

This section presents a standard approach to the design of pump stations ranging in size from 50 to 1000 gallons per minute (gpm). The sizing criteria and specifications for design and construction of pump stations presented herein are intended to be used as a guide for engineers and developers. The design criteria presented includes features that enhance the operation and maintenance of the pump stations. The standard design will also help engineers meet an acceptable level of quality that is consistent with the District's overall objective to provide cost-effective service to its customers.

7.3.1 PUMP STATION TYPE

Pump stations shall be designed for non-submersible, non-clog sewage pumps. See Standard Drawings 17-18 in Appendix 1.

7.3.2 PUMP STATION SIZING CRITERIA

The dimensions of the wet well, control building (if required) and station site should be considered in the design of the pump station. Criteria for establishing the dimensions, as well as the importance of each of these components, is presented herein. Criteria for establishing pump station type, pump capacity and wet well size is also presented in this section.

7.3.3 CONTROL BUILDING (if required)

A control building that houses the pumps and electrical control equipment may be required by the District in certain instances. The control building will provide a controlled environment for motors, control panels and telemetry equipment. Adequate space shall be provided for each of these components and for operation and maintenance of the pump station. Repair of major components in the control building is not intended. However, adequate working room is required to allow pump removal and replacement from within the control room.

The interior of the control building shall provide for a minimum for 4 feet of clearance around pumping equipment. The control building shall be provided with a power ventilator, thermostatically controlled electric wall heater and adequate lighting. The control building shall be adequately insulated and shall meet all local building code and architectural requirements.

Interior lighting in the control building shall consist of fluorescent fixtures capable of providing a minimum lighting level of 80 foot-candles. Exterior lighting shall be located over the entrance door and shall be switched from within the building.

Electrical receptacles shall be ground fault trip within the building. An exterior emergency generator connection shall be provided to allow quick connection of a portable generator by District personnel in the event of a primary power failure.

Conduits for general use shall be rigid steel. Buried conduits shall be schedule 40 PVC or PVC coated rigid steel. Conduits penetrating the wet well shall be adequately sealed to prevent gases from entering the control building or control panels.

Heating and ventilation shall be provided by electric, wall mounted units. The wall ventilator shall be sized to provide 15 air changes per hour and shall be a manually switched unit with a gravity back draft damper. Heating shall be thermostatically controlled.

7.3.4 WET WELL

Wet wells shall be designed to resist floatation, while empty, under completely saturated soil conditions. The weight of the backfill on the wet well base slab overhang shall not be considered in this calculation.

The wet well dimensions determine the frequency and duration of pumping cycles and determine the detention time of the wastewater at the pump station. Ideally, the pumping rate should match the incoming flow rate. In this case, the pumps would run continuously and the detention time would be zero. However, for economy, fixed rate pumping is preferred, thereby preventing the pumps from being paced with the incoming wastewater flow rate. As a result, a fixed volume of liquid must be retained and then pumped at a fixed rate, creating a cyclic pump operation. The following section presents the criteria to be used to determine the minimum wet well volume needed for a pump station.

7.3.5 MINIMUM WET WELL VOLUME

The following terms are used in determining the minimum wet well volume.

V Minimum Usable Volume per Pump cycle (gallons)

Note: An additional minimum pump submergence must be added for submersible type pump stations. Consult the pump manufacturer for additional submergence requirements.

N Number of cycles per hour (typically, a maximum of 6 starts per hour is used for small pumps)

P The number of pumps operating at a time

Q_p Design flow rate of the pump (gpm)
(typically, twice the peak flow)

Q_i Influent wastewater flow rate (gpm)

The minimum cycle time is obtained when $Q_i = 1/2Q_p$.

T_{on} Time that the pump(s) is on (minutes)

T_{off} Time that the pump(s) is off (minutes)

The formula for determining the minimum wet well volume is:

$$V = (60/(N \times P)) \times Q_i / ((Q_p \times P) - Q_i) \text{ gallons}$$

$$T_{on} = V / ((Q_p \times P) - Q_i) \text{ minutes}$$

$$T_{off} = V / Q_i \text{ minutes}$$

Example Minimum Wet Well Volume Calculation

Given: Duplex Pump Station

Q_i = Influent wastewater flow = 200 gpm

Q_p = Pump Capacity = 380 gpm (each)

P = One pump operates at a time = 1

N = Number of pump cycles = 6

Required: Determine the minimum wet well volume, pump run time and pump off time.

Solution: $V = (60/6 \times 1) \times (200/(380 \times 1)) \times ((380 \times 1) - 200)$ gallons = 947 gallons

$T_{on} = 947 / ((380 \times 1) - 200)$ minutes = 5.26 minutes

$T_{off} = 947 / 200$ minutes = 4.74

Note: For submersible pump stations, an additional volume for minimum pump submergence must be added to the volume calculated above. The pump manufacturer should calculate this amount.

7.3.6 SITE

Pump station site must be accessible by District vehicles. The pump station shall be located within a permanent easement acceptable to the District.

7.3.7 FORCE MAIN SIZING CRITERIA

Minimum velocities have been established for force mains so that grit and associated solids are moved through the pipe reliably to minimize solids deposition. In force main design, the Hazen-Williams formula shall be used in determining the head loss in a pipe, given known flow.

The Hazen-Williams roughness coefficient C depends on pipe material, size, velocity and age of the pipe. Common C values range from 140 for new PVC pipe to below 80 for aged, rough pipe. Force mains shall be designed using a C = 100, as this allows for an increase in friction losses as the pipe ages, which results in reduced pumped flows.

Velocities in the force main shall range from 3 fps to 6 fps. Velocities less than 3 fps are not high enough to prevent solids deposition. Velocities higher than 6 fps result in significant energy loss due to friction and increasing pumping costs.

Force mains shall be either ductile iron pipe or C900 PVC and shall meet the requirements set forth in Section 8.4.2.

7.4 TECHNICAL SPECIFICATIONS

7.4.1 CONCRETE

All concrete shall conform to ACI, ASTM and CRSI standards.

7.4.1.1 CAST IN PLACE CONCRETE

Cast in place concrete shall conform to the following requirements:

- Ready-mixed meeting ASTM C94-90, Option A
- Portland Cement: ASTM C150-89, Type II
- Admixtures:
 1. Air Entraining: ASTM C260-86
 2. Water-reducing: ASTM C494-90, Type A or D

- Mix Design:
 1. 28-Day Compressive Field Strength: 4,000 psi
 2. Coarse Aggregate Size: 3/4 inches and smaller
 3. Slump Range: 3 to 5 inches
 4. Air Entrainment: 3% to 6% by volume
 5. Water Reducers: Use in concrete without plasticizers
- Mixing: Minimum 70 and maximum 270 revolutions of drum mixing.
Non-agitating equipment is not allowed.
- Reinforcing Steel:
 1. ASTM A615-90, Grade 40 or 60, deformed bars
 2. ASTM A497-90b, welded wire fabric
- Ancillary Materials:
 1. Nonshrink grout: Master Builder Co., Master Flow 928
 2. Curing Compound: ASTM C309-89e, Master Builders Co., Masterkure CR

7.4.1.2 PRECAST CONCRETE

Precast concrete wet wells and manholes shall comply with ASTM C-478. Cement shall conform to ASTM C-150, Type II or Type II Modified.

7.4.1.3 INSTALLATION

Concrete shall be placed in accordance with ACI. Reinforcing steel shall be placed according to the CSRI Recommended Practice for Placing Reinforcing Bars.

Concrete shall be placed in accordance with ACI 301-89. Prior to placing concrete, remove water from excavation and debris from forms. Check reinforcing steel for proper placement. Place concrete as soon as possible after leaving mixer in layers not over 2 feet deep. Concrete shall be placed within 1-1/2 hours of initial mixing. A maximum of 8 feet vertical drop to final placement, when not guided with chutes, is allowed to prevent segregation due to impact with reinforcing.

Concrete shall not be placed when the ambient air temperature is below 40 degrees F or approaching 40 degrees F, without special protection to keep concrete above 40 degrees F for the first 7 days of curing.

Concrete shall be compacted by vibrating until concrete becomes uniformly plastic. Vibrator must penetrate fresh concrete and into previous layer of concrete below.

Concrete shall be finished with a wood float and given a trowel finish to seal the surface. Exterior slabs and sidewalks shall be given a light broom finish to obtain a nonskid surface.

Concrete shall be protected from direct sunlight, drying winds and rain. Concrete slabs shall be kept continuously wet for 7 days or curing compound may be used, as approved by the District. Remove and replace concrete damaged by freezing.

7.4.1.4 TESTING

Quality control testing of concrete will be provided by the District. Test cylinders may be taken by the District and tested to verify concrete strength.

7.4.2 PIPE

Pipe within the pump station and wet well and force main piping shall be ductile iron, conforming to the following specifications.

7.4.2.1 DUCTILE IRON PIPE

Piping, 4-inch and larger, shall conform to ANSI A21.5 and AWWA C151 and shall be coal tar epoxy lined.

7.4.2.2 FITTINGS

Fittings shall conform to ANSI/AWWA C110 and shall be coal tar epoxy lined.

7.4.2.3 JOINTS

All pipe joints within the pump station, not buried, shall be flanged type joints. All flanged joints shall use stainless steel bolts, nuts and washers. Gaskets shall be a minimum of 1/8 inch thick and shall conform to ANSI B16.21 and AWWA C207. Flanged coupling adapters, with restraint as necessary, shall be used to facilitate installation and disassembly.

Buried or submerged joints shall be push-on or mechanical joint. Gaskets shall be rubber conforming to ANSI A21.11 and AWWA C111.

Buried ductile iron pipe shall be wrapped in polyethylene conforming to AWWA C105.

7.4.2.4 INSTALLATION

Force main piping shall be buried to a minimum depth of 4 feet or greater to prevent freezing. Trenching, installation and backfilling shall conform to applicable existing District Specifications and applicable ASTM and AWWA standards.

Pipe shall be bedded in 3/4 inch class 6 extending from 4 inches below the pipe to 12 inches above the top of the pipe. Backfill above the bedding material shall consist of suitable excavated material, placed in 8 inch lifts and compacted to 95% Modified Proctor Density, as specified in ASTM D698, when in roadways and 90% if not in a roadway or within 10 feet of structure. A typical trench section is shown in Appendix 1.

Force mains shall discharge into a gravity sewer manhole in a manner which produces the least amount of turbulence. Where possible, the force main shall discharge upstream of the outgoing pipe, in the same general direction, to prevent unnecessary turbulence and minimize the liberation of hydrogen sulfide. The design engineer shall provide a detail of each force main connection to the District for review and approval.

Thrust restraint, in the form of concrete blocking or restrained joints, shall be provided on all bends in the force main.

7.4.2.5 TESTING

Force mains shall be pressure and leak tested. Pressure testing shall be performed at 50 psi or 1.5 times the maximum developable pressure, whichever is higher. The tests shall be witnessed by the District.

All necessary piping connections, test pump equipment, water meter, pressure gauge, plugs and other equipment, materials and facilities shall be provided for the test by the applicant.

Pressure shall be applied by a force pump of sufficient design and capacity so that the required pressure can be applied and maintained without interruption for the duration of the test. The pressure shall be maintained constant (within 5% variation) during the line leakage measurements.

Leakage measurements shall not be started until constant pressure has been established (compression of trapped air will give false readings under changing pressures). Line leakage shall be measured by a calibrated water meter, after the test pressure has been stabilized. Line leakage shall be determined by the following formula:

$L = .00025NDP$, in which

L = maximum permissible leakage rate, in gallons per hour, for the entire length of pipe being tested

N = number of joints in the pipeline

D = nominal internal diameter of the pipe, in inches

P = the square root of the test pressure, in psig

The water meter and pressure gauge shall be calibrated and shall be suitable for the specified tests.

All joints in the pipeline shall be water-tight and free from visible leaks during the tests. Repairs shall be made to all pipelines with a leakage rate in excess of the permissible maximum and the pipeline retested until accepted by the District.

7.4.3 VALVES

Check valves and shut off valves at the pump station shall be provided by the pump station manufacturer as part of the packaged system. Isolation valves in the force main piping, if required, shall be eccentric plug valves.

7.4.3.1 ISOLATION VALVES

Plug valves shall be non-lubricated type, cast iron body, balanced plug coated with Hycar or EPT elastomer, Buna N vee packing or O-ring seals, stainless steel bearings and nickel or epoxy coated seats. Valves in exposed locations shall have flanged ends with hand wheel operators. Buried valves shall have mechanical joint ends, with a 2-inch operating nut, valve box and cover. Valves shall be DeZurik Series 100 or Keystone Ballcentric or approved equal.

7.4.3.2 AIR AND VACUUM VALVES

Air and vacuum release valves shall be installed in high points in all force mains or in discharge piping that will trap air, due to the piping configuration. Air and vacuum release valves shall be designed for 150 psi working pressure and shall be suitable for sewage service. Sewage air and vacuum valves shall be fitted with inlet shutoff valves, blowoff valves, quick disconnect couplings and a minimum of 6 feet of hose to permit back flushing. Valves shall be APCO or Val-Matic.

