PIMA COUNTY, ARIZONA

DEPARTMENT OF WASTEWATER MANAGEMENT

DESIGN STANDARDS

FOR PUBLIC SEWERAGE FACILITIES

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PIMA COUNTY, ARIZONA

DEPARTMENT OF WASTEWATER MANAGEMENT

DESIGN STANDARDS FOR PUBLIC SANITARY SEWERAGE FACILITIES

PREAMBLE

General

The construction documents for all new sanitary sewerage facilities which are designated to become a part of the Pima County Public sanitary sewerage system shall be reviewed and approved by Pima County Wastewater Management. These standards set forth the minimum criteria for the design of such sanitary sewerage facilities. It is not intended that these standards cover all situations that may arise or that they be a substitute for creative engineering design. Creative design based on sound engineering principles is encouraged.

New public sanitary sewerage facilities shall be designed in accordance with the Pima County Wastewater Management Department's Standard Specifications and Details (latest editions) and the Arizona Department of Health Services Engineering Bulletin No. 11 (latest edition). Any deviations from these design standards, specifications and/or details, shall have the prior (preferably prior to the first formal submittal for review of the involved construction documents) written approval of Wastewater Management.

Special Projects

Projects which involve the design of "over-sized" sewer conveyance facilities or wastewater treatment/reclamation facilities (new ones or the expansion of existing plants) shall be considered as "special projects". In those instances, the following additional requirements may be imposed:

1. The Pima County Wastewater Management Department reserves the right to participate in and/or to approve (in advance) the selection of the qualified design engineer/consultant being retained by the Developer to design the facility. In certain instances, a special agreement between the developer and Pima County Wastewater Management may supercede this requirement.
2. A pre-design meeting should be held in order to clarify the design issues/considerations which may be unique to the "special project" being designed.
3. The developer may be required by Wastewater Management, as the specific case dictates, to perform any or all of the following tasks:
   a. Amend the Regional 208 Water Quality Plan.
   b. Develop an acceptable facility plan for the new sewerage facility.
   c. Assist in developing an approvable method/means of disposing of the treated effluent and/or solids generated by the facility.
   d. Attend any required public meetings and/or hearings and answer all questions relating to the design/integrity of the proposed facility.

Public vs. Private Sewers

The determination of the appropriate classification (public or private) for the proposed sanitary sewers will be made by Wastewater Management during the planning/subdivision review phase of each projected development. For classification, the following information is presented:

Public sanitary sewerage facilities - Those facilities which are to be owned, operated, and maintained by Pima County. All such facilities shall be designed, constructed and/or installed in accordance with the aforementioned standard specifications and details, as contained within Wastewater Management's Manual of Engineering Standards and Procedures.

Privately Owned sanitary sewerage facilities -Those facilities constructed at the expense of the property owner in accordance with the standards established for sanitary sewage conveyance facilities located on private property as adopted by the governmental entity within whose jurisdiction the system is located or in accordance with construction plans approved by the Building Codes Agency having jurisdiction over the area involved. The ownership and responsibility for maintenance and operation of the private sewerage facilities rests with the owner of the private property or an authorized Homeowners'/Lot Owners' Association. The limits of said responsibility extend from the actual point of connection to the public sewer system through to the plumbing fixtures within the connected buildings. (See Appendix B for Design Standards for Sanitary Sewerage Conveyance Facilities on Private Property.)

CRITERIA FOR SANITARY SEWERAGE FACILITY CONSTRUCTION PLAN LAYOUT

General

All construction plans shall be drawn on 24 inch by 36 inch material (paper, mylar, linen, etc.) and accomplished in such a manner, that clear and readable blueline prints are attainable. Plans which involve modifications of or extensions to existing systems shall indicate clearly the method of connection and/or the relationship thereto. If not already on file, submission of construction plans for the existing system may also be required. Plan review fees must be paid prior to the review of the initial submittal by Wastewater Management.

Adequate Design Data Shall Accompany All Final Plans

Construction plan documents for raw sewage facilities shall be prepared by a registered professional engineer licensed to practice in the State of Arizona under provisions of A.R.S. 32:141-145 and shall have the necessary professional seal "legibly" affixed to each sheet of the plan documents, signed and dated. One complete blueline set of the detailed construction plans and specifications shall be required for initial review and one set for each subsequent review required. The original check prints are to be resubmitted with each subsequent submittal.

Complete detailed specifications for the construction of the facilities and the involved appurtenances shall accompany or be placed on the construction plans and/or reference made on the plans to appropriate Pima County Wastewater Management Department Standard Specifications and/or Details. The "General Notes", as shown on Appendix "A", shall apply to the Planning, Design, and Construction of all Public Sewerage Facilities. These General Notes must appear conspicuously on the cover sheet or detail sheet of all construction plans.

If, after the construction documents have been approved by Wastewater Management, any deviations or changes from approved plans or specifications affecting the structural integrity, capacity, or operational and maintenance characteristics of the facility are proposed, written approval from Wastewater Management must be secured and the plans/specifications reviewed prior to implementation in the field.

After completion and acceptance (by Pima County) of the construction, accurate "As Built" or "As Staked" plans (as the specific case dictates) will be prepared and submitted to Pima County Wastewater Management Department for permanent records. Those plans must be clear blueline prints suitable for reproduction/microfilming and shall clearly and accurately represent the facilities as they were constructed. The prints will be placed on file with the Pima County Wastewater Management Department before the final release of the facility(ies) will be issued.

Pima County Wastewater Management reserves the right to require the design consultant to submit the project's final design calculations in acceptable, legible and understandable form for Departmental records.

Sanitary Sewage Conveyance Facilities

Title Sheet

The title sheet for sanitary sewer plans shall show the following:

a. The recorded subdivision name or job title.

b. The specific lots to be served. If certain lots of the platted subdivision are to remain unsewered, it shall be boldly called out on the title sheet by noting and labeling of the specific lots.

c. The overall system layout and the location of the sewers (inclusive of the manholes and HCS's) - scaled but not dimensioned. The background plan for this layout shall be a scaled presentation of the plat, the subdivision development plan and/or existing rights-of-way/easements, inclusive of street names and lot numbers. Sheet numbers shall be called out. Also, the lots requiring backwater valves on the house connection sewers shall be called out by symbol and/or listed in numerical order as the situation/scale permits.

d. The owner/developer's name, address and phone number.

e. The consulting engineering firm's name, address and phone number.

f. Information such as the plan scale, north arrow, bench mark and datum base.

g. Location plan - scale three (3") inches equals one (1) mile, with proposed development, projected or high-lighted, adjacent platted subdivisions called out, major street intersections and the section(s), township(s), and range(s) noted.

h. Legend for all symbols utilized.

i. The boundary line of the municipality, sewer district or area (property) to be sewered shall be indicated.

j. Approval (signature) blocks for Pima County Wastewater Management Department and for the Department of Transportation and Flood Control District or the City Engineer, as appropriate.

k. Pima County Wastewater Management Department Plan Reference Number <u>AND CO 12 NUMBER.</u>

<u>Plan, Profile and Detail Sheets</u>

The plan and profile views shall be aligned at the beginning of each sheet. Sewer plans should be oriented so that the flow in the sewer is from right to left on the sheet. Each sewer plan should include a north arrow consistent with this arrangement. Stationing should be upgrade from left to right, generally along the sewer centerline.

