PART III – SANITARY SEWER
POLICIES AND DESIGN CRITERIA MANUAL

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SECTION 1.0

INTRODUCTION AND GENERAL POLICIES

1.1 SCOPE

The following Policies & Design Criteria Manual has been adopted by the City Council of the City of West Jordan to govern and regulate sanitary sewer work pertaining to the City of West Jordan and for the benefit of the City. Persons and/or entities performing sanitary sewer work must be come familiar with and follow this Policies & Design Criteria Manual. City personnel and representatives are not authorized to waive the requirements set forth herein or to excuse performance on the par of persons or entities doing sanitary sewer work. These regulations may be amended from time to time by the City Manager.

The design and construction of sanitary sewer mains and other sanitary sewer appurtenances in the City of West Jordan shall comply with these policies, design criteria and standards herein called the "Engineering Policies & Design Criteria Manual, Part III – Sanitary Sewer Policies & Design Criteria", or the permit requirements of various governing bodies, except where specific modifications have been approved, in writing, by the City Engineer.

This document sets forth minimum standards, policies, procedures, and design criteria for designing and preparing plans and specifications for culinary water systems built in the City. Wherever there are differences between these standards and other county, state or federal regulations, the most stringent or highest requirement shall govern.

Other policy and design criteria standards, which are separate from these documents, also exist for land disturbance, transportation, stormwater, water, parks & trails, and secondary water systems.

1.2 CITY OF WEST JORDAN, SEWER COLLECTION, TRANSMISSION, AND TREATMENT SYSTEMS

The City of West Jordan owns and operates the sanitary sewer collection and transmission systems servicing the City, and the City is also a joint owner of the regional sewer treatment plant serving West Jordan and neighboring communities called the South Valley Water Reclamation Facility (SVWRF). A brief description of these facilities and their history is contained in the following paragraphs.

A. Sewer Collection and Transmission Systems - West Jordan incorporated in 1941 as the Town of West Jordan. In the 1950's there were efforts to construct a community sewer system. Construction of a sewer collection system began in 1957 and by 1958 portions of the system were operational. The current collection system has grown and been expanded over the years to meet the service needs of this growing community. At the present time the collection system includes nearly 300-miles of pipeline ranging in size from 8-inch to 60-inch in size. The collection system generally flows by gravity down hill from the west, toward the east, and has three major trunk lines located in: 7000 South, 7800 South, and 9000 South, and one smaller trunk line on 8050 South. The trunk lines connect to interceptor sewers that carry the flows to the treatment plant site which is located near the Jordan River at approximately 7500 South. There is currently one

City operated sewer pump station located at approximately 8600 South and 1200 West to serve the local neighborhood area and lift the sewer flows into the gravity flow sewer in 1300 West.

The collection system transports flows that range between a low-flow of 4-million gallons per day (MGD) to a peak high-flow of 14-MGD. The current average daily flows are approximately 8-MGD. The collection system has approximately 20,000 connections serving individual residents, multi family residences, business, and variety of commercial and industrial users. The flows are monitored and measured at four permanent meter stations located on the four trunk lines servicing the City. Samples of the wastewater are regularly collected and tested to measure the sewer strength and contaminate levels.

B. Sewer Treatment Plant - Sewer flows from the collection system were originally treated at the Midvale sewer treatment plant constructed in about 1950 and located east of the Jordan River at 7100 south. In 1957 Midvale allowed West Jordan to join the treatment plant. In 1958 Midvale, West Jordan, and Salt Lake City Suburban Sanitary District #2 (currently Mid Valley Sewer District) agreed to jointly operate the sewer treatment plant located in Midvale. Two years later the Tri Community Treatment Plant Board was formally organized. Then sewer flows from the Salt Lake County Sewer Improvement District No 1. (currently the South Valley Sewer District) jointed the existing treatment plant. The combined flow of these agencies overloaded the capacity of the existing trickling filter plant system and as a result the plant was expanded with the addition of an aerated lagoon system. The expanded Tri-Community Treatment Plant became operational in June 1977. The expanded treatment plant was considered a temporary facility and the governing agencies began negotiations and planning for construction of a new regional waste water treatment facility.

In 1978, by execution of an inter-local agreement, a new sewer treatment plant governing board was formed that included Midvale City, Mid-Valley Sewer District, West Jordan City, South Valley Sewer District, and the Sandy Suburban Improvement District. The new governing board began the planning and design of a new regional waste water treatment facility to be known as the South Valley Water Reclamation Facility (SVWRF). In 1982 construction began on a new treatment plant located west of the Jordan River at approximately 7500 South in West Jordan. The new treatment plant began operation in 1985 with a capacity to treat 25.5-MGD. The plant was expanded in 1992 and currently is rated for a design capacity of 38-MGD, or a population equivalent of 380,000 people. Present average daily flows at the plant are approximately 30-MGD and peak flows are approximately 47-MGD.

The plant utilizes an aeration activated sludge treatment process, and has 3 bar screens, 2 aerated grit chambers, 4 oxidation ditches, 6 final clarifiers, UV disinfection with backup chlorine contact basins, and 1 cascade aerator, one dissolved air filtration sludge thickener and 4 belt presses. The plant effluent discharges to the Jordan River through a permit with the State of Utah. Bio-solids are shipped to an offsite facility where 20 to30-percent of the bio-solids are composed and 65 to 70-percent are shipped to a solids regeneration site and the remainder is disposed in a solid waste landfill.

The treatment plant is currently engaged in an additional expansion and up-grade project that will increase the capacity to 50-MGD and treat bio solids using a thermal drying process. This expansion project is scheduled for completion in 2008.

The SVWRF (treatment plant), administers a Waste Water Pretreatment Program to sample and monitor all commercial and industrial accounts requiring a pretreatment permit. Users that exceed the standards for sewer strength and contaminant levels are required to pre-treat sewer discharges or pay assessments for exceeding discharge standards.

1.3 AUTHORITY

Titles 87, 89, and 90 of the City of West Jordan Municipal Code, establishes the legal authority for the planning, design and construction of the City's sanitary sewer systems and appurtenances. In addition to these City ordinances, the State of Utah, Rules for Sanitary sewer Systems, most current version apply to the City's sanitary sewer systems as well.

1.4 INTERPRETATION

The City Engineer will decide all questions of interpretation of "good engineering practice" being guided by "Design and Construction of Sanitary and Storm Sewers" (ASCE Manual of Engineering Practice No. 37 or WPCF Manual of Practice No.9) both prepared by joint committees of the American Society of Civil Engineers and the Water Pollution Control Federation.

1.5 QUALITY ASSURANCE

All work shall be performed in accordance with City drafting/submittal requirements. Design work shall be accomplished under the direct supervision of a Utah Registered Professional Engineer, and shall carry the seal and signature of the same supervising Professional Engineer. All submitted designs, specifications, reports and plans shall be signed by a civil engineer, registered in the State of Utah, and all work shall be in accordance with good engineering practice.

1.6 SUBMITTALS

A. Design Data - Provide data on peak, average, and maximum daily flow.

B. Project Documents - Meet all checklist items required by Engineering Department before document submission.

C. Easements and Land Acquisition

1. All easements and land acquisitions shall be submitted on the city's standard easement form and shall be included on the recorded subdivision plat.
2. One copy of all necessary easement forms shall be submitted to the City Engineer for review.
3. All necessary permits shall be submitted to the City Engineer for final approval. Required permits include but are not limited to state and county utility line permits, canal crossing permits, Railroad crossing permits, Army Corp. of Engineer permits, etc.
4. All necessary permits and easements must be submitted prior to final approval being granted by the City.

D. All commercial or industrial developments must be submitted to the pretreatment coordinator of the South Valley Water Reclamation Facility for approval.

E. Where required by the City Engineer, detailed computations, including hydraulic calculations showing depth of flow, velocity, water surface profiles and gradients shall be submitted with the plans.

1.7 DEFINITIONS AND TERMS

Whenever in these specifications or in any document or instruments where these specifications govern, the following terms, abbreviations or definitions are used, the intent and meaning shall be interpreted as follows:

ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ANSI	American National Standards Institute
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
Ft	Feet
GPAD	Gallons per acre per day
GPM	Gallons per minute
IBC	International Building Code
IPC	International Plumbing Code
IPS	Iron Pipe Size
IRC	International Residence Code
MDD	Maximum daily demand
MG	Million gallons
MGD	Million gallons per day
O&M	Operations and Maintenance
PWD	Public Works Department
PSI	Pounds per square inch
UBC	Uniform Building Code
UPC	Uniform Plumbing Code
USGS	United State Geologic Survey
WPCF	Water Pollution Control Federation

Pipe Types**:**

ABS	Acrylonitrile Butadiene Styrene
AC	Asbestos Cement
CI	Cast Iron
CMP	Corrugated Metal Pipe
DIP	Ductile Iron Pipe
ML & C Steel	Mortar Lined and Coated Steel Pipe
PB	Polybutylene.
PE	Polyethylene
PVC	Poly-Vinyl Chloride

RC	Reinforced Concrete
VC	Vitrified Clay

DEFINITIONS

"Acceptance"	Field acceptance is when the Engineering Department inspector approves the physical installation of the sanitary sewer system, completes the required checklist for water systems, signs, and dates the checklist and also obtains the other necessary approvals indicated on the checklist form. The City Engineer acceptance or final acceptance follows field acceptance and is when the City Engineer approves both physical improvements as well as the administrative items associated with development, the public improvement bonds have been processed, and the Public Works Department accepts ownership and operations and maintenance responsibilities.
"Approved"	Unless specifically otherwise indicated, this shall mean approval by the City Engineer.
"Approved Drawings"	Final construction drawings approved by the City of West Jordan in the form of the "Released for Construction Drawings".
"Bedding"	A bed of small aggregate or sand used to support the piping materials prior to backfilling and sometimes a larger aggregate for encasing the pipe.
"City"	City of West Jordan, Utah
"Casing"	A steel or PVC pipe shell, placed after drilling subsoil, to a predetermined elevation.
"City Engineer"	City Engineer shall mean the City Engineer of the City of West Jordan, or the person(s) engaged by the City and authorized to perform the duties assigned to the City Engineer, and shall include any deputies and representatives.
"City Engineering Inspector"	The Engineering Department Inspector assigned to perform compliance to Drawings inspections for the City.
"Consolidated Fee Schedule"	A summary document, which identifies all of the fees and charges, allowed to be charged by City staff for various services, fees, requests, and documents. This document is adopted by the City Council and is changed upon occasion as needed, and is done so by Resolution adopted by the City Council.

"Contract Documents"	Includes the written contract specifications and drawings for a given project. Includes what is termed as the *"Released for Construction Drawings"*.
"Contractor"	The person, company or firm performing the construction work.
"County"	Salt Lake County, Utah
"Developer"	An individual or organized group; partnership, corporation, etc.; proposing to subdivide or improve land.
"Developer's Engineer"	The engineer licensed by the State of Utah as a civil engineer, employed by the developer, under whose direction construction plans, profiles and details of the work are prepared and submitted to the City for review and approval.
"Director"	Director shall mean the Director of Engineering of the City, or the person(s) engaged by the City and authorized to perform the duties assigned to the Director of Engineering, and shall include his/her duties and representative.
"Drawings"	These are the 'Released for Construction Drawings' prepared by the Developer and his/her consultants, submitted to the City for their review, and released by the City Engineer for construction of indicated improvements.
"Easement"	A recorded document in which the landowner gives the City permanent rights to construct and maintain improvements across private or other property.
"Engineer"	A professional engineer or firm of professional civil engineers appointed by and acting for the Engineering Department in the case of a City sponsored capital project. In the case of a developer-sponsored project, the term refers to the engineer hired by the developer and may also be referred to as "developer's engineer".
"Engineering Department"	The City department responsible for planning, designing and construction of the City's culinary water, roadways, sanitary sewer, storm drain and secondary water systems.
"Fire Department"	City of West Jordan Fire Department
"Fixture Unit"	The unit equivalent of plumbing fixtures as tabulated in the Uniform Plumbing Code.
"House Plumbing"	Plumbing fixtures, devices and piping within a building or structure, including pipes on the property, contributing wastes to he City's sewers.

"House Sewer" or "Building Sewer"	A sewer on private property connecting a building with the lateral on public property at the lot line.
“Inspector”	An employee or agent of the City engaged to observe and record field compliance with design criteria, plans and construction standards. In most cases, this refers to the Engineering Department inspector(s).
“Lateral”	The sewer line and appurtenances extending from the building to the public sewer.
“Master Plan”	As used in this Standard, this refers to the City of West Jordan, Sanitary sewer Master Plan. This plan is updated upon occasion and is adopted by the City Council. The use of this term shall mean the most up-to-date version of this document.
“Offsite” or “Off-Project Improvement”	An improvement beyond project boundaries connecting the development/project to the City’s systems.
“Plans”	Drawings of infrastructure improvements such as transportation, water, secondary water, storm drainage and sanitary sewer systems and their appurtenances within the City.
“Private Sewer”	The sewer line, 8 inch or larger, which is privately owned, which collects and transports sewage.
“Public Sewer”	The sewer line, 8-inch or larger, owned by the city of West Jordan, which collects and transports sewage.
“Public Works Department (PWD)”	The City department responsible for operations and maintenance of the City’s culinary water, roadways, sanitary sewer, storm drainage, and secondary water systems.
“Required”	Unless specifically otherwise indicated, this shall mean a requirement of the Engineering Department.
“Resident Project Representative”	For each project, the City will designate a person through whom all reviews and approvals will flow, and the Developer is also responsible for designating such a person. The ‘Resident Project Representative’ is just that, the person on-site, one who acts on behalf of the City, and one that acts on behalf of the Developer.
“Service”	A term used to identify the primary connector from the public utility to a building or site system.

"Service Lateral"	A service sewer in a public street or easement connecting a house or building sewer to the street or main sewer.
“Sewer” or “Sewerage”	Sanitary sewer main or sanitary sewer facilities and/or appurtenances, or sanitary sewer being transported or treated by the sanitary sewer system.
“Staff Engineer”	A registered civil engineer employed by the City and designated by the City Engineer to act on the City’s behalf.
“Standard Drawing”	Where not specified to the contrary, this refers to standard drawings which are part of these standards.
“Subdivision Sewers”	The system of street sewers, house laterals, and manholes constructed by a developer within an approved subdivision.
“Subdivision Sanitary sewer Lines”	The system of street sanitary sewer lines and service laterals constructed by the developer within an approved subdivision.
"Trunk Sewer"	A main sewer which receives flow from tracts and other collecting sewers.
“Thrust Block”	Cast-in-place concrete place at a change in pipe direction to resist pipe movement caused by water hammer or rapid change in flow rate.
“Wastewater”	A different term meaning the same thing as “sewer” or “sewerage”.

1.8 APPLICABLE CODES, MANUALS AND POLICIES

A. Ordinances and Codes - Ordinances, requirements and applicable standards of governmental agencies having jurisdiction within the City’s service area shall be observed in the design and construction of water systems. Such requirements include but are not limited to current revisions of the following:

1. The International Building Code, most current version.
2. The International Plumbing Code as amended by the Building Department, City of West Jordan, Utah.
3. ASCE Manual and Reports on Engineering Practice No. 60, Gravity Sanitary Sewer Design & Construction.
4. Utah State Department of Health Code of Waste Disposal Regulations
5. Utah Division of Water Quality Administration Rules for Design Requirement for Sanitary sewer Collection, Treatment and Disposal Systems.
6. W.E.F Manual of Practice FD-4, Design of Sanitary sewer and Stormwater Pumping Stations.
7. Municipal Code of City of West Jordan.
8. Road encroachment regulations of City of West Jordan, State of Utah, and Salt Lake County, as applicable.

9. Standard Specifications – American Public Works Association, State of Utah Chapter, Standard Specifications, current Edition.
10. City of West Jordan, Engineering Policies & Design Criteria Manual.

B. City Manuals – In addition to the Codes indicated above, the City has prepared and adopted the following manuals, which provide additional City requirements and procedures.

1. Development Processing Manual – Describes processes, procedures and requirements for various City processes, i.e. subdivision or site plan processing, for private development projects. It contains detailed, step-by-step processes and requirements for each step to assist developers and their engineers through a particular process.
2. Private Development Construction Inspection Manual – Prepared to describe the processes and procedures required of all construction inspection of private development projects. In addition to processes and procedures, it also includes various forms and checklists to be used with private development projects.
3. Capital Improvement Project (CIP) Construction Inspection and Management Manual – Prepared to describe the processes and procedures required of all City CIP projects. In addition to processes and procedures, it also includes various forms and checklists to be used with CIP projects.

C. City Policies – The following policies also apply to private development projects and CIP projects alike:

1. Design Regulations
   a. In new subdivisions, where sanitary sewer service is available, all lots within the subdivision shall be connected to the sanitary sewer system.
   b. Design shall conform to this "Policies & Design Criteria Manual".
   c. All sanitary sewer lines shall be designed to protect them from freezing.
   d. All sanitary sewer systems shall be designed to exclude all storm water and water from under drain systems, roofs, streets, and other paved areas.
   e. Down spout connections, foundation and basement drains, storm drain sumps and storm drain connections shall be prohibited from discharging into the sanitary sewer system.
   c. Each dwelling unit shall be served by an individual lateral. A common lateral of appropriate size may serve stacked dwelling units.
   d. There shall be no physical connection between a public or private potable water supply system and a sewer, or other appurtenances thereto, which could permit the passage of any sanitary sewer or polluted water into the potable supply.
   e. Sewers shall be laid at least ten feet horizontally from any existing or proposed water main. Separation distances shall be measured pipe edge to pipe edge.
   f. Where a water and sewer line must cross, the water main shall be at least 2 feet above the sewer line measured from pipe edge to pipe edge.
   g. Water mains and sewer lines shall not be installed in the same trench.
   h. Sanitary sewer shall be designed to flow by gravity. Use of sanitary sewer pumping stations shall be avoided wherever possible and shall not be permitted within the public sewer line.
2. Design Capacity - Design average flow shall be estimated at not less than 100 gallons per capita day, including infiltration at 200 gallons per diameter inch per mile per day. To

accommodate peak flows, sewers shall be designed, flowing full, to carry not less than the following contributions:

Table 1.8.1.

Minimum Sanitary Sewer Design Peak Flow	
4 inch and 6 inch laterals	400 gallons per capita day
8 inch through 12 inch sewers	400 gallons per capita day
15 inch sewers	300 gallons per capita day
larger than 15 inch sewers	250 gallons per capita day
Flow from commercial, municipal and industrial connections	**
Additional ground water infiltration	**
** Submit calculations for approval by Utilities Engineer	

3. If the City General Plan for sanitary sewer shows a sewer passing through the proposed development, which will service other areas, the developer shall install the sewer line of proper diameter, as determined by the City Engineer.
4. Construction Water Use Policy – All water used for any purpose is to be metered through a City issued meter containing an approved backflow prevention device. Violation of this requirement will make the person and company subject to the City's Municipal Code and its penalties. Check with the City's Engineering Inspector for information on how to obtain the requirement meter.
5. Confined Space Entry Policy - All Developer/Contractor and City staff is subject to the City's Confined Space Entry Program requirements and as such shall meet its requirements. Confined spaces shall not be entered until all requirements of the City's Program have been made and approved by the City's Inspector on the project and all applicable permits have been received. Also of concern is that all "Lock-out, Tag-out" procedures be complied with to provide for a safe working environment for all personnel. Personnel not complying with the City's requirements for these items is subject to penalties.
6. Material/Product Suppliers Approval Process - Materials not indicated in this manual as being approved for use in the City's stormwater system must be approved by the City Engineer. The process for approval of these materials will be as follows:
   a. Material supplier submits a written request to the City Engineer for consideration of the material/product to be considered. The request must contain a letter making the request along with any material/product data sheets the City will need in determining its compatibility in the City's stormwater system.
   b. The City will form a Review Committee comprising of Engineering Department engineers and Public Works Department staff to review, discuss, and evaluate the material's/product's acceptability to the City.
   c. The material/product supplier will be asked to come and make a presentation on their material/product to the City's Review Committee where additional questions will be

asked of the supplier. Additional information will be required to be submitted as indicated by the Review Committee.

d. Based upon all information, the Committee will make a recommendation to the City Engineer for his review and approval.
e. The City Engineer will make a finding based upon the Committee's information and his own experience and render that decision to the supplier in writing.

7. Public/Private Sewage Disposal - As required by the Municipal Code, which should be referred to for a complete explanation, a public sewer connection is required where anyone or more *of* the following situations exist:
   a. "... any part of a parcel of property is situated within 300 feet from an accessible public sewer."
   b. "... the Council declares a private disposal facility to be a public nuisance."
   c. There is a change of ownership and a public sewer is accessible.
   d. All new developments (except single family dwellings) not included in a new subdivision and greater than 300 feet away from a public sewer.

   Also, connections of any cesspool seepage pit or septic tank or any other private disposal system to any sewer main line or service lateral is strictly prohibited.

1.9 CITY DEPARTMENTS' RESPONSIBILITIES/JURISDICTIONS

A. Engineering Department - The Engineering Department is responsible for the approval of plans and inspection of all public main sanitary sewer lines and service laterals, within the public right-of-way of the City's sanitary sewer service area. The Building Department is responsible for all systems beyond the connection to the main line.

B. Public Works Department - The Public Works Department (PW) is responsible for the operation and maintenance of all public main sanitary sewer lines, manholes and other sanitary sewer facilities within the public right-of-way. The property owner is responsible for operation and maintenance of his/her own sewer lateral beginning at the nose-on at the main, to structure which it is serving.

C. Community Development Department, Building Division - The Building Division is responsible for the residential and commercial building sites after final grade has been reached.