7.4.3.3 INSTALLATION

7.4.3.3.1 ISOLATION VALVES

Valves shall be the same size as the pipe run in which they are to be installed. Valves shall be installed so that the bolt holes of flanged valves straddle the vertical centerline of the piping. Valves shall be installed per manufacturer's recommendations.

7.4.3.3.2 AIR AND VACUUM VALVES

Air and vacuum valves shall be installed in an insulated, precast concrete manhole.

7.4.3.4 TESTING

Valves shall be tested at the same time that the adjacent piping is tested. Joints shall show no visible leakage.

7.4.4 PUMP STATIONS

7.4.4.1 SUBMERSIBLE PUMPS, IF APPROVED

Submersible pumps shall be designed to be installed on a guide rail system using a cantilever discharge flange mating system that engages the pump solely by the weight of the pump. Pumps shall be heavy duty, non-clog submersible type. All pump mating surfaces shall be sealed using machined surfaces with fitted O-rings. The pump shaft shall use tandem mechanical oil-lubricated seals. Pump cooling shall use an internally circulated liquid system that allows the pump to be operated continuously in a non-submerged condition. Pump impellers shall be double shrouded non-clogging design capable of passing a 3 inch sphere.

7.4.4.2 INSTALLATION

Installation shall be in accordance with manufacturer's instructions and recommendations. Pump stations shall be installed so that the wet well is completely sealed within the control building, preventing gases from entering the building.

Operation and maintenance manuals shall be furnished which include a parts list and complete service procedures and troubleshooting guide.

7.4.4.3 TESTING

All components of the pump stations shall be factory tested, prior to shipping of the unit to the site. A manufacturer's representative shall provide on-site start up assistance and testing as required by the District.

7.4.5 ELECTRICAL AND INSTRUMENTATION

Electrical service and wiring shall be in accordance with NEC and local ordinances. All pump stations shall have an exterior mounted generator receptacle and manual transfer switch to allow temporary power hook-up by the District.

7.4.5.1 CONTROL PANEL AND ACCESSORIES

Control equipment for submersible pump stations, to be mounted outdoors, shall be mounted in a NEMA 12 enclosure with rubber gasket, continuous hinged door. Exterior mounted electrical and control equipment shall be mounted on a free standing frame capable of supporting the enclosures to be attached. The panel shall include a circuit breaker - protected 120 volt, 15 amp duplex receptacle.

Pump control shall turn the lead pump on upon rising level. If the level rises higher than a predetermined elevation in the wet well, the lag pump shall also turn on. Further rise of the liquid level in the wet well shall activate and alarm. Upon decrease in level to the lowest set point, all pumps shall stop. Pumps shall alternate lead, lag position after each pumping cycle.

7.4.5.2 LEVEL SWITCHES

Level switches shall be direct acting, float type mercury switches. Switches shall be constructed of chemical resistant material, suitable for sewage applications. The cable shall be 304 stainless steel in a neoprene or PVC jacket. The switch shall be rated at 5 amps at 120 volts AC and shall actuate with a 1-inch differential.

7.4.5.3 ALARMS

All pump stations shall be equipped with audible and visual alarms.

SECTION 8 - SPECIAL CONSIDERATIONS

8.1 WATER AND SEWER LINE CROSSINGS

8.1.1 WATER SUPPLY INTER-CONNECTIONS

There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any sewage or polluted water into the potable water supply.

8.1.2 RELATION TO WATER WORKS STRUCTURES

While no general statement can be made that will cover all conditions, it is generally recognized that sewers must be kept remote from public water supply wells or other water supply sources.

8.1.3 RELATION TO WATER LINES

Where sewer lines cross water lines or where water lines and sewer lines come within 10 horizontal feet of each other, the sewer pipe shall be a minimum of 18 inches clear distance vertically below the water line. If this clear distance is not feasible, the sewer pipe section must be designed and constructed so as to protect the water line. Minimum protection shall consist of the installation of an impervious and structurally sound sewer line.

8.1.4 C-900 PIPE

One length of C-900 pipe at least 20 feet long and centered over the water line shall be installed where any sewer line crosses above or within 18 inches below a water line. Joints between sewer pipe and C900 shall be made with a mechanical coupler as approved by the District.

8.1.5 MECHANICAL JOINTS

When C-900 pipe is used for a water line crossing the transition joint from the sewer pipe to the C-900 pipe shall be connected with a mechanical joint coupling, as manufactured by Mueller Couplings, Dresser Couplings or approved equal, in lieu of concrete joint encasement as required in Section 9.1.4.

Pipe joints at water line crossings shall be equivalent to water main standards of construction.

8.1.6 BACKFILL

In all cases where C-900 pipe is used, suitable backfill or other structural protection shall be provided to preclude settlement or failure of the pipe. Bedding material shall be placed between water and sewer lines at all crossings.

8.2 STREAM CROSSINGS

8.2.1 GENERAL

All work in wet or wetland areas adjacent to streams shall conform to the applicable provisions of Section 11.

8.2.2 PIPE

C-900 or certa-loc pipe shall be used for all stream crossings and shall extend 10 feet either side of the stream banks. The top of the pipe shall be laid a minimum of 2 feet below the stream bed. Every effort shall be made to keep pipe joints out of the stream bed area. All pipe joints which occur within the stream bed or within 10 feet of the edge of the stream shall have mechanical joint couplings as specified in Section 9.1.6. The pipe shall be adequately anchored to prevent displacement. This should be accomplished by using a trench section which incorporates concrete anchors to prevent displacement of the pipe by stream flow. All pipe which may be buoyant when empty shall be anchored by using concrete encasement.

SECTION 9 - SEWER TESTING AND ACCEPTANCE

9.1 GENERAL

9.1.1 PIPE AND MANHOLE CLEANING

All new manholes and pipe shall be thoroughly cleaned prior to performing acceptance tests. Pipe cleaning shall be performed by the District.

9.1.2 TESTING

After installing a reasonable section of sewer line with the contractors' "OK", the District will perform the video and lamp tests required. The first two tests shall be at the expense of the District but if a third test is required due to failures, the Contractor will be billed for the Staffs time.

9.2 DEFLECTION (lamp) TESTING

After backfilling is complete and prior to acceptance of the work the Cortez Sanitation District shall hydraulically clean the line followed by a deflection test (Lamp test) by flashing a light through the installed pipe between manholes to check for true alignment, obstructions or crushed or broken pipe. The observed light shall be a complete circle of light (full moon) in the opinion of the District inspector for that section to be acceptable to the District.

Pipe sections that do not show a "full moon" of light shall be removed and replaced in accordance with District specifications, backfilled and retested. **All such removal, replacement, remedial work and retesting shall be at the contractor's expense.**

9.2.1 LOW PRESSURE AIR TESTING (WHERE APPLICABLE)

- a. Check pneumatic plugs for proper sealing.
- b. Place plugs in line at each manhole and inflate to 25 PSIG.
- c. Introduce low pressure air into sealed line segment until air pressure reaches 4 PSIG greater than ground water that may be over the pipe. Use test gage conforming to ANSI B40.1 with 0 to 5 PSI scale and accuracy of 1 percent of full range.
- d. Allow 2 minutes for air pressure to stabilize.
- e. After stabilization period (3.5 PSI minimum pressure in pipe) discontinue air supply to line segment.
- f. Acceptable time for loss of 1 PSIG of air pressure shall be:

PIPE SIZE	TIME, MINUTES/100FT
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21 and larger	3.0

9.3 CCTV INSPECTION

The interior of all pipe shall be inspected by Closed Circuit Television (CCTV) prior to final acceptance by the District. Copies of acceptable CCTV videos will be on file prior to acceptance by the District.

CCTV equipment is expressly designed for pipeline inspection purposes and operated by District personnel. The CCTV operator shall maintain a log of all inspections and note the location, type and extent of all deficiencies. The contractor shall bear all costs incurred in correcting deficiencies found during the CCTV inspection and in the event the line fails two inspections, the third inspection required will be at the expense of the Contractor.

9.4 PRESSURE AND LEAKAGE TESTS OF FORCE MAINS

All force mains shall be subjected to a pressure test and a leakage test. The pressure test shall be to a pressure 1.5 times the maximum developable pump pressure (pump operating on a dead end line) or to the rated pressure of the pipe, whichever is less.

The applicant shall provide all necessary piping connections between the pipeline to be tested and the source of water supply, together with test pumping equipment, water meter, pressure gage, plugs and other equipment, materials and facilities required for the tests.

Test pressure shall be applied by means of a force pump of such design and capacity that the required pressure can be applied and maintained without interruption for the duration of each test. The pressure shall be maintained constant (within a maximum variation, plus or minus, of 5%) during the entire time the line leakage measurements are being made, so that the allowable leakage rate may be accurately determined from the leakage rate formula.

Leakage tests shall not be started until a constant test pressure has been established (compression of air trapped in un-vented pipes or fittings will give false leakage readings under changing pressure conditions). After the test pressure to be used has been established and stabilized, the line leakage shall be measured by means of a water meter installed on the intake side of the force pump.

Line leakage is defined as the total amount of water introduced into the line as measured by the meter during the leakage test. No pipeline, or tested section thereof, will be accepted if and while it has a leakage rate in excess of the rate determined by the following formula:

$$L = .00025NDp$$

Where

L = maximum permissible leakage rate in gallons per hour through out the entire length of line being tested;

N = number of joints in the line under test;

D = nominal internal diameter of the pipeline in inches;

p = the square root of the leakage test pressure in PSIG.

The water meter and pressure gauge shall be accurately calibrated, bear a calibration certification and be suitable for the specified tests.

All joints in the piping shall be water tight and free from visible leaks during the prescribed tests. If the leakage test is made after the pipeline has been backfilled and the joints covered, and such test shows a leakage rate in excess of the permissible maximum, the contractor shall make all necessary surveys in connection with the location and repair of leaking joints to the extent required to reduce the total leakage to an acceptable amount. All such repair and re-testing costs shall be borne by the applicant.

Each leak which is discovered within one year after the pipeline is placed in operation shall be located and repaired by the applicant.

9.5 ACCEPTANCE

After all required tests and inspections have been performed with satisfactory results, the Manager of the District will issue a letter of acceptance for the facilities. The applicant shall warranty the accepted work against defects for a period of two (2) calendar years. The applicant or contractor shall be responsible for all repairs necessary during this time period.

9.6 GUARANTEE

The applicant or contractor shall guarantee all materials and equipment furnished and work performed for a period of two (2) years from the date that the District issues a letter of acceptance. The applicant or contractor shall warrant and guarantee for a period of two (2) years from the date that the District issues a letter of acceptance that the system is free from all defects due to faulty materials or workmanship and the applicant or contractor shall promptly make such corrections as may be necessary by reason of such defects including the repairs of any damage to other parts of the system resulting from such defects. The District will give notice of observed defects with reasonable promptness. In the event that the applicant or contractor should fail to make such repairs, adjustments or other work that may be necessary by such defects, the District may do so and charge the applicant or contractor the costs thereby incurred.

9.7 CONTRACTOR QUALITY ASSURANCE

The applicant must have a qualified construction supervisor, who must certify that the lines were installed per drawings and specifications and certify the results of the acceptance tests.

9.8 DISTRICT QUALITY ASSURANCE

In addition to any construction supervision required by the contractor, the District may designate a construction Inspector who shall observe the installation of all sewer facilities which are to be connected to the District sewer system. The representative of the District shall ascertain that District standards are being met and that the system is constructed in conformance with the final plans and specifications as approved by the District. During construction where ground conditions or other factors reveal that minor modifications to the plans and specifications are in the best interest of the Cortez Sanitation District and in the interest of diligent prosecution of the work, the District may, at its discretion, approve minor changes in the work. Such changes shall be in writing with copies provided to:

1. the contractor;
2. the engineer;
3. the Manager of the Cortez Sanitation District.

Failure to construct sewer facilities in accordance with the approved plans and specifications will result in non-acceptance of the facilities by the District. Facilities which have not been accepted by the District shall not be connected to the District's system until all deficiencies are corrected to the satisfaction of the Cortez Sanitation District.

9.9 DISTRICT RESPONSIBILITY

The District or its representative shall keep a daily construction report. At no time shall the District or its representative be responsible for the quality or execution of the work. All such responsibilities shall be borne by the contractor. The sole purpose of the District's inspection of construction is to determine if the construction complies with the District's rules, regulations and specifications at the time of inspection.

Approval by the District is not intended and shall not be interpreted as guaranteeing the construction of the project and the District shall not be responsible for any damages arising out of the construction of the project.

9.10 CONTRACTOR RESPONSIBILITY

The qualified construction inspector representing the applicant shall have responsibility for reporting all construction deficiencies to the District and the applicant's construction supervisor. At no time shall the District or its representative be responsible for the quality or execution of the work or safety of the worksite. All such responsibilities shall be borne by the applicant.