<u>The Plan View</u> shall show all easement boundaries (labeled as to type, purpose & width), land ownership and recording data. It will be necessary to include such pertinent features as existing and proposed utilities (both public <u>and</u> private), all structures such as driveways, roads, bridges and culverts and an adequate description of them. All plan views will show such items as 100-year flood limit, bench mark(s), north arrow, scale, match lines and associated sheet numbers. The plan view should be oriented on the sheet such that North is toward the top of the plan view/sheet.

Stationing shall be shown for all appurtenant facilities such as manholes, cleanouts and house connection sewers. The new sewer facility shall be correctly dimensioned from section lines, survey control lines, property lines and/or easement boundaries - all as the situation dictates. Coordinates and bearings <u>or</u> bearings (only) will be utilized to define the horizontal position of the proposed main line sewer in all instances except when the main is located within dedicated/monumented public rights-of-way. Within such rights-of-way, the alignment of the main shall be described using either bearings or coordinates or calculated stationing in combination with calculated right angle dimensional ties to the centerline of the rights-of-way.

<u>The Profile View</u> shall contain information describing each reach of sewer line and include both the existing and finished ground profile, pipe/constructon to be utilized, material, length, size, slope and station of each appurtenance relevant to the system. Elevations of all manhole inverts and rims must also appear in profile and be called out to the nearest hundredth of a foot (0.01').

All pertinent utilities which could affect construction should be accurately plotted in the profile view to show their relationship to the proposed sewer facility. All special fittings must be properly identified and described as to their size, material and their effect upon the elevations of the facility.

Where adjacent drainageways or washes are in possible conflict with, or could have a future negative impact upon the proposed line, special details such as enlarged profiles, plotting the flowline invert elevation of the adjacent wash on the sewer design profile or related cross sections may be required on the construction plans by the reviewing agency. Attention must be given to local run-off conditions where flood damage to the line may occur, or where run-off may be diverted onto contiguous private property.

Special profiles or details drawn to scale may be required for connections to existing manholes and large diameter (24 inches or more in diameter) trunk or interceptor sewers, as well as non-standard structures which are a part of the system or provide structural support. All details should be accompanied by notes explaining their function, capacities and their location in the system. Where Pima County Wastewater Management Department standard details apply, reference may be made to these details by number only.

Unless otherwise approved, the scales used in the main body of the drawings shall conform to the standard of this agency and shall be one inch equals forty feet (1" = 40') horizontally and one inch equals four feet (1" = 4') vertically. Where the profile is exceptionally irregular or steep, a vertical scale up to one inch equals eight feet (1" = 8') may be used.

Design Criteria for Sewage Conveyance Facilities

The design of sanitary sewers and related facilities, to be installed within public rights-of-way and/or easements for public ownership and maintenance, shall conform to the Arizona State Department of Health's Bulletin No. 11, entitled: Minimum Requirements for Design, Submission of Plans and Specifications of Sewage Works (latest revision) and to the Pima County Wastewater Management Department Standard Specifications and Details, latest revision.

Design Capacities

All new sanitary sewers shall be designed to carry the designated PWWF (peak wet weather flow) from the area ultimately tributary to the respective reach of sewer. The diameter of the proposed gravity sanitary sewer shall be selected such that the designated PWWF is conveyed at "full flow" depths when placed at the design grade and alignment.

The design must meet the minimum criteria established by the Arizona Department of Health Services Engineering Bulletin No. 11. However, more stringent requirements by Pima County Wastewater Management Department may be necessary.

The required minimum flow carrying capacities (PWWF) for all new sewers, which are being designed (or oversized, as the specific case dictates) to provide for flow-through capacity, or are classified as outfall or as off-site augmentation sewers, shall be reviewed and approved by the Pima

County Wastewater Management Department, Engineering Division. The required capacity may either be established by Wastewater Management or by means of a basin study developed by the designer - County option.

CORROSION MITIGATION

The possibility of either external or internal corrosion taking place on sewerage facilities shall be considered in the design phase. Protective measures shall be incorporated into the design plans to assure that a 100 year usable life is attainable for a given sewerage facility.

Standard Pipe Material for Public Gravity Sanitary Sewer Mains

The following sewer pipe materials, as outlined in PCWMD Directive No. ENG-D-2, are considered acceptable for installation in public sewer system:

Material	ASTM	Special Comments
Extra Strength Vitrified Clay Pipe (ESVCP)	C-700	See Note No. 1 Below
	C-425	
Ductile Iron Pipe (DIP)	A-746	See Note No. 3 Below
Poly Vinyl Chloride Pipe (PVC)	D-3034	See Note No. 4 Below

Notes:

1. The following types of Extra Strength Vitrified Clay Pipe (ESVCP) are acceptable:
   a. ESVCP with bell & spigot
   b. Plain-end ESVCP pipe utilizing a mechanical compression coupling type joint with an internally positioned shear ring.

2. All DIP shall have its interior surface lined. The type of lining shall be one of the following:

   a. Polyethylene.

   b. Coal Tar Epoxy.

   The type of interior lining to be used shall be decided by the Pima County Wastewater Management Department.

3. All DIP shall have a Polyethylene encasement unless the Pima County Wastewater Management Department approves or directs otherwise. In determining whether or not a polyethylene encasement, some type of exterior coating or cathodic protection is needed, a corrosion report may be required by the Pima County Wastewater Management Department for their review, approval, and use. This corrosion report shall evaluate the soil and any other conditions that might affect the corrosion rate of the exterior of gray and ductile case-iron pipe and steel H-piles. This corrosion report shall address one or more of the following factors when required by PCWWMD:

   a. Earth Resistivity

      1) Single-probe at pipe depth or water-saturated soil box

      2) Wenner 4 electrode method

   b. pH

      1) Beckman Electromate pH meter

   c. Oxidation-Reduction (REDOX) Potential

      1) Beckman pH Meter with Platinum and Reference Electrodes

   d. Sulfides

      1) Sodium Azide-Iodine Qualitative Test

e. Moisture Content (Relative)

1) Prevalence

f. Soil Description

1) Particle Size

2) Uniformity

3) Type

4) Color

g. Potential Stray Direct Current

1) Nearby Cathodic Protection Utilizing Rectifiers

2) Railroad (Electric)

3) Industrial Equipment, Including Welding Equipment

4) Mine Transportation Equipment

h. Experience with existing installation in the area

i. Cost of protective measures

j. Expected usage life of the pipe or pile.

4. If cathodic protection is necessary for a given project, a design report shall be submitted to the PCWWMD for review and approval prior to final approval of the construction plans and specifications.

5. The nominal laying length of each full pipe section of PVC pipe shall be 12.5 feet. All such pipe shall be deflection tested after completion of the final backfill, with a 5.0% maximum deflection allowed. PVC pipe shall have a maximum Standard Dimension Ratio (SDR) of 35 in conformance to ASTM D-2241. Joints shall be bell & spigot type - with elastomeric gaskets, suitable for sanitary sewer service.

6. The above noted pipe materials are those acceptable for use in constructing public collector and trunk sewers of less than 18" nominal internal diameter. For new systems involving pressure main, gravity pipe with diameters of 18" or greater, conveyance facilities which require structural provisions, and/or for systems that will be conveying sewage with unique characteristics, Pima County Wastewater Management Department reserves the right to specify which materials shall be considered as being viable, on an individual case basis.