1.10 CITY ENGINEER'S RESPONSIBILITY

The City Engineer, and his/her staff, has the following responsibilities in regards to review and approval of projects:

A. The City Engineer shall review submitted "Released for Construction Drawings" and accompanying studies and reports for compliance with these "Policies & Design Criteria Manual", the City's Municipal Code, and the most current version of the City's Sanitary Sewer Master Plan.

B. The City Engineer shall note any changes to the "Released for Construction Drawings", required to bring the "Drawings" into compliance with the documents mentioned above.

C. Required changes to the Construction Drawings shall be made by the Developer's Engineer and returned to the City Engineer or his or her designee for final approval.

D. The City Engineer shall have additional authority as provided in this Policies & Design Criteria Manual.

E. The City shall not be responsible for any errors in the design and construction required due to an oversight of the Developer and/or Developer's Engineer, or upgrades/revisions required because of lack of planning, incompetence or negligence by the Developer and/or Developer's Engineer. By the Developer's Engineer signing the various studies, reports, other supporting documents, and the "Released for Construction Drawings", the Developer and Developer's Engineer accepts full responsibility for their studies, designs, "Released for Construction Drawings", and other supporting documents prepared for the project. The City's role in this process is to review the documents submitted by Developer and his/her Engineer for compliance with the City's "Policies & Design Criteria Manual(s)", the City's Municipal Code, and the most current version of the City's Sanitary Sewer Master Plan. If the Developer or Developer's Engineer do not agree with requirements of these documents, they shall submit their concerns in writing prior to the final approval of the "Released for Construction Drawings" stating their position, providing substantiating documents, and requesting a waiver to these standards. Requests for waivers will be submitted to the City Council for their approval.

F. The City Engineer's review of these various documents shall not be viewed as directing the design of the Developer's Engineer in the performance of his/her professional duties. The City Engineer's review is a review for compliance with the "Policies & Design Criteria Manual", the City's Municipal Code, and the most current version of the City's Sanitary Sewer Master Plan only.

1.11 DEVELOPER ENGINEER'S RESPONSIBILITY

These standards establish uniform policies and procedures for the design and construction of the City sanitary sewer system. They are not intended to be a substitute for engineering knowledge, judgment or experience. These procedures shall be reviewed by the developer's engineer and shall be applied as necessary to the project. Proposed deviations to these standards shall be submitted in writing, prior to preliminary plat and or development project approval.

It is the developer engineer's responsibility to be aware of the City's sanitary sewer system master plan for sanitary sewer system improvements and to indicate any main line relocations, extensions or oversizing on the project's construction plans. It is also the developer's engineer's responsibility to be familiar with these "Policies & Design Criteria Manual" and the City's Municipal Code as he/she prepares documents required to be prepared for this project.

A copy of the Executive Summary of the Sanitary Sewer System Master Plan is available on the City's website for information. A complete version of the master plan is available for review at the City's Engineering Department. This responsibility shall include investigating any changes from the Master Plan necessitated by development subsequent to the Master Plan, although the above shall not relieve the developer from the responsibility to provide an approved system consistent with Engineering Department requirements. Verification of the adequacy of the surrounding sanitary sewer system rests jointly with the Engineering Department and the developer.

All plans, specifications, reports or documents shall be prepared by a registered civil engineer, or by a subordinate employee under direction of a registered civil engineer. Each of these documents shall be signed and stamped with a professional engineer seal, to indicate responsibility for them. A wet stamp is required on all documents except reproducible plans, where a stamp on the original is acceptable.

A “Preliminary Review” and or “Released for Construction Drawings” stamp or signature of the City on the plans does not in any way relieve the developer’s engineer of the responsibility to meet all requirements of the City. The plans shall be revised or supplemented at any time it is determined that the City’s requirements have not been met. Generally, plans that are signed as being authorized for construction will not require revisions based upon subsequent revisions to these standards, however, when the Engineering Department’s opinion, a change to the project is necessary, based upon a significant change in the standards, which significantly affects public safety, future maintenance costs, or similar concerns, such a charge may be required during construction by the City Engineer. Changes may also be required in the case where a developer does not proceed to construction within the time allowed in the agreement with the City.

1.12 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

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References to standards such as ASTM shall refer to the latest edition or revision of such standards unless otherwise specified.

1.13 CITY ENGINEER ACCEPTANCE

The City Engineer will not accept the sanitary sewer system until all applicable requirements of these standards and of the City of West Jordan Municipal Code have been met.

1.14 OCCUPANCY/SEWER SERVICE

As a part of the clearance procedure for individual house/building occupancy, the Engineering Department must "clear" the house/building. Such clearance is given after the Engineering Department’s acceptance of the work through the bond release process for public improvements.

1.15 METRIC UNITS

The maximum extent practicable, ‘standard’ units are to be used as the primary method of displaying and indicating lengths, volumes, etc.

1.16 CONSTRUCTION SPECIFICATIONS

Nothing contained in the Construction Specifications Manual or in any other part of this standard as implying the City will pay for any of these improvements. In addition to the construction specifications being used for defining private development work, they are also used for City capital improvement projects, and therefore contain some language about methods of payment.

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SECTION 2.0

DESIGN CRITERIA

2.1 CITY SANITARY SEWER SYSTEM

A. General - There are two sanitary sewer companies within the boundaries of the City of West Jordan: the City of West Jordan (City) who collects the vast majority of sanitary sewer from these customers, and the Kearns Improvement District (KID) who serves a small area near 6200 South and 4200 West. The City's Engineering Department is responsible for all studies, design and construction for these sanitary sewer facilities and the Public Works Department is responsible for all operations and maintenance of these facilities.

B. South Valley Water Reclamation Facility (SVWRF) - The SVWRF is located at approximately 7600 South and 1500 West, just west of the Jordan River. This facility is a separate entity from the City with its own staff and governing board. It collects the effluent from five south valley agencies, treats the effluent, and then releases it to the Jordan River. The Developer and his/her Engineer are responsible for addressing all of the SVWRF's concerns as part of the review and approval process.

2.2 GENERAL SANITARY SEWER DESIGN STANDARDS

The following general requirements apply to design and construction of sanitary sewer systems in the City's sanitary sewer system.

A. General

1. In new subdivisions, where sanitary sewer service is available, all lots within the subdivision shall be connected to the sanitary sewer system.
2. Design shall conform to this "Policies & Design Criteria Manual".
3. All sanitary sewer lines shall be designed to protect them from freezing.
4. All sanitary sewer systems shall be designed to exclude all storm water and water from under drain systems, roofs, streets, and other paved areas.
5. Wherever possible, sanitary sewer lines shall be located in public streets. In locations where sanitary sewer lines must leave the public right-of-way, a 20-foot sanitary sewer easement will be required.
6. All sanitary sewer facilities shall be located a 10-foot minimum horizontal distance from culinary water lines.
7. Where possible, sanitary sewer lines shall be located at 10-foot minimum horizontal distance from all other public utilities including but not limited to storm drainage, and secondary waterlines.
8. Sanitary sewer grades shall be based upon Salt Lake County benchmark elevations.

B. Gravity Sanitary Sewer Mains

1. City sanitary sewer lines shall be a minimum of 8-inches in diameter.

2. Unless otherwise approved and/or required by the City Engineer, sanitary sewer lines 8 through 10-inches in diameter, shall be designed to flow no more than one-half (1/2) full during peak flow. Sanitary sewer lines 12 through 15-inches in diameter shall be designed to flow 60-percent full. Sanitary sewer lines larger than 15-inches in diameter shall be designed to flow three-fourths (3/4) full.
3. The minimum sanitary sewer line depth shall be at least 11.0-feet unless otherwise approved by the City Engineer.
   a. In areas of sanitary sewer service, the following note shall be written on the development plat: "Shallow Sanitary sewer Depths! Contractor shall verify sanitary sewer lateral depth and set foundation elevation to provide adequate fall into sewer lateral. Buildings with a basement may not have sanitary sewer service available for basement".
   b. The City Engineer may increase the minimum sanitary sewer line depth if required to meet overall system requirements.
4. Check topography for low lots and problem service connections.
   a. In areas of low lots, the following note shall be written on the development plat: "Low Lots! Contractor shall verify sewer lateral depth and set foundation elevation to provide adequate fall into sanitary sewer lateral. Buildings with basement may not have sanitary sewer service available for basement".
5. A minimum of 4-feet of cover shall be placed over all main sanitary sewer lines, unless additional cover is required by the City Engineer.
6. The invert of new sanitary sewer lines shall tie into existing sanitary sewer lines at the 0.75 depth of the existing sanitary sewer main; except where otherwise approved by the City Engineer.
7. Sanitary sewer main lines shall be extended to property lines as per the City Engineer's directive to service future developers.
8. Ten-foot sanitary sewer stubs shall be extended beyond terminal manholes to facilitate future developments.
9. No connections may be made to a sanitary sewer stub.

C. <u>Sanitary Sewer Laterals</u>

1. General
   a. Wherever possible, buildings shall be discharged to the sanitary sewer Main Line with a gravity flow sanitary sewer lateral.
   b. Sewer laterals shall conform to the requirements of the Salt Lake City – County Department of Health Regulations and the Uniform Plumbing Code.
   c. Each unit of separate ownership shall be required to have a separate sanitary sewer lateral, unless otherwise approved by the City Council.
   d. Sanitary sewer laterals shall have at least 4-foot of cover, unless otherwise approved by the City Engineer.
   e. Sanitary sewer laterals may tie directly into manholes.
2. Gravity Sanitary sewer Laterals
   a. The size of sanitary sewer laterals shall be determined on the basis of the total fixture units drained by such sewer, in accordance with the Uniform Plumbing Code. The minimum size for gravity sanitary sewer laterals shall be 4-inches in diameter.
   b. Sanitary sewer laterals shall be designed and constructed at a uniform slope of not less than 2-percent grade. Where it is impractical to run the sanitary sewer lateral at a 2-

percent grade due to the depth of the sanitary sewer main line, sanitary sewer laterals may be run at 1-percent grade if approved by the City Engineer.

c. Cleanouts shall be installed at no more than 100-foot spacing.
d. No more than two (2) bends in excess of 45-degrees will be installed without a cleanout.

3. Pressure Sanitary Sewer Laterals
   a. Professional engineering advice shall be obtained prior to installing pumping equipment or pressure sanitary sewer laterals.

D. Sanitary Sewer Casings

1. Sanitary sewer casings shall be required at locations where sanitary sewer lines cross rivers, streams, canals, aqueducts, railroads, box culverts and/or other locations as required by the City Engineer or other governing entity.
2. Sanitary sewer casings shall be sized at least twice the inner diameter of the sanitary sewer line, unless otherwise approved by the City Engineer.
3. Sanitary sewer pipe shall be supported in casing by casing insulators and sealed with manufactured end seals.
4. Casing wall thickness shall be as shown on the standard steel casing drawing.

E. Sanitary Sewer Manholes

1. The minimum size manhole shall be 4-foot in diameter.
2. Manholes must be constructed at the ends of sanitary sewer lines.
3. Drop manholes are not allowed unless approved by the City Engineer.
4. A minimum of 5-feet shall be maintained between the edge of all manhole collars and the edge of the street pavement.
5. Manholes on sewer lines larger than 12-inches in diameter, or with 3 or more connections, shall be 5-foot in diameter.

2.3 SANITARY SEWER CAPACITIES, HYDRAULICS AND SIZES

A. Quantity of Flow: Sewage flows shall be determined from maximum potential population of the tributary area. Unless otherwise approved, the following criteria shall be used. If the number of housing units is known:

Table 2.3.1.

3.64 persons/single family unit	100 gallons/capita/day (gpcd)
2. 15 persons/multiple family dwelling	100 gallons/capita/day (gpcd)

If the number of units is not known:

Table 2.3.2.

	Ground	Persons per	Computed Average

Type of Zoning	Slope	Acre	Flow
Residential	0-0.10	12.5	100 gpcd
Residential	0.10-0.25	7.0	100 gpcd
Residential	Over 0.25	1.0	100 gpcd
General Commercial	0-0.10	---	3870 gal/acre/day
Limited Commercial	0-0.10	---	3870 gal/acre/day
Hospital	Any	---	2.5×10^5 gal/acre/day
School	Any	---	4000 gal/acre/day
Light Industry	0-10	---	5160 gal/acre/day
Other Industry	Any	---	Varies*

*Contact City Engineer for approval of values.

After calculating the average flow, a peak factor shall be determined by Ratio of Peak to Average Flow.

An additional amount for infiltration shall be added when a sewer is to be constructed below the ground water level. This amount shall be approved by the City Engineer.

B. Hydraulics - Sewers shall be designed to accommodate future tributary flows, in addition to those from the project. Pipe capacities shall be determined for peak flow rates by Manning's Formula using an "n" value of 0.013 for all pipelines. Sewers less than 12-inches in diameter shall be designed to flow half full at peak flow rates. Sewers 12-inches and larger shall be designed to flow two-thirds at peak flow rate.

C. Velocity - A main line sewer shall be designed to provide a mean velocity of not less than two (2) feet per second flowing one-half full except that the City Engineer may approve a gradient that will develop a velocity of less than two (2) feet per second in unusual circumstances. Where there is conflict between design by velocity and design using minimum slopes in Section 2.6, the design resulting in the steepest slope shall be used.

D. Oversizing and Extra Depth - Oversizing of certain tract sewers may be required where such sewers can logically serve an upstream tributary area.

E. Minimum Line Size - All public sanitary sewer lines shall be 8-inches in diameter or larger.

G. PVC Pipes - PVC sewer pipe shall not be greater than 15-inches in diameter and shall be furnished in standard lengths not exceeding 20.0-feet. Use of 15-inch pipe requires special approval. In addition, the developer's engineer should be familiar with the "Design and Construction Handbook of PVC Pipe" as published by the Uni-Bell Plastic Pipe Association, most current version.

2.4 LOCATION OF LINES (Streets)

A. Location Requirements - The sanitary sewer line centerline, wherever possible, shall be located in public streets parallel to and 5-feet south or west of the street centerline, and a minimum of 5-feet

from the lip of gutters. No other utilities shall be located parallel to sewer lines within 5-feet (either side) of sanitary sewer main, measured pipe edge to pipe edge. Sanitary sewer mains shall be extended 10-feet past property lines if requested by the City Engineer to service future development. No lateral connections may be made to the sanitary sewer stub.

However, where storm drains are in the center of the street, the water or sanitary sewer lines should be located to provide a minimum of 4-feet clearance between the outsides of pipe (measured on a horizontal plane). This pertains as well to any case of paralleling lines.

Special care is required where storm drains or other pipes cross above flexible pipes to avoid deflection problems when the other lines are installed.

B. Sanitary Sewer Line Extension for Future Development - When an area outside the improvements can be logically served by future extension of the sewer, it shall extend to the improvement boundary or to the end of a paved street in a manner facilitating future extensions.

2.5 LOCATION OF LINES (Easements)

Easements should be avoided where a reasonable alternate solution exists. Unless there are either physical limitations or extreme economic penalties, sanitary sewer lines should be installed within streets. When easements are required, there shall be careful consideration of how the line is to be maintained and/or replaced, if necessary. Where easements are necessary and where the side slope (perpendicular to the pipe) exceeds 50-percent (1 vertical to 2 horizontal) then the plans shall clearly indicate appropriate contours within the easement.

In general, all manholes within easements shall be accessible by conventional maintenance vehicles traveling over paved roads or driveways unless otherwise approved. Thus manholes within private property are discouraged and subject to special approval, unless the above can be met.

Laterals should not be connected to a main line within an easement unless specifically approved. This is to avoid root intrusion into the main via the lateral. Specifically, laterals should not be connected into the main where such a tie-in would be between or adjacent to a structure.

A. Width - Sanitary sewer easements for pipes up to 15-inches in diameter should normally be a minimum of 20-feet wide. However, additional easement width shall be required where the depths of pipe exceed 15-feet or as deemed necessary. The plans should clearly indicate any known block walls, pavement, trees or other obstructions within a proposed easement. Such items are contrary to Engineering Department policy and require special approval. Included with such approval may be a monetary obligation towards the operation and maintenance of the sanitary sewer line within the easement; also, the "as-built" drawings are to indicate such approval.

B. Pipeline Location - Pipelines shall generally be placed in the center of easements; only in unusual circumstances will a line be approved which is closer than 5-feet from the easement edge. Unless specifically otherwise approved, the line shall be straight without horizontal bends or deflections.

C. Easement Location - The full easement width shall be on one lot or property in such manner that access to manholes will not be obstructed by walls, trees or permanent improvements. Where this requirement cannot be met without interfering with existing buildings, easements may straddle lot lines providing approval is received and the sewer is not located on the lot lines.

D. Oversizing of Line - If a sanitary sewer line within an easement is over 15-feet deep, the Engineering Department may require the oversizing (such as from an 8-inch to a 10-inch line) to facilitate future slip lining.

E. Deeds - Deeds for easements shall provide for restrictions of permanent construction within easement to provide ingress and egress for maintenance.

F. Easement Provisions - Easements shall be provided as follows:

1. For subdivisions - The owners of land included within the subdivision shall offer to dedicate, for public use, the sanitary sewer (sewer) easements so designated on the final plat map. Standard language is included in Appendix E of this Manual.
2. For other than subdivisions - Dedication of sewer rights of way shall occur by means of deeds of conveyance to the City of West Jordan for all dedications other than those dedications created by subdivision plat maps on a form and as approved.

2.6 SLOPES OF LINES

Minimum slope requirements are necessary to assure self-cleaning and self-oxidizing velocities to avoid significant generation of hazardous, odorous, and corrosive sulfur compounds. Where possible, use of the minimum slopes should be avoided and should not be construed as guidelines for system design.

A. Minimum Grade - All sewer lines shall be designed and constructed for mean flow velocities, when flowing full, of not less than 2.25 fps, based on Manning's formula using an n value of 0.013. The following are minimum slopes, which shall be provided; however slopes greater than these are desirable.

Table 2.6.1. – Sanitary Sewer Line Size and Minimum Slopes

Sewer Line Size	Minimum Slope

(inches)	(In feet per 100)
8	0.40
10	0.28
12	0.22
15	0.15
18	0.12
21	0.10
24	0.08

B. Maximum Grades - The maximum grade for sanitary sewer lines shall be 12-percent or less, and in no case shall the velocity exceed 15-fps, except in steep terrain where the sewer grade may approximate the finished grade over the sewer. In no case shall the grade exceed 45-percent without special approval. Prior to the design of any sewer on a slope over 12-percent, special approval shall be obtained from the City Engineer. Typical details required for such design and construction are contained in Appendix A of this Manual. To minimize the turbulence in manholes, the grade of any incoming sewer shall not exceed the grade of the outgoing sewer by more than 10-percent. Where this value is exceeded, the designer should check the hydraulic considerations and pay particular attention to the invert drop across the manhole. Refer to Section 2.13 for further discussion of steep grades. All high slope, high velocity sewer lines shall be properly restrained per state code.

C. Substandard Grades - If grades below the standard minimum must be used in order to avoid pumping, the designer shall advise the Engineering Department before proceeding with design. Grades below the standard minimum may be used only upon specific approval (with approval designated on the improvement drawings), solicited well in advance of completion of design.

2.7 DEPTH OF LINES

Depth of cover is measured as the distance to the top of pipe from the finished grade surface over the sewer centerline. Sewers shall be installed at a depth, which shall provide suitable service to the properties connected and will allow subsequent installation of water lines, in accordance with Standard Drawing Nos. SS-005 and SS-010.

A. Minimum Depth - Sewers shall be placed at an 11 foot minimum depth to service all basements. In areas of shallow sewer, the following note shall be added to the subdivision plat: Shallow Sewer Depths! Contractor to verify sewer depths before excavating for basement. Home(s) with a basement may not have sewer service available for basement. The City Engineer may increase the proposed depth if required to meet system requirements. 4 foot minimum depth to crown of pipe is required at all times in all locations. The top of the sewer line shall be a minimum 2 feet lower than the bottom of any water lines placed in the same street. Sewers at depths greater than 16 feet shall be given special design considerations. Sewer mains below 18-feet are allowed only with

written permission from the City Engineer.

B. Standard depth of cover is 7-feet in paved areas or 5-feet minimum in areas not expected to receive traffic. Where this cover cannot be maintained, other details may be required, such as higher strength pipe, pipe encasements, special backfill, or concrete trench slabs. Whereas depths of cover less than 7-feet require approval via the plan check process and are discouraged, the use of concrete encasements or trench slabs will in general be reserved for depths of cover below 5-feet in paved areas and 3-feet in non-traffic areas.

C. Designs not in accordance with standard depths shall be submitted to the City Engineer for prior approval.

2.8 HORIZONTAL AND VERTICAL CURVES

In curved streets, the sewer shall follow the street curvature, but not cross the centerline. In general, vertical plus horizontal curves will not be allowed between manholes unless it is demonstrated that another solution is not reasonably feasible. Vertical curves should not be used unless excessive extra depth of excavation would be otherwise incurred.

Allowable joint deflections shall be the more stringent of those set forth below and the manufacturer's recommendations.

A. Curves - PVC Pipe - Except for perhaps 4-inch and 6-inch diameter PVC pipe, deflection at the joints is very limited due to the joint design. Curvature can be obtained by bending the pipe along its length within the trench. Beveling pipe ends will not be allowed. The following table should be used as a basis for curvature:

Table 2.8.1.

Pipe Size (inches)	Minimum Radius of Curvature (feet)
6	175
8	225
10	275
12	325
15	400

The above values are independent of pipe length since curvature is not achieved through joint deflection. Curves with smaller radii require deflection fittings or smooth curve "sweeps."