SECTION 10 – OFF ROAD CONSTRUCTION

10.1 GENERAL

All off road construction shall be undertaken with extreme care to minimize environmental impacts. All necessary measures to minimize erosion and damage to existing vegetation shall be employed by the applicant. **The applicant shall restore all areas affected by construction to preconstruction conditions or better.**

10.1.1 GUIDELINES FOR MINIMIZING EROSION/ENVIRONMENTAL IMPACTS

10.1.2 EQUIPMENT

Equipment must be used that is appropriate to the task and the terrain. Because of many variables in the landscape, pieces of equipment suitable in one area might not be acceptable in another area. Under different conditions, there are advantages and disadvantages to both rubber tire and track equipment. Flexibility should be exercised in the field.

10.1.3 CONSTRUCTION IN WET AREAS

When the ground is wet, construction activity should be limited to “low impact tasks”. Permanently wet areas shall be circumvented when possible. Saturated soils are particularly prone to movement when additional water is added.

Water bars, and possibly contour trenching, should be constructed as needed in order to disperse discharge and to prevent excessive concentrations and erosion.

Construction activity should not encroach upon streams or other water bodies. A buffer strip will reduce the risk of pollution. Methods consistent with established county standards shall be employed to prevent the discharge of pollutants from the construction site into local ground or surface waters. The contractor must conform to all City and/or County erosion control and runoff regulations.

10.1.4 ACCESS ROADS

A high potential for erosion is associated with access roads. Specific suggestions for reducing this potential are presented in “Guidelines for Controlling Sediment from Secondary Logging Roads”, Intermountain Forest and Range Experiment Station, Northern Region, Missoula, Montana, United States Department of Agriculture.

Roadway ruts tend to concentrate potentially hazardous heads of water. Activities which produce ruts should be avoided. If ruts are produced, they should be repaired immediately. Discharge points shall be controlled to prevent high velocities and flows which may cause erosion and silting of streams.

10.1.5 CONSTRUCTION ON SLOPES

There is a dramatic increase in the erosion potential on slopes in excess of 15%. Activity in such areas should be avoided, or at least, minimized. If it becomes necessary to develop any cut or fill slopes, the grade should not exceed 2 to 1. Whenever steep slopes or banks present serious problems such as slumping or mass movement, rip-rapping, cribbing or other stabilization procedures must be employed.

10.1.6 EROSION CONTROL

Whenever soils are disrupted the erosion potential increases and immediate stabilization should be considered.

One of the most effective stabilization procedures is revegetation. Due to the varying conditions of surfaces and types of soil, there is a minimum amount of vegetative cover necessary to prevent erosion in each case. If this vegetative cover is lost it must be replaced as soon as possible. Considering the costs of revegetation and the risk of interim failure, the maintenance of existing vegetative cover is preferred.

Special emphasis shall be made to direct and control excessive water flow within any disturbed area and especially over the trench area. On slopes greater than 6%, erosion bars shall be constructed at least every 50 feet along the trench. These bars shall extend the width of the disturbed area. All erosion control work shall be done prior to the seeding and mulching operation.

10.1.7 POLLUTION CONTROL

The applicant shall maintain adequate measures to completely prevent the pollution of adjacent property, storm drains or natural or manmade water courses by sewage, sediment caused by erosion, debris, oil and grease or other sources of pollution caused by the construction of the facilities. All measures shall be “the best possible practice” and shall conform to all applicable standards. The District may require submittal of an erosion control plan with the plans for construction. The contractor shall be responsible to comply with the local County or City regulations regarding erosion control.

10.2 LANDSCAPE REMOVAL

The contractor shall be responsible for obtaining all permits/permission from all governing agencies, property owners and developers concerning the clearing of trees and underbrush. The disposal of the debris shall be handled in accordance with all applicable local/county regulations.

10.3 LANDSCAPE REPLACEMENT

Revegetation shall be in accordance with applicable local/county regulations.

10.4 DAMAGED SURFACES AND PROPERTY

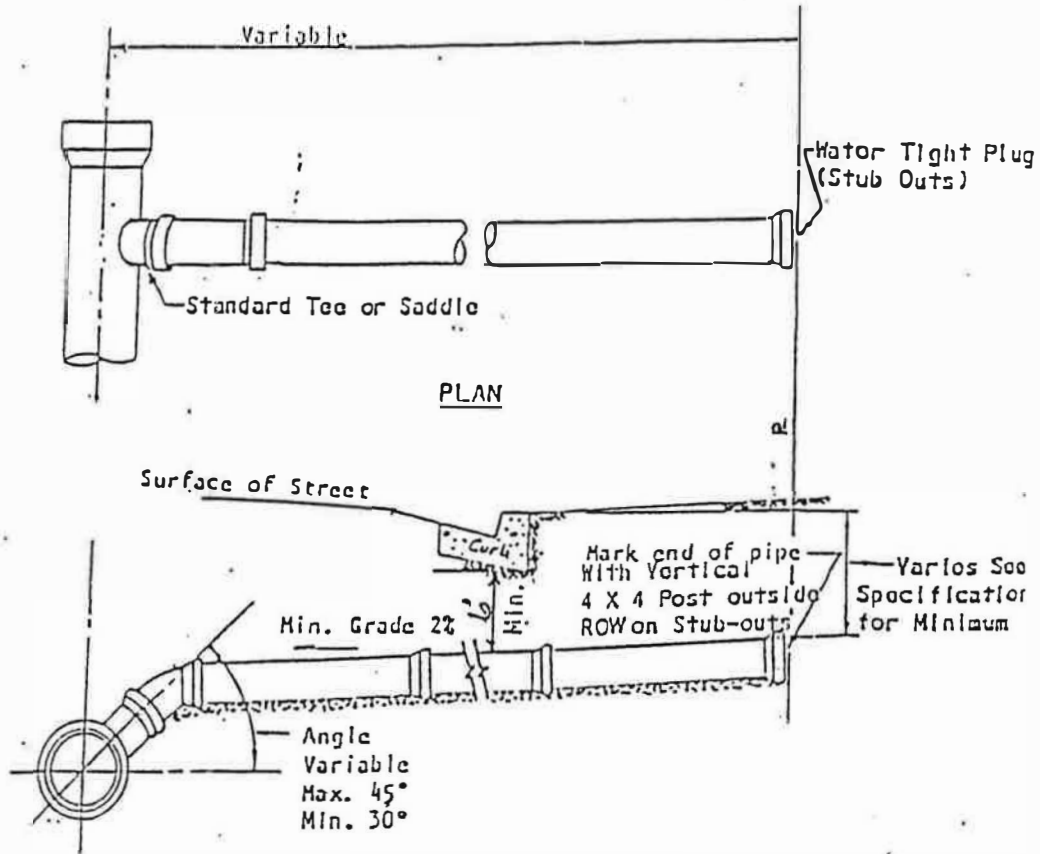
If any pavement, street, shrubbery, sod, rock, fences, poles or other property and surface structures have been damaged, removed or disturbed by the Contractor, whether deliberately or through failure to carry out the requirements of the controlling agency or the specific directions of the District, or through failure to employ usual and reasonable safeguards, such property and surface structures shall be replaced or repaired, to the satisfaction of the owner, at the expense of the Contractor. All restoration shall be performed in a timely manner and to the satisfaction of the District.

APPENDIX 1

STANDARD DRAWINGS

Drawings not present have been repealed

STANDARD

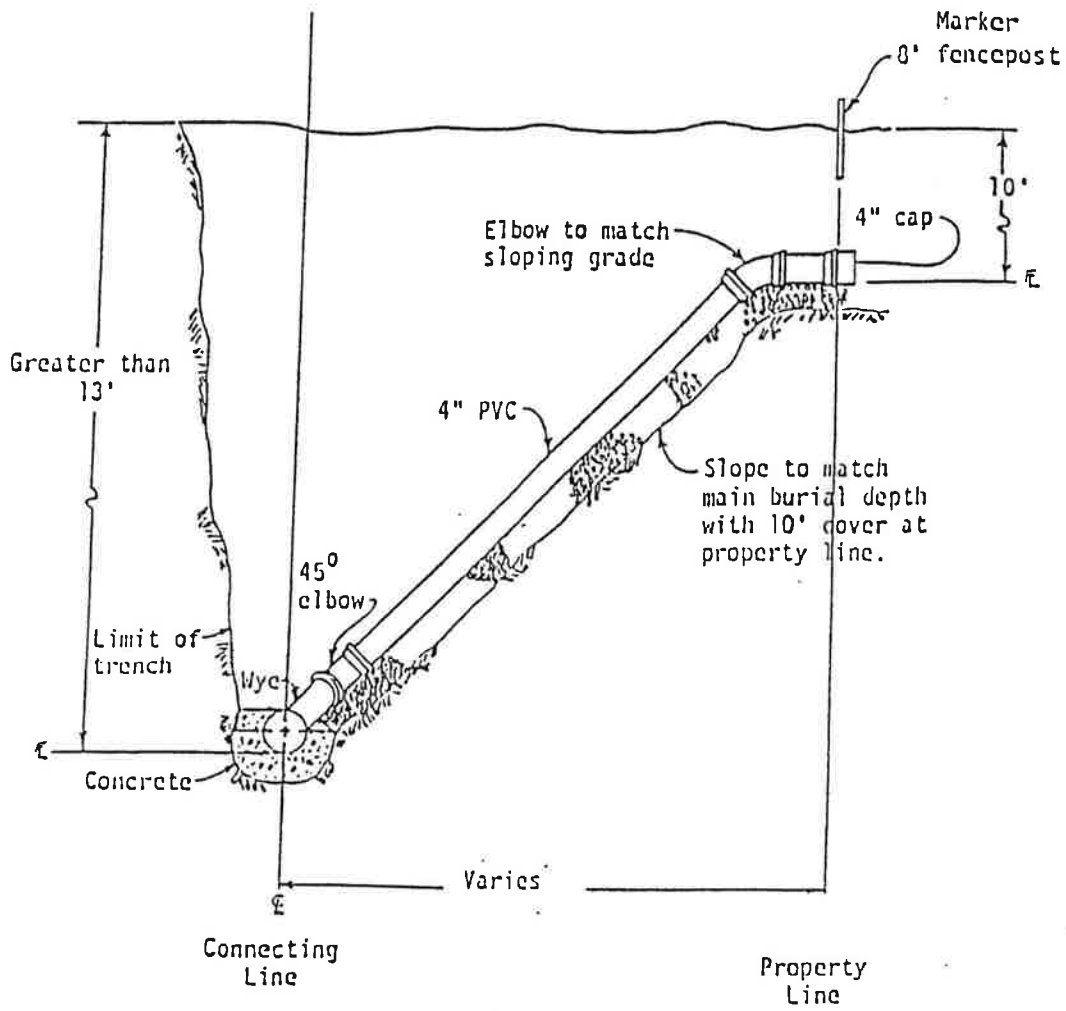


NOTES:

1. 2 Service connections shall not be closer than 5'
2. Cleanouts required
 - a. Vertical with In-line Tee
 - b. 1 - each 100' of service line or 1 @ 5' from building.

STANDARD

Deep Sewer Service Connection

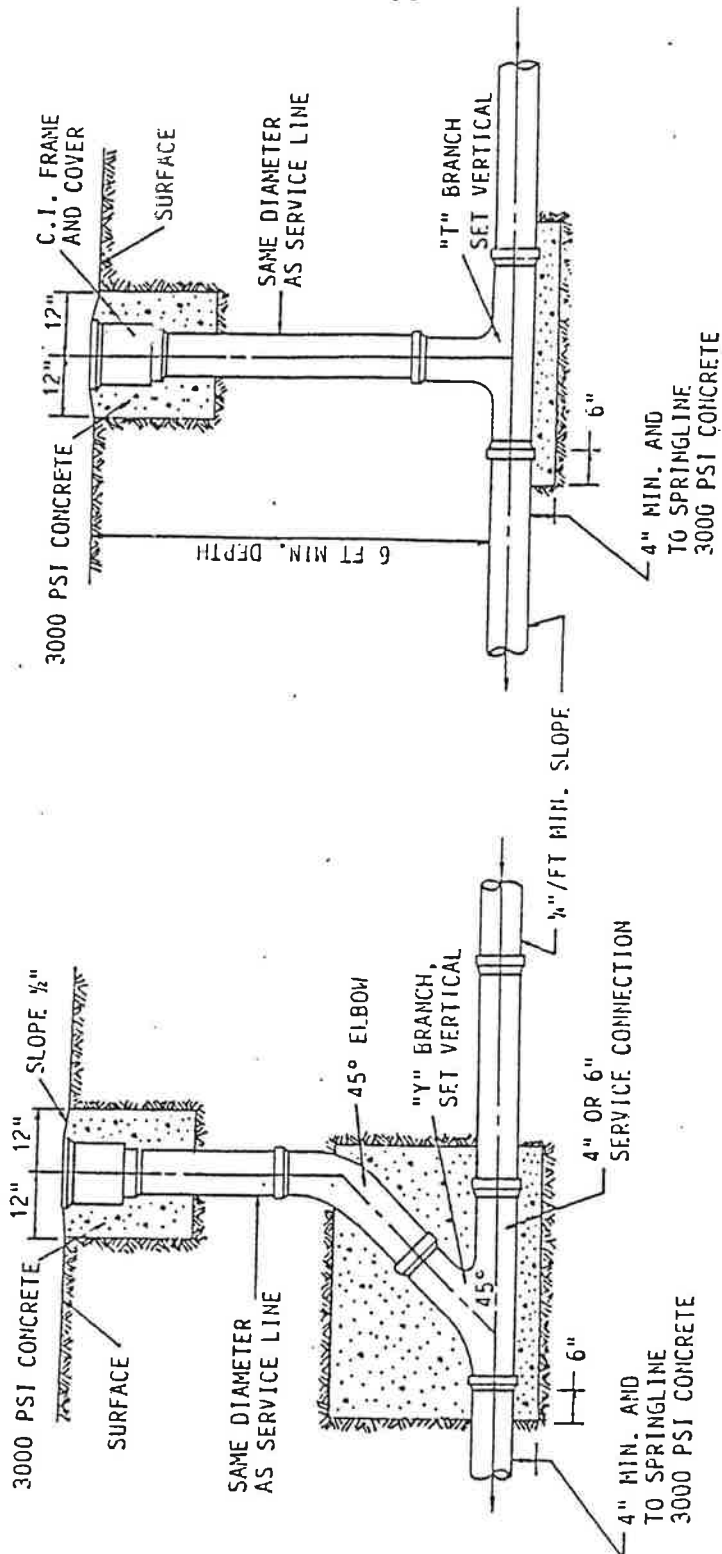


CORTEZ SANITATION DISTRICT

SEWER SERVICE CONNECTION

DRAWING 2

STANDARD



CORTEZ SANITATION DISTRICT

SEWER SERVICE CONNECTION

DRAWING 3

STANDARD

Cast Straight Couplings Cast Transition Couplings 2" thru 16"