General

An "n" factor of 0.013 shall be utilized for the design/sizing of mainline gravity sewers involving all of the above noted pipe materials.

Size, Depth and Velocity of Flow

No public gravity sewer should be less than eight (8") inches in diameter. Sewer shall be laid out vertically so as to provide a minimum of four (4') feet of cover over the connected house sewers where they intersect the property lines of the tributary properties. The depths of gravity mains in alleys, easements or of extensions from or connecting to existing shallow sewer systems shall be evaluated on an "available-depth" basis.

For all major sewers crossing a wash, the Engineer shall submit calculations evaluating the anticipated scour depth in the wash for a 100-year storm. See Appendix C for further information in this regard.

Ductile iron pipe, along with any required supporting structures and/or special joints, may be required for such wash crossings. Ductile iron pipe may also be specified if the sewer line is to lie underneath a culvert or other type of structure. Concrete encasement of sewer lines is not considered equivalent to ductile iron pipe and is not allowed by PCWMD.

The type of bedding shall be in accordance with the latest Pima County Wastewater Management Standard Details for pipe beddings. This criteria shall be specified on the plans and any deviation from the stated conditions will require approval by the Wastewater Management Department, Chief Engineer.

The requirements for the type and/or degree of backfill compaction (above the pipe zone) shall be those of the agency (Pima County Department of Transportation & Flood Control District or the City of Tucson Department of Transportation) having jurisdiction over the rights-of-way in which the installation is taking place.

In the case of sewers where the slope, pipe diameter and quantity of sewage being transported are such that velocities of 10 feet per second or greater are predicted to occur during peak dry weather flow, special provisions shall be made to protect against erosion of and shock to the gravity sewer system.

Pipe Diameter Changes

When sewers are increased in size, or when a smaller sewer joins a larger one, the invert of the smaller sewer should be raised sufficiently to maintain the same energy gradient. (An approximate method for obtaining this result is to place the crowns of both sewer lines at the same elevation).

Required Grades

All sanitary sewers shall be designed to provide self-cleansing velocities. All sanitary sewers shall be designed to provide a minimum velocity of two (2) feet per second at peak daily dry weather flow. In all cases, unless otherwise approved by the Engineering Manager of the Pima County Wastewater Management Department, the minimum slopes for eight (8") inch diameter sewers shall be: .44% except terminal reaches which will be at 1.0%, regardless of material. Slopes for all new sewers, 10 inch diameter and larger, shall be reviewed on an individual basis.

Where situations are encountered and the above noted slopes for eight (8") inch diameter sewers cannot be maintained, and with written justification, the Pima County Wastewater Management Department may approve lesser slopes. True slope of the pipe shall be shown.

When slope changes within the gravity sewer are required, they shall be made only at manholes. The grade change shall be designed to avoid hydraulic jumps, to insure full capacity without excessive head losses and avoid turbulence and the resultant release of gas.

House Connection Sewer (Private) Connection to the Public Main

House Connection Sewer (HCS) slopes within the public rights-of-way shall correspond to the minimum required by the appropriate Building Codes Agency. H.C.S. connections to the public main shall be made via wye or tee fittings or epoxy joined saddles (utilizing a machine cut tap through the wall of the main). Residential H.C.S. connections to manholes (new or existing) are to be avoided. If a sewer main terminates in a cul-de-sac, with no feasibility of future extension, and a manhole is placed at the upstream terminal end of this sewer, a maximum of three (3) H.C.S.'s may be connected into the manhole. Crowns of the four (4') inch diameter H.C.S.'s are to match the crown of the outgoing public main, and a channel through the sidebench of the manhole base shall be constructed for each H.C.S. - to insure a smooth transition of flow between the H.C.S. and the public main. The balance of the H.C.S.'s from the cul-de-sac lots will be connected directly into the main by approved methods.

If H.C.S.'s are installed via saddles/machine cut holes, the minimum spacing shall be five (5') feet, i.e., one (1) connection per laying length of mainline for ESVCP and two (2) per laying length for PVC main (the five feet minimum dimension being respected at all times).

Proposed House Connection Sewers shall be located such that they do not violate the frontage of an adjacent lot(s) while traversing to the point of connection with the public main. The overall length of the H.C.S. conduit within public rights-of-way is to be minimized.

An approved backwater valve shall be installed when the Finished Floor Elevation (FFE) of the connected unit is one (1') foot or less above the nearest upstream manhole or cleanout rim elevation. If the involved public mainline incorporates 30 inch manhole covers, the elevation criteria is increased to 18 inches. A self-explanatory tabulated numerical listing of lots requiring backwater valves shall appear on the plans. The backwater valve shall not be installed within the public rights-of-way or sewer easements.

Alignment

Sewers shall be laid with uniform slope and alignment (horizontally and vertically) between manholes. Curved sewers are not permitted.

Separation of Water and Sewer Mains

Sewers shall be designed so as to comply with the horizontal and vertical separation of water and sewers as established by the Arizona

Department of Health Services Engineering Bulletin No. 11, latest edition. Concrete encasement of sewer lines to meet these standards will not be allowed by PCWWMD

Manholes

Manholes shall be installed at the end of each line (except as noted later on); at all changes of grade, size, alignment; at all sewer intersections; and at distances shown below:

Manhole Spacing

Pipe Size (Dia. in inches)	Maximum Manhole Spacing (feet)
8-15	500
18-30	600
36 and Larger	800

A sufficient number of manholes shall be placed in curved streets so that the sewer and manholes stay within the proposed curb lines of the street.

Drop manholes shall be avoided.

The minimum diameter of manholes shall be 48 inches for mains 10 inches or less in diameter, and 60 inches for lines 12 inches to 36 inches in diameter. Where special conditions exist, larger diameters may be required (a special detail will be required on the plan for manholes with a diameter greater than five (5') feet). The maximum horizontal deflection angle for 8" diameter lines shall be 90°. For 10" to 36" diameter lines the maximum deflection angle shall be 60°.

The flow channel through manholes shall be made to conform in size and shape to that of the interior surface of the servicing sewer lines. Where no break in grade occurs through a manhole, and where there is no horizontal deflection in the alignment, the invert of the channel shall conform to the slope of the sewer line. For horizontal alignment changes of 10° to 44°, a minimum of 0.10 foot fall shall be designed into the channel invert. For alignment changes of 45° to 90° (maximum), a minimum of 0.20 foot fall shall be designed into the channel invert. Where changes in grade occur at a manhole, the slope of the channel bottom through said manhole shall be such as to provide for a smooth transition of flow from all inlet pipes to the outlet pipe(s). All channels within new manholes shall be shaped and formed to provide a smooth transition of flow from all the inlet(s) to the outlet(s). The minimum flow line radius shall be 2.0 feet.

When plans call for the construction of a new manhole over an existing main, the following note (with data blanks accurately completed) shall be placed in the profile view in the immediate vicinity of the manhole in question:

"New Manhole No. ______ is to be constructed over the existing in service ______ inch diameter________________ (material) sewer. The rough base and/or benches shall be constructed with existing main intact. Cut out the top portion of the _____ inch diameter main and complete the construction of the new manhole in accordance with referenced standard details".

Where the placement of the public sewer through the manhole is adjusted dimensionally (from the "standard" location as called for on the standard detail) to compensate for construction problems, etc., a special, scaled detail shall be placed on the plan sheet describing the dimensioning of the required layout for the manhole in question.