B. Vertical Curves: Vertical curves in sewers shall conform to the requirements for horizontal curves except that the radius shall not be less than 400-feet. Vertical curves may be either circular or parabolic in profile. An approximate formula for determining the required minimum length of a parabolic curve is:

$L = R (S_1 – S_2)$ where
L = minimum length of curve
R = minimum radius of curve permitted
S_1 and S_2 are the two sewer grades being used, with S_1 being the steeper grade.

2.9 SELECTION OF PIPE MATERIAL

A. Acceptable Pipe Materials - All Sewer lines in the City shall be constructed of concrete, plastic, or ductile iron pipes. The designer is referred to Sections 3.7, 3.8, and 3.9 of this Manual, for further details on this subject.

2.10 MANHOLES

A. General – The following section describes various design criteria for manholes including minimum size, maximum spacing of manholes, location requirements, flow-line requirements, and construction requirements. Section 3.11 – Manholes, discusses appropriate manhole materials.

Unless otherwise approved, all manholes should be accessible to standard maintenance vehicles. Therefore, manholes placed in back or side yards will not normally be approved. Every reasonable effort should be made to provide a paved or gravel roadway to manholes in open space areas.

B. Design (Size) - Standard manholes shall be in accordance with Standard Drawing Nos. SS-030 and SS-035 (4-feet diameter). Shallow manholes shall be in accordance with Standard Drawing No. SS-065. Normally, manholes will be 4-feet diameter; 5-feet diameter manholes are required for lines 18-inches and larger or where the depth to pipe invert exceeds 18-feet. Where the depth exceeds 18-feet, the cover (lid) shal1 be 30-inches for safety reasons.

C. Minimum Size - The following rules shall apply to all sanitary sewer manholes:

1. Manhole diameters shall be at least 4-feet in diameter.
2. Manholes on sewer lines 12-inches and greater shall be 5-feet in diameter.
3. Manholes with three or more main lines connecting shall be 5-feet in diameter.
4. When the deflection angle of the pipeline exceeds 90-degrees manholes shall be 5-feet in diameter.
5. Manholes deeper than 14-feet shall be 5-feet in diameter.
6. When the deflection angle of the pipe exceeds 90-degrees and at intersections of 3 or more 8 inch pipelines, a 6-foot manhole is required.
7. Where incoming slopes at manholes are greater than or equal to 5-percent and the deflection angle within the manhole is greater than or equal to 45-egrees but less than 90-egree, a 5-foot manhole with an extra deep trough is required.
8. Where incoming slopes at manholes are greater than or equal to 5-percent and the deflection angle within the manhole is greater than 90-degrees, a 6-foot manhole with an extra deep trough is required.
9. Manholes deeper than 18-feet are not permitted except with written permission from the City Engineer.

D. Maximum Spacing - The maximum distance between manholes shall be 400-feet from centerline to centerline. Manholes shall be installed at the end of each line, at all changes in pipe size or alignment; and at intervals not to exceed 400-feet.

Although the approved distance for any particular reach may be modified by the items listed below. Brick and mortar blockouts for future extensions are preferred over stub and capped pipes except where the exact orientation and slope of the future extension is known at the time of plan submittal.

E. Location of Manholes – Manholes shall be located at the following:

1. At all abrupt grade changes (too large for a vertical curve).
2. At all changes in horizontal alignment (except on curves).
3. At all changes in pipe sizes.
4. At the terminal end of all lines exceeding 200-feet in length from the next downstream manhole. Manholes will be required in cul-de-sacs, which have three (3) or more fronting lots.
5. At all junctions of main sewers.
6. At the point of tangency of each reverse curve. (No reverse curves will be allowed between manholes, except where the Engineering Department determines that the nature of the reverse curve is not significant or detrimental to the system.)

F. Additional Manhole Requirements – In considering the placement of manholes, the following issues also need to be addressed:

1. Watertight, seal down covers shall be provided in areas subject to flooding.
2. Manholes shall not be positioned in waterways.
3. A minimum of 5-feet shall be maintained between the edges of manhole collars to the edge of the street pavement.
4. Manholes shall not be placed within 10-feet of storm drain catch basins or in low points where catch basins are located.
5. Manholes shall generally be located no less than 15-feet from the curb line when within a cul-de-sac.
6. Also, manholes shall not be located within the street such that rainfall runoff is directed to the manhole.
7. Manholes (and cleanouts) shall generally be located at least 10-feet past the downstream property line of the last property served.
8. Where future extensions of the sanitary sewer line will be required, then the manhole shall be located parallel with the upstream property line, if required (i.e. within the street along the property's entire frontage).

G. Slope of Manhole Channels - When sewers of uniform size and slope pass through a manhole, the slope shall be maintained and the invert at the center of the manhole shall be given. In sewers that change slope but are uniform in size, the slope of the incoming sewer (s) shall be carried through to the outlet and the invert elevations at the inlet (s) and the outlet shall be given. Where diameters of sewer pipes change, and in junctions involving major direction or slope changes, the various elevations shall be selected to match water surfaces under average (not maximum) flow conditions

at ultimate tributary area development.

The slopes in manhole channels indicated below are minimum values and must be increased where required by hydraulic consideration within the manhole.

Table 2.8.1. - Added Drop through Manholes (feet)

Diameter of Inlet Pipe (inches)	Diameter of Outlet Pipe				
	8”	10”	12”	15”	18”
8	---	0.08	0.33	0.50	0.67
10	---	---	0.25	0.42	0.58
12	---	---	---	0.17	0.33
15	---	---	---	---	0.17

When the incoming sewer makes an angle of 45-degrees to 90-degrees with the outlet sewer, add 0.10-foot to the above values with the exception that the minimum drop shall be 0.20-foot. When the angle is 15-degrees to 45-degrees, add 0.05-foot to the tabulated value with a minimum drop of 0.10-foot.

H. Flow-line Requirements

1. Flow channels through manholes shall be shaped to conform to cross section and slopes of connecting sewers. Floors and channels shall be shaped such that television camera and jet cleaning access will not be impeded.
2. A 0.20-foot minimum elevation step shall be provided in all junction manholes; except where accepted otherwise by the City Engineer.
3. The maximum allowable drop, between inlet and outlet inverts, through a manhole is two feet. When a drop manhole is required a 60-inch manhole is required. All drop manholes must be approved by the City Engineer.
4. Where incoming slopes at manholes are greater than or equal to 5-percent, the incoming slope shall be carried through the manhole, unless otherwise approved by the City Engineer.

I. Construction Requirements

1. See Standard Drawing No. SS-030, and SS-035 for Sewer Manhole construction requirements.
2. See Standard Drawing No. SS-045 for Sewer Drop Manhole construction requirements.
3. See Standard Drawing No. SS-040 for Sewer Cast in Place Manhole Base construction requirements.
4. See Standard Drawing No. SS-050 for Sewer Concrete Collar construction requirements.
5. See Standard Drawing No. SS-055 for Sewer Manhole Cover construction requirements.

J. Drop Manholes - While not encouraged, drop manholes may be necessary due to physical constraint; they should not be used to merely avoid extra depth in trench unless unusual

circumstances exist. Where approved, the drop shall not exceed 10-feet and shall be constructed in accordance with Standard Drawing No. SS-045.

K. Undeveloped Areas - Manholes in undeveloped areas require special protection as discussed in Section 3.11.

L. Rim Elevations of Manholes - Top elevations for all manholes shall be shown on the profile. In paved areas, the manhole rim elevation shall match the finished grade. In unpaved areas or traveled way, the height of the manhole rim will normally be 18-inches above the finished grade, high water mark, or above the top of future fill areas. The elevations shown for the tops of manholes on the design plans shall not relieve the contractor from making final adjustments to match street surfaces.

M. Protection - Where new sewers are to be connected to a manhole, which is in active use, the designer shall require such protection as is necessary to prevent construction debris from being washed into the active sewer. Plugged inlets or other suitable protection shall be required for the active manhole before beginning manhole modification or cleaning of new sewers. Bypass methods shall be to the satisfaction of the Engineering Department.

N. Safety - Refer Technical Specification No. 02606 – Manholes for discussion of manhole safety.

O. Pipe Transitions - At manholes, where sewer diameters change, the flow energy gradient shall be continuous. The 0.8 depth point of the two sewers shall be placed at the same elevation, with proper allowance for any manhole head loss or as required to provide proper flow.

P. No plugged ends of sewer lines will be allowed. Manholes must be constructed at the ends of sewer lines.

Q. Pipe Construction – See Standard Drawing No. SS-020 for pipe construction requirements

2.11 CLEANOUTS

Dead-end sanitary sewer lines under 200-feet long may terminate in a cleanout unless Section 2.10 requires a manhole. If a future extension of said dead-end line will include a manhole within 400-feet of the uppermost manhole, a temporary cleanout is permitted. The following also apply to cleanouts:

A. Location - Refer to applicable portion of Section 2.10.

B. Design - Cleanouts shall be constructed in accordance with Standard Drawing No. SS-081.

C. Clean-outs shall not be used as an alternative to manholes on sewer lines 8-inches in diameter or greater.

D. All sanitary sewer clean-outs shall conform to the requirements of the Utah State Department of Health Code and the International Plumbing Code.

E. All Clean-outs shall have a metal cap and shall not be placed any lower than 10-inches below finished grade.

2.12 SERVICE LATERALS

A. General –The private sanitary sewer line is the sanitary sewer line beginning at the "nose-off" at the public sanitary sewer main in the public street, extending to the building. The service lateral as defined above, is the responsibility of the private property owner, who is responsible for operations and maintenance of the service lateral. The Engineering Department will inspect the construction of service laterals from the main sewer line to the property line. The Building and Safety Division inspects the lateral from the property line to the building or house.

Wherever it is known or can be reasonably assumed that a building sewer connection is required, a service lateral shall be shown on the plans and installed to the property line as a part of the street sewer construction prior to paving. An independent service lateral shall be provided for each owner. Service laterals shall be installed in general conformity with Standard Drawing No. SS-020.

B. Tapping Requirements - Contractor shall not tap the existing sewer main using any method other than core drilling with a water tight rubber seal at the nose-on connection to the City sewer main.

C. Size and Slope Requirements - Service laterals for single-family dwellings shall normally be 4-inch minimum diameter, unless otherwise required by the Uniform Plumbing Code. Condominiums or townhouses shall normally be required to have separate 4-inch minimum diameter laterals, rather than one 6-inch minimum diameter lateral per building. All other laterals for commercial or industrial uses shall be no less than 6-inches minimum diameter.

Pipe lengths for laterals shall not exceed manufacturer's recommendations. The maximum size lateral connection by wye or tee fitting to a larger diameter sewer shall be 6-inches. A manhole shall be installed when an 8-inches or larger sewer is connected to an equal or larger diameter sewer.

1. The minimum lateral size shall be 4-inches.
2. A 6-inch sewer lateral may be constructed at a minimum slope of 1-percent.
3. A 4-inch sewer lateral shall be constructed at a minimum slope of 2-percent.

D. Depth - Service laterals from the main sewer to the property line shall be constructed at a 2.0-percent grade unless otherwise approved. In addition, the depth at the curb or property line shall normally be 6-feet minimum from top of pipe to ground surface.

E. The grade and location of laterals within the property are under the jurisdiction of the Building and Safety Division. As a guide, the laterals should be at a minimum 2.0-percent grade from the property line to the point of connection at the house.

F. Location - Sewer laterals shall tie directly into manholes in cul-de-sacs and at dead end manholes. Sewer laterals may tie directly into manholes wherever possible and practical.

G. Responsibility - The city does not assume responsibility for sewer laterals. It is the responsibility

of the home or business owner to construct, maintain, and operate any and all sewer lateral service connections.

H. Construction - See Standard Drawing No. SS-025 sewer lateral construction requirements.

I. Future Connection - Unused openings shall be tightly sealed and supported in a manner to facilitate their future location and use. Developer's engineer shall select appropriate service lateral locations and shall instruct contractor to locate lateral according to the design elevations and locations. Likewise, the adequacy of such in-place laterals shall be verified by the owner/developer prior to the future connection.

J. Manhole and Laterals in Cul-de-sac Streets - Where numerous laterals connect to the end of a sewer, they shall be brought into a standard manhole. Two such laterals may enter each of three inlet channels in preference to installing numerous wye branches in series downstream from the terminal manhole.

K. Backflow Prevention - It is the designer's responsibility to recognize the possibility of reverse flow in service laterals serving lots or buildings with plumbing fixtures below the nearest upstream sewer manhole rim (device required where pad elevation is below upstream manhole rim). In such instances, a suitable backflow or overflow device shall be provided. The lots where prevention is required shall be indicated on the plans; the device or valve used shall be approved and inspected by the Building & Safety Division. See Standard Drawing No. SS-082 for details regarding installation.

2.13 STRUCTURAL REQUIREMENTS

A. Under Roads - All structures and pipe placed under public roads shall be of sufficient strength to support, with an adequate factor of safety, the backfill, road surfacing and H-20 per AASHTO Standard Specifications, truck loading with Impact. Higher loading may be as specified by the Engineering Department or as required by good design.

B. Other Pipes and Structures - Sewers designed to cross under or over other pipes or structures shall be protected from damage and shall be constructed to prevent endangering the other pipe or structure. In this regard, particular attention should be given to the possibility and prevention of settlement-caused damage. Also where future replacement of any line may be extremely difficult due to the pipe or structure, special design consideration may be required. Any of the standard drawings, which detail various encasements or other protection, may be required in such instances.

C. Flexible Joints- Flexible joints which will allow for differential settlements or other movement of sewer pipe, sewer structures, adjacent pipe and adjacent structures shall be provided where sewer lines enter encasements, manholes or other structures. Flexible joints shall be within a minimum of 24-inches of such structure, except for ABS Composite pipe for which this requirement does not pertain.

D. Steep Grades - Sewers laid on grades steeper than 10-percent, which are not under, nor intended to be under pavement, should be examined for possible erosion protection. Where the slope exceeds 30-percent (3.33 horizontal to vertical) a redwood check dam (Standard Drawing No. SS-090)

shall be installed across the trench line at 20-feet intervals to reduce erosion.

Slopes above 35-percent (2.86 horizontal to 1 vertical) shall require sand/cement bags be placed along the trench line at the intervals specified in Standard Drawing No. SS-095 to reduce the flow of water within the pipe trench.

Concrete anchors in accordance with Standard Drawing No. SS-115 will only be required in special instances, where such anchorage is deemed necessary to prevent pipe movement.

2.14 PRIVATE SEWER LINE REQUIREMENTS

A. All private sewer line construction shall be required to meet these standards, and/or be subject to review of City Engineer.

B. Sanitary sewer pumping stations, where they cannot be avoided, may be permitted within a private sewer line and shall not be located within a public sewer line.

2.15 PRIVATE (RESIDENTIAL) PUMPING SYSTEMS

General City policy is to avoid private residential pumping systems except in those cases where such a system is either: (1) in the City's best interest or (2) the only method for sewering a lot which cannot be adapted to a gravity system or eliminated. In any case, the use of a private pumping system requires special Engineering Department approval.

Where such a system is employed, the City will not accept responsibility for the satisfactory operation and maintenance of the private system; a document recorded against the property shall confirm this.

A. All equipment and accessories shall be standard manufactured items with those in contact with sewage being specifically manufactured for sewage use.

B. The Engineer shall submit, if required, a listing of satisfactory installations using the same products.

C. Individual systems shall meet the City Engineer’s requirements. Of particular importance are the following:

1. The sump shall have a minimum 400-gallon capacity.
2. The system shall be of the duplex type (2 pumps) and have duplex controls, which will automatically alternate the pumps and energize both pumps and an alarm during high liquid level.
3. Pumps shall be heavy-duty centrifugal non-clog type with mechanical seals and cast iron construction. Each pump shall have a minimum 60-gpm capacity when pumping against a total dynamic head of 20-feet. The impeller shall have a 2-inch solids handling capacity. The motors shall be completely oil filled and fully submersible.
4. Discharge line shall be 3-inches in diameter with a working pressure of not less than 150-psi. All underground discharge piping shall be PVC schedule 40, and above ground piping shall be

PVC schedule 80.

5. The shutoff valve shall be either the ballcentric or eccentric type with a working pressure of not less than 150-psi and suitable for sanitary sewer use. The check valve shall be a rubber flapper swing non-slamming type with a working pressure of not less than 150-psi and suitable for sanitary sewer use.

D. The discharge lines shall be arranged such that there is gravity flow into the main sewer from the property line.

E. Where a unit serves a number of homes, it shall be sized to handle daily flows of at least 500-gallons per day and a peak discharge into the unit to reflect the number of residences.

F. All controls shall be non-fouling type and all mechanical and electrical equipment shall equal or exceed City or other pertinent codes.

G. Backflow prevention devices as required to prevent water system contamination shall be installed.

H. Where a pumping unit is proposed, it shall be requested prior to preliminary plat map approval, except for those cases where the City may decide to approve the unit at a later date.

2.16 FORCE MAINS AND LIFT STATIONS

All sewage shall reach the system by gravity flow, in a fresh (non-septic) condition susceptible to conventional sewage treatment processes. Where extreme hardship conditions prevail and a substantial area cannot be sewered by gravity sewers, in accordance with these requirements, a sewage pumping station may be considered. No pumping facilities shall be designed or incorporated in sewer plans without prior approval.

A. Lift Stations Design: Lift stations, where permitted, shall be of the dry-pit type incorporating the following features:

1. Pumps or other devices shall be provided in duplicate, arranged for positive priming.
2. Capacity shall be provided to handle ultimate peak flow from the tributary area with the largest pump out of service. Stage installation of pumps will be permitted if space is provided for future pump units.
3. Access shall be provided to site for removal and repair of equipment.
4. A means for dewatering force mains shall be provided.
5. Holding capacity in the wet well equivalent to a 24-hour accumulation of sewage from the fully developed area tributary to the pump station.
6. Bottom of wet well shall slope to suction lines at least 1.75 vertical to 1.0 horizontal. It is recommended that the width of the flat bottom in the wet well not exceed twice the diameter of the suction pipes.
7. Pump stations for newly developed areas shall not be located in road right of way, but shall be located on a separate parcel of land and shall include fence, gates, landscaping, etc. Pump stations located in road right of way will only be considered when it can be demonstrated to

the governing body of the road right of way and the Director of Engineering that no other site out of the road right of way is possible and such facility is not temporary.

8. A pump station shall have suitable adjustable level control, sump pump, dehumidifier, ventilation, lights, locking entrance door, running time meters, and cathodic corrosion control.
9. Pump and fittings shall be designed to permit the passage of a 3-inches diameter sphere through the pump.
10. Standby power with automatic pump drive transfer shall be provided except when waived by the Director of Engineering. Consideration should be given to using natural gas engines.
11. Compressor to inject air into the force main at a point outside of pump station so that air will not collect back of check valve with possibility of air locking pump.

B. Force Mains - Force mains shall be laid on a continuous positive grade and to grades designed to eliminate air pockets in the line.

C. Construction of Special Structures - Design criteria for special facilities (i.e. junction boxes, etc.) that are not covered in previous sections are to be prepared individually for each specific job, and shall be as approved.

2.17 INDUSTRIAL WASTE DISCHARGE

The Developer/Developer's Engineer is to be aware that the City regulates the physical and chemical content of sanitary sewers discharged to the sewerage system. These regulations are contained in an Appendix G to this Manual and are the requirements of the South Valley Water Reclamation Facility (SVWRF). The SVWRF requirements have been adopted by the City by Ordinance in Title 90 of the City's Municipal Code.

Typically, this ordinance only applies to those developments without a discharge of other than domestic sanitary sewer. However, the ordinance should be reviewed if sanitary sewer will contain any hazardous toxic materials, heavy metals, or any other substances, which may be harmful to the operation and maintenance of the sewerage system. The ordinance then requires either the substance be prohibited from discharge or pretreated prior to its discharge to the sewer. Questions and further details concerning these regulations should be directed to the South Valley Water Reclamation Facility industrial waste inspector.

2.18 ABANDONMENT OF SANITARY SEWER LINES

Refer to Section 8.0 of this Manual.

2.19 SPECIAL REQUIREMENTS

A. Commercial, and Industrial Uses - Prior to the installation of a sewer lateral into a commercial, industrial, or municipal building the developer is required to obtain approval from South Valley Water Reclamation Facility. They will determine the requirements related to the installation of a grease interceptor, sand trap, or sewer monitoring manhole. The city will not grant a Certificate of Occupancy until written notification of compliance is received from a SVWRF representative.

B. Special Impact Fees - There is a possibility in the future of a sewer surcharge fee to facilities generating high levels of BOD5 and/or TKN concentrations because of the treatment process limitations at South Valley Water Reclamation Facility. Regulations regarding this subject are currently under review by the State.

C. Easements

1. Easements shall be required on all public sewer lines not located in a Public Street.
2. All easements must be a minimum of 20-feet wide.
3. Combined sewer and storm drain easements shall be a minimum of 25-feet wide.
4. Easement shall be centered on the sewer line, unless otherwise directed by the City Engineer.
5. Easements shall extend 10-feet beyond the last manhole on a line.
6. When a sewer is located in an easement, not abutting a public street right of way, access easements shall be provided for maintenance purposes and shall be a consistent width of 20-feet the entire length of the easement.
7. All easements shall be submitted and approved by the City Engineer, or his designee, before Final development approval shall be granted.

D. Boring

1. Boring under canals, pipelines, watercourses shall be steel encased, or other material as approved by the City Engineer.
2. Minimum clearance between outside of casing and other utilities shall be 18-nches, unless otherwise approved by the City Engineer.