MATERIAL SPECIFICATIONS

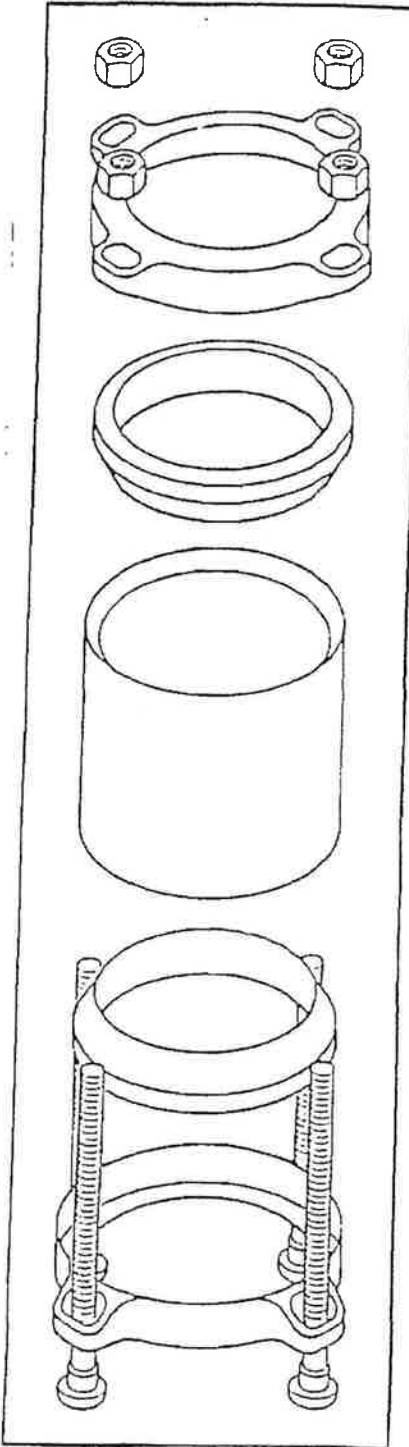
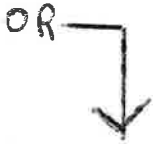
SLEEVE: Ductile Iron ASTM A-536. Ends have smooth inside taper for uniform gasket sealing.

GASKETS: Grade 30 - standard - specially compounded rubber of all new materials with ingredients to produce superior storage characteristics, permanence and resistance to set after installation. Recommended for water, salt solutions, mild acids and bases. Temperature range -40° to +150°f.

FOLLOWER FLANGES: Ductile Iron ASTM A-536. Designed for high strength/weight ratio. Thickness determined by coupling size.

BOLTS & NUTS: High strength low alloy steel bolts ASTM A-325 with heavy, semi-finished hexagon nuts ASTM A-563 to AWWA C111 (ANSI-A21.1) standards. Stainless Steel bolts available on request.

FINISH: Blue shopcoat enamel standard. Special coatings available on request.



The District uses and allows the use of these mechanical type couplers:

1. Shear Guard
2. Power Max
3. Hymax

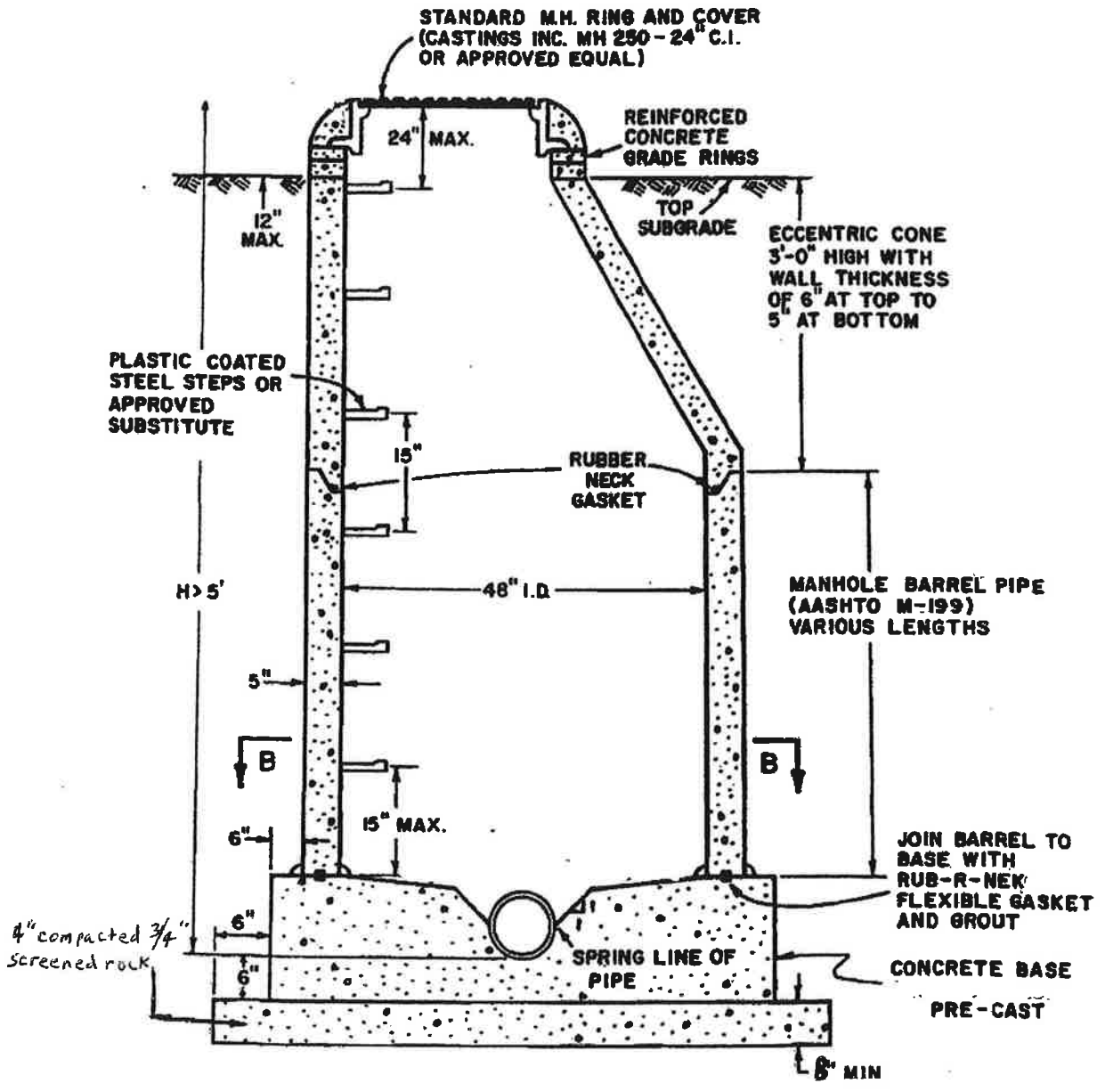
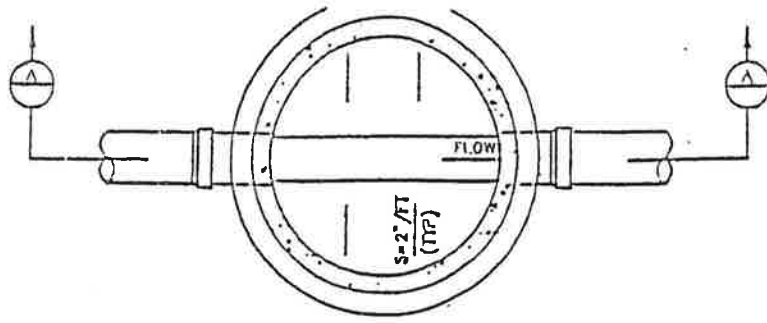
Or as approved by **District Management**