Special Conveyance Facilities

Special conveyance facilities are such items as inverted siphons, junction chambers, sampling and/or metering manholes, structures and/or pilings for wash crossings, etc. Scaled details shall be shown on the contract plans, adequately specifying such items as materials of construction, dimensions, joints, welds, reinforcement, slopes, lengths, etc.

Design calculations shall be submitted by the Engineer for review and approval by the Pima County Wastewater Management Department for all siphons, structures, wash crossing structures and pilings, etc., prior to final approval of the construction plans.

Use of inverted siphons shall be avoided.

Sewage pumping facilities shall only be incorporated into the public sewerage system after conceptual approval by the Pima County Wastewater Management Department. If the property to be sewered is going through the rezoning/subdivision plat/development plan review process, then the concept of using a pumping station should be addressed during that review process and not during the design stage.

Pump stations will be constructed in accordance with Wastewater Management Standard Details or, upon prior approval or instruction by PCWMD, a special design. Site conditions, permanency and/or tributary area will dictate the choice. The Consultant shall discuss these issues with the Pima County Wastewater Management Department prior to the initial submittal of the plans for review. In all cases, a complete plan and profile of the route for the new pressure main shall be provided - see Plan, Profile and Detail sheets section for plan requirements.
The type of Wastewater Pumping System (WWPS) shall be determined by the PCWMD. If PCWMD estimates the expected life span of the WWPS to be 10 years or less, a submersible-type WWPS shall be designed and installed. In addition, the owner-developer shall pay the PCWMD 10 years of operation and maintenance expenses (As determined by PCWMD) prior to approval and acceptance for operation of the new WWPS by the PCWMD.

If PCWMD estimates that the expected life span of the WWPS to be longer than 10 years, a wet well/dry well-type WWPS shall be designed and installed. In addition, the owner-developer shall pay the PCWMD 15 years of operation and maintenance expenses prior to approval and acceptance for operation of the new WWPS by the PCWMD.

If an existing WWPS is expanded to increase its discharge capacity, its expected life span shall also be evaluated as previously outlined. The payment of operation and maintenance expenses shall also be the same as previously outlined.

However, it should be noted that the operation and maintenance (O & M) costs are those attributable to a given development. If oversizing capacity is built into a WWPS, Only that capacity that is reserved for a given development should be used for determining the O & M costs. If a later development comes along and utilizes oversizing capacity that no O/& M payments have been made on, then that development will be responsible for making these O & M payments, even though it did not build a new WWPS.

In those cases where type of lift station called out on the Standard Details will suffice, the following additional information will be placed on the contract plans:

a. Pump data, inclusive of the rated horsepower, efficiency pumping capacity, total dynamic head, manufacturer and model number (including the complete design calculations for the sewage lift station and pressure main system) shall be submitted to Pima County Wastewater Management Department for review and approval. In addition, a copy of the head discharge curve and the system head curve for pumps installed in the lift station shall also be submitted to the Pima County Department of Wastewater Management.

b. Sump capacity and cycle time.

c. Complete plan and profile of the pump station and valve manhole site, inclusive of an overall, scaled site plan (including surface drainage and two foot interval contours) for stations not located within public streets and/or alleys. Show elevation of extraordinary high water (100-year floodplain) at the site and elevation of sewage overflow in the collection system in the event there is a station malfunction. In those instances where a specially designed pump station is to be utilized, the following information/details, in addition to the information requested for the "standard" installations, will be shown on the plans:

   (1) All details (plans, cross-sections and otherwise) needed to specify the construction of the station and appurtenances inclusive of mechanical, civil and electrical details/ specifications.

   (2) Pertinent data on the individual pump <u>or</u> package unit to be installed.

It is required that the Engineer submit to the Pima County Wastewater Management Department acceptable, legible and understandable design calculations and manufacturer's literature for all non-standard pumping equipment for reveiw/preliminary approval, all prior to incorporating the equipment into the final design. Prior to approval of the final construction plan documents for such a pumping facility, the Engineer shall submit a set of the final design calculations to the Pima County Wastewater Management Department for its records.

Easements

Complete detailed and accurate descriptions for all new sewer easements shall be submitted to the Pima County Wastewater Management Department for review and approval after the initial review of the construction plans has been completed and prior to the next plan submittal. Included with the written description shall be a scaled plan of the property(s) involved, showing the owner's name, property dimensions, location of the new easement (tied dimensionally to the property's corners at each end of the easement and at all horizontal deflection points along thc easement) within the affected property; i.e., all vital information necessary to accurately portray the location of the easement for Pima County Property Management purposes.

Easements shall be required where the proposed facility is outside the limits of the road right-of-way. The easement shall be of sufficient width to allow maintenance of and access to the line, but, in no case, less than twenty (20') feet. The sewer shall not be located less than five (5') feet from any easement boundary. Dead end easements shall be avoided, (except for flow-through sewers which shall be constructed to the subdivision/development boundary during initial sewer installation.

Unless previously agreed upon between the developer and Pima County Wastewater Management, the developer shall be responsible for the acquisition of all easements/rights-of-way needed to install the proposed sewerage facility. Easements shall be recorded on a standard Pima County

Right-of-Way form. When completed and signed by the Grantor, the easement(s) and attached 8 1/2" X 11" sketch(es) will be forwarded (Through Wastewater Management) to Property Management for recording.

Sanitary Sewage Treatment/Reclamation Facilities

The design shall result in a wastewater treatment/reclamation facility that is reliably and economically capable of treating the influent raw sewage to the designated effluent quality. Because each such facility is unique unto its intended location and purpose, specific design requirements/criteria will be established by Wastewater Management prior to the start of the actual design effort.

Variances

The Director of the Wastewater Management Department and his designated representatives may allow variances to the Design Standards and Standard Details when strict adherence would less adequately provide for the development, maintenance, efficiency and effectiveness of public sanitary sewerage facilities. The variance shall secure substantially the objectives of the Design Standard or Standard Detail to which the variance is granted. Variances may be allowed when:

- design slopes less than the Standard minimums would eliminate the need for a pump station;
- a substitution for or change in a Standard material results in the use of a material which can be clearly demonstrated to be of equal or superior quality;

- a strict adherence to a Design Standard or Standard Detail would be impractical or impossible because of field conditions such as existing utility facilities or incompatible existing sewerage facilities; or
- an emergency situation prohibits strict adherence to a Design Standard or Standard Detail.

APPENDIX

APPENDIX A

GENERAL NOTES--SEWER CONSTRUCTION

1. All design standards, materials and workmanship for sewers are to be in accordance with the Pima County Wastewater Management Department Manual of Engineering Standards and Procedures. Said Manual is on file in that office.
2. Bench mark elevations are based on ______________________________ Datum.
3. Bedding shall be in accordance with standard details 104 and 105 or as shown on the plans. Should ground water or other unanticipated soil condition be encountered, the bedding shall be modified as directed by the Engineer.
4. Standard Detail 106 Applies to this project.

APPENDIX B

DESIGN STANDARDS FOR SANITARY SEWERAGE CONVEYANCE FACILITIES LOCATED ON PRIVATE PROPERTY

General

The construction documents for Privately Owned Sanitary Sewer Conveyance Facilities connecting to the Pima County sanitary sewerage system shall be submitted for review and approval by the Building Code agency of this jurisdiction. These facilities may be constructed to Uniform Plumbing Code requirements, or when a "low slope" design is necessary, or at the option of the owner, to Pima County Wastewater Management Design Standards for public sewer conveyance facilities. If Wastewater Management Standards are used, the plans will be forwarded by the Building Code Department to Wastewater Management for review and approval. The permit will be issued by Building Codes.