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SECTION 3.0

MATERIALS

3.1 GENERAL REQUIREMENTS

This section discusses the materials involved in sanitary sewer pipeline, appurtenances, and associated construction activities. Design and construction related to land disturbance and other underground infrastructure are subject to the policies and design criteria manuals for that specific type of facility. Separate policies and design criteria are available from the City's Engineering Department. Materials shall be chosen for their strength, durability and ease of maintenance, with due consideration for dead and live loads, beam strength and resistance to corrosion. Pipe joints are to be selected to provide positive protection against entrance of roots and ground water, with sufficient flexibility to adjust to the trench bedding. All materials, unless specifically approved otherwise, shall be new and unused.

The *'Sanitary Sewer Policies & Design Criteria Manual'* establishes the material requirements for pipe products, backfill materials, manholes, and other sanitary sewer related appurtenances. Approval to use any of these materials on a specific sanitary sewer project is subject to the constraints imposed by other pertinent sections of these standards or as required by the Engineering Department.

The City has adopted the use of the *'Manual of Standard Specifications'*, prepared by the American Public Works Association (APWA), 2007 or latest version, as the primary source for construction specifications for its public roadway improvements. The APWA Manual of Standard Specifications does not provide sufficient detail to address the City's concerns regarding the construction of sanitary sewer, and therefore this *'Sanitary sewer Policies & Design Criteria Manual'* has been prepared to be the *'primary sources'* for sanitary sewer related design and construction activities. Where this *'Manual'* does not address issues of concern, then the *'APWA Manual of Standard Specifications'* can reviewed as a *'secondary source'* for information. This applies to both private development projects as well as City Capital Improvement Projects (CIP). In the case of CIP projects, the Contract Documents take precedence over any other documents.

Where applicable, American Society of Testing Materials (ASTM), American Association of State Highway Transportation Officials (AASHTO) or other standards have been referenced and it shall be the responsibility of the developer/engineer/contractor to be familiar with those standards to insure compliance. Titles corresponding to the specific numbers are given in the reference section of the standards.

In some instances, particular manufacturers and product names have been mentioned as being approved. Other products may also meet the requirements, but must be first approved in writing by the City Engineer. One factor, which may be considered by the City Engineer in any consideration of other products, is the need for some degree of standardization.

If at any time the Engineering Department believes that the use of a specific product must either be halted or changed, the City Engineer has the authority to make the change providing the decision is based upon an engineering, performance or maintenance evaluation.
In general, pipe installations for most projects will either be PVC, concrete, or ductile iron products. Unless the Engineering Department takes exception during the plan review process, it can be assumed

that these materials are acceptable. However, if exception is made, such shall be reflected in the next plan redline. Where alternate materials are shown, the various load factors for each reach must be indicated by the corresponding material type.

3.2 TESTING AND FINAL ACCEPTABILITY OF MATERIALS

The Engineering Department will require such tests and certifications as deemed necessary to show the specified materials have been employed. Notwithstanding prior factory or yard inspections, the City Engineer shall have the right to reject any damaged or defective materials found on the job and order its removal from the site. Further information on testing is contained in the *'Private Development Construction Inspection Manual'*.

3.3 OTHER UTILITIES MATERIALS (Trench Zone)

Please refer to the following policies & design criteria manual for the appropriate utility to specify other materials for these other infrastructure:

A. Culinary Water Policies & Design Criteria Manual
B. Land Disturbance Policies & Design Criteria Manual
C. Stormwater Policies & Design Criteria Manual
D. Secondary Water Policies & Design Criteria Manual
E. Landscape & Irrigation Policies & Design Criteria Manual

3.4 GENERAL SANITARY SEWER SYSTEM REQUIREMENTS

A. General – This work includes the general materials, processes and other requirements related to sanitary sewer infrastructure construction. The Engineer shall provide for these items as part of his/her design using he following technical specifications sections for items:

1. Section 02667 – Hydraulic Structures and Pipeline Testing
2. Section 02719 – Sanitary Sewer System
3. Section 02750 – Sanitary and Storm Drainage System Testing

3.5 SITE WORK RELATED TO SANITARY SEWER INFRASTRUCTURE CONSTRUCTION

A. General – This work includes the materials, processes and other requirements coincident with sanitary sewer infrastructure construction during the construction process. The Engineer shall provide for these items as part of his/her design using he following technical specifications sections for items:

1. Section 01525A – Temporary Construction Aids
2. Section 01554A – Traffic Control
3. Section 02005 – Diversion and Cre of Stream During Construction
4. Section 02105 – Dust Control
5. Section 02112 – Clearing, Grubbing, and Stripping
6. Section 02140 – Dewatering

7. Section 02160 – Excavation Support Systems
8. Section 02161 – Care of Water
9. Section 02200 – Earthwork
10. Section 02222 – Excavation and Backfill for Structures
11. Section 02224 – Trenching, Backfilling, and Compacting
12. Section 02227 – Sand-Cement Slurry
13. Section 02228 – Blasting
14. Section 02276 – Stablilized Construction Entrance
15. Sectrion 02313 – Trench Excavation
16. Section 02316 – Trench Backfill and Compaction

3.6 RIGID PIPES

Rigid pipe, fittings and joint materials specified consist of Reinforced Concrete (RC), and Ductile Iron (DI).

A. Reinforced Concrete Pipe and Fittings - Reinforced concrete pipe and fittings shall conform to the following:

1. Section 02617 – Reinforced Concrete Pipe
2. Section 02618 – Reinforced Concrete Pressure Pipe
3. Section 02621 – Reinforced Concrete Cylinder Pipe

B. Ductile Iron Pipe and Fittings - Ductile Iron pipe and fittings shall conform to the following:

1. Section 02625 – Ductile Iron Pipe

3.7 PLASTIC PIPE

Plastic pipe, fittings and joint materials specified herein consist of PolyVinyl Chloride (PVC) and shall conform to the following:

1. Section 02645 – PVC Schedule Rated Pipe
2. Section 02648 – PVC Sewer Force Mains
3. Section 02649 – PVC Gravity Sewers

3.8 OTHER PIPE MATERIALS

With prior written request and approval, the Engineering Department may consider the use of other pipe materials for a specific project.

3.9 PIPE TRENCH MATERIALS

Refer to Standard Drawing No. SS-020 for trench cross section terminology.

The follow sections define the types of materials to be provided:

1. Section 02224 – Trenching, Backfilling and Compacting
2. Section 02316 – Trenching, Backfilling and Compacting

This material is primarily intended where the trench has been over-excavated so that a firm foundation can be made in areas of excessive groundwater flow. In such cases, a transition material must be used to separate the pipe from the coarser type G material. Such transition material must be well chocked into the voids of the coarser material.

3.10 MANHOLES

Manhole materials shall conform to those listed in Standard Dawing Nos. SS-030 through SS-075. The following sections also provide additional details regarding City requirements for this item:
, in addition to the following:

1. Section 02606 – Manholes
2. Section 02608 – Diversion Structures
3. Section 02719 – Sanitary Sewer System

3.11 MANHOLE/CLEANOUT LIDS

All public manhole covers shall have "West Jordan Sewer" cast around the perimeter of the top with minimum 1-1/2-inch letters, indicating the use of the manhole. Two-inch letters are preferable but not required. For private sewers omit "West Jordan" on the lid and substitute "Private". Cleanout lids shall include the word "Sewer".

3.12 TESTING

A. General - This work includes the testing of the sanitary sewer system(s) and materials. The Engineer shall design the City's sanitary sewer using the following technical specifications sections for items.

1. Section 02667 – Hydraulic Structures and Pipeline Testing
2. Section 02719 – Sanitary Sewer System
3. Ssection 02750 – Sanitary and Storm Drainage System Testing

3.13 CONCRETE MATERIAL

Approved concrete material shall be based on the 28-day compressive design strength and shall be chosen according to the following chart showing its intended use:

Class	Application	28-Day Compressive Strength (psi –min)	Maximum Aggregate Size (inches)	Slump (inches)

A	Walls, drip structures, and reinforced structural encasement	3,500	1-1/2	3	6
B	Manhole bottoms, drop pipe encasement, pipe bedding, non-structural use	3,000	1-1/2	2	6
C	Pump mix for abandoning lines	2,000	3/8	--	--

The following Sections apply to concrete and related work in the City's sanitary sewer system:

1. Section 03100 – Concrete Formwork
2. Section 03102 – General Concrete Construction
3. Section 03210 – Reinforcement Steel
4. Section 03300 – Cast-in-Place Concrete
5. Section 03401 – Precast Concrete Vaults
6. Section 03480 – Precast Concrete Specialties

3.14 REINFORCING STEEL

The following section defines the City's requirements in regards to reinforcing steel:

1. Section 03210 – Reinforcmeent Steel

3.15 GENERAL ROADWAY CONSTRUCTION

Pavement materials for resurfacing of trenches cut Into existing pavement shall comply with the requirements of the City of West Jordan, Road & Bridge Policies & Design Criterial Manual adopted by the City Council on January 22, 2008 and all subsequent amendments thereto (for Information, Standard Drawing No. SS-020 contains portion of those requirements. Asphalt, aggregate base and aggregate sub-base specifications are those set at by the latest publlshed edition of American Public Works Association *"Manual of Standard Specifications"*.

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SECTION 4.0

PLAN PREPARATION

4.1 GENERAL

Section 4.0 of the manual identifies work which is to be coordinated through the Engineering Department. The Developer is responsible for obtaining the necessary City design and construction standards, permits and for coordinating with the Engineering Department to ensure its requirements have been met. It is the Developer's responsibility to complete the work required. The Developer is responsible for expediting the work and obtaining the necessary approvals and permits to proceed with construction.

In the case of construction of secondary water canal weirs, the Developer is responsible for processing these approvals through the respective canal company prior to preliminary plat approval. The Developer is to provide all fees and securities necessary to construct these facilities.

For the most part, these requirements apply equally to commercial and industrial site plans as well as residential construction plans. Commercial sites include all commercial buildings and church sites.

4.2 MASTER PLANS

One of the first items the Developer needs to do is to review the City's master plans prior to starting design of various utilities or street systems. The City has completed the following master plans:

1. Culinary water system
2. Secondary water system
3. Transportation
4. Storm drainage system
5. Sanitary sewer system
6. Parks and trails

The Developer needs to contact the Engineering Department and review these documents with them prior to proceeding with design.

4.3 DESIGN AND CONSTRUCTION STANDARDS

The Developer is responsible for obtaining the City's design and construction standards for land disturbance, roads and bridges, culinary water, and storm drain facilities. These standards are available through the Engineering Department for a fee, which covers the cost of reproduction of these documents. The fee is indicated in the City's Consolidated Fee Schedule and is available on the City's Website *www.wjordan.com*. Please see the Finance Department for the most current version.

4.4 PRELIMINARY DESIGN

All preliminary and final design is to be in compliance with the City's master plans and design and construction standards and is to include the following:

A. Master Plan Compliance – Prior to beginning design of any facilities, the Developer is to meet with the Engineering Department and receive information regarding facility sizing/locations for the proposed project. Call ahead and set up an appointment through the Engineering Department secretary.

B. Fire Flow Calculations – The Developer is to demonstrate to City Staff, through engineering calculations prepared by a registered civil engineer, that the fireflow required by the Fire Department can be met, prior to the construction of buildings being started. Prior to an outside consultant preparing these calculations, the Developer's consultant must obtain Engineering Department approval of the modeling technique and assumptions.

C. Flood Plain Evaluation – The Developer is to submit a flood plain evaluation performed and stamped by a registered civil engineer to document whether the property lies within a flood plain or not.

D. Drainage Calculation – The City has completed a storm drain and flood control master plan, which identifies major storm drain facilities to which each Developer must connect. The Developer is responsible for constructing pipelines and other facilities to the master plan facilities. Calculations must be prepared for the Developer provided facilities by a registered civil engineer and submitted to the Engineering Department for review and comment. The City will return an approved set of calculations to the Developer once these calculations are deemed to meet the City's requirements.

E. Traffic Impact Study – The Developer may be required to pay for a traffic impact study to be prepared by a registered traffic engineer, under the Engineering Department's direction that addresses the traffic and transportation impacts of the project. The extent of investigation and scope of work is defined in Appendix R – Guidelines for Traffic Impact Studies and will be determined by the Engineering Department. All original copies of the report are to be wet stamped and signed by the traffic engineer.

F. Geotechnical Report – The Developer is to submit to the Engineering Department for approval, a geotechnical report prepared by a registered geotechnical engineer. This report is to contain a soils report of the project's underlying soils, which is to identify groundwater levels and other soils data important to construction of the road and structures. The report is to contain recommendations to correct problems in the field and is to also contain a section that identifies pavement design for all facilities to be dedicated to the City. Appendix S – Guidelines for Geotechnical Reports identifies the extent and scope of work for the geotechnical report and the report is to be delivered to the Engineering Department directly from the geotechnical engineer preparing the report. All original copies of the report are to be wet stamped and signed by the engineer.

G. Subdrain/basement Drain Report – A separate report is to be prepared by a registered civil or geotechnical engineer which identifies design of subdrain/basement drains for the project. Those projects of specific concern are those, which lie near to, or adjacent to irrigation canals which run through the City. The City will, however, determine whether such a report needs to be prepared and what its extent will be. All original copies of the report are to be wet stamped and signed by the engineer.

H. Grading Report – The City has established a Land Disturbance Ordinance as part of its Municipal Code and will require a grading report including drawings prepared for each project. The report will need to identify where dirt will be move from, where its final placement will be, how it will be placed and methods of placement and compaction to meet the City's land disturbance ordinance. Prior to performing any grading on the project, the Developer is to obtain a Land Disturbance Permit from the Engineering Department. All projects over 5 acres in size are also required to have Utah Pollution Discharge Elimination System (UPDES) and Storm Water Pollution Prevention (SWPP) permits from the State of Utah, Department of Environmental Quality.

4.5 FINAL DESIGN AND DRAWING PREPARATION

Final design is to take into account the City's design and construction standards for all publicly dedicated facilities. These standards are available through the City's Engineering Department for a fee or online at *www.wjordan.com*.

A packet is to be submitted to the City's Engineering Department that includes all design assumptions and calculations and certifies the City's standards have been followed. Final drawings are to be submitted on the City's standard size sheets of 24x 36. Final drawings will be signed and stamped by the Developer's registered professional engineer for the project.

For commercial site plans, the Engineering Department will review all sheets which show the site improvements outside the building envelope, including site grading, drainage facilities, on-site public water lines, and hydrants, overland release path for storm water overflows, street lighting, and landscaping on street frontages.

Drawings submitted to the Engineering Department are to be organized according to the following order:

1. Cover Sheet
2. Abbreviations, Legends and Sheet Index Sheet
3. General Notes Sheet
4. Typical Sections Sheet
5. Survey Control Plan
6. Overall Utility Plan
7. Site Demolition Plan
8. Subdivision Plat or Site Plan
9. Street Signs and Striping Plan
10. Overall Grading and Master Storm Drainage Plan
11. Grading and Storm Drainage Details
12. Grading and Drainage Plan Key Sheet
13. Grading and Drainage Plan
14. Overall Storm Water Pollution Prevention Plan
15. Street Plan and Profile Sheets
16. Traffic Signal Plan

Additional information is provided in the Engineering Department, Construction Drawings Checklist contained in Appendix M – Subdivision Final Plat Process. This completed and filled-out checklist is required to be submitted with the copies of the check prints submitted for City review.

The following items are required as part of the construction plans:

A. Copies - Three copies of construction plans are to be submitted:

1. One set for Engineering Department review
2. One set for the City
3. One set returned to the Developer for corrections and revisions

B. All drawings are to be clear and legible and conform to good engineering and drafting practice.

C. Drawings are to have signature blocks for Engineering, Community Development, Public Works, Fire Department and other City departments on all sheets. Departments will sign off on their block as they review it.

D. Size - 24x36 with ½-inch border on top, bottom, and right sides; left side is to be 1 ½-inches.

E. Plans are to include the following information:

1. North arrow (plan)
2. Elevations reference to USGS datum
3. Stationing and elevations for profiles
4. Title block located in lower right corner of sheet to include:
   a. Project title
   b. Specific type and location of work
   c. Name of engineer with license number and Utah Engineer's stamps
5. Scale: 1"=20' or 1"=40' horizontally, 1"=2' or 4' vertically
6. Both plan and profile views for curb and gutter plans for:
   a. Each side of the street
   b. Center line, may be eliminated
   c. Top of curb elevations with curve data must be shown for all curb returns
7. Culinary water system - Size and location of mains, laterals, mains, valves, hydrants and pipe type.
8. Secondary water system - Size and location of mains, laterals, vales, fittings, etc.
9. Sanitary Sewer system - Size and location of mains, laterals, mains, valves, hydrants and pipe type.
10. Storm Drain system - Size and location of mains, laterals, mains, valves, hydrants and pipe type.
11. Subdrains, their manholes and cleanouts
12. Irrigation facilities
    a. Size and location of all required irrigation piping
    b. Data regarding flow and outfall of affected irrigation water
    c. Separate sheets of details for structures, etc.

4.6 GUIDELINES AND CRITERIA FOR PLAN PREPARATION

A. Plan Submittal - Submittal to the city generally falls into three categories:

1. Initial submittal,
2. Resubmission addressing City comments and
3. The final submittal of the originals for City approval. The general requirements for each of these submittals are outlined in Table 1.1.

Table 4.6.1. – Submittal Requirements

Item	Required for initial Screening Acceptance	Required for Resubmmittal	Required for Approval
Number of Plan Sets (bluelines)	4	As Requested	Original Mylar Duplicate Mylar
Bond Estimate Form (completed by engineer)	1 Copy	As Requested	Approved Estimate
Tentative Map or other Conditions	1 Copy	-	On File
Final Map Conditions	-	1 Copy	On File
Geotechnical Soils Investigation Report (1)	2 Copies	-	On File
Traffic Impact Analysis (2)	2 Copies	Approved	On File
Drainage Study (2)	2 Copies	Approved	On File
Notarized Off-Site Grading Authorization Letter (3)	-	1 Copy	On File
Developer Agreement Information Form (5)	-	1 Copy	On File
Subdivision or Improvement Agreement	-	-	Completed
Improvement Bonds	-	-	Posted
Plan Review and other Fees	-	-	Paid

(1) – if construction of public street is required
(2) – if required as a condition of approval
(3) – if offsite grading or construction is required
(4) – if design deviates from Guidelines or Standard Requirements
(5) – Required if Subdivision Agreement is to be used

The specific requirements of each of these categories are discussed in greater detail in the following subsections.

B. Plan Submittal - Engineers submitting plans to the City for initial screening are to provide:

1. Three (3) sets of complete plans (check prints) sealed by a registered Engineer in responsible charge.
2. One (1) copy of the completed bond estimate form with quantities for all public improvements, also quantities should be shown on construction plans.

In addition, the following items are required as part of the initial review submittal:

1. Two (2) copies of the geotechnical soils investigation report if the project includes construction of public streets. The report must include a pavement section recommendation for all proposed public streets.
2. Verification of traffic impact analysis (TIA) submittal to the traffic engineer if a TIA is a condition of approval.
3. Verification of drainage study submittal to Engineering Department if a drainage study is a condition of approval.
4. When a project requires grading or construction off-site, One (1) copy of a notarized authorization from every private property owner on whose property work is required.
5. Completed Development Agreement information form if a Subdivision Agreement will be prepared.
6. Written notice of deviations. If the plan submittal contains deviations from either these guidelines or the requirements of the uniform standards and City policy, the design engineer is to as part of the initial submittal include a letter to the City outlining all deviations and substantial reasons for requesting the deviations.

In addition to the items outlined above the Assessor's Parcel Number (APN#) is to be placed on the cover or title sheet of the submittal. Fire flow information is to be placed on the water plan and secondary water information is to be placed on the master utility plan.

All initial submittals are reviewed for conformance to the Engineering Department initial plan screening checklist. Failure of the design engineer to include the required information with the initial submittal will result in rejection of the plan submittal and the return to the design engineer. If the submittal contains sufficient information to be processed for review, the submittal will be accepted and both the design engineer and developer will be notified. Following the initial plan screening, the three plan sets submitted will be circulated to various sections within the City for review and comment. This process generally takes two weeks. When comments are received from the other City reviewing groups, the Engineering Department will consolidate the comments and review the plans for conformance to City standards. The entire initial review process generally takes 4 to 6 weeks depending on the current workload and complexity of the project. The Engineering Department will transmit the review comments to the design engineer and either request the plans be resubmitted for review or that mylars be submitted following corrections.

C. Resubmittal - If the conditions of approval or the Engineering Department require a drainage study or traffic impact analysis, those studies are to be approved prior to resubmittal of the improvement plans to the Engineering Department.

Engineers resubmitting plans to the City for review are to provide:

1. One (1) to three (3) sets of complete plans (check prints) as requested from the initial review sealed by the Engineer in responsible charge.
2. One (1) copy of the initial plan review comments (redlined plans). The redline of the fire plan should be retained by the engineer for use in obtaining fire signature on the Mylar.
3. Verification of Traffic Impact Study (TIS) approval by the Engineering Department if a TIS is a condition of approval.
4. Verification of drainage study approval by Engineering Department if a drainage study is a condition of approval.

5. Design engineer's certification that the grading plan is in conformance with the approved drainage study.
6. Design engineer's certification that the plans are in conformance with the approved traffic impact study.

Plans resubmitted to the City for subsequent review are to address all previously made land development review comments. The design engineer is to certify the grading plan conformance to the approved drainage study with the initial resubmittal and subsequently thereafter. All redesign from the previous submittal is to be clearly identified. In the event of major changes or significant redesign from the previous submittal, the design engineer should contact the Engineering Department to schedule a meeting to discuss the redesign concurrent with the resubmittal. Failure to meet with the Engineering Department to resubmitting a major redesign may delay the plan process.