CORTEZ SANITATION DISTRICT

MECHANICAL COUPLING

DRAWING 4

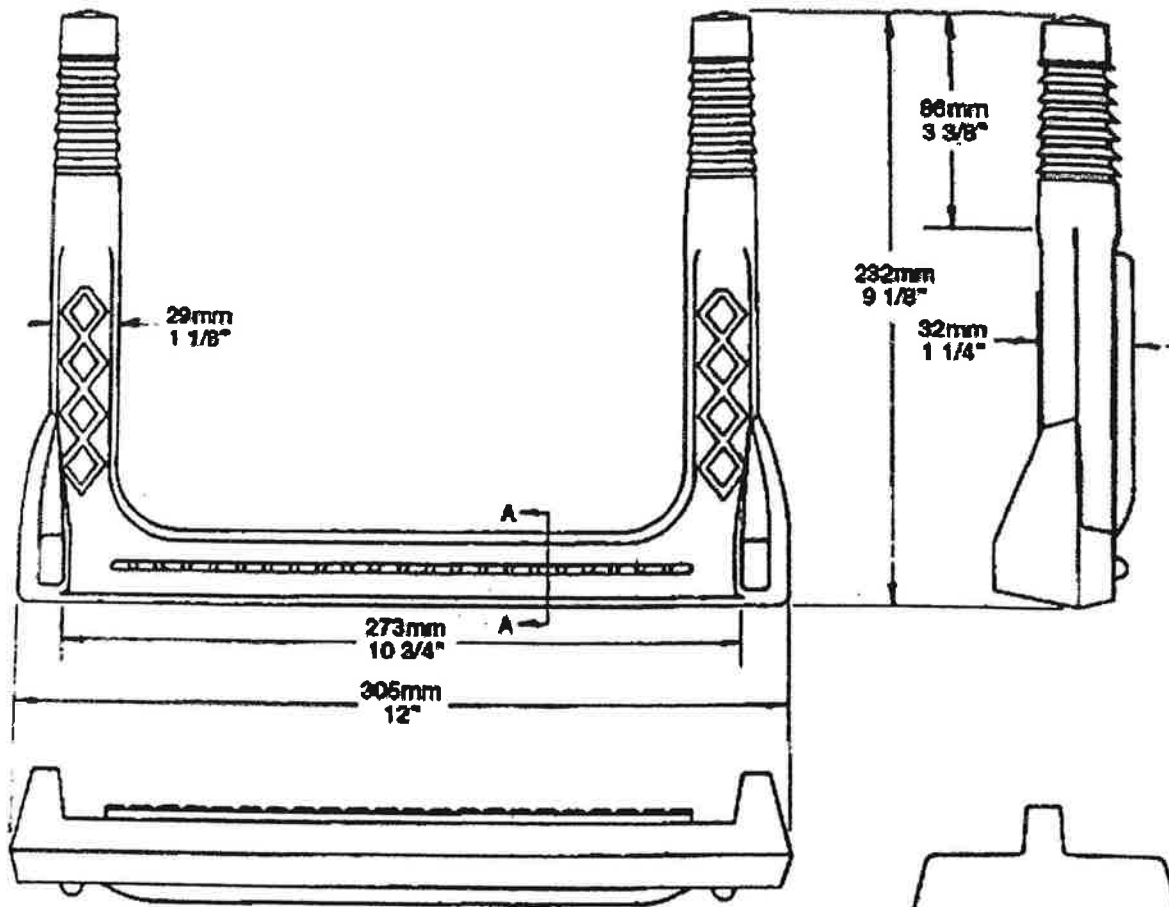
STANDARD



CORTEZ SANITATION DISTRICT

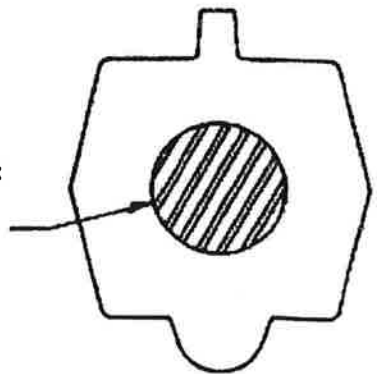
STANDARD MANHOLE

DRAWING 5 47

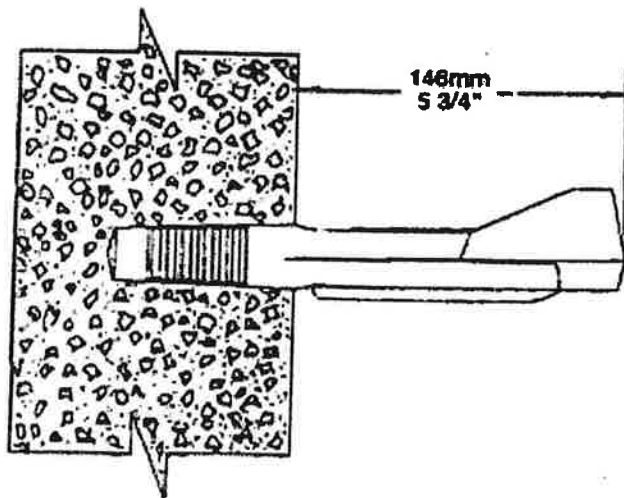


Copolymer Polypropylene Plastic

13mm
1/2" GRADE 60 STEEL REINFORCEMENT



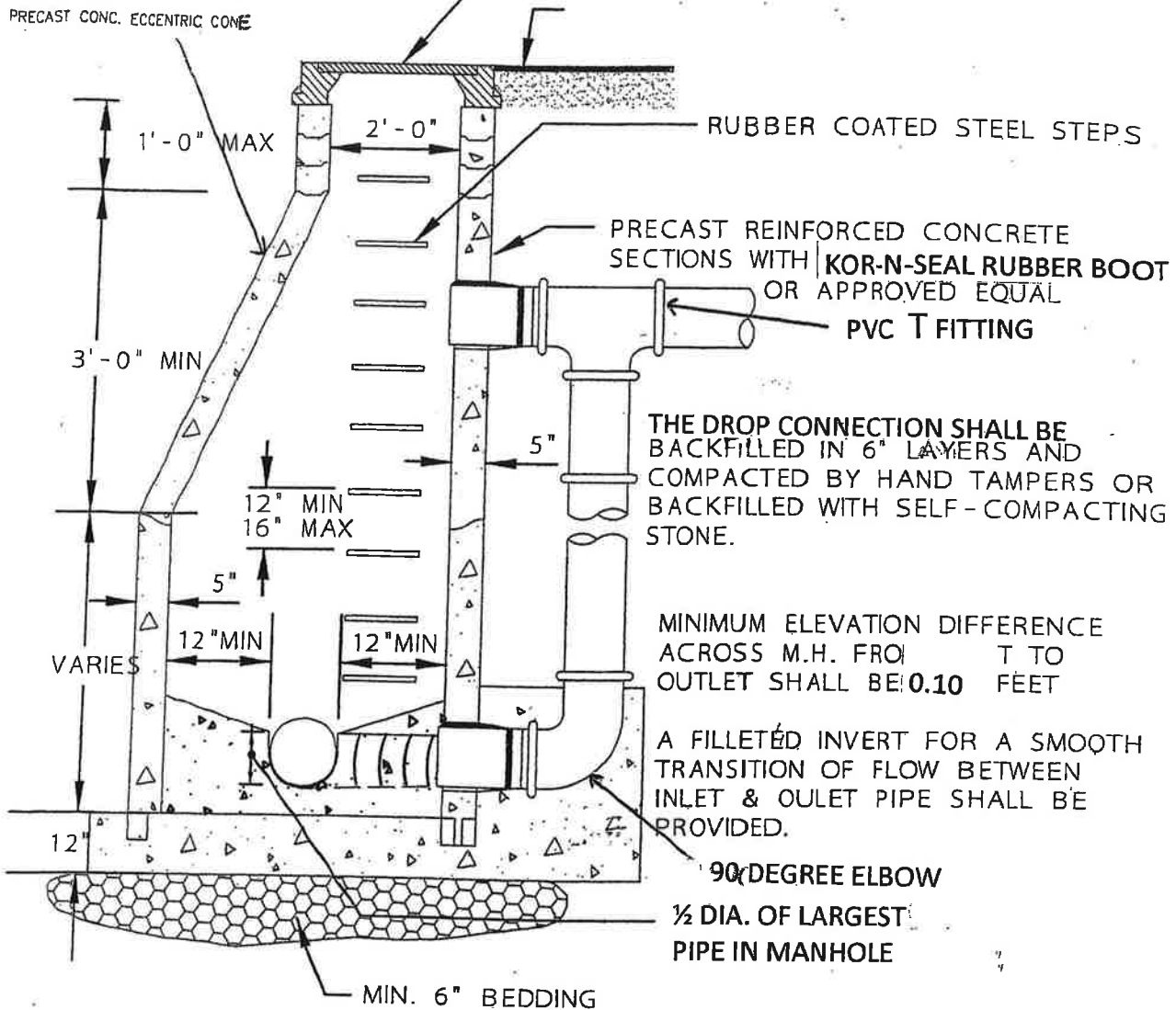
SECTION-A



**MEETS: ASTM-C-478
ASTM-D-4101
ASTM-A-615
AASHTO-M-199**

STANDARD DROP MANHOLE

(SUB GRADE INSTALLATION
MAY BE REQUIRED)



NOTES :

1. ALL COMPONENTS SHALL BE CAPABLE OF HS-20 LOADING.
 2. INSTALL ALL PIPES INTO MANHOLES WITH RUBBER BOOT CONNECTOR ASSEMBLIES
 3. DROP MH SHALL BE USED FOR ALL SITUATIONS WHERE PIPES ENTER MH AT 24" OR HIGHER ABOVE BENCH.
 4. MIN. OF 18" CONC. REQUIRED BENEATH 90° BEND.
 5. COAT EXTERIOR OF ALL MANHOLES WITH 2 COATS OF BITUMASTIC SEALANT.
6. SEAL ALL JOINTS W/ RAMNECK OR APPROVED EQUAL AND GROUT OUTSIDE.

TYPICAL MANHOLE WITH DROP CONNECTION

CORTEZ SANITATION DISTRICT

REVISED

49

DROP MANHOLE

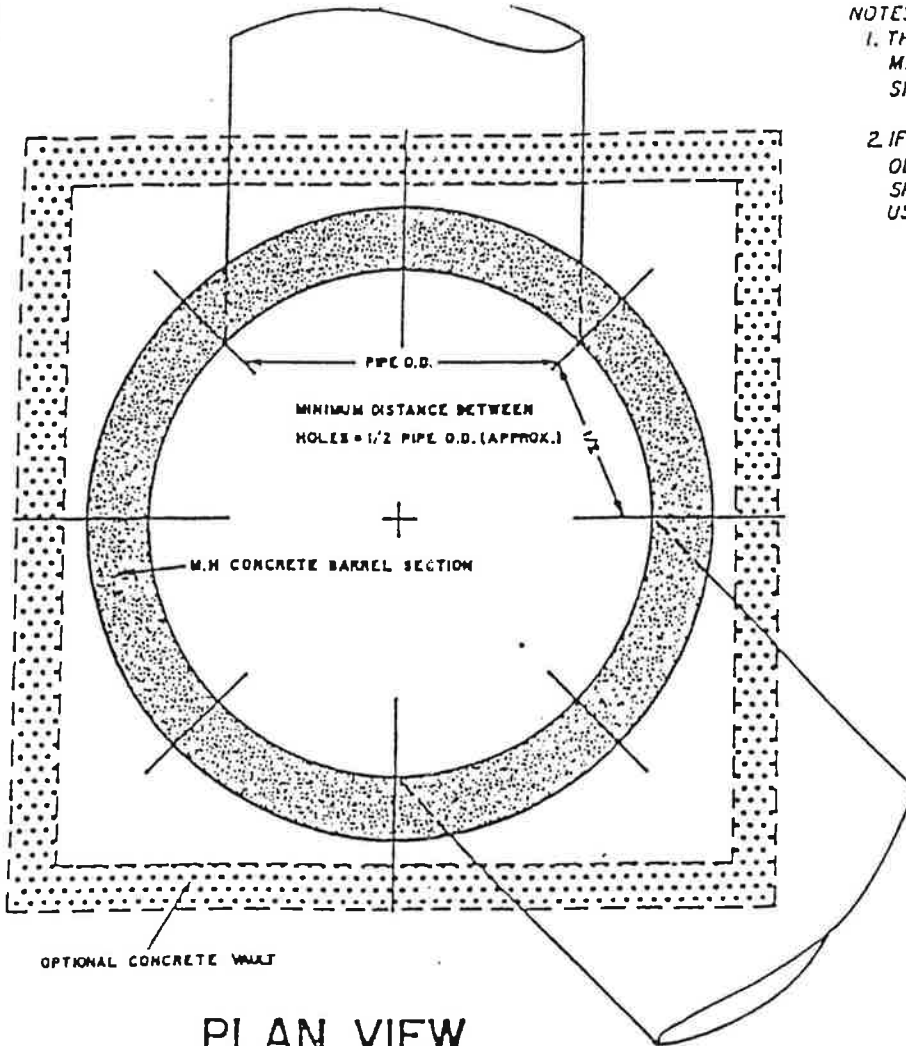
DRAWING 6

STANDARD

NOTES:

1. THE ALIGNMENT OF PIPES INTO THE M.H. WILL DETERMINE THE BARREL SIZE FOR THE SIZE OF PIPE USED.

2. IF MINIMUM DISTANCE CANNOT BE OBTAINED DUE TO PIPE DIAMETERS, A SPECIAL CONCRETE VAULT SHALL BE USED IN PLACE OF A STANDARD M.H.



PLAN VIEW

THE INTERNAL DIAMETER OF THE M.H. BARREL SHALL BE:

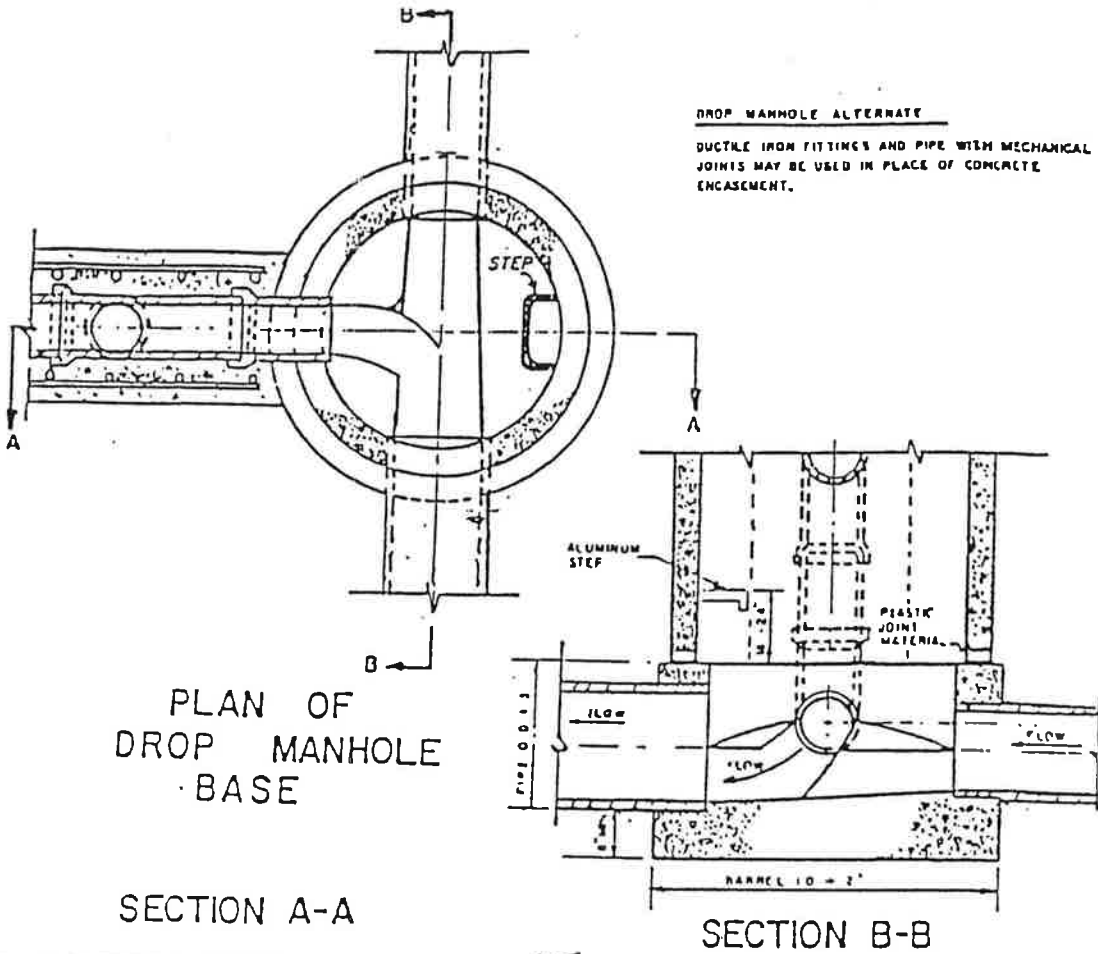
SANITARY SEWER	
PIPE SIZE	BARREL SIZE
12" or LESS	48"
15" to 27"	60"
30" to 48"	72"