Plans

Plans will be submitted on 24" x 36" right reading sepias and shall contain the information required by the Plumbing Code or Wastewater Management Design Standards.

Design

The conveyance system, if designed to Wastewater Management Standards, must be designed, inspected and certified in writing as to conformance with the approved plans by a qualified registered engineer. The slope and location certification must be received prior to backfilling the trench. The Building Department will inspect only for proper pipe material, depth and connections. All other criteria are to be certified. Minimum slopes for on site sewer lines designed to Plumbing Code standards shall be 1% for 4" or 6" diameter lines or 2% for 3" lines. Lines 8" or larger in diameter are to be constructed to Wastewater Management Standards.

Backfill

Backfill of on-site private sewer lines shall be in accordance with Building Code requirements and/or street standards whenever the trench is located under a building parking lot or private street. House connections constructed in the public right-of-way will be backfilled and compacted to public design standards and warranted by the owner or developer that the backfill complies with those standards.

Limits

When the option for a Wastewater Management Standard system is chosen all design criteria required for public sewers shall be adhered to. No mixing of Plumbing Code and Wastewater Management Standards will be permitted.

When no criteria has been developed in the Plumbing Code for lift stations, manholes and other features permitted under a public system, the Wastewater Management Standards shall be followed for private systems.

No portion of these requirements shall supercede Arizona Department of Health Services Engineering Bulletin No. 11. If conflicts occur the most restrictive criteria shall govern.

Other Agencies

Permits or approvals required by other public agencies shall be obtained for street cuts and any work affecting public property, prior to the commencement of the work.

APPENDIX C

SIMPLIFIED, STEP-BY-STEP, DESIGN PROCEDURE

FOR THE PLACEMENT OF PIPELINES ACROSS

ALLUVIAL DRAINAGE CHANNELS

Prepared for:

Pima County Wastewater Management Department
130 W. Congress
Tucson, Arizona 85701

Under Contract to:

Anderson, Passarelli & Associates
288 N. Church Avenue
Tucson, Arizona 85701

Prepared by:

Simons, Li & Associates, Inc.
120 W. Broadway, Suite 260
P.O. Box 2712
Tucson, Arizona 85702

August, 1984

TABLE OF CONTENTS

CONDITIONS OF USE

This simplified hydraulic design procedure contains technical concepts and guidelines to aid the engineer in the planning and design of pipelines to be placed across and/or parallel to alluvial drainage channels. It has been developed for use only with sand-bed channels, and is not applicable to channels whose beds consist primarily of cobbles and/or boulders. Because of the general nature of this procedure, its use will normally produce very safe results. However, site-specific evaluations, which encompass more-detailed analyses and consider ALL local factors, are recommended whenever and wherever possible. This procedure has been developed using both sound engineering judgement and the best, "state-of-the-art" information available. Nonetheless, this procedure should only be accepted and used by the recipient individual or group entity with the express understanding that Pima County and/or the Author's of this procedure make no warranties, express or implied, concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the information contained herein. As such, Pima County and/or the Author's of this procedure shall be under no liability whatsoever to any such individual or group entity by reason of any use made thereof.

LIST OF SYMBOLS

B_W The bottom width of the channel, in feet

D_P Distance from the control or "pivot" point along the downstream channel bed to the crossing location, in feet

E_P Depth to the centerline elevation of the pipeline below the existing channel bed, in feet

E_{PP} Depth to the centerline elevation of the "parallel pipeline" below the existing channel bed, in feet

F_{MH} Force of the total lateral loading upon an individual manhole, in pounds

F_P Force of the total lateral loading on pipeline and pile/support structures, between center-to-center supports, in pounds

F_{PP} Force of the total lateral loading upon an individual pile/support structure for the "parallel pipeline," in pounds

G_M Maximum total scour from all sources (i.e., primary plus the pipeline/lateral supports), in feet

G_{MH} Maximum total scour at manhole from all sources (i.e., primary plus the manhole itself), in feet

G_{MP} Maximum total scour at the "parallel pipeline" from all sources (i.e., primary plus the pipeline/lateral supports), in feet

G_P Scour below the centerline of the pipeline due to the exposure, within the primary scour zone, of both the pipeline itself and its piles or lateral-support structures, in feet

G_{PP} Scour below the centerline of the "parallel pipeline" due to the exposure, within the primary scour zone, of both the pipeline itself and its piles or lateral-support structures, in feet

G_S General scour, created by both the design flow scour depth and low-flow thalweg incisement, in feet

G_T Total scour from primary sources (i.e., other than from the pipeline or its support structures), in feet

LIST OF SYMBOLS
(Continued)

H_B The existing height of the lowest "active" channel bank at the crossing location, in feet

I_P "Point of fixity" below the centerline elevation of the pipeline, in feet

I_{PP} "Point of fixity" below the centerline elevation of the "parallel pipeline," in feet

L_S Long-term scour potential, in feet

M_{LC} The minimum "safe" setback distance necessary to preclude impacts from lateral migration of the channel along a curved reach, in feet

M_{LS} The minimum "safe" setback distance necessary to preclude impacts from lateral migration of the channel along a straight reach, in feet

O_P Outer diameter of "parallel pipeline," in feet

P_C Bridge pier-scour component (i.e., the amount of scour at the pipeline crossing due to bridge piers), in feet

P_S Bridge pier scour, in feet

Q_D Design discharge, usually either Q_{100} or the "bank-full" flow (if smaller than Q_{100}), in cubic feet per second (cfs)

Q_{100} 100-year peak discharge, in cfs

R_C Channel centerline radius of curvature, in feet

S_C The slope of the channel bed, in feet per foot

T_W The top width of the channel, in feet

V The velocity of flow, in feet per second

W_P Width between the centerline of the piles or lateral-support structures for the pipeline, in feet

LIST OF SYMBOLS
(Continued)

Y The depth of flow, in feet

Y_P Height of the centerline elevation of the "parallel pipeline" above the point where the horizontal projection of the existing channel bed intersects a plane perpendicular to the axis of the pipeline, in feet

Y_S Design flow scour depth, in feet

Y_T Depth of low-flow thalweg, in feet

Z Distance the pipeline crossing is located upstream or downstream of bridge piers, in feet

SIMPLIFIED, STEP-BY-STEP, HYDRAULIC DESIGN PROCEDURE FOR THE PLACEMENT OF PIPELINES ACROSS AND/OR PARALLEL TO ALLUVIAL DRAINAGE CHANNELS

I. PROCEDURE FOR PIPELINE CROSSINGS

STEP 1

Compute the velocity of flow in the channel from the following formula:

$$V = 11.6\ (Q_D/T_W)^{0.4}\ S_C^{0.3} \qquad (1)$$

Where,

V = the velocity of flow, in feet per second;

Q_D = design discharge, usually either Q_{100} or the "bank-full" flow (if smaller than Q_{100}), in cubic feet per second (cfs);

Q_{100} = 100-year peak discharge, in cfs;

T_W = the top width of the channel, in feet; and,

S_C = the slope of the channel bed, in feet per foot.