The resubmittal review process generally takes between 5 and 15 working days depending on the current workload, complexity of the project, and thoroughness of the design engineer in addressing previously made comments. After reviewing the plans, the Engineering Department will either return the plans to the design engineer to address comments or request that original and duplicate mylars be submitted to the City for approval.

D. Required Easements and Rights-of Way - When improvement plans indicate easements to be dedicated or rights-of-way granted a complete package must be submitted prior to approval of the plans. This package must include legal descriptions, 8 ½ by 11 sketch and current vesting document. Easements may include ingress/egress, drainage, sewer, and intersite easements.

E. Final Submittal and Plan Approval - Improvement plans for subdivisions cannot be approved until after the final plat is approved. Prior to submitting original mylars and duplicate mylars to the Engineering Department for approval, certain prerequisite items must be submitted to and approved by the City. As part of the initial plan submittal the design engineer is required to submit a complete bond estimate form. This form is reviewed and if it is deemed accurate with no major design issues outstanding, an approved bond estimate form will be provided to the design engineer. The process of completing the bond estimate and obtaining the required bond estimate form is the responsibility of the developer and should be commenced early on in the process.

F. Request for Deviation Procedure - All deviations from these guidelines, the uniform standards or City policy are to be submitted to and approved by the Engineering Department. There are two types of deviations the engineer may need to address during the design process. First, deviations from the guideline requirements. All deviations from the guidelines are to be listed and submitted with the plans and other documents identified in " Initial plan submittal". Upon receipt, the deviation listing will be reviewed by the plan screener and supervisor. If the deviations are deemed to have merit, the plans will be screened and either accepted or rejected. If the deviations are considered to be only for the convenience of the design engineer, the Engineering Department will review the deviation request. If the Engineering Department considers the deviations acceptable, the plans will be screened and either accepted or rejected. If the plans are rejected and the design engineer desires to appeal the decision, the appeal is to be made in writing to the City. Upon receipt of the design engineer appeal, the engineer will schedule a meeting with the design engineer and the City staff engineer. The purpose of the meeting is to allow the design

engineer the opportunity to present its case to support the request. Within five working days following the appeal meeting, the Engineering Department is to inform the design engineer of its decision. The decision of the Engineering Department is to be final at this time.

The second type of deviation is a deviation from the requirements of the uniform standards and/or drawings or City policy. The design engineer is to identify and request a deviation from standards in writing and submit the request along with the other documents required in subsection 4.7.B., " Initial plan submittal". If the deviation is deemed to be in the best interest of the City and the project, the plans will be allowed to proceed through the plan review process. If the deviation as requested is determined to be unacceptable to the City, the Engineering Department is to schedule a meeting with the design engineer to attempt to resolve the issue. If the deviation is rejected and the design engineer desires to appeal the decision, the appeal is to be made in writing to the City Engineer. Upon receipt of the design engineer appeal, the City Engineer will schedule a meeting with the design engineer and the City staff engineer. The purpose of the meeting is to allow the design engineer the opportunity to present its case in support of the request. Within five working days following the appeal meeting, City staff engineer is to inform the design engineer of his decision. The decision of the City Engineer is to be final. If the denial of a deviation from standards or City policy will significantly impact a project, the design engineer is to contact the Engineering Department to review and resolve the design issue prior to making the initial submittal.

G. Plan Setup Requirements - The City is required to be the custodian of all improvement plans in perpetuity once they are approved. As the City moves to archiving plans on electronic media it is important that some degree of uniformity is maintained. The objective of the following plan setup requirements is to provide uniformity and standardization of plan submittal while allowing the design engineer flexibility with respect to presentation. Standardization of information along with uniformity in setup and presentation allows the review process to occur in a more orderly and timely fashion.

H. Plan Sheet Size - All plans submitted to the City of City of West Jordan must be signed and sealed by a civil engineer who is registered in the State of Utah. Plans are to be plotted or drafted onto mylar reproducible sheets and having an overall size of 24-inches wide by 36-inches long with margins placed accordingly. One and one-half inches on the left side and ½-inch on all remaining sides with a line thickness of 0.075 inches.

I. Title Block - Each plan sheet is to contain a title block located adjacent to the right side margin. The design engineer has the flexibility to determine the layout of the title block provided the following information is included somewhere in the title block. The title block is to include:

1. Title of sheet
2. Project name
3. Developer's or owner's name, address, and phone number
4. Engineering consultants name, address, and phone number
5. Professional engineer's name, P.E. number and seal and
6. Revision block

J. Benchmark - All projects are to utilize and reference an existing recorded City benchmark datum within one-quarter mile of the project site. If an existing benchmark is not located within the one-

quarter mile limit, a temporary benchmark on the project site suitable for the project construction/inspection purposes is to be established and referenced to the City datum. Every plan sheet to be utilized for construction of improvements is to indicate the referenced benchmark.

K. Drawing Scales - Drawing scales are to be a minimum of one-inch = forty feet (40') horizontal for plan views, unless otherwise noted in these guidelines. Drawing scales are to be a minimum of one inch = 40-feet horizontal, one inch = 4-feet vertical for plan and profile when slopes are less than 5 percent and a minimum of one inch = 40-feet horizontal, one inch = 8-feet vertical for plan and profile when slopes are greater than 5 percent. Plan and profile sheets are to be arranged such that the plan view is in the top half and the profile view is in the bottom half of the sheet. Profiles are to have vertical lines at every 50-foot station and horizontal lines at every 4-foot elevation.

All details are to be drawn to scale. The horizontal and vertical scale need not be the same. The purpose of requiring details be presented at scale is to allow the plan reviewer the ability to see spatial relationships of the various elements in the detail.

L. Plan Orientation - Generally, in lying out and developing the design, the design engineer is to consider the following hierarchy in establishing plan sheet orientation;

1. North should be to the top or right of the sheet
2. Stationing is to be left to right unless the sheet orientation with respect to North will not permit. The image is to only be drawn on the front side of the mylar.

M. Text Size and Line Weights - The final criteria for acceptance will be that all information provided on the plans be clear, concise and legible when the 24-inch x 36-inch sheet drawing is reduced to an 11-inch x 17-inch format. The following text size and line weight references are recommended for clarity but are not required. All text, which includes but not limited to dimensional text, spot elevations text, notes and other text are recommended to be leroy (L80) or romans. Shx font type with a text height of 0.08 inches and a pen thickness of 0.25mm. Profile elevations and stations are recommended to have a text height of 0.1 inches and a pen thickness of 0.50mm. Detail titles are recommended to have bold type font with a height of 0.20 inches. Street names are recommended to also have a bold type font with text height of 0.25 inches. All existing underground utilities are recommended to be shown dashed.

N. Line Type, Symbols and Abbreviations - The City requires the use of line types, symbols and abbreviations consistent with the *Uniform Standard Drawings for Public Works' Construction Off-Site Improvements, City of West Jordan City* Legends and abbreviation listings used on the plans are to only include those terms that are not included in the standards.

O. Plan Set Organization - The City requires that all sheets in the plan set be sequentially numbered, beginning with the title or cover sheet, with information presented and arranged in the following order:

1. Title/vicinity map/ quantities
2. Plat
3. Survey contour data sheet

4. Storm water pollution previous plan
5. General notes
6. Master utility plan
7. Grading plan and details
8. Street plan & profile/sections/details
9. Traffic signal plan
10. Striping/signage/streetlight plans
11. Sanitary sewer plan & profile/details
12. Storm drain plan & profiles/details
13. Water utility plan & profile/details

Depending on the complexity and scope of the project, a complete plan set may contain plan sheets from any or all of the above referenced groups. The guidelines indicate the minimum information. Data that must be presented and should not deter the design engineer from providing additional information as may be required. In the event the design engineer believes that the requirements of these guidelines are not applicable to a specific site or condition, the engineer is to request a deviation from the City. To facilitate the plan review and construction process, the City prefers that certain information be placed in a specific location on given sheets. The preferred location is identified in ***bold italics*** following the item description.

Example: North Arrow (upper right quadrant of sheet)

The above example indicates that the preferred location for the north arrow is in the upper right quadrant of the plan sheet. The City realizes that on rare occasions it may not be possible for the design engineer to comply with the City information placement preference. In those instances, the design engineer needs to identify all deviations from these guidelines in writing and submit the deviation listing to the City in accordance witH, “Request for deviation procedure”.

P. Cover Sheet Requirements - The design engineer may elect to provide a separate title sheet as part of the entire plan set or utilize the first sheet of the plan set to present additional information such as the vicinity map or quantities and thereby eliminate the need for separate sheets for those items. The guidelines allow the design engineer flexibility in the placement of information provided that such information is presented in a clear and concise manner. Regardless of whether or not the design engineer elects to utilize a separate title sheet, the first sheet of the plan set is to contain at a minimum the following information:

1. Title block
2. Project title
3. North arrow
4. Scale of drawing
5. “Call Before You Dig” symbol and telephone number is shown (plan sheets).
6. Revisions block is shown.
7. Sheet size of improvement plans is 24" x 36".
8. Mylar sepia or vellum drawing sheets, not paper sepia drawing sheets, has been used for all drawings (At final submittal).
9. All lettering in capital letters, 3/16-inch (0.120-inch) size minimum.
10. Accepted City layout of title block.
11. Initials and last name of designer, drafter and checker on the drawings.

12. Name of City is shown.
13. Shows name and address of owner and/or developer.
14. Must show the name, address, fax number, and telephone number of the engineering firm preparing the plans.
15. Assessor's Parcel Number is shown.
16. Must clearly show the name, and "Phase" or "Unit", of the project. For subdivisions the name is to agree with the final map. For multiple units, each final map is to have a separate set of improvement drawings.
17. Drawings must be numbered consecutively and show the total number of sheets.
18. Provide an area map showing the project and how it fits into the immediate area. The map is to include a north arrow and details about the project (1" = 500').
19. Provide a vicinity map showing the location of the project. The map is to include a north arrow.
20. Seal and signature of the design professional is shown.
21. Approval block - Engineering Department.
22. Approval block for design engineer and statement/disclaimer is provided.

Q. Vicinity Map Requirements - Every plan set submitted is to contain a vicinity map. The design engineer may elect to place the vicinity map on a separate sheet immediately following the title sheet or place the vicinity map on the title sheet. If the design engineer elects to place the vicinity map on the title sheet, no separate vicinity map sheet is required provided the information required by this subsection is presented on the title sheet. The vicinity map is to relate the project to major landlines and prominent geographic features on an expanded scale. The following information is to be provided either on the title sheet or the vicinity map sheet:

1. A map of the City of City of West Jordan area with the project highlighted
2. A site map of the project and construction area (*upper right quadrant of sheet)*
3. North arrow for City and site maps

In addition, the vicinity map may include the following items when applicable:

4. Highways, streets, roads and railroads
5. Channels, washes and bridges
6. Other pertinent geographic features

The City's information placement preference is not applicable when the vicinity map and associated required information is placed on the title sheet.

R. Abbreviations, Legends and Sheet Index – This drawing sheet is to include the necessary abbreviations, legends and sheet index necessary for the project and are to include the following:

1. Title block
2. Project title
3. North arrow
4. "Call Before You Dig" symbol and telephone number is shown (plan sheets).
5. Revisions block is shown.
6. Provide a sheet index for all sheets in the lower right corner. All sheets are to be numbered consecutively.

7. Abbreviations are provided.
8. Legend is shown.
9. Section identification system is provided.
10. Detail identification system is shown.

S. General Notes Requirements - Every plan set submitted is to contain a General Note sheet that provides applicable City standard notes. The following information is to be presented on either the second or third sheet of the plan set depending on how the design engineer elected to present the information required for the title sheet and vicinity map. The General Note sheet is to contain the following information where applicable:

1. Title block
2. City of City of West Jordan General Notes
3. City of City of West Jordan Clearing and Grubbing Notes
4. City of City of West Jordan Grading Notes
5. City of City of West Jordan Sewer Notes
6. City of City of West Jordan Traffic Notes
7. City of City of West Jordan Streetlight Notes
8. City of City of West Jordan Fire Department Notes
9. City of City of West Jordan Water Standards Notes
10. City of City of West Jordan Dewatering Notes
11. City of City of West Jordan Storm Drainage and Flood Control Notes
12. City of City of West Jordan U.P.D.E.S. Notes
13. City of City of West Jordan Erosion Control Notes
14. "Call Before You Dig" symbol & telephone # (plan sheets)

T. Typical Sections – This drawing is to show the typical sections to be used for the project and may include the following:

1. Title block
2. "Call Before You Dig" symbol and telephone number is provided (plan sheets).
3. Local street, 60-foot right-of-way, minor collector, 72-foot right-of-way, major collector, 84-foot right-of-way, arterial, 106-foot plus right-of-way, cross-sections are shown. Drawings are to shown maximum cut and fill lines.
4. Residential collector, 57-foot right-of-way is shown.
5. Typical sections must have right-of-way or property line dimensions, cross slopes, type of curb, width of sidewalks, and the structural section material and thickness shown.
6. Typical utility locations
7. Typical trail sections

U. Survey Control Plan - Survey Control Data Sheet includes:

1. Title block
2. North arrow
3. "Call Before You Dig" symbol and telephone number is shown (plan sheets).
4. Co-ordinates at each outside boundary corner are shown.
5. Basis of bearings is shown on the drawing.

6. Shows the bearing equation, 10,000/10,000 co-ordinate at section corner or at point of beginning is shown.
7. Shows survey monuments found with identifying marker plates.
8. Indicates the class of survey and references to appropriate Record of Survey plats.
9. Shows monument lines, bearings, and distances between monuments.
10. At least two section corner ties to boundary are provided.
11. Legal description of boundary is provided.
12. Benchmark acceptable to the County, with elevation is provided. The plan must show identification number, location, and elevation per NAVD 88.
13. USGS datum of elevations is shown on plans.
14. Signature and stamp of the registered land surveyor who prepared the survey.

V. Overall Utility Plan - Many design engineers find it useful to provide a master utility plan as part of the plan set. The inclusion of this sheet is mandatory. Master utility plans are generally provided for one of two purposes, either for construction or to indicate the schematic relationships of the various utilities. If the intent of the master utility plan is for construction, the plan is to have a scale of not less than one-inch = 40-feet to conform to the requirements of "General plan sheet requirements" and provide the information required by this subsection.

If construction plans are included in the submittal for the various utilities at a scale of not less than one-inch = 40-feet and the intent of the master utility plan is to indicate the schematic relationship of the utilities, then the plan scale can be reduced to a scale of not less than one-inch = 100-feet. Schematic master utility plans need to conform to the requirements of this subsection.

Master utility plans to be utilized for construction are to provide the following information:

1. Title block
2. Scale at 1"= 60' or 1"= 100'
3. "Call Before You Dig" symbol and telephone number are shown (plan sheets).
4. Complete the separate Street Plan and Profile Checklist (C100) and show this information on this plan.
5. Complete the separate Sanitary Sewer Plan and Profile Checklist (SS100) and show this information on this plan.
6. Complete the separate Storm Drain Plan and Profile Checklist (D100) and show this information on this plan.
7. Complete the separate Culinary Water Plan and Profile. Checklist (CW100) and show this information on this plan.
8. Complete the separate Secondary Water Plan and Profile Checklist (SW100) and show this information on this plan. This will include pressurized secondary water design (pipelines) and unpressurized secondary water design (ditches and canals).
9. Shows relationship of utilities to each other on plan view.
10. Indicates all utilities including culinary water, sanitary sewer, storm drain, natural gas, secondary water, power, telephone, cable and all other utilities.
11. Water meter locations are shown.
12. Overhead utilities must be buried. Show existing overhead utilities on this drawing and indicate how and where they will be buried.
13. All utility stub-outs are to be shown. They are to be constructed into each lot past the City's right-of-way at least 10-feet.

14. Utility easements are to be shown. The City's standard is a 20-foot easement for one utility, and a 25-foot easement for two utilities.
15. All streets are named and existing and future right-of-way width to centerline is shown.
16. Existing and proposed hydrants and streetlights are shown.
17. Must show existing improvements in, and adjacent to, the project. Must clearly distinguish "existing" and "to be constructed" improvements (Plan Sheets).
18. Water and sewer facilities located and dimensioned from the centerline of the road or property line, are shown. Drawings must show a mandatory 10-foot separation between culinary water and sewer facilities.
19. Driveways, if known, are shown – sidewalk ramps are located.
20. Fire Department flow calculation information is indicated.
21. Fire Department approval block is shown.
22. Public Works Department approval block is shown.

Street Lighting

1. Streetlights are shown on the preliminary plat, final plat and construction drawings.
2. Developer contacts UP&L with plat information, UP&L designs street lighting, pull boxes, conduits, wires, etc.
3. UP&L gets City a letter or report indicating where the streetlights and facilities are to be located and their design.
4. Detail of streetlight locations is indicated.
5. Streetlights are provided at ends of cul-de-sacs, all street intersections, at 250-feet spacing.
6. A streetlight is located at the entrance to any pedestrian pass-through

If construction information and data is clearly and concisely presented on other sheets of the plan set and the intent of the master utility plan is to indicate the spatial relationships of the various utilities, the amount of information on this plan may be reduced.

W. Site Demolition Plan – In the event that site demolition is required, this plan will be required to be prepared. This drawing will show all demolition included as part of the project and the drawing is to include:

1. Title block
2. Project title
3. North arrow
4. Scale of drawing
5. "Call Before You Dig" symbol and telephone number are shown (plan sheets).
6. Revisions block is shown.
7. Structures and other facilities to be removed are shown.
8. Complete the separate Street Plan and Profile Checklist (C100) and show this information on this plan.
9. Obtain State permit for demolition of structures.

X. Subdivision Plat or Site Plan – Plat/Copy of Plat that will be recorded with Salt Lake County Recorder's Office. The plat is to follow the guidelines/requirements of Salt Lake County requirements and is to included the following:

1. Complete the separate Land Development, Concept Plan, Preliminary Plat and Final Plat or Site Plan Checklists to complete this item.

Y. Street Signs and Striping Plan – This drawing is to indicate all traffic control required during construction to adequately and safely construct the project. This drawing will require the following:

1. Title block
2. Project title
3. North arrow
4. Scale of drawing
5. "Call Before You Dig" symbol and telephone number is shown (plan sheets).
6. Revisions block is indicated.
7. 12" x 36" W14-1P "Dead End" and W14-2P "No Outlet" placards are provided with street name sign on residential streets where they intersect with collector streets, when applicable – the sign is to face the collector street. Placards also provided on interior intersections if the end of the street is more than 300-feet from or not visible from the intersection.
8. 30" x 30" W14-1 "Dead End" and W14-2 "No Outlet" signs are provided on the lot line past a thru intersection when conditions are as above.
9. A 6" x 24" yellow "Temporary" placard with black lettering and border is included under any W14 sign, where applicable.
10. 30" x 30" R1-1 "Stop" signs are provided on residential streets at intersections with collector streets and where otherwise warranted – "T" intersections will not typically require a stop sign, but most 4-legged intersections should have stop signs on the lesser legs.
11. 24" x 30" R2-1 Speed limit signs (25mph) are provided at entrance points into the subdivision, generally located at the first lot line, and at intervals of approximately 1,500-feet.
12. Crosswalk, Trail crossing signs
13. Striping plan
14. Bike lanes

Z. Overall Grading and Master Storm Water Drainage Plan – This drawing is to provide a summary, or overall view, of the project's grading and master storm water drainage plan. Subsequent drawings also are required to provide additional detail, if required. These drawings are to include the following:

1. Title block
2. Project title
3. North arrow
4. Scale of drawing
5. "Call Before You Dig" symbol and telephone number are shown (plan sheets).
6. Revisions block is indicated.
7. A note on the drawing from the design engineer verifying that the proposed improvements comply with the City's design and construction standards and master plan for storm drainage and flood control.
8. Location of FEMA 100-year flood plain and wetlands are shown.
9. Drainage calculations – These are to include the assumption of the 100-year storm event with 0.2 cubic foot per second/acre discharge in 24 hours and are to be stamped by a registered professional engineer. Engineer is to use TR55 or HEC1 and provide output from these calculations. (Separate report)
10. Orifice sizes, number of manholes, invert and rim elevations; required riprap, required double inlet/dissipator, etc. are indicated.

11. Detention areas and details are shown. This is to include spillways at a 3:1 maximum side slopes.
12. Permits – State stream alteration, county flood control, Corps of Engineer (COE), etc. permits have been obtained and evidence has been received by the City.
13. Cross-sections showing the elevational relationship, property line, and existing or "to be constructed" walls project's boundary with adjacent properties are provided.
14. Finished floor elevation of all buildings adjacent to this property and spot grades on adjacent properties to show elevational relationships.
15. Pad and finished floor elevations for all new structures are shown. (Site Plan only)
16. Street names are shown, show at the front of each lot.
17. Percentage of grade and direction of flow is indicated.
18. Proposed and existing drainage easements, with dimensions, elevations and typical sections as needed.
19. Size, slope, location, and description of existing and "to be constructed" storm drain facilities are shown.
20. All existing and "to be constructed" block walls are shown.
21. "Sight visibility easements", with dimensions, are shown.
22. Distance and bearing from project boundary to major intersection or major roadway is shown.
23. Sidewalk ramps with dimensions are indicated.
24. Engineer's note stating that the grading plan conforms to the approved drainage study is provided.
25. Elevations shown (top of curb, flowline and crownline) at limits of construction, P.C.'s, P.T.'s, and grade breaks.
26. Contours, at two-foot intervals, for undeveloped property are shown.
27. Dashed lines and labels showing existing improvements, with elevations noted, as needed, are provided to show the project's conformity with the existing conditions.
28. Shows existing or "to be dedicated" rights-of-way and easements.
29. Existing conditions - Must show "Existing Conditions" for the property being developed and within 100-feet of the project's boundary.
30. Existing contours are shown.
31. Slopes of 30-percent or greater are shown.
32. Proposed contours for parking lot and landscaping are shown.
33. Floodplain note/ evaluation was provided.
34. Road widths match Transportation Master Plan and/or Planning Commission requirements.
35. Road grades are minimum 0.5-percent and a maximum of 12-percent.
36. Sidewalks are provided as required.
37. Curb and gutter are provided as required.
38. Any waterways provided are 6-feet wide and only used with prior Engineering Department approval.
39. Erosion protection is provided for all cut and fill slopes.
40. Energy dissipaters are provided on the outfall of drain lines discharging into creeks and earthen channels capable of slowing velocities to 3-feet per second.
41. Storm drainage calculations were provided and reviewed.
42. Subdrain system – If project fronts canal property, the geotechnical report indicates groundwater within the footing zone, or the area is known for a high groundwater table.
43. Subdrain note was shown, if applicable.
44. Storm drains lines, catch basins, and clean out boxes are provided as needed.