CORTEZ SANITATION DISTRICT

MANHOLE BASE

DRAWING 7

STANDARD

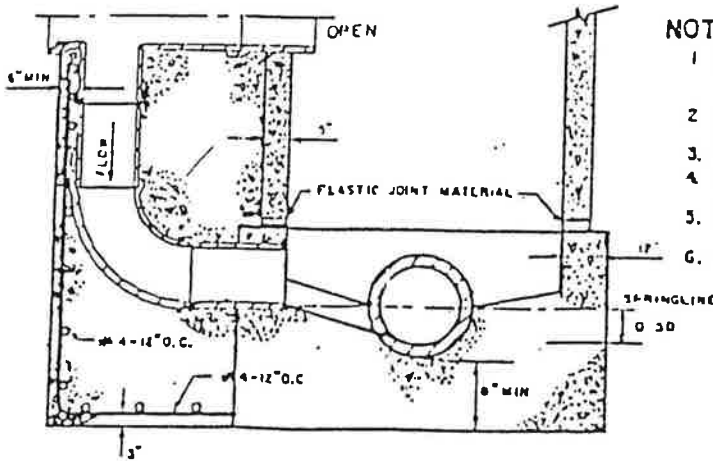


DROP MANHOLE ALTERNATE

DUCTILE IRON FITTINGS AND PIPE WITH MECHANICAL JOINTS MAY BE USED IN PLACE OF CONCRETE ENCASUREMENT.

NOTES

- 1 STRAIGHT PIPE SECTIONS MAY BE LAID THROUGH THE MANHOLE WITH THE CROWN REMOVED.
- 2 UNIFORM PIPE SIZE SECTIONS NOT LAID THROUGH THE MANHOLE SHALL DROP MIN. OF 0.2 FT.
- 3 BENCHES SHALL SLOPE 1 INCH/FT.
- 4 THERE SHALL BE A JOINT MADE AT THE EDGE OF THE MANHOLE BASE
- 5 THE OUTSIDE WALLS SHALL BE FORMED TO THE DESIGNED SHAPE
- 6 THE TOP OF THE BASE SHALL BE LEVEL IN ALL CASES.



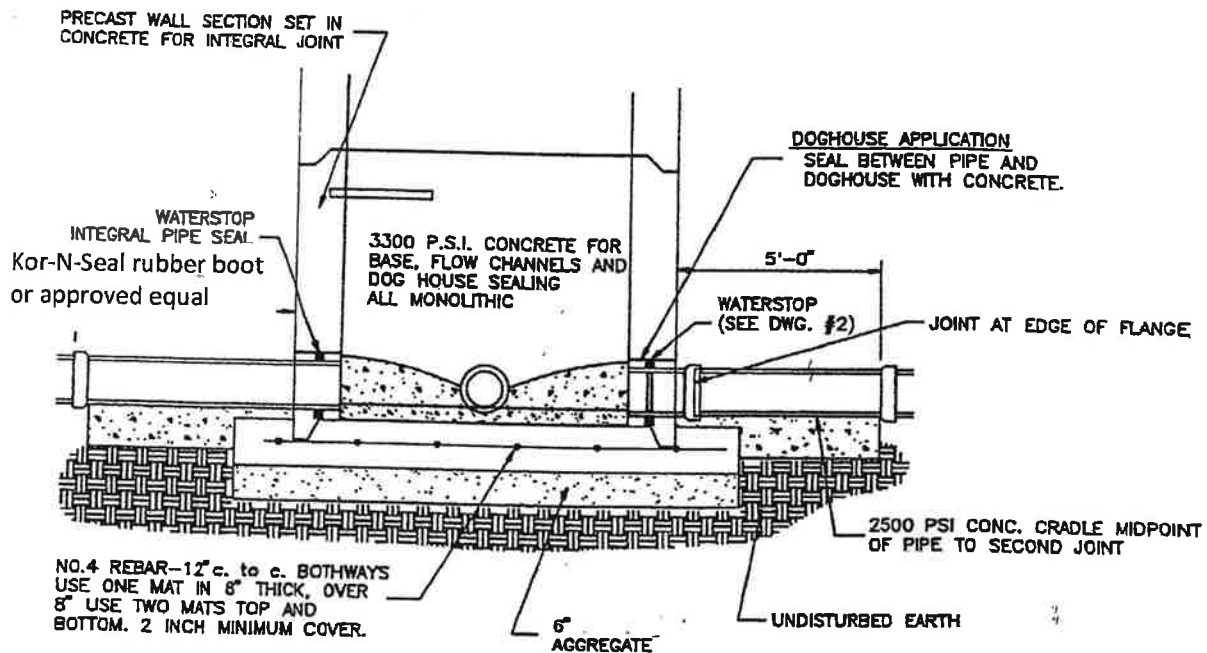
CORTEZ SANITATION DISTRICT

DROP MANHOLE

DRAWING 8

STANDARD

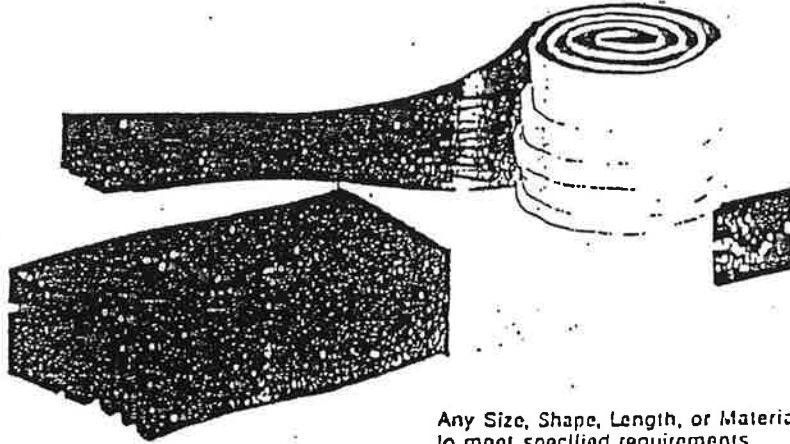
Cast-in-place base/precast wall sections



BASE THICKNESS
 2'-15" PIPE-8"
 18"-27" PIPE-12"
 30"-UP---DESIGN

NOTE:
 Vacuum test required

STANDARD



Any Size, Shape, Length, or Material
to meet specified requirements.

Butyl Resin CONSEAL CS-102 & CS-202

APPLICATION AND SEALING PROPERTIES

- Provides permanently flexible watertight joints.
- Low to high temperature workability:
 - CS-102... 30°F to 130°F
 - CS-202... 10°F to 130°F
- Rugged service temperature resistance of -30°F to +200°F.
- Excellent chemical and mechanical adhesion to clean and dry surfaces.
- Greater cohesive and adhesive strengths.
- Sealed joints will not shrink, harden or oxidize upon aging.
- Available in numerous standard sizes:
 - Specific area cross sections designed for specific joint requirements.
 - Lengths from 36-inch strips to 21-foot rolls.
 - Custom cut lengths at minimum costs.
 - Lower sealing costs resulting from use of proper sizes.
- Controlled flow resistance for application ease.
- Primer is not usually required, however, if temperature is below 40°F, or installation is in a wet hole, or a dust condition exists, apply Concrete Sealants Primer CS-100 to joint.
- Meets Federal Specification SS-S-00210 (210-A) and AASHTO M-1900.

For self-sealing joints in:

CONCRETE MANHOLES • CONCRETE PIPES • VAULTS
UTILITY BOXES • SEWER CONSTRUCTION • SEPTIC TANKS
BOX CULVERTS • VERTICAL PANEL STRUCTURES

CORTEZ SANITATION DISTRICT

MANHOLE SEALANT

REVISED

DRAWING 10

STANDARD

Technical Data Flexible Butyl Resin Sealant CONCRETE SEALANTS

CS-102 & CS-202

CHEMICAL COMPOSITION

	Spec	Required	CS-102	CS-202
Hydrocarbon plastic content % by weight	ASTM D4 (mod.)	50-70	50.8	51.2
Inert mineral filler % by weight	SS-S-210A	30-50	49.2	48.8
Volatile Matter % by weight	ASTM D6	3.0 max.	1.2	1.2

PHYSICAL PROPERTIES

Specific Gravity, 77°F	ASTM D71	1.20-1.35	1.35	1.34
Ductility, 77°F	ASTM D113	5.0 min.	10	12
Softening point, ring and ball °F	ASTM D36	320 min.	390 +	335 +
Penetration, cone 77°F, 150 gm. 5 sec.	ASTM D217	50-120 mm	105 mm	114 mm
Flash point, C.O.C., °F	ASTM D92	600 min.	630°	630°
Fire point, C.O.C., °F	ASTM D92	625 min.	630°	630°

30-Day Immersion: No visible deterioration when tested for 30 days in 5% caustic potash, 5% Hydrochloric Acid, 5% Sulphuric Acid, or 5% saturated Hydrogen Sulfide.

Laboratory-certified test data available upon request

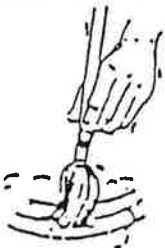
HOW TO SPECIFY

Review the CHEMICAL COMPOSITION and PHYSICAL PROPERTIES listed above and on the front side of this sheet to determine which sealant, CS-102 or CS-202, is more desirable for the project. Note that the installation ambient temperature will be the major deciding factor. Then specify as follows:

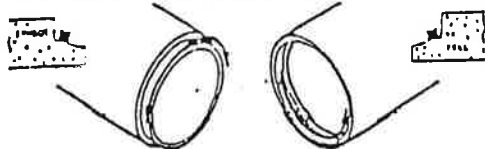
The flexible plastic gasket shall be equal to the flexible butyl resin sealant CONSEAL CS-102 or CS-202 as manufactured by Concrete Sealants, Inc. of New Carlisle, Ohio, and shall conform to Federal Specification SS-S-210A and AASHTO M-198B.

INSTALLATION INSTRUCTIONS

Clean surface.



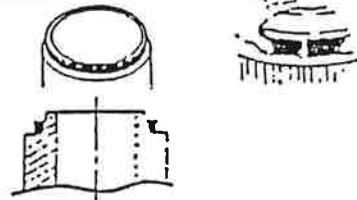
VERTICAL JOINTS ON ROUND, ELLIPTICAL, OR ARCHED PIPE, OR BOX CULVERTS.



Apply CONSEAL on upper 180° of spigot and lower 180° of bell. Allow sufficient overlap of CONSEAL to form a joined seal.

HORIZONTAL JOINTS

Apply CONSEAL all around Butt at joint spigot.



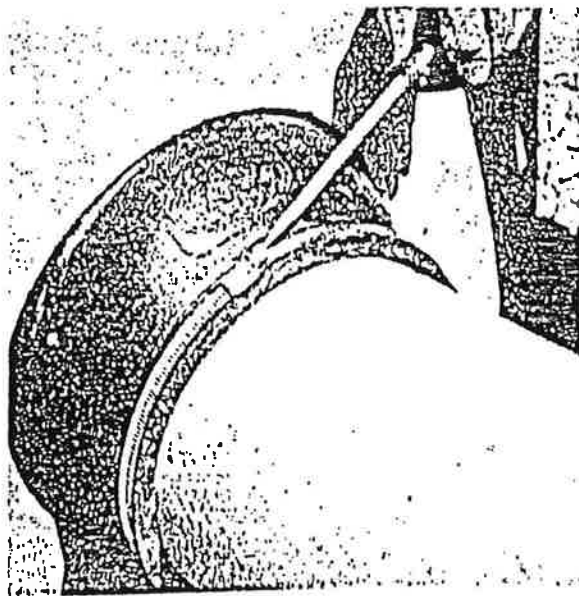
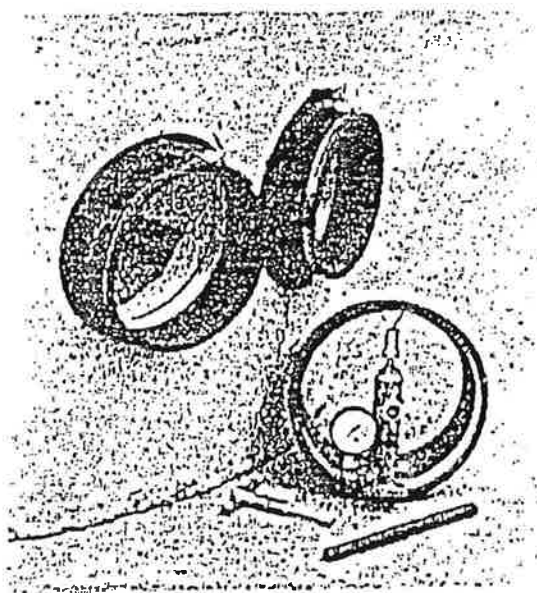
CORTEZ SANITATION DISTRICT

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MANHOLE SEALANT

DRAWING 11

STANDARD



Flexible joint connection between pipe and manhole.