STEP 2

Compute the depth of flow in the channel from the following formula:

$$Y = \frac{2.0\ Q_D}{(T_W + B_W)V} \qquad (2)$$

Where,

Y = the depth of flow, in feet;

B_W = the bottom width of the channel, in feet; and,

V, Q_D, T_W = as defined for Equation 1.

STEP 3

Determine the design flow scour depth (Y_S) below the channel bed by either obtaining this value from a detailed analysis, if available; or by assuming that this depth is equal to 0.8 times the depth of flow (0.8Y) along straight reaches of the channel, where the ratio of the channel centerline radius of curvature to the channel top width is equal to or greater than a value of 10 (i.e., $R_c/T_W \geq 10$); or by assuming that this depth is equal to 1.0 times the depth of flow (1.0Y) along curved reaches where $5 < R_c/T_W < 10$; or by assuming that this depth is equal to 1.3 times the depth of flow (1.3Y) along curved reaches where $R_c/T_W \leq 5$. That is,

$$Y_S = 0.8Y, \text{ for } R_c/T_W \geq 10 \tag{4}$$

;or,

$$Y_S = 1.0Y, \text{ for } 5 < R_c/T_W < 10 \tag{5}$$

;or,

$$Y_S = 1.3Y, \text{ for } R_c/T_W \leq 5 \tag{6}$$

Where,

R_c = channel centerline radius of curvature, in feet;
Y_S = design flow scour depth, in feet;
Y = as defined for Equation 2; and,
T_W = as defined for Equation 1.

STEP 4

If the existing top width (T_W) of the* channel exceeds the value derived from the following formula, assume that a two-foot, low-flow thalweg depth (Y_T) will form if the watershed has a $Q_{100} \geq 5000$ cfs; and that a one-foot, low-flow thalweg depth (Y_T) will form if the watershed has a $Q_{100} < 5000$ cfs. That is, if

*Note: If the channel width and depth is such that it can carry a flow greater than the Q_{100} discharge, then measure the channel width at the Q_{100} water surface elevation and use this value as the top width in equation 7.

$$T_W \geq 1.0\ (Q_D)^{0.5} \tag{7}$$

;then,

$$Y_T = 2.0,\ \text{for}\ Q_{100} \geq 5000 \tag{8}$$

;or,

$$Y_T = 1.0,\ \text{for}\ Q_{100} < 5000 \tag{9}$$

Where,

Y_T = depth of low-flow thalweg, in feet; and,
T_W, Q_D, Q_{100} = as defined for Equation 1.

If T_W is less than the value derived from Equation 7, omit Step 4 from the procedure.

STEP 5

To compute the general scour depth, created by both the design flow scour depth and low-flow thalweg incisement, sum the results obtained from Steps 3 and 4, and multiply by a factor of 1.3 to account for non-uniform flow distribution within the channel cross section:

$$G_S = 1.3\ (Y_S + Y_T) \tag{10}$$

Where,

G_S = general scour, created by both the design flow scour depth and low-flow thalweg incisement, in feet;
Y_S = as defined for Equations 4 through 6; and,
Y_T = as defined for Equations 8 and 9.

STEP 6

Long-term scour (i.e., degradation potential) can be determined by applying the following slope-reduction factors and formulas, as applicable:

(a) For **REGIONAL DRAINAGE SYSTEMS** (e.g., the Santa Cruz River, Rillito Creek, Canada del Oro Wash, Tanque Verde Creek, Pantano Wash, etc.) use:

$$L_S = 0.50 S_C D_P \quad (11)$$

Where,

L_S = long-term scour potential, in feet;
S_C = as defined for Equation 1; and
D_P = distance from the control or "pivot" point along the downstream channel bed to the crossing location, in feet.

(b) For **SUBURBAN WATERCOURSES** [that is, where the percent of impervious ground cover due to urbanization will never exceed twenty (20) percent] which are not regional drainage systems use:

$$L_S = 0.67 S_C D_P \quad (12)$$

Where all terms are as defined for Equation 11.

(c) For **URBAN WATERCOURSES** [that is, where the percent of impervious ground cover due to urbanization will always exceed twenty (20) percent] which are not regional drainage systems use:

$$L_S = 0.85 S_C D_P \quad (13)$$

Where all terms are as defined for Equation 11.

The location of the control or "pivot" point is the most difficult part of accomplishing Step 6. Therefore, unless some stable point along the channel bed of the system can readily be identified downstream of the crossing, such as a geologic control (e.g., bed-rock outcrop) or a man-made control (e.g., grade-control structure or box culvert), the long-term scour (i.e., degradation potential) to be used for estimating purposes should be obtained from the following formula:

$$L_S = 30 - H_B \quad (14)$$

Where,

L_S = as defined for Equation 11; and,
H_B = the existing height of the lowest "active" channel bank at the crossing location, in feet.

Additionally, if a control or "pivot" point exists downstream but the value computed for L_S by use of the applicable equation from Equations 11 through 13 is **GREATER** than the value computed for L_S by use of Equation 14, then the **SMALLER** value computed by use of Equation 14 should always be used for L_S **UNLESS** in-situ soils or stabilized banks are present which have the **POTENTIAL** to support bank heights in excess of 30 feet.

In Equation 14, an "active" channel bank is defined as the natural surface of an embankment, normally inclined within the range of 0° to 60° from a vertical plane, where all or a portion of same comes into "frequent" contact with floodwaters (i.e., "frequent" meaning flows of a magnitude equal to or less than a 10-year event).

STEP 7

Pipeline crossings should be kept well away from bridge structures in order to preclude the possibility of pier scour impacting upon them. However, should this not be possible, pier scour can be computed from the following formula, which includes a built-in factor for debris accumulation:

$$P_S = 6.3\ Y^{0.35} \quad (15)$$

Where,

P_S = bridge pier scour, in feet; and,
Y = as defined for Equation 2.

Depending upon the relative distance (Z) of the pipeline crossing upstream of or downstream from the bridge piers, the amount of pier scour impacting upon same can be obtained through the use of one of the following formulas:

$$P_C = 1.0\ P_s, \text{ for } Z \leq 10 \qquad (16)$$

;or,

$$P_C = P_S \left[1 - \frac{(Z-10)}{3P_S} \right], \text{ for } 10 < Z < 3P_S + 10 \qquad (17)$$

;or,

$$P_C = 0.0, \text{ for } Z \geq 3P_S + 10 \qquad (18)$$

Where,

P_C = bridge pier-scour component (i.e., the amount of scour at the pipeline crossing due to bridge piers), in feet;
Z = distance the pipeline crossing is located upstream or downstream of bridge piers, in feet; and,
P_S = as defined for Equation 15.

STEP 8

Compute the total **PRIMARY SCOUR** impacting the pipeline from the following formula, utilizing its appropriate components where applicable:

$$G_T = G_S + L_S + P_C \qquad (19)$$

Where,

G_T = total scour from primary sources (i.e., other than from the pipeline or its support structures), in feet;

G_S = as defined for Equation 10;

L_S = as defined for Equation 11; and,

P_C = as defined for Equations 16 through 18.