45. Catch basins are provided at all sag points and every 500-feet. Doublewide catch basins, with two grates, are provided at sag points so the directional vanes can be installed in both directions.
46. Combination cleanout boxes provided at all changes in direction and every 500-feet.
47. An overland release for storm water is provided for all sag points such that no structures would be flooded if the underground drain system were blocked or the capacity exceeded.
48. Cul-de-sacs are graded to drain away from the bulb.
49. Drainage calculations were submitted and checked.
50. Storm drainpipe within paved area of City streets is reinforced concrete pipe (RCP), CL III and is a minimum 15-inch in diameter. Laterals may be sized to a 12-inch minimum size.
51. Smooth-wall corrugated HDPE pipe may be used in areas outside the City's right-of-way.
52. Subsurface drains are provided to an approved system or outfall where needed to lower groundwater levels to 3-feet below all basement levels. (To be maintained by Homeowner's Association)
53. Existing irrigation ditches have been piped or abandoned as approved by the ditch master.
54. Existing irrigation tailwater ditches or sheet flow is properly conveyed through the property.
55. All storm drainage conveyance systems have an oil water separator system, in heavily traveled areas (i.e. Commercial subdivisions, car washes, gas stations, etc.), in place before it discharges into the city system.

AA. Grading and Storm Drainage Details – This sheet is to include all of the details necessary to construct the grading and storm drainage facilities for the project. This sheet is to include:

1. Title block
2. Project title
3. North arrow
4. Scale of drawing
5. "Call Before You Dig" symbol and telephone number is shown (plan sheets).
6. Revisions block is indicated.
7. Keyed Slope Detail
8. Backdrain Plan Section
9. Cut-Fill Transition Detail
10. Rear Lot Drainage Swale (Permanent)
11. Typical Section (Front to Back Lot Benching
12. Standard Rear Lot Inlet Box – Plan View
13. Standard Rear Lot Inlet Box – Profile View

BB. Grading and Drainage Plan Key Sheet – This sheet is to include the following:

1. Title block
2. Project title
3. North arrow
4. Scale of drawing
5. "Call Before You Dig" symbol and telephone number is shown (plan sheets).
6. Revisions block is indicated.
7. Legend
8. Grading & Drainage Plan Key Drawing – Show adjacent roads, properties, etc.
9. Subdivision – Site Summary

CC. Grading and Drainage Plan - This sheet is to include the following:

1. Title block
2. Project title
3. North arrow
4. Scale of drawing
5. "Call Before You Dig" symbol and telephone number is shown (plan sheets).
6. Revisions block is indicated.
7. Grading & Drainage Plan Key Drawing – Show adjacent roads, properties, existing contours, graded contours, vegetation, etc.

(One of Several Sheets)(For a portion of the Subdivision, based on the Key Sheet)

DD. Overall Storm Water Pollution Prevention Plan – This plan is meet the requirements of the City's ordinances and standards and the first part of the drawings/plan are to show the overall plan for erosion control and revegetation. Additional drawings may also be necessary to provide additional detail.

1. Title block
2. Project title
3. North arrow
4. Scale of drawing
5. "Call Before You Dig" symbol and telephone number are provided (plan sheets).
6. Revisions block is provided.
7. A verification from the design engineer that the proposed improvements comply with the City's design and construction standards for land disturbance.
8. Any project over 1-acre requires a SWPP plan and permit be prepared (permit application available in the Engineering Department).
9. Project description - Type of project, area to be disturbed, number of units (residential/commercial) or square feet (single-parcel commercial/industrial sites).
10. Description of existing site conditions - Topography, vegetation, streams, lakes, canals, drainage features.
11. Description of bounding areas that may be affected by land-disturbing activities - Streams, canals, roads, residential and commercial areas.
12. Critical areas called out on plan such as steep slopes and environmentally sensitive areas.
13. Erosion and Sediment control plan showing BMP practices
14. Permanent stabilization - Methods used to permanently stabilize the site (e.g., sod, seed.).
15. Grading report - Identify where dirt will be moved from, final placement, placement methods and compaction. Prior to any grading on project, this report is to be submitted to the Engineering Department for review.
16. Grading Permit from the Engineering Department.
17. Erosion protection is provided for all cut and fill slopes.
18. Energy dissipaters are provided on the outfall of drain lines discharging into creeks and earthen channels capable of slowing velocities to 3-feet per second.

EE. Street Plan and Profile - This drawing is to provide all necessary information required to review the street plan and underlying utility work for adequacy for design as well as for eventual construction of the project. This will require that the following be provided:

1. Title block
2. Project title
3. North arrow
4. Scale of drawing
5. "Call Before You Dig" symbol and telephone number are shown (plan sheets).
6. Revisions block is shown.

Typical Sections

1. Typical street cross-sections
2. Local street, 50-foot right-of-way, minor collector, 66-foot right-of-way, major collector, 80, 90-foot right-of-way, arterial, 126-foot plus right-of-way, cross-sections are shown. Drawings are to shown maximum cut and fill lines.
3. Show sidewalk ramps with dimensions.
4. Extend existing ground profile 200-feet beyond project.
5. Typical sections must have right-of-way or property line dimensions, cross slopes, type of curb, width of sidewalks, and the structural section material and thickness shown.

General Requirements

1. Profile view over plan view is shown.
2. A verification from the design engineer that the proposed improvements comply with the City's design and construction standards and master plan for roads and bridges and transportation.
3. Permits – Permits have been received by the developer and evidence has been provided to the City. This may include Utah Department of Transportation (UDOT) if the project impacts State roads, railroads, City encroachment permits, etc.
4. Design efficient for snow removal and storage, and for traffic circulation.
5. A soils report has been prepared, submitted, and reviewed by the City recommending a pavement design.
6. The roadway cross-section meets at least the minimum City standards of local residential streets. The actual thicknesses are to be determined by the soils report.
7. Roadway designs meet the City standard for curb radii for local residential streets of 28-feet; for collector roadways of 35-feet and cul-de-sacs of 40-feet.
8. Roadway designs meet the City standard for vertical/horizontal design of 10-percent maximum grade for residential roadways, 8-percent for collector roadways, 6-percent for arterial roadways, and 100-feet of 3-percent. The minimum slope for these roadways is 0.5-percent. These roadways are also to meet the requirements of 90-degrees at intersections, intersections spaced 300-feet apart, the correct K value, 2-percent cross-slopes, etc.
9. Driveway designs meet the City standard of concrete apron, 30-feet maximum; for residential roadways – 50-feet from intersections, for collector roadways – 150-feet from intersections, and for arterial roadways – 200 to 250-feet from intersections. The spacing of these accesses shall be 85 to 150-feet for collectors, and 200 to 275 for arterial roadways.
10. Street names with right-of-way and back of curb widths are indicated and a designation as "Public" or "Private" to be maintained by …. are shown on each street plan or section, if on each sheet.
11. Centerline bearing(s) and stationing are shown.
12. Curve data is indicated.
13. Profile for centerline, near and far curbs - Also show crown profile, if there is an offset crown.

14. Centerline profile view – Curb profile may be eliminated.
15. Top of curb elevations with curve data shown for all curb returns.
16. No scale larger than 1”= 40’ horizontally / 1”= 4’ vertically grades less than 5-percent are shown. Grades more than 5-percent can be 1”= 40’ / 1” = 8’.
17. If vertical curve is shown on profile, the vertical curve is shown on the plan view.
18. Curve table is shown in plan view.
19. Line of sight line shown in plan view.

Culinary Water

1. A verification from the design engineer that the proposed improvements comply with the City’s design and construction standards and master plan for culinary water.
2. Culinary water meter are located within the City’s right-of-way and within landscaped areas unless otherwise directed by the City.
3. Drawings indicate water system line sizes, valve locations and that the water lines are looped.
4. Notes indicate the method/procedure for connecting onto existing water line source. Needs to indicate it will be done according to the City’s Culinary Water Design and Construction Standards.
5. Plan view over profile view is shown (12-inch and over, or in unimproved areas).
6. Street names with right-of-way and back of curb dimensions are shown.
7. Waterline(s) located with dimensions from centerline (CL) or property line (PL), provide bearing of waterline if not parallel to CL or PL.
8. Length of pipe distance between valves, type, size and slope are shown.
9. Indicate separation at all utility crossings.
10. All waterline easements are shown (document no., if existing).
11. Culinary water lines are provided, 8-inch minimum PVC C-900 water pipe, generally located on the north and east sides of the streets.
12. All culinary water lines are required to show all valves, fittings, and thrust blocks.
13. Service laterals are provided to each lot.
14. Combination air/vacuum relief valve assemblies (Apco 140C Series, Crispin UL Series, or approved equivalent) are provided at all high points of the water system.
15. Fire hydrants are provided at 500-feet minimum spacing on residential streets, 400-feet on cul-de-sacs, 200-feet minimum on collector streets with commercial frontage, and where otherwise needed as marked by the Engineering Department.
16. Fire hydrants are located on lot lines whenever possible.
17. Fire hydrants are called out as Mueller Super Centurion, Waterous Pacer 100, or Clow Medallion.
18. Fire hydrants in cul-de-sacs are placed at the lot line closest to the neck of the bulb, where feasible.
19. Fire hydrants, which are preferred, or wash-out valves are placed at low points and end-of-line points of culinary water mains, to act as blow-offs.
20. Secondary water lines are located in the south and west side of roadways in the parkstrips.
21. Public Works Department approval signature block and Water Notes are indicated.
22. Fire Department signature block is shown.
23. Fire flow calculations have been provided and reviewed.
24. Centerline profile view – Curb profile may be eliminated
25. Top of curb elevations with curve data shown for all curb returns.
26. Scale no larger than 1”= 40’ horizontally / 1” = 4’ vertically are used.
27. If a vertical curve is shown on the profile view, a vertical curve is shown on plan view.

28. Curve table shown in plan view.
29. Curve table shown in plan view.
30. Line of sight line shown in plan view.

Storm Drainage and Flood Control

1. Plan view over profile view is shown
2. A verification from the design engineer that the proposed improvements comply with the City's design and construction standards and master plan for storm drainage and flood control.
3. Street names with right-of-way and back of curb dimensions are shown.
4. Drainage calculations (Separate Document from Drawings) - These are to include the assumption of the 100-year storm event with 0.2 cubic foot per second/acre discharge in 24 hours and are to be stamped by a registered professional engineer.
5. Orifice sizes, number of manholes, invert and rim elevations; required riprap, required double inlet/dissipator, etc. are indicated.
6. Detention areas and details are shown. This is to include spillways at a 3:1 maximum side slopes.
7. Ditch master approvals have been provided.
8. Storm drain line(s) are labeled as public or private.
9. Show all laterals and drop inlets.
10. Storm sewer(s) located with dimensions from centerline (CL) or property line (PL), provide bearing of storm sewer line if not parallel to CL or PL.
11. Manholes are numbered.
12. Indicate the length of pipe, distance between manholes, type, size, and slope.
13. Indicate separation at all waterline crossings.
14. All drainage easements are shown (document no., if existing).
15. Storm drainage calculations were provided and reviewed.
16. All catch basins or storm drain appurtenances are to have proposed rim elevations with invert elevations shown on plan. A 3-foot minimum distance is shown between the rim and invert of the pipeline, unless approved by the Engineering Department.
17. Floodplain notes / evaluation are provided.
18. Subdrain system – Provide a subdrain system if the project fronts canal property, the geotechnical report indicates groundwater within the footing zone, or the area is known for a high groundwater table.
19. Subdrain Note are shown, if applicable.
20. All curb and gutter PC/PT, direction changes, sidewalks, handicap ramps, are to have finish grade (FG) calculations shown on the plan.
21. Storm drain lines, catch basins, and clean-out boxes are provided as needed.
22. Catch basins are provided at all sag points and every 500-feet or at all intersections, to intercept storm water runoff discharge. Doublewide catch basins, with two grates are provided at sag points so the directional vanes can be installed in both directions.
23. Manholes are to be located every 400-feet.
24. An overland release for storm water is provided for all sag points such that no structures will be flooded if the underground drain system were blocked or the capacity exceeded.
25. Storm drainpipe within paved area of City streets is reinforced concrete pipe (RCP), CL 111 and is a minimum of 15-inches in diameter.
26. Smooth-wall corrugated HDPE pipe may be used in areas outside the City's right-of-way only.

27. Subsurface drains are provided to an approved system, or outfall, where needed to lower groundwater levels to 3-feet below all basement levels.
28. Existing irrigation ditches are piped or abandoned as allowed in writing by ditch master.
29. Existing irrigation tailwater ditches or sheet flow is properly conveyed through the property.
30. In heavily traveled areas, i.e. commercial subdivisions, car washes, gas stations, etc., all storm drainage conveyance systems are to have an oil water separator system .in place before it discharges into the City's system.
31. Centerline profile view – Curb profile may be eliminated on new street construction.
32. Top of curb elevations with curve data shown for all curb returns.
33. No scale larger than 1"= 40' horizontally / 1" = 4' vertically is used.
34. If a vertical curve shown on the profile view, a vertical curve is shown on plan view.
35. Curve table is shown in the plan view.

Sanitary Sewer

1. Complete the requirements for the Sanitary Sewer Plan and Profile Sheets as indicated by the South Valley Water Reclamation Plant and show this information on this set of drawings.

Secondary Water

1. Complete the Secondary Water Plan and Profile Sheets checklist and show the information.

FF. Traffic Signal Plan – When a project requires the construction or modification of a traffic signal, a separate traffic signal plan will be required. The traffic signal plan is to have a scale of one-inch = 20-feet. In addition to the general requirements of drawings, the signal plans are to contain the following information:

1. Title block
2. Project title
3. North arrow
4. Scale of drawing
5. "Call Before You Dig" symbol and telephone number is shown (plan sheets).
6. Revisions block is shown.
7. All streets are named and dimensioned.
8. Conduit runs are shown.
9. Detail of signal pole location are shown.
10. Detail of signal improvements, i.e. foundation and pole type/size, location of pull boxes, cabinets, conduits, detection facilities, are shown.
11. Traffic signal notes
12. All existing improvements including streetlights, signal poles, curb and gutter, driveways, sidewalk ramps, drop inlets, surface and subsurface utilities are to be shown and located by centerline stationing.
13. All existing or "to be constructed" hand holes, pull boxes, underground conduits and detector loops are to be shown and located by centerline stationing
14. All existing or "to be constructed" stop bars, cross walks and pavement markings are to be shown and dimensioned
15. All improvements "to be constructed" including streetlights, signal poles, pull boxes, driveways, sidewalk ramps, curb, drop inlets, and subsurface utilities are to be shown and located by centerline stationing
16. Each signal type and location

17. Street name sign schedule
18. Conduit and cable schedule
19. Phase diagram

GG. Quantity and Schedule Requirements - Every plan set submitted is to contain a quantity estimate. The City requires the quantity estimate to contain quantities of all public improvements in a format consistent with the City's bond estimate form. In addition, the City requires quantities of improvements constructed within public easements, whether or not they are publicly maintained. If the project contains both public and private improvements, the design engineer may elect to indicate both quantity estimates on the plans to facilitate the review of the public improvement bond estimate. The quantity estimate may be placed on a separate sheet or on the title sheet. The design engineer may elect to use schedules to clarify construction items, however; the use of schedules is not mandatory.

4.7 STANDARD NOTES

A. General Notes

1. All construction and materials are to be in accordance with the " City of West Jordan Design and Construction Standards"; and other applicable approved standards issued by the controlling agency; the International Building Code; and all local city codes and ordinances applicable, except as noted on this sheet as "Deviations from Standards".
2. The existence and location of any overhead or underground utility lines, pipes, or structures shown on these plans are obtained by a research of the available records. Existing utilities are located on plans only for the convenience of the Contractor. Existing utility service laterals may not be shown on the plans. The Contractor is to, at his own expense, locate all underground and overhead interference's, which may affect his operation during construction and is to take all necessary precautions to avoid damage to it. The Contractor is to use extreme caution when working near overhead utilities so as to safely protect all personnel and equipment, and is to be responsible for all cost and liability in connection therewith.
3. The Contractor is to take all precautionary measures necessary to protect existing utility lines, structures and street improvements which are to remain in place, from damage, and all such improvements or structures damaged by the Contractor's operations are to be repaired or replaced satisfactory to the Engineering Department and owning utility company at the expense of the Contractor.
4. All construction is to be as shown on these plans, any revisions are to have the prior written approval of the Engineering Department.
5. Type V cement is to be used in all off-site concrete work. Concrete to be 3,000 P.S.I. minimum @ 28 days. Mix designs to be approved by the City, prior to the use on the project.
6. Permits are required for any work in the public Right-of-way. The Contractor is to secure all permits and inspections required for this construction.
7. Expansion joints required, maximum every 300-feet in extruded-type curb.
8. Asphalt cement (AC) pavement to be ½-inch above lip of all gutters after compaction, except at sidewalk ramps and cross gutters.
9. Curb and gutter found to be unacceptable to the City is to be removed and replaced.
10. Sidewalk ramps are to be constructed in each quadrant of an intersection per standard drawing 234. Exact location of ramps may be adjusted in the field by a City inspector.

11. Contractor is to provide all necessary horizontal and vertical transitions between new construction and existing surfaces to provide for proper drainage and for ingress and egress to new construction. The extent of transitions to be as shown on plans.
12. All grading work is to conform to the soils report as prepared by the Soils Engineer approved by the Engineering Department, and as shown on these plans.
13. Exact location of all saw cut lines may be adjusted or determined in the field by a City of West Jordan Engineer if location on plans is not clearly shown, or existing pavement condition requires relocation.
14. The Contractor is to take all precautions necessary to protect existing permanent surveying monuments. Any monuments disturbed are to be replaced and adjusted per available records at the Salt Lake County Surveyors Office.
15. Utility company meter boxes, manhole lids, valve covers, etc., are to be located out of driveways, driveway aprons, flow lines, and cross gutters unless written approval is granted by the utility company and the Engineering Department.
16. Wall notes: (Below)
17. All walls, new or existing, are only shown on civil plans for the purpose of reviewing grading relationships; flood control and sight distance at intersections. New walls require a separate permit and inspection by the Building Department.
18. Asphalt mix design must be submitted and approved by the Engineering Department prior to the placement of Asphalt within City Right of Way.
19. Contractor is to adjust all new and existing inlets, valve boxes, manhole rims, and sewer clean outs, etc. to finish grade as applicable whether or not they are shown on the plans.

B. Traffic Notes

1. All construction signing, barricading, and traffic delineation is to conform to the “Manual on Uniform Traffic Control Devices”, latest edition.
2. The street sign Contractor is to obtain street names and block numbering from the Engineering Department prior to construction.
3. Before any work is started in the right-of-way, the Contractor is to install all advance warning signs for the construction zone. The Contractor is to install temporary stop signs at all new street encroachments into existing City streets where warranted immediately after first grading work is accomplished, and is to maintain said signs until permanent signs are installed.
4. When a designated “Safe Route To School” is encroached upon by a construction work zone and the Traffic Engineer identifies a need for students to be assisted in the safe crossing through that work zone, the Contractor is to be required to provide a qualified “crossing guard”. The guard is to be present for the full duration of time those children are likely to be present.
5. If the improvements necessitate the obliteration, temporary obstruction, temporary removal or relocation of any existing traffic pavement marking, such pavement marking is to be restored or replaced with like materials to the satisfaction of the Engineering Department.
6. The Contractor is to be responsible for providing and installing all permanent signs shown on the plans. Street name signs are to conform in their entirety to current City standards. All other signs are to be standard size unless otherwise specified on the plans. All signposts are to be installed in accordance with the current City standards.

7. When a proposed street light standard is located within 5-feet of any proposed sign shown on the plans to be mounted on a signpost, the sign is to be mounted on the street light standard and the signpost is to be eliminated.
8. All permanent traffic control devices called for hereon are to be in place and in final position prior to allowing any public traffic onto the portions of the road(s) being improved hereunder, regardless of the status of completion of paving or other off-site improvements called for by these plans.
9. Street signs and stop signs are to be installed per City standard specifications for placement of street name signs.
10. The Contractor is to provide barricades, signs, flashers, other equipment and flag persons necessary to insure the safety of workers and visitors.
11. Work in public streets as approved by City excavation permits, once begun, is to be expedited to completion so as to provide minimum inconvenience to adjust property owners and to the traveling public.
12. The Contractor is to be responsible for notifying for Utah Transit Authority (UTA) and the Jordan School District Transportation Services Department if the construction interrupts or relocates a bus stop or has an adverse effect on bus service on that street to arrange for temporary relocation of stop.