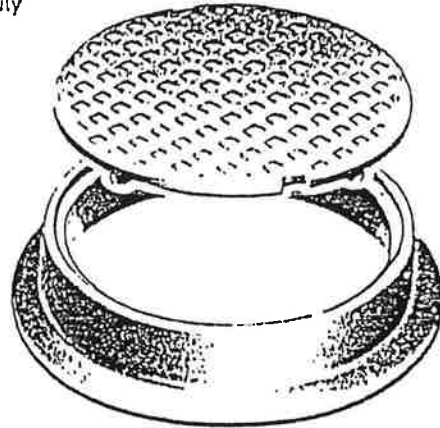
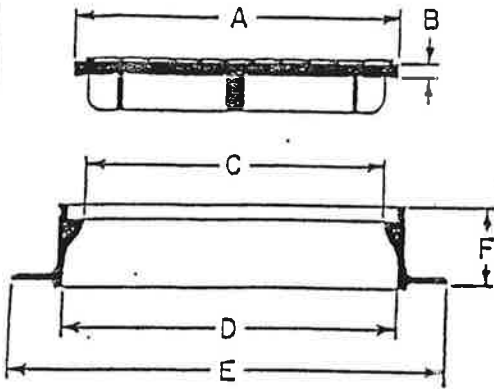
CORTEZ SANITATION DISTRICT

MANHOLE CONNECTION

DRAWING 12

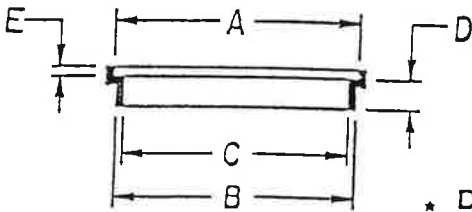
STANDARD

Manhole Ring and Cover Light, Medium and Heavy Duty



Dimensions in inches						Combined
A	B	C	D	E	F	Wt. Lbs.
24	1 1/16	22 1/4	24 5/8	32	6	295

Manhole Adapter Ring (Riser)



★ Denver Standard Rings

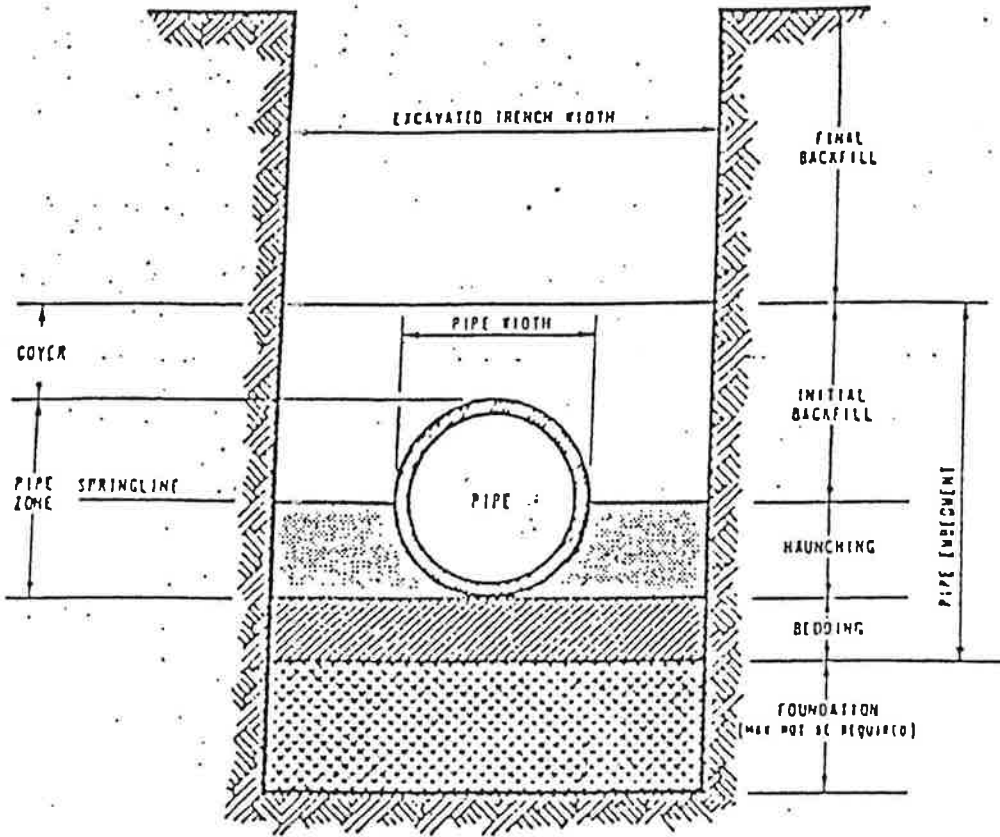
Dimensions in inches						Wt. lbs.
A	B	C	D	E		
24 1/4	23 3/4	22 1/4	1 1/2	1		50
24 1/4	23 3/4	22 1/4	2	1		64
24 1/4	23 3/4	22 1/4	2 1/2	1		73
24 1/4	23 3/4	22 1/4	3	1		82
24 1/4	23 3/4	22 1/4	4	1		85
24 1/4	23 3/4	22 1/4	5	1		89
24 1/4	23 3/4	22 1/4	6	1		95

CORTEZ SANITATION DISTRICT

MANHOLE RING AND COVER

DRAWING 13

STANDARD



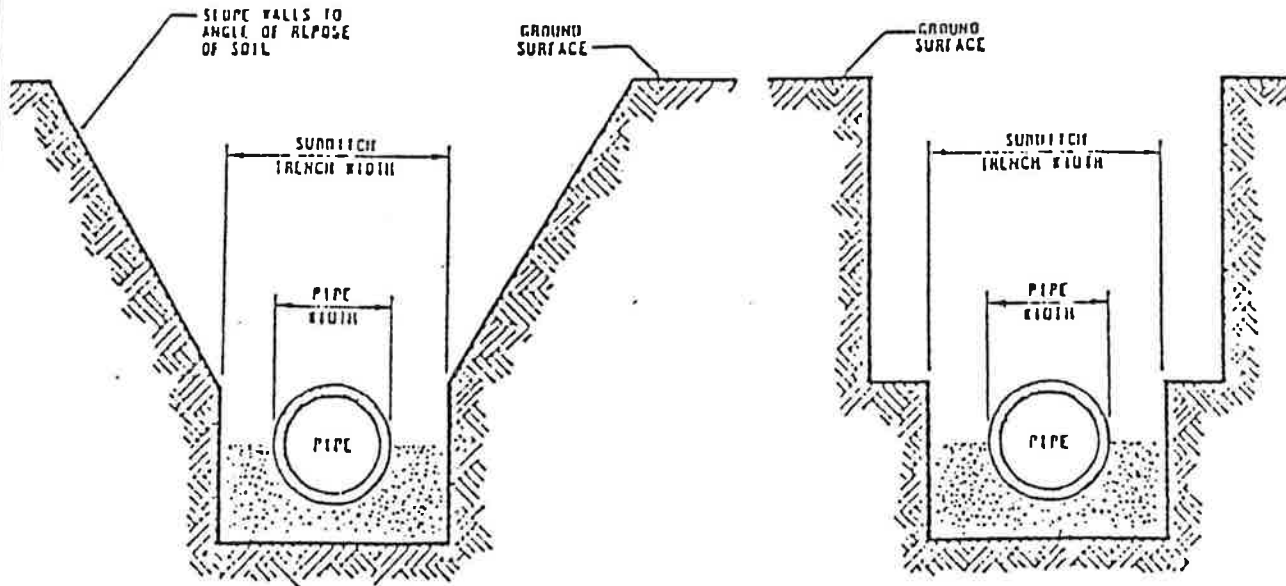
CORTEZ SANITATION DISTRICT

TYPICAL TRENCH SECTION

DRAWING 14

STANDARD

EXAMPLES OF SUBDITCH



CORTEZ SANITATION DISTRICT

TRENCH SECTION WITH SUB DITCH

DRAWING 15

EXAMPLE

CITY OF CORTEZ STREET CUT PERMIT

Project Address:
 Legal Description:
 Applicant: Cortez Sanitation District Phone: 970.565.3962
 Other Permits on this project: No other permits on file
 Project Description: Test
 Special Conditions:

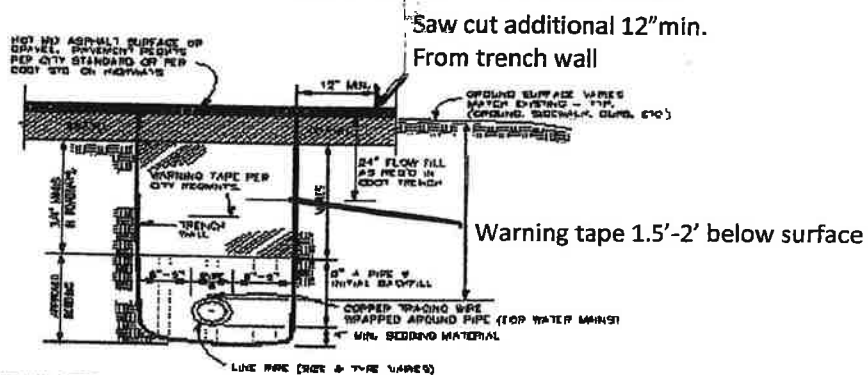
***CALL UNCC @ 1-800-922-1987 FOR LINE LOCATES BEFORE YOU DIG ***

ROADWAY BACKFILL: In roadways, alleys, and driveways, the backfill shall be a road base material as approved by the engineer to the top of the existing road grade. Proper moisture conditioning and compaction will be required as needed to obtain 95% relative compaction based on a Modified Proctor (ASTM D1557) for the trench backfill material. Class 6 road base, or equal, per CDOT specifications, is required.

NON-ROADWAY AREAS BACKFILL: Soil compacted to 90% of a Modified Proctor density may be placed on non-roadway areas. Soil used for backfill in trenches will not contain particles greater than 6 inches (6") in diameter.

TRAFFIC CONTROL: Applicant must provide traffic control for work zones, per MUTCD. If it is necessary to completely block the street, applicant must notify the City Police Department (565-8441) and Cortez Fire Department (564-0212). Please contact the City Engineer at 565-7320 with questions.

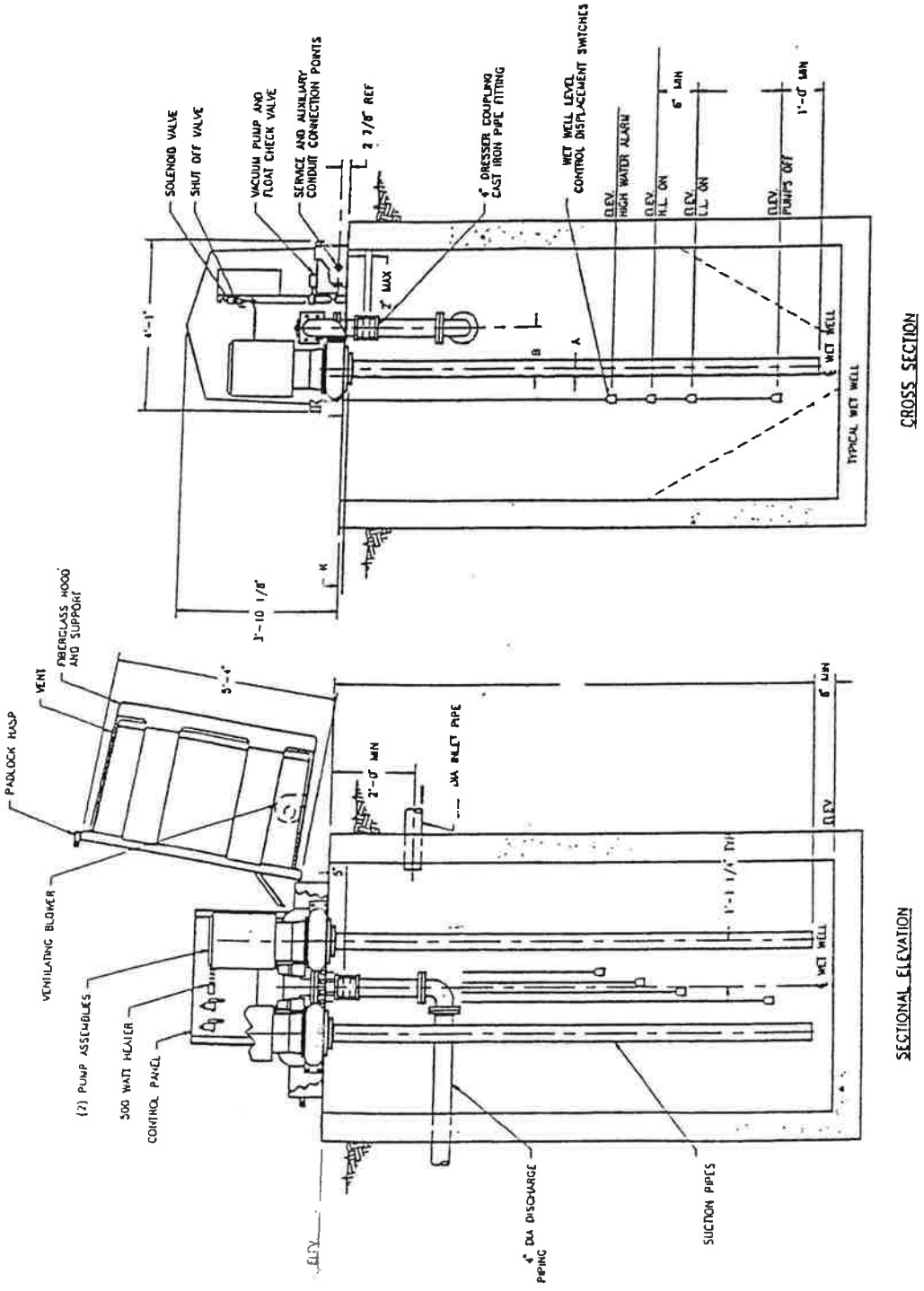
Note: Applicant is responsible for workmanship and material defects for a period of ninety (90) days.