STEP 9

Unless the long-term scour potential (L_S) can be **ABSOLUTELY ESTABLISHED** by grade controls, in which case Steps 9 through 12 of this simplified design procedure can be omitted if the elevation of the crown of the pipeline is below the primary scour, **IT SHOULD BE ASSUMED** that the pipeline becomes exposed to the primary scour during the design discharge (Q_D), even if the total primary scour (as calculated from Equation 19) does not exceed a depth which is below the elevation of the crown of the pipeline. When making this assumption, only Equation 20 (to follow) should be used for determining the scour component needed for sizing the piles or lateral-support structures that will be required under these conditions in order to safeguard against the failure of the pipeline due to lateral loadings, especially loadings caused by debris accumulation. In other words, Equation 20 should always be used when G_T is either assumed to be or actually is less than or equal to 5.0 feet below the centerline of the pipeline.

To compute the*scour that will occur below the centerline of the pipeline due to the exposure of the pipeline and piles (or lateral supports) within the PRIMARY SCOUR ZONE, one or the other of the following formulas should be used:

$$G_P = 12.0, \text{ for } (G_T - E_P) \leq 5.0 \qquad (20)$$

;or,

$$G_P = 4.0\,(G_T - E_P)^{0.35} + (G_T - E_P), \text{ for } (G_T - E_P) > 5.0 \qquad (21)$$

*Note: When long term degradation causes the pipe to be exposed to scour, figure new bed surface as a result of the degradation and then compute $G_T = G_S + P_C$ and solve for formulas 20 & 21.

Where,

G_P = scour below the centerline of the pipeline due to the exposure, within the primary scour zone, of both the pipeline itself and its piles or lateral-support structures, in feet;

G_T = as defined for Equation 19; and,

E_P = depth to the centerline elevation of the pipeline below the existing channel bed, in feet.

STEP 10

The combined, or **MAXIMUM SCOUR DEPTH** that will occur below the channel bed from both the primary and pipeline/lateral-support components is determined from the following formula:

$$G_M = G_P + E_P \quad (22)$$

Where,

G_M = maximum total scour from all sources (i.e., primary plus the pipeline/lateral supports), in feet; and,

G_P, E_P = as defined for Equations 20 and 21.

STEP 11

The "point of fixity" of any piling or lateral supports **BELOW THE CENTERLINE ELEVATION OF THE PIPELINE** can be determined by merely assuming that:

$$I_P = G_P \quad (23)$$

Where,

I_P = "point of fixity" below the centerline elevation of the pipeline, in feet; and,

G_P = as defined for Equations 20 and 21.

STEP 12

The force of the total lateral loading between the center-to-center supports of the pipeline that will occur upon both the pipeline itself and its pile/support structures can be calculated from the following formula, which includes a factor for debris accumulation:

$$F_p = 2.5W_pV^2 + 2.5(G_p - 2.5)V^2 \qquad (24)$$

Where,

F_p = force of the total lateral loading on pipeline and pile/support structures, between center-to-center supports, in pounds;

W_p = width between the centerline of the piles or lateral-support structures for the pipeline, in feet;

G_p = as defined for Equations 20 and 21; and,

V = as defined for Equation 1.

In Equation 24, the first component [i.e., $2.5W_pV^2$] represents the force on the pipeline itself. The second component [i.e., $2.5(G_p - 2.5)V^2$] represents the force on the pile or lateral-support structure.

The results obtained from Steps 11 and 12 can now be used to calculate the proper size of the structural components needed to support the pipeline. The method for such calculations is not a part of this design procedure.

STEP 13

Once the calculations are complete for determining burial requirements and lateral-support requirements for the pipeline crossing of the existing alluvial channel, some type of determination must also be made as to the lateral-migration potential of the channel. This must be done in order to determine what distance beyond the existing banks the pipeline should be continued using the same design standards that are required for the pipeline when it is located within the actual crossing itself.

To compute a "safe" setback to guard against lateral migration of a channel with "natural banks" (i.e., channel segments which do not contain stabilized banks), either of the following formulas should be utilized:

(a) For REGIONAL SYSTEMS (e.g., the Santa Cruz River, Rillito Creek, Canada del Oro Wash, Tanque Verde Creek, Pantano Wash, etc.) use:

$$M_{LS} > 1.7\ (Q_D)^{0.5}, \text{ for } R_c/T_W \geq 10 \tag{25}$$

;or,

$$M_{LC} > 2.8\ (Q_D)^{0.5}, \text{ for } 5 < R_c/T_W < 10 \tag{26}$$

;or,

$$M_{LC} > 4.4\ (Q_D)^{0.5}, \text{ for } R_c/T_W \leq 5 \tag{27}$$

Where,

M_{LS} = The minimum "safe" setback distance necessary to preclude impacts from lateral migration of the channel along a straight reach, in feet;

M_{LC} = The minimum "safe" setback distance necessary to preclude impacts from lateral migration of the channel along a curved reach, in feet;

Q_D = as defined for Equation 1; and,

R_c/T_W = as defined under Step 3 of this simplified design procedure.

(b) For MAJOR WASHES AND MINOR WATERCOURSES (i.e., drainage channels for other than regional systems) use:

$$M_{LS} = 0.7\ (Q_D)^{0.5}, \text{ for } R_c/T_W \geq 10 \tag{28}$$

;or,

$$M_{LC} = 1.2\ (Q_D)^{0.5},\ \text{for}\ 5 < R_C/T_W < 10 \qquad (29)$$

;or,

$$M_{LC} = 1.8\ (Q_D)^{0.5},\ \text{for}\ R_C/T_W \leq 5 \qquad (30)$$

Where all terms are as previously defined for equations 25 through 27.

If a pipeline crossing is designed using the criteria as outlined in Steps 1 through 12 of this procedure, and does NOT extend beyond the "safe" setback limits as determined from the use of the applicable equation selected from Equations 25 through 30 above, it should be assumed that the total primary scour depth (G_T), as determined from Equation 19, can occur at any point within the migratory zone of the channel. Therefore, under such circumstances, the design of the pipeline crossing must proceed accordingly by taking into account the possibility that the maximum total scour (G_M), as determined from Equation 22, would have just as adverse of an impact upon the pipeline at any point where it is located within the limits of channel migration as it would have for the case where it is located only within the limits of the existing channel proper. This emphasizes the importance of extending pipeline crossings of alluvial channels for a distance far enough beyond existing banks at an adequate depth, and with sufficient design standards incorporated, so as to preclude their structural failure within "overbank" floodplain areas in the event of lateral channel migration.

II. PROCEDURE FOR "PARALLEL PIPELINES" (I.E., PIPELINES WHICH RUN PARALLEL TO ALLUVIAL DRAINAGE CHANNELS)

STEP 1

The primary threat to pipelines which run parallel to alluvial drainage channels comes from lateral migration of the channel proper. Such migration can ultimately expose the installation to the full brunt of river scour and its associated dynamic loadings. Therefore, if it is anticipated that pipelines will be running parallel to alluvial drainage channels, and will also be within close proximity to existing, unprotected channel banks, the simplest approach to safeguarding against their failure due to lateral migration of the channel is to compute a "safe" setback distance for the pipelines by utilizing the applicable equation selected from Equations 25 through 30 of this design procedure. Placing "parallel pipelines" beyond this "safe" setback limit will automatically obviate the need to incorporate any additional structural support components during the construction of the system as safety measures in order to guard against potential failure due to river scour/migration. Should this alternative be possible (i.e., from a design standpoint), its use would eliminate the need to proceed with the following steps of this procedure.