C. Streetlight Notes

1. No deviation of street light, pull box, conduits (etc.) locations are to be permitted without written approval of the Engineering Department. Any deviation from the plan location will require written notice from the Engineering Department.
2. All existing street lighting is to remain operational during construction.
3. All empty conduits are to have pull strings installed prior to final inspection.
4. Any structure such as block walls, chain link fences, retaining walls, etc., are to leave a minimum clearance of 18-inches to the face of street lightning pole on all sides when streetlight is installed behind sidewalk, and is to at no time completely enclose the street lighting pole.
5. As-built drawings are to be supplied to the Engineering Department who will provide copies to the Public Works Department prior to any pre-final inspection. The as-built drawing needs to be stamped as –built and signed by the preparer.
6. Service points are to be coordinated with Utah Power and Light, and wherever possible, be located near the center of the circuit. Service points are to be shown on the plans.
7. It is to be assumed that in the absence of an existing, workable circuit to attach to, all installations are to require a new service for operation of the circuit. In this case contact Utah Power and Light.
8. Wherever there is an overhead utility that may conflict with the installation of street lighting circuits and/or poles, these conflicts must be resolved between the developer and the utilities involved before streetlight bases are installed at no expense to the City of West Jordan and UPL.
9. The Contractor is to furnish complete service to transformers and control systems if required on plans, and is deemed necessary by UPL.

D. Grading Notes

1. In the event that any unforeseen conditions not covered by these notes are encountered during grading operations, the owner/engineer is to be immediately notified for direction.

2. It is the responsibility of the Contractor to perform all necessary cuts and fills within the limits of this project and the related off-site work, so as to generate the desired subgrade, finish grades and slopes shown.
3. Contractor is to take full responsibility for all excavation. Adequate shoring is to be designed and provided by the Contractor to prevent undermining of any adjacent features or facilities and/or caving of the excavation.
4. The Contractor is warned that an earthwork balance was not necessarily the intent of this project. Any additional material required or leftover material following earthwork operations becomes the responsibility of the Contractor.
5. The grading Contractor is responsible to coordinate with the owner to provide for the requirements of the project Storm Water Pollution Prevention Plan (SWPPP) and associated permit.
6. Contractor is to grade to the lines and elevations shown on the plans within the following horizontal and vertical tolerances and degrees of compaction, in the areas indicated:

		Horizontal	Vertical	Compaction
a.	Pavement area subgrade	0.1'+	+0.0' to –0.1'	See soils report
b.	Engineered fill	0.5'+	+0.1' to –0.1'	See soils report

Compaction Testing will be performed by the owner or his representative.

7. All cut and fill slopes are to be protected until effective erosion control has been established.
8. The use of potable water without a special permit for building or construction purposes including consolidation of backfill or dust control is prohibited. The Contractor is to obtain all necessary permits for construction water.
9. The Contractor is to maintain the streets, sidewalks and all other public right-of-way in a clean, safe and usable condition. All spills of soil, rock or construction debris is to be promptly removed from the publicly owned property during construction and upon completion of the project. All adjacent property, private or public is to be maintained in a clean, safe and usable condition.
10. In the event that any temporary construction items is required that is not shown on these drawings, the owner agrees to provide and install such item at his own expense and at the direction of the Engineering Department. Temporary construction includes ditches, berms, road signs and barricades, etc.

E. Fire Department Notes

1. Authorized hydrants for this project are:
   a. Kennedy Guardian
   b. Mueller a-423 Centurion
   c. Clow Model 2546 Medallion
2. On any new home or building installation, accessible fire hydrants are to be installed before combustible construction commences and said fire hydrants are to be in good working order with an adequate water supply.
3. Contractor is to call the Public Works Department and Engineering inspector for underground inspection, pressure and flush verification of all fire hydrants and fire lines before back filling.
4. Painting of the curbs and hydrant and any work necessary for protection of hydrants from physical damage is to be completed before approval.

5. A permit is required from the Fire Department for on-site water lines and fire hydrants. The permit and Contractor's material and test certificate for underground piping form is to obtain the Fire Department prior to any work beginning.
6. A flow test must be witnessed by the Fire Department prior to occupancy for verification of required on-site water supply.
7. All on-site fire main materials must be U.L. listed and A.W.W.A. approved.
8. Fire Hydrant Spacing:
   Residential – 500-feet unsprinklered; 1,000-feet sprinklered.
   Commercial, including multi-family – 300-feet unsprinklered; 600-feet sprinklered.
9. Where new water mains are extended along streets, hydrants are to be spaced at maximum 1,000-foot spacing to provide for transportation hazards.
10. No fire hydrant is to be located within 6-feet of any curb return, driveway, power pole, street light or any other obstruction.
11. Two sources of supply are required whenever there are four or more fire hydrants installed on a single system.
12. Not more than two hydrants can be out of service due to a single main break.
13. Fire apparatus access roads are to have an unobstructed width of not less than 20-feet provided no parking is allowed, not less than 28-feet if parallel parking is allowed on one side, and not less than 36-feet if parallel parking is allowed on both sides. Vertical clearance is to not be less than 13-feet, 6-inches and is to be paved.
14. The turning radius for any fire apparatus access road and/or fire lane, public or private, is to be not less than 45-feet outside radius and 22-feet inside radius and is to be paved.
15. A fire apparatus road is to be required when any portion of an exterior wall of the first story is located more than 150-feet from Fire Department vehicle access roads and/or fire lanes, public or private, in excess of 150-feet in length is to be provided with an approved turn around area.
16. Access roads are to be marked by placing approved signs at the start of the designated fire lane, one sign at the end of the fire lane and width signs at intervals of 100-feet along all designated fire lanes. Signs to be placed on both sides of an access roadway if needed to prevent parking on either side. Signs to be installed no higher than 10-feet or less than 6-feet from roadway level. The curb along or on the pavement or cement if curb is not present, is to be painted with red weather resistant paint in addition to the signs.
17. Electrically controlled access gates are to be provided with an approved emergency vehicle detector/receiver system. Said system is to be installed in accordance with the City of West Jordan City F.D. approval. Gates are only allowed with prior approval.

F. Culinary Water Notes

1. No work is to begin until the water plans have been released for construction by the Engineering Department. Following water plan approval, 48-hour notice is to be given to the Public Works Department prior to the start of construction. Notice must be given by 2:00 P.M. the business day prior to an inspection.
2. All work is to conform to City of West Jordan City standard plates, drawing, and specifications and the Culinary Water Design and Construction Standards, latest edition.
3. All work, except as modified by these plans or by note 2, is to be done in accordance with the most current draft or edition of the Road and Bridge Design and Construction Standards for off-site improvements.

4. A single pipe material is to be used throughout the project, unless otherwise approved by the Engineering Department.
5. All service laterals 2-inches in diameter and smaller are to be copper tubing with City of West Jordan City approved service saddles.
6. All water meter boxes are to be located outside of driveway areas.
7. All valves are to be located outside of driveways, gutters, curbs and alley gutters.
8. The following requirements must be met in the event a water line and sanitary sewer or storm sewer line cross:

   A minimum 18-inch vertical separation (outside to outside) must be maintained when the water line is installed over the sanitary or storm sewer line. If the vertical separation cannot be maintained or the water line must be placed <u>under</u> the sanitary or storm sewer line, <u>the sanitary or storm sewer line</u> must be constructed with one of the following or, as shown on these plans:

   a. Potable water supply quality material
   b. Encasement, with 4-inch concrete (minimum)
   c. Sleeving with potable water supply quality pipe.

   Each provision must extend along the sanitary or storm sewer, on either side of the water main, a minimum 10-foot distance perpendicular to the exterior of main.
9. Warning tape is to be required over all mains, all 6-inch diameter and larger service laterals, and any service lateral not installed perpendicular to the main.
10. All water facilities are to be filled, disinfected, pressure tested, flushed, filled and an acceptance water sample obtained prior to connection to the City of West Jordan distribution system.
11. The Contractor must obtain all meters 2-inches and smaller from City of West Jordan Public Works – 48-hours prior to pick-up.
12. Construction may interrupt service, with City of West Jordan Public Works approval and proper notification, between the hours of 10:00 P.M. and 6:00 A.M. Sunday through Thursday. Circumstances that may require temporary service feed must have prior City of West Jordan Public Works approval.
13. All water facility construction materials used must be as listed on the City of West Jordan Public Works pre-approved materials and manufacturers listing for new facilities, latest revision or specifically approved on these plans.
14. Approval of these plans for the water used stubout installation will not be construed as a commitment for water service to this property.
15. <u>Conditional approval of valved outlet (6-inch and larger)</u>
    In the event the water plans show one or more valved outlets extending out of paved areas, installations of these outlets is acceptable, however, if the outlets are incorrectly located or not used for any reason when the property is developed, the developer is to abandon the outlets at the connection to the active main in accordance with the district's standards and at the developer's expense.

16. <u>Water Crossing Note</u>

    The following are the requirements that must be met when there is a water-sewer crossing:

When protection of the water line is considered, the minimum vertical distance 18-inches must be maintained when the water line is installed over the sewer/storm line. If this distance cannot be maintained because of physical obstructions or the water line must be placed under the sewer/storm line, the sewer/line must be constructed with any on if the following:

a. Extra heavy cast iron or ductile iron pipe
b. Water supply quality
c. Encasement with 4-inches minimum of concrete or sleeving with water quality pipe.

Each of these provisions must be extended for 10-feet on either sides of the water line at 90 degrees to the crossing.

4.8 PLAN CHECK

Two plan check reviews are provided as part of the engineering review fees. The Developer will be charged an additional $100.00 for each subsequent plan check, which must be paid to the City's Finance Department prior to the Engineering Department reviewing the drawings.

4.9 ENGINEERING DEPARTMENT APPROVAL

Once the Engineering Department staff has reviewed all corrections to the plans and have verified that the requested changes have been made, the plans will be submitted to the Engineering Department for review and approval. The Engineering Department will then notify the Developer in writing of that approval.

4.10 EASEMENT AND FEE PARCEL DEDICATIONS

The Developer is to verify to the Engineering Department's satisfaction that all easement and fee parcels needed for the project have been dedicated to the City. The Developer is to submit such recorded documents to the Engineering Department for their files.

4.11 SUBDIVISION INSPECTION

All improvements to be dedicated to the City for public use are to be inspected by the City's Engineering Department. A preconstruction meeting will be held for each project before any work is done. At this meeting the Developer and the Developer's contractor will be notified of the points when City staff must be present and have the facilities inspected prior to proceeding with the next step. No facilities are to be covered up or concrete poured without first receiving the proper inspection by the Engineering Department. Failure to comply with this requirement will result in the pipeline being uncovered, or concrete being removed and replaced, at the contractor's expense, to ensure proper procedures have been followed.

4.12 ENGINEERING DEPARTMENT APPROVAL LETTER

Once the Engineering Department is fully satisfied that all Engineering Department requirements have been met, the Engineering Department will notify the City's Building Department, through CityView, indicating that building permits may be issued for the project.

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SECTION 5.0

PLAN REVIEW & APPROVAL

5.1 GENERAL

A. General - The process of City staff review and correction of Developer provided building elevations, plats, site plan drawings, construction drawings, reports, studies, calculations, and other documents used in the processing of a private development project through the City, is called the *'Redline Review Process'*. *'Redlines'* refer to those hand written corrections, usually written in red pencil or pen, on building elevations, plats, site plan drawings, and construction drawings, and other hand-written or typed documents, which provide direction to the Developer and his/her engineer/architect on what items need to be changed on these documents. They also include written documentation of alternatives the Developer might consider in order to meet the City's requirements, or optional suggestions the Developer might wish to consider in finalizing his/her project.

The process is initiated by the Developer submitting ***all*** of the required documents the City has indicated are necessary for the review of the specific project type. ***All*** of the documents required by the City must be provided at the time of submittal after application, or the City staff will return the submitted materials back to the Developer, mark those documents that are missing on an appropriate checklist, and require that the Developer obtain the other documents prior to submitting the application packet back to the City. City staff will inventory the documents to ensure all of the documents are present, and the City's Project Review Team will complete the detailed review of the documents later. The City's project planner, engineer, and other City staff involved in the project are referred to as the City's 'Project Review Team' and they will be responsible for reviewing the project and processing it through the City.

B. Definitions – The following definitions apply when referring to the review process for private development:

1. Released for Construction Drawings (RFCD) – The Engineering Department has established a set of drawings required for these RFCD. It consists of all of the construction drawings necessary to construct the entire project, including public and private infrastructure such as roadways, water, sewer, storm drain lines, and landscaping & irrigation drawings. This set of drawings is combined into what is referred to as the *'Released for Construction Drawings'*. The purpose of this manual is to describe what is necessary to review and approve just the landscaping and irrigation portion of these *'Released for Construction Drawings'*.
2. Redline – City staff comments written on drawings, reports, plats, and other documents submitted by the Developer for review, for the project. These are meant to give direction as to what needs to be corrected to make them acceptable to the City for further processing.
3. Redline return – The redline process consists of an *'Initial or 1st Review'* of a given document, which contains City staff's redlines (comments), which is then followed by a *'Second Review'*, *'Third Review'*, etc., depending on how well the Developer's engineer addresses City staff's redlines. A *'redline return'* is that portion of the process where the

Developer returns the correct document from a City review, for additional City staff review.

4. *'Project Redline Memorandum'* – This is a memorandum prepared by City staff which has three main categories of comments: 1) comments made to address Code or Standards requirements, 2) alternatives for Code, standards, manual or other Planning Commission or City Council approved requirements, and 3) optional suggestions the Developer and his engineer may consider, and which are not required.

C. Purposes of Redlines – The purposes of the 'Redlining' process are as follows:

1. Explain and clarify the City staff's comments regarding various documents they have reviewed which were provided to the City staff for review as part of the private development project.
2. Create documentation, which sets the standard for what will be required of the project, in order for it to be processed through the City.

D. Types of Comments – Redline comments come in three distinct types, they are:

1. Comments Required to meet Code, standard, manual or other Planning Commission and/or City Council conditions or approved requirements – These are comments the Project Review Team will make on *'redline'* documents which are required by the City of West Jordan Municipal Code, standards, manuals, or other Planning Commission or City Council approved documents. These are required to be complied with by the Developer and his/her engineer and other professionals and are not optional for them to consider. If the Developer wishes to contest these requirements, they must be done through the appeal process set forth in *'Section 5.6 – Developer's Appeal Process'* and or Municipal Code. City staff does not have the authority to waive or change these requirements.
2. Alternatives for Code, standard, manual or other Planning Commission or City Council approved requirements – There are situations where a given project may have alternatives City staff may indicate are available to meeting City Code, standards, or manual requirements. These will be indicated in a separate *'Project Redline Memorandum'* which will detail the alternatives available to the Developer, along with any other information City staff may wish to communicate to the Developer for his/her consideration. It the responsibility of the Developer to weigh and select a given alternative and indicate so in writing to the Project Review Team. The project will not proceed with further review until the Developer provides this written decision.
3. Optional suggestions – There may also be optional suggestions the Project Review Team wishes the Developer to consider in the remaining preparations for the project. These will also be included in the *'Project Redline Memorandum'* and will be included under the heading of *'Optional Suggestions'*. The Developer must provide a written response to whether these suggestions will be included in the project and can be included with the *'Alternatives for Code Compliance'* items.

E. Types of Redline Documents – *'Redline Documents'* typically include building elevations, plats, site plan drawings, construction drawings, studies, reports, calculations, property documents of all types, and any other type of document which may be submitted to the Project Review Team in order to adequately address City requirements for a given project. The Project Review Team will mark on these *'Redline Documents'* any corrections, which may be necessary to meet City requirements. Redline comments are to be prepared after reviewing the City's Municipal Code, standards, and manuals.

F. All Redlines Must be Addressed in Order to Process Project – The Developer must note that all redlines must be addressed to the satisfaction of the City staff before the City Planner and City Engineer will schedule the project for Planning Commission or City Council review.

5.2 PROJECT REVIEW TEAM'S RESPONSIBILITIES IN THE REDLINE REVIEW PROCESS

The Project Review Team is responsible for reviewing the documents submitted by the Developer in accordance with the established Municipal Code, standards, policies and design criteria manuals, specifications, the Development Processing Manual, and any other City Council approved documents meant for this purpose. The Project Review Team will mark on the drawings, any corrections that are necessary in order for the project to meet the requirements indicated above. The Project Review Team will indicate the Code, standard, or manual requirement, which applies to the comment. If the Developer does not agree with the Project Review Team's interpretation of regulations, or wishes to challenge the requirement, the Developer needs to understand that City staff does not have the authority to waive, or not enforce these requirements. These are City Council approved requirements, and only the City Council can change or alter the requirement. The Developer will need to follow the appeal process outline in *'Section 5.6 – Developer's Appeal Process'* or Municipal Code appeal process.

In addition to the 'redline' marking of building elevations, plats, site plan drawings, construction drawings, or other types of drawings, City staff will also provide a separate hand-written or typed document called a *'Project Redline Memorandum'*, which provides alternatives to the Developer for meeting the City's codes, standards or manuals. Review will be based on code, general plan, standards and specifications. As part of this effort, the Project Review Team will provide a written description of what the alternatives are, any concerns that City staff may have regarding the alternatives, pros and cons they may be aware of, and other items which may be useful in the Developer's decision on which alternative to select. The Developer will then choose the alternative course of action. The Developer must indicate, in writing, to the Project Review Team which alternative he/she elects to select. ***The project cannot be further processed until the Project Review Team receives this document.***

City staff may also elect to provide *'Optional Suggestions'* they wish the Developer to consider in finalizing the project. These will be included in the *'Project Redline Memorandum'* under the heading of *'Optional Suggestions'*. The Developer is not required to include these suggestions in the project, but must provide in writing, an indication as to whether he/she intends to include them in the project.

City staff's responsibility is to be as clear as possible in defining the issue(s) for the Developer, so the Developer and his/her engineers/architects understand the issue(s), and what the resolution to the issue(s) may be. Typically there will be one to three 'redline reviews' produced for a given project unless the Developer and his/her engineer/architect are not adhering to the 'redline' comments, and additional 'redlines' are required. If the Developer's project requires more than 3 sets of 'redlines', the Developer will be charged extra for the review of these additional sets of 'redlines'.

5.3 DEVELOPER'S RESPONSIBILITIES IN THE REDLINE REVIEW PROCESS

The Developer and his/her engineer/architect have responsibilities for making the 'redline' process a productive and efficient effort.

The first responsibility the Developer and his/her engineer/architect have in the process is to understand the City's general plan, codes, standards, manuals and other documents, and that the project is planned and designed in accordance with these documents. If the Developer and his/her engineer/architect are not familiar with the City's requirements, the project will not be able to be processed as quickly as it would, if there aren't extensive 'redlines' to the project documents. The Project Review Team has extensive experience in these types of reviews and will 'redline' all deficiencies and require they be changed to meet City requirements prior to further processing the project. Not following these guidelines will result in delays to the Developer and his/her project.

The Developer has the responsibility of making the corrections noted on the 'redlines' if they are City code, standards, manuals, or other City Council approved documents comments. These corrections are not optional and are required to be made. If the Developer disagrees with these requirements, the Developer is required to indicate this disagreement in writing to the Project Review Team, once the Developer has received and reviewed the 'redlines'. *'Section 5.6 – Developer's Appeal Process'* must be followed in resolving these types of issues. Possible modification of project requirements/agreements are closed once the Planning Commission and/or City Council approve the project. If modifications are requested, the plan or application must go back to the Planning Commission and/or City Council for modification.

The Developer has the responsibility to respond to alternatives for code compliance contained in the *'Project Redline Memorandum'* in writing. The Developer is required to consider the alternatives and then select one for implementation into the project. City staff may indicate a list of items available for the Developer to consider in this process, but the decision to select one alternative over another is solely for the Developer to make.

The Developer has the responsibility to consider optional suggestions, but is not required to comply with these suggestions. The Developer does have the responsibility of responding to Project Review Team about whether he/she intends to implement these suggestions into the project.

The Developer and his/her engineer/architect have the responsibility of being as clear as possible in responding to the concerns expressed by the Project Review Team on the *'Redline Documents'*, so the Project Review Team understands the Developer's concerns, and what the Developer's proposed resolution to the concern(s) may be.

5.4 TYPES OF REDLINE DOCUMENTS

A. Building Elevations – One of the documents which may be redlined are the building elevations. These drawings depict the appearance of the structure from various vantage points and provide the Developer and City staff an opportunity to review the outward appearance of the structure to ensure it meets the City's codes and other requirements.

B. Plats – These are official property documents which depict how property is presently configured, or how the Developer wishes to configure property as part of the proposed project. It consists of a drawing of the property with various notations, acknowledgements, legal descriptions of the property and easements, signature blocks, etc. This document is recorded at the Salt Lake County Recorder's Office.

C. Site Plan Drawings – These drawings may depict property information but they are not legal, recordable documents, which alter property configurations. These documents are *'plan view*

drawings' which indicate what the project will look like once the project is complete. It will indicate locations of property lines and easements, building, parking, landscaping, infrastructure and other site improvements required for the project.

D. Construction Drawings – These are specific drawings used by engineers, contractors, and others in the actual construction of the project. They consist of a number of different types of drawings including erosion control, sanitary sewer system, stormwater system, water system, secondary water system, roadway improvements, notes, details, etc., which depict in detail how the project is to be constructed. The City requires that *'Approved for Construction Drawings'* be provided and followed in the construction of approved projects.

E. Studies and Reports – Projects may require the preparation of various types of studies and reports in order to quantify issues related to the project. These may include geotechnical reports, geologic reports, traffic impact studies, drainage studies, development plans, modifications of various master plans, etc., which may be required for the individual project. The Project Review Team will identify which reports are necessary at the beginning of the project and may require additional studies/reports as work on the project progresses.

F. Property Documents – Various types of property documents may be required for the project including warranty deeds, permanent easements, temporary easements, etc.