GENERAL NOTES:
 1. ALL BACKFILL SHALL BE EIGHT (8) INCHES (8") MAX. SIZE COMPACTED TO AT LEAST 90% FOR AREAS UNDER PAVEMENT & SIDEWALKS (STD. PROCTOR DENSITY)
 2. ALL VISIBLE WARNING TAPE SHALL BE INSTALLED IN THE TRENCH AT APPROX. 1/2 THE TRENCH DEPTH INDICATED THE TYPE OF UTILITY PRINTED ON IT.
 3. ALL TRENCH WIDTHS ARE 18" FOR PIPE SIZES LESS THAN 18". FOR PIPE SIZES LARGER THAN 18" A MIN. 6" CLEARANCE SHALL BE ALLOWED ON EACH SIDE OF PIPE.
 4. TRENCHES LESS THAN 18" IN DEPTH SHALL BE BACKFILLED WITH FLOW FILL MATERIAL.
 TYPICAL TRENCH DETAIL
 N.T.S.

SURFACED ROADWAY REPLACEMENT: The City of Cortez will patch back the roadway trench with hot-mix asphalt based on a square foot price of \$6.50/sq.ft. and invoice the APPLICANT.

STANDARD

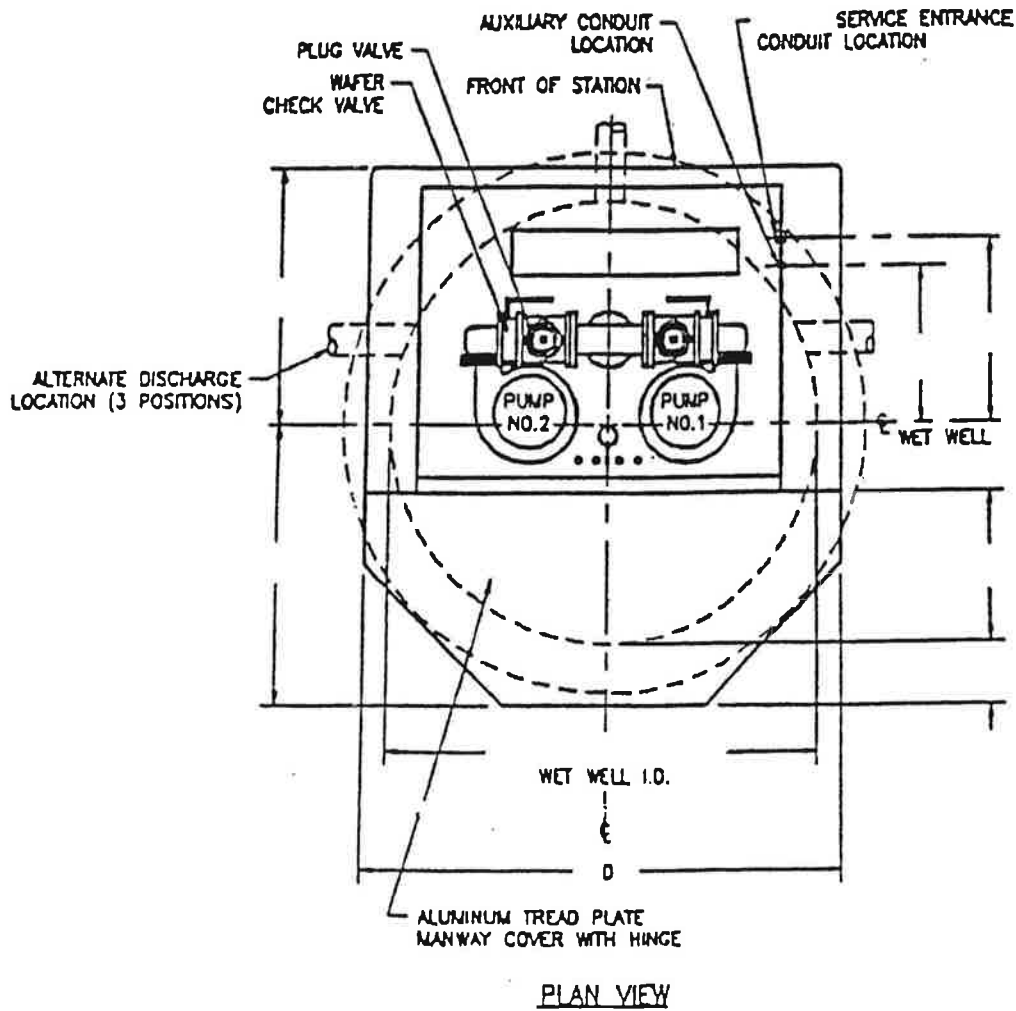


CORTEZ SANITATION DISTRICT

LIFT STATION - TYPICAL

DRAWING 17

STANDARD



CORTEZ SANITATION DISTRICT

LIFT STATION - TYPICAL

DRAWING 18

APPENDIX 2

NEGATIVE AIR PRESSURE TEST FOR MANHOLES

VACUUM TESTING OF MANHOLES:

A. This specification shall govern the vacuum testing of sanitary sewer manholes and structures and shall be used as a method of determining acceptability by the OWNER, in accepting maintenance of a sanitary sewer manhole or structure on behalf of the public. Vacuum testing shall be according to ASTM C1244-11 for tests prior to backfill. Other forms of testing of some manholes may be required as deemed necessary by the OWNER.



Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill¹

This standard is issued under the fixed designation C1244; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers procedures for testing precast concrete manhole sections when using the vacuum test method to demonstrate the integrity of the installed materials and the construction procedures. This test method is used for testing concrete manhole sections utilizing mortar, mastic, or gasketed joints.

1.2 This test method is intended to be used as a preliminary test to enable the installer to demonstrate the condition of the concrete manholes prior to backfill. Users are hereby cautioned that misuse or misapplication of the test criteria contained herein can cause permanent damage to the system being tested.

NOTE 1 Vacuum test criteria presented in this test method are similar to those in general use. The test and criteria have been widely and successfully used in testing manholes.

NOTE 2—The user of this test method is advised that no correlation has been found between vacuum (air) and hydrostatic tests.

1.3 This test method is the companion to metric Test Method C1244M; therefore, no SI equivalents are shown in this test method.

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

¹ This test method is under the jurisdiction of ASTM Committee C13 on Manholes and Specials.

Current edition approved Nov. 1, 2011. Published November 2011. Originally approved in 1993. Last previous edition approved in 2005 as C1244 – 05a ¹. DOI: 10.1520/C1244-11.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

C822 Terminology Relating to Concrete Pipe and Related Products

C924 Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method

C969 Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

C1244M Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill (Metric)

3. Terminology

3.1 For definitions of terms relating to manholes, see Terminology C822.

4. Summary of Practice

4.1 All lift holes and any pipes entering the manhole are to be plugged. A vacuum will be drawn and the vacuum drop over a specified time period is used to determine the acceptability of the manhole.

5. Significance and Use

5.1 This is not a routine test. The values recorded are applicable only to the manhole being tested and at the time of testing.

6. Preparation of the Manhole

6.1 All lift holes shall be plugged.

6.2 All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.

7. Procedure

7.1 The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.

7.2 A vacuum of 10 in. Hg shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 in. Hg.

TABLE 1 Minimum Test Times for Various Manhole Diameters (30 – 120 in.) in Seconds

Depth (ft)	Diameter, in.								
	30	33	36	42	48	54	60	66	72
	Time, in seconds								
<4	6	7	7	9	10	12	13	15	16
6	9	10	11	13	15	18	20	22	25
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	29	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

TABLE 1 Minimum Test Times for Various Manhole Diameters (30 – 120 in.) in Seconds (continued)

Depth (ft)	Diameter, in.							
	78	84	90	96	102	108	114	120
	Time, in seconds							
<4	18	19	21	23	24	25	27	29
6	26	29	31	34	36	38	41	43
8	35	38	41	45	48	51	54	57
10	44	48	52	56	60	63	67	71
12	53	57	62	67	71	76	81	85
14	62	67	72	78	83	89	94	100
16	70	76	83	89	95	101	108	114
18	79	86	93	100	107	114	121	128
20	88	95	103	111	119	126	135	142
22	97	105	114	122	131	139	148	156
24	106	114	124	133	143	152	161	170
26	114	124	134	144	155	164	175	185
28	123	133	145	155	167	177	188	199
30	132	143	155	166	178	189	202	213

7.3 The manhole is acceptable if the time for the vacuum reading to drop from 10 in. Hg to 9 in. Hg meets or exceeds the values indicated in Table 1.

7.4 If the manhole fails the initial test, the manhole shall be repaired by an approved method until a satisfactory test is obtained.

7.5 Use or failure of this vacuum test shall not preclude acceptance by appropriate water infiltration or exfiltration testing, (see Practice C969), or other means.

8. Precision and Bias

8.1 No justifiable statement is presently capable of being made either on the precision or bias of this procedure, since the test result merely states whether there is conformance to the criteria for the success specified.

9. Keywords

9.1 acceptance criteria; concrete; manhole sections; test method; vacuum test

APPENDIX

(Nonmandatory Information)

X1. Air Testing for a Single Diameter Pipe

X1.1 The standard accepted method of air testing, for a single diameter pipe, Practice C924, allows a drop of 1 psi pressure during the time calculated by the formula:

$$T_{press} = \frac{KD^2L}{Q} \quad (X1.1)$$

where:

- T time for 1 psi drop in pressure
- K 0.00037 for in./lb units
- D pipe diameter, in.
- L length of line, ft
- Q air loss, ft³/min

X1.2 A pressure drop of 1 in. Hg for the vacuum test compares to a pressure drop of 0.490 psi for the air test.

$$1 \text{ in. Hg} \times \frac{14.696 \text{ lb/in.}^2}{29.02 \text{ in. Hg}} = 0.490 \text{ psie} \quad (X1.2)$$

Therefore, the time relationship is:

$$T_{vac} = 0.490 T_{press} \quad (X1.3)$$

or

$$T_{vac} = \frac{T_{press}}{2.04} \quad (X1.4)$$

X1.3 The allowable test times cited in Practice C924, Table 2, for pipe sizes 4 in. to 24 in. diameter are provided in Table X1.1 and Table X1.2. The allowable test times for sizes above 24 in. were obtained by extrapolation. Therefore, using the appropriate Q , we find that:

for 30 in. ($Q = 7 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.023 L$

for 78 in. ($Q = 15 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.073 L$

for 36 in. ($Q = 8 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.029 L$

for 84 in. ($Q = 16 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.079 L$

for 42 in. ($Q = 9 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.035 L$

for 90 in. ($Q = 17 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.086 L$

for 48 in. ($Q = 10 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.041 L$

for 96 in. ($Q = 18 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.092 L$

for 54 in. ($Q = 11 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.048 L$

for 102 in. ($Q = 19 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.099 L$

for 60 in. ($Q = 12 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.054 L$

for 108 in. ($Q = 20 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.105 L$

for 66 in. ($Q = 13 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.060 L$

for 114 in. ($Q = 21 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.112 L$

for 72 in. ($Q = 14 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.067 L$

for 120 in. ($Q = 22 \text{ ft}^3/\text{min}$), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.118 L$

**TABLE X1.1 Minimum Test Times for Various Pipe Diameters
(Practice C924)**

Nominal Pipe Size, in.	Time (T), min 100 ft.
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0

**TABLE X1.2 Allowable Air Loss for Various Pipe Diameters
(Practice C924)**

Nominal Pipe Size, in.	Air Loss (Q), ft ³ /min
4	2
6	2
8	2
10	2.5
12	3
15	4
18	5
21	5.5
24	6
30	7
36	8
42	9
48	10
54	11
60	12
66	13
72	14

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