STEP 2

If it is NOT possible to place "parallel pipelines" beyond the "safe" setback limits, as described in Step 1 above, it should be ASSUMED that the total PRIMARY SCOUR DEPTH (G_T), as determined from Equation 19 of this design procedure, can occur at any point within the migratory zone of the channel. Therefore, under such circumstances, the design of pipelines which run parallel to alluvial drainage channels must proceed accordingly by taking such a possibility into account. This can be done by estimating the maximum total scour that will occur below the channel bed at the "parallel pipeline" from the following relationship (which assumes that pile/support structures will be utilized in order to safeguard against the failure of the pipeline due to lateral loadings):

$$G_{MP} = G_T + G_{PP} \tag{31}$$

Where,

G_{MP} = maximum total scour at the "parallel pipeline" from all sources (i.e., primary plus the pipeline/lateral supports), in feet;

G_T = as defined for Equation 19; and,

G_{PP} = scour below the centerline of the "parallel pipeline" due to the exposure, within the primary scour zone, of both the pipeline itself and its piles or lateral-support structures, in feet.

There are **TWO DISTINCT CASES** for which Equation 31 applies, as follows:

CASE A

When the **CROWN** of the pipeline is **BELOW** the point where the horizontal projection of the existing channel bed intersects a plane perpendicular to the axis of the pipeline, G_{PP} is determined as follows:

$$G_{PP} = 0.0, \text{ for } (E_{PP} - 0.5O_P) \geq G_T \tag{32}$$

;or,

$$G_{PP} = 4.0\ (G_T - E_{PP})^{0.35}, \text{ for } (G_T - E_{PP}) > 0 \tag{33}$$

Where,

G_{PP} = as defined for Equation 31;

E_{PP} = depth to the centerline elevation of the "parallel pipeline" **BELOW** the existing channel bed, in feet;

G_T = as defined for Equation 19; and,

O_P = outer diameter of "parallel pipeline," in feet.

CASE B

When the **INVERT** of the pipeline is **ABOVE** the point where the horizontal projection of the existing channel bed intersects a plane perpendicular to the axis of the pipeline, G_{PP} is determined as follows:

$$G_{PP} = Y_P + 6.3Y_P^{0.35}, \text{ for } 0 < Y_P \leq Y \quad (34)$$

Where,

G_{PP} = as defined for Equation 31;

Y_P = height of the centerline elevation of the "parallel pipeline" **ABOVE** the point where the horizontal projection of the existing channel bed intersects a plane perpendicular to the axis of the pipeline, in feet; and,

Y = as defined for Equation 2.

When using Equation 34, it should be assumed that Y, the depth of flow, is the same after channel migration as before channel migration.

STEP 3

As can be deduced from Equations 32 and 33, if $E_{PP} - 0.5O_P \geq G_T$, no structural support components or bank-protection measures need be provided as methods to counteract the potential impacts upon "parallel pipelines" due to lateral migration of the channel. However, if $E_{PP} < G_T$; or, the pipeline is buried in the floodplain at a point which is **ABOVE** a plane containing the horizontal projection of the existing channel bed, such protective measures would indeed be required in order to counteract the potential impacts of lateral migration.

However, should placing a pipeline upon pile/support structures be selected as the preferred countermeasure, as opposed to providing bank protection along the affected channel reach, either one of the following equations, depending upon hydraulic conditions, should be employed for computing the "point of fixity" BELOW THE CENTERLINE ELEVATION OF THE PIPELINE for any INDIVIDUAL pile/support structure:

$$I_{PP} = 4.0\ (G_T - E_{PP})^{0.35} + (G_T - E_{PP}),\ \text{for}\ (G_T - E_{PP}) > 0 \quad (35)$$

;or,

$$I_{PP} = G_T + Y_P + 6.3Y_P^{0.35},\ \text{for}\ 0 < Y_P \leq Y \quad (36)$$

Where,

I_{PP} = "point of fixity" below the centerline elevation of the "parallel pipeline," in feet;

E_{PP} = as defined for Equations 32 and 33;

G_T = as defined for Equation 19; and,

Y_P = as defined for Equation 34.

Equation 35 should be employed for conditions as described under CASE A of Step 2 above, and Equation 36 should be employed for conditions as described under CASE B of Step 2 above.

STEP 4

The force of the total lateral loading upon INDIVIDUAL pile/support structures can be calculated from either one of the following equations, depending upon hydraulic conditions:

$$F_{PP} = 2.5I_{PP}V^2 \quad (37)$$

;or,

$$F_{PP} = 9.9Y_PV^2 + 2.5\ (G_T + 6.3Y_P^{0.35})V^2 \quad (38)$$

Where,

F_{PP} = force of the total lateral loading upon an individual pile/support structure for the "parallel pipeline," in pounds;

I_{PP} = as defined for Equations 35 and 36;
G_T = as defined for Equation 19;
Y_P = as defined for Equation 34; and,
V = as defined for Equation 1.

When computing I_{PP}, only Equation 35 should be used in conjunction with Equation 37 when conditions are as described under CASE A of Step 2 above. Only Equation 38 should be used when conditions are as described under CASE B of Step 2 above.

In both Equations 37 and 38, it should be assumed that V, the velocity of flow, is the same after channel migration as before channel migration.

In Equation 38, the first component (i.e., $9.9Y_PV^2$) represents the force on the pile/support structure ABOVE the channel bed. The second component [i.e., $2.5\ (G_T + 6.3Y_P^{0.35})V^2$] represents the force on the pile/support structure BELOW the channel bed. Note that neither Equation 37 nor Equation 38 includes a component for the force upon the pipeline itself, since it is assumed that the pipeline will be essentially parallel to the direction of flow. However, a factor is included within these equations to account for debris accumulation upon the pile/support structures themselves.

The results obtained from Steps 3 and 4 can now be used to calculate the proper size of the structural components needed to support the "parallel pipeline." The method for such calculations is not a part of this design procedure.

STEP 5

An additional element that must also be considered in the design of pipelines which run parallel to alluvial drainage channels is the adequate design of MANHOLES to safeguard them from failure due to exposure to flow/scour resulting from lateral migration of the channel.

If manholes are not protected by bank protection of the channel; or, revetment measures within the immediate vicinity of the structure, the maximum total scour to be expected below the channel bed **AT THE BASE OF THE MANHOLE** can be computed from the following relationship:

$$G_{MH} = G_T + 6.3Y^{0.35} \qquad (39)$$

Where,

G_{MH} = maximum total scour at manhole from all sources (i.e., primary plus the manhole itself), in feet;

G_T = as defined for Equation 19; and,

Y = as defined for Equation 2.

The force of the total lateral loading on an individual manhole can be calculated by use of the following equation:

$$F_{MH} = 9.9YV^2 + 2.5\ (G_T + 6.3Y^{0.35})V^2 \qquad (40)$$

Where,

F_{MH} = force of the total lateral loading upon an individual manhole, in pounds;

Y = as defined for Equation 2;

G_P = as defined for Equation 19; and,

V = as defined for Equation 1.

In Equation 40, it should be assumed that V, the velocity of flow, is the same after channel migration as before channel migration.

The first component in Equation 40 (i.e., $9.9YV^2$) represents the force on the manhole **ABOVE** the channel bed. The second component [i.e., $2.5\ (G_T + 6.3Y^{0.35})V^2$] represents the force on the manhole **BELOW** the channel bed.

It is assumed that the tops of the manholes are, in all cases, **ABOVE** the water-surface elevation of the design flood (Q_D); or, in other words, they are always above the depth of flow (Y).