G. Other Types of Documents – Each project is unique and may require other types of documents to be submitted for the project to be processed. As the project is processed through the City, the documents will become evident and will be indicated to the Developer by the Project Review Team.

5.5 REDLINES

The Project Review Team will provide responses to the Developer's project submittals in three different forms. These are:

A. *'Project Redline Memorandum'* – In every case, the Project Review Team will assemble a *'Project Redline Memorandum'* which indicates the status of the project and provides code requirements, *'Alternatives for Code Compliance'* issues, *'Optional Suggestions'*, and any other comments the Project Review Team feels will help the Developer revise the *'Redline Documents'* and allow them to be further processed. The Memorandum may or may not include the items listed above, depending upon the needs of the specific project. This Memorandum will act as a summary of the 'redline' effort by the City staff.

B. *'Redlined Drawings'* – Most projects will contain some type of drawing or drawings. The Project Review Team may mark on these drawings any changes they wish to see made, as long as the comments were identified *as 'code requirements'*, *'alternatives'*, or *'Optional Suggestions'*, or they may include this discussion in the *'Project Redline Memorandum'*.

C. Other Redline Documents – There are a variety of these types of documents and the Project Review Team may mark on these documents, or may include a summary of concerns in the *'Project Redline Memorandum'*.

The Developer needs to check all documents for comments, which are returned to the Developer from the Project Review Team.

5.6 DEVELOPER'S APPEAL PROCESS

The *'Appeals Process'* to the Project Review Team's conditions and corrections as part of the 'Redline review process' is contained in the City's Municipal Code. This includes Title 89-1-201 and 89-2-303. Please refer to these sections for additional information regarding this process.

It needs to be noted that the appeals process will take time and will delay the Developer's project until a resolution of the issues can be finalized.

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SECTION 6.0

CONSTRUCTION & CONSTRUCTION INSPECTION

6.1 GENERAL REQUIREMENTS

This section describes the use of materials and workmanship to be employed in construction of roads and bridges. Construction of other infrastructure needs to be completed in accordance with those policies & design criteria manuals. The developer/engineer shall prepare such general and special specifications as are necessary to define the nature and location of the work, contractual arrangements, payment for work and any other matters concerning the owner or his contractor; these items are not discussed within the standards presented here.

A. Use of This Section - The construction section is intended to highlight the features of construction, which are deemed to be most significant. In any construction activity, the recommendations of the manufacturer of a product, especially where more stringent, should apply. Also, the omission of a particular practice, which is not considered to be a good construction technique common to the construction industry, should not be construed to mean that it is not required.

   Finally, Section 4.0 of this Manual contains material descriptions and the developer/contractor is required to use that section along with this section, and the respective plates as a reference. Section 6.0 describes testing procedures and requirements.

B. Quality of Materials - Materials and equipment to be incorporated into the work shall be new. In case a reference is not clear as to which of several available grades is desired, the highest quality material shall be used. When construction bids are received directly by the City such bids shall show the proposed pipe material and the manufacturer's name, if more than one type is allowed.

   Contractor shall have at the job site or be able to supply upon request, certified copies of factory or laboratory test reports showing the strength characteristics of any materials used in the work. For all reinforced concrete work, the contractor shall furnish in advance of pouring concrete and, if requested, the mix design and calculated concrete strength as prepared by the concrete supplier.

C. Substitutions - Where articles or materials are specified by brand or trade name, alternate materials or articles equal to those specified may be approved provided the request for approval is in writing accompanied by supporting data, in ample time to permit investigations without delaying the work. Unless substitutions have received prior approval, no deviation from the Standards will be allowed.

D. Quality of Workmanship - All work will be done by persons experienced in the specific work, under competent supervision and in a first class manner to the City's complete satisfaction. When work is being done directly for the City, the contractor in the proposal shall name each subcontractor and no substitutions will be permitted without prior approval.

E. Defective Work - Any defective materials or workmanship, which shall become evident within one year after field acceptance of completed work shall be replaced or repaired without cost to the City. Refusal of the contractor to correct defective work, which is clearly his responsibility, will

be considered just cause for exclusion from performing future work for the City. Such exclusion does not impair the City's right to bring legal action to correct the deficiencies as well as to withhold release/exoneration of cash/letter of credit bond and payment bond.

F. City Inspection, Field Acceptance and Guarantee Period - The Engineering Department is responsible for inspection of all excavation, pipe laying including appurtenant structures, trench backfill within the pipe zone and testing. The administration of this work is described in more detail in the City's *'Private Development Construction Inspection Manual'* which is available from the Engineering Department. All such work shall be available for inspection at all times. It will be the contractor's responsibility to provide a working day notice to the Engineering Department prior to the start of any work. Such notification will allow for scheduling a preconstruction meeting between interested parties. Failure to provide proper notification may delay the starting date since the Engineering Department may not be able to inspect the work and cannot accept any work for which inspection has not been arranged. It must be emphasized that the primary responsibility for compliance with all City requirements and standards rests with the developer and/or contractor. Any acceptance of a portion of the work by a construction inspector does not relieve the developer/contractor of this basic responsibility.

   Field acceptance is made by the inspector and will not coincide with the date of City Engineer acceptance of the work. However, the one year guarantee period for all work shall begin as of City Engineer acceptance. As mentioned in Section 6.I.E., any deflective work discovered during this period shall be repaired or replaced but a new one year period will not begin for the corrected work.

   All holiday or weekend inspection will be subject to additional charges as detailed in the City's standard rates for such work.

G. Public Relations - The contractor shall conduct its affairs in a manner which will lessen the disturbance to residents in the vicinity of the work. In this regard, standard working hours as specified in the Municipal Code (currently 7:00 a.m. to 7:00 p.m., Monday through Friday) shall be observed unless prior approval is received, which also includes City observed holidays. The job site shall be maintained in a condition which shall bring no discredit to the City or its personnel, and all affected private improvements shall be restored to at least their original condition. Saturday work may be provided for only by approval of the Engineering Department an the contractor will be responsible for payment of all overtime and other charges associated with having City staff available for inspection and other coordination. Special care must be taken in regards to school zones. These zones must be maintained open at all times and any alterations to existing shall be coordinated with the School District and the City's Engineering Department.

6.2 PERMITS

The following permits may be required of the contractor:

A. Encroachment - Where construction or other types of activities will encroach into the public right-of-way or easements, the contractor shall obtain all necessary Encroachment Permit. Within City of West Jordan right-of-way, the permit is secured from the Engineering Department. Within the County areas, a similar permit is required from the County. State roads require a

permit from UDOT. Particular attention is called to Section 6.15 and the appropriate standard drawings.

B. Explosives - Where the contractor anticipates the use of explosives in conjunction with construction, a blasting permit shall be first obtained from the City of West Jordan Fire and Police Departments, and all nearby property owners shall be notified. These permits are discretionary and may not be given for a particular circumstance.

C. Land Disturbance Permit – Prior to the movement of any dirt on the site, the Contractor shall obtain a land disturbance permit from the City for the project. The land disturbance permit application may be obtained from the Executive Secretary of the Engineering Department. In obtaining the necessary information required for this permit, the Contract should also obtain a copy of the City's most current version of the *Land Disturbance Policies & Design Criteria Manual*. This Manual contains all of the particulars for obtaining this permit which also contains information about erosion control, revegetation and sedimentation control.

D. Other Permits - Other permits may also be required by other agencies, which must be applied for and obtained by the developer or his contractor. Certain permits are also required as part of the development conditioning process which must be provided prior to beginning construction of the project. Please refer to the City's *'Development Processing Manual'* for additional information.

6.3 TRAFFIC REGULATION

A. General - The Contractor shall submit a traffic control plan to the City for review and approval. The traffic control plan shall include the times the work shall be ongoing, streets affected, the proposed plan for dealing with traffic as well as a schedule for work to be performed. This work shall be done in accordance with the following technical specification and the City Traffic Engineer's additional requirements:

1. Section 02010 – Traffic Regulation

6.4 CLEARING AND GRUBBING

A. General - Clearing and grubbing which consists of removal of objectionable material from the right-of-way shall be done with caution such that existing sanitary sewer improvements, adjacent property and trees and shrubbery that are not to be removed shall be protected from injury or damage.

Within water easements or rights-of-way, trees, shrubs, fences and all other improvements that have to be removed to permit construction and which are intended for replacement, shall be replaced in kind or size (excluding native trees under 2-inch diameter or native brush) or with approved substitutes unless permission to exclude such replacement is obtained from the owner/agency or granted by the Engineering Department. Replacement trees shall have a minimum diameter at breast height (DBH) recommended by the American Association of Nurserymen, but shall be larger if so required. This work shall be done in accordance with the following technical specification:

1. Section 02112 – Clearing, Grubbing and Stripping

B. Removal and Disposal of Material - The contractor shall be responsible for leaving the site in a neat and finished appearance, free from debris and/or inflammable material.

6.5 UTILITIES, EXISTING FACILITIES AND CONCRETE REMOVAL

A. Abandonment - Refer to Section 5.0 regarding abandonment of roadways and/or structures.

B. Utilities and Existing Facilities - The existing utilities and/or facilities shown on the drawings or the location of which is made known to the contractor prior to excavation, by contacting Blue Stakes 2 working days prior, shall be protected from damage during the excavation and backfilling of trenches and, if damaged, shall be repaired by and at the contractor's expense. Any existing utility or facility not shown on the drawings or the location of which is not shown to the contractor in sufficient time to avoid damage, if inadvertently damaged during excavation, shall be repaired by the contractor; and adjustment in payment, if any, is subject to negotiation between the contractor and the developer without any City liability, unless it is a City sponsored project.

Whether expressly indicated on the drawings or not, all contractors shall call Blue Stakes prior to any construction of pipelines. Failure to do so shall not relieve the contractor of any liability associated with disturbance/ breakage of existing utilities. This work shall be done in accordance with the following technical specification:

1. Section 02223 – Protecting Existing Underground Utilities

In case it shall be necessary to remove any such utilities, facilities or any portions thereof, the contractor shall notify the Engineering Department and the owner of the structure. The contractor shall not interfere with said utility and/or facility structures until disposition of the obstruction to the work has been determined and/or notice to relocate or remove has been given by the Engineering Department or authorized agent of the owner of the utility and/or facility so affected.

The fact that any underground utility and/or facility is not shown on plans shall not relieve the contractor's responsibility to comply with these standards. It shall be the contractor's responsibility to ascertain prior to commencing work the existence of any underground utilities or facilities which may be subject to damage by reason of operations performed by the contractor.

The Public Works Department will provide service line location services of existing services upon request and with satisfactory notification in advance.

C. Concrete, Masonry or Mortared Construction Removal - At locations shown on plans, portions of existing concrete pavement, curbs, gutters, sidewalks, foundations and other concrete or mortared structures shall be removed to the lines and elevations specified. Concrete structures or objects not shown or noted on the plans shall be removed where necessary and disposed of by the contractor.

Concrete removal operations in connection with the reconstruction of existing structures shall be performed without damage to any portion of the structure that is to remain in place. If damage

occurs, the contractor shall repair any such damage at his own expense, to the satisfaction of the Engineering Department. Repair/replacement of any sidewalks, curbs and/or gutters shall be to the satisfaction of the Engineering Department, as appropriate. Where existing reinforcement is to be incorporated in new work, such reinforcement shall be protected from damage and shall be thoroughly cleaned of all adhering material before being embedded in new concrete.

6.6 EXCAVATION AND TRENCHING

A. General - Trench excavation shall consist of all excavation involved in the grading and construction of water lines as shown on plans. The contractor shall perform all excavation of every description and of whatever substances encountered, to depths indicated on the drawings or otherwise specified or required. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. The material piles shall also not obstruct existing sidewalks or driveways unless it cannot be avoided. All excavated materials not required or unsuitable for backfill shall be removed. Such grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water from any source accumulating therein shall be removed by pumping or by other approved methods. Such sheeting and shoring shall be done as may be necessary for the protection of the work and for the safety of personnel.

Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled if, in the opinion of the Engineering Department, the pipe or duct can be safely and properly installed and backfill can be properly tamped in such tunnel sections. If blasting is necessary, the contractor shall notify the City of his blasting schedule and procedures and obtain a blasting permit, and shall observe all reasonable precautions in protecting life and property. This work shall be done in accordance with the following technical specification:

1. Section 02200 - Earthwork
2. Section 02201 – Earthwork (For Roads and Highways Only)
3. Section 02211 - Rough Grading

B. Excavation - Excavation for water lines shall be made only after pipe and other necessary materials are delivered on the work site. After such delivery, trench excavation shall proceed as rapidly as possible, and the pipe installed and the trench backfilled without undue delay.

C. Shoring - All shoring for open excavations shall conform to the State of Utah, Department of Industrial Relations, and Division of Industrial Safety "Construction Safety orders (O.S.H.A)."

The contractor shall be responsible for adequately shored and braced excavations so that the earth will not slide, move or settle, and so that all-existing improvements of any kind will be fully protected from damage.

No shoring once installed shall be removed until the trench has been approved for backfill operations. Removal of shoring shall only be accomplished during backfill operations and in such a manner as to prevent any movement of the ground or damage to the pipe or other structures.

The contractor shall obtain and pay for all permits for any excavations over 5 feet (1.5m) in depth into which a person is required to descend or any excavation less than 5 feet (1.5m) in depth in soils where hazardous ground movement may be expected and into which a person is required to descend.

6.7 BACKFILL AND COMPACTION

A. General - There are several distinct zones to be considered in the backfilling procedure as follows (refer to Plate No. 3).

1. Pipe Zone. This area is from the trench bottom to 12 inches (300 mm) above the pipe. This zone is to be backfilled under the strict jurisdiction of the Engineering Department.

2. Above pipe zone but below pavement subgrade plus the zone including the subgrade and pavement Backfill and compaction in existing streets and in the area above the pipe zone shall be in full accordance with the City excavation permit issued for the specific work, and with the City land development specifications. In both cases, the filling of trenches shall be subject to approval by the City or Engineering inspector who shall have full authority to order compaction tests to demonstrate the actual backfill density.

Section 3.12 of the Culinary Water Design and Construction Standards contains the material designations for both the pipe zone and above pipe zone regions.

6.8 BORING AND JACKING OPERATIONS

A. General - Placement of pipe by boring or jacking methods requires special Engineering Department approval for each instance. However, as a general guideline, the following shall pertain:

1. Except for the use of air or water, the methods and equipment used in boring and jacking operations shall be optional to the contractor provided that the Engineering Department reviews them prior to any work.
2. The placement of pipe shall be to the lines and grades shown on the plans.
3. Voids remaining outside the pipe (or carrier pipe if applicable) shall be backfilled with 200 psi concrete.
6. Where a casing pipe is used, it shall be no less than 8 inches (200 mm) greater in diameter than the pipe to be installed.
5. The placement of pipe in casings shall be supported with redwood skids, shims or wedges to the lines and grades shown on the plans.

B. Bores - The boring machine shall cut a true circular bore to the required line and grade. The bored tunnel shall be no more than 2-inches larger in diameter than the maximum outside diameter of the casing or water pipe to be installed.

C. Jacked Steel Casings - In addition to applicable portions above, the following shall pertain:

1. Where casings are used, the size and wall thickness of the casing shall be at the contractor's option except that the minimum casing thickness shall be not less than 3/8 inch.
2. Field joints of steel casings shall be welded with a continuous circumferential weld.
3. The placement of pipe in casings shall be supported with redwood skids, shims or wedges to the lines and grades shown on the plans.
6. Prior to backfilling the annular space between the pipe and casing, the pipeline shall be tested in accordance with Section 6.0 – Testing.
5. The annular space shall be backfilled with washed concrete sand blown or rammed into place until the entire cavity is filled. Concrete bulkheads shall be placed at each end of the cased section to retain the backfill material.

6.9 CONSTRUCTION WATER

A. General - The developer/contractor shall not take unmetered water from the City's culinary water system. Instead, he or she should sign up at the Public Works Department for one or more construction meters after receipt of a deposit amount. The developer/contractor is not to move the construction meters. Charges for construction water are covered by City Council Resolution. The developer/contractor is put on notice that unpaid invoices will result in removal of the construction meter. This work shall be done in accordance with the following technical specification:

1. Section 02161 - Care of Water

6.10 SUBGRADE PREPARATION AND PLACEMENT OF BASE MATERIALS

A. General – This work shall provide for the preparation of natural, filled, or excavated roadbed material prior to the placement of subbase or base material, pavement, curbs and gutters, driveways, sidewalks, or other roadway structures.

B. Subgrade Preparation – This work shall be done in accordance with the following technical specification:

1. Section 02227 - Sand-Cement Slurry
2. Section 02280 - Soil Treatment
3. Section 02514 - Soil Cement Base

C. Untreated Base – This work provides for untreated base for pavement, curb, gutter and similar types of improvements that shall be constructed according to their technical specification sections.

6.11 ROADWAY SURFACING

A. General – This section provides for work related to finish surfacing of roadways including oiled roadways and shoulders, granular surfacing, chip seals, asphalt concrete pavement, portland cement concrete pavement and pavement fabrics.

B. Oiled Roadways and Shoulders – The roadway or shoulder to be oiled shall be prepared in accordance with these specifications following which it shall be uniformly water sufficiently to

eliminate dust, but not to such extent as to form mud or pools of water. Grade SC-70 liquid asphalt shall then be applied to the dampened surface at a uniform rate of 0.35 gallon per square yard unless otherwise specified.

The application of oil to the roadway or should shall be scheduled to commence after 7:00 a.m. and shall be completed prior to 1:00 p.m., and is further specified that no oil shall be applied when the air temperature is less than 40-degrees Fahrenheit.

During all oiling operations, precautions shall be exercised to prevent marring or discoloring adjacent improvements and adequate protection against such possibility shall be provided.
After the applied oil has dried, or penetrated to such extent that no free oil remains on the surface, and the condition of the oiled area will otherwise permit, the roadway or shoulder shall be opened to traffic.

C. Granular Surfacing – This work shall be done in accordance with the following technical specification:

1. Section 02506 – Granular Surfacing

D. Asphalt Concrete Pavement – Asphalt concrete pavement shall consist of one or more course of mixture of paving asphalt and graded aggregate placed upon a prepared roadbed or base, or over existing pavement. The courses shall be of the type of mixture and the dimensions shown on the plans and specifications. This work shall be done in accordance with the following technical specification:

1. Section 02510 – Asphaltic Concrete Paving
2. Section 02511 - A.C. Pavement and Base
3. Section 02513 - Asphalt Concrete Pavement and Base

E. Portland Cement Concrete Pavement – This work shall be done in accordance with the following technical specification:

1. Section 02520 - Portland Cement Concrete Paving

F. Pavement Fabric – Pavement fabric shall be nonwoven polyester or polypropylene materials conforming to the following:

Property	ASTM Test No.	Requirements
Weight, oz./sq.yd.	D3776	3.5 to 5.0
Grab Tensile Strength (1-inch grip), lbs	D1682	90 Min.
Elongation at Break, Percent	D1682	40 Min, 100 Max.
Fabric Thickness, Mils	D461	30 to 50

Pavement fabric shall be accompanied with a test certificate from an approved testing laboratory with actual identification test results. Additional testing may be required of the City Engineer. The fabric shall be protected from exposure to ultraviolet rays.

The surface of the distressed pavement shall be prepared by sweeping and removal of all loose materials prior to placement of the tack coat and pavement fabric. The fabric shall then be covered with an overlay of asphalt concrete.

6.12 CONCRETE AND MASONRY CONSTRUCTION

A. General – This work provides for construction of concrete structures, curbs & gutter, sidewalks, cross gutters and driveways connected to road and bridge projects. This work shall be done in accordance with the following technical specification:

1. Section 03100 - Concrete Formwork
2. Section 03102 – General Concrete Construction
3. Section 03200 - Concrete Reinforcement Steel
4. Section 03300 - Cast-in-Place Concrete
5. Section 03304 – Minor Concrete

B. Concrete Structures – Concrete bridges, culverts, catch basins, retaining walls, abutments, piers, footings foundations, and similar structures shall be constructed in conformity with the plans and specifications.

C. Concrete Curbs & Gutters, Sidewalks, Cross Gutters, and Driveways – Concrete curbs, walks, gutters cross gutters, alley intersections, access ramps, and driveways shall be constructed of portland cement concrete of the class and other requirements prescribed in the plans and specifications. The finish coat to be applied to curbs shall consist of Class “B” mortar.

6.13 LANDSCAPE AND IRRIGATION SYSTEMS

A. General – This section shall govern the preparation, planting, and irrigation system construction for landscape areas required by the City.

Existing utilities and improvements not designated for removal shall be protected in place. Unless otherwise provided, walls, curbs, planter boxes, walks, irrigation systems, and similar improvements required by the City shall be constructed following rough grading and before landscaping.

B. Testing - All work on the irrigation system, including hydrostatic and coverage tests, preliminary operational tests of the automatic control system, and the backfill and densification of trenches, and other excavations shall be performed after topsoil work and before planting. This work shall be done in accordance with the following technical specification:

1. Section 02811 - Landscape Irrigation System

6.14 WINTER-TIME WORK REQUIREMENTS

Winter-time work is defined as time past November 1st of each year, where temperatures are typically consistently lower than the 50-degree F requirement and weather conditions are such, that they bring into question the quality of the materials, ability to properly place and compact them, or otherwise perform proper construction of the given facility.

The asphalt placement requirement is 50-degrees F and rising and whether work proceeds, is dependant upon the City Engineer with advice from the Engineering Inspector and Engineering Inspection Supervisor.

Placement of other materials after the November 1st date are subject to the approval of the City Engineer. Situations and weather conditions may also be such that even prior to November 1st, that the ability of the Contactor to adequately construct a facility may result in the City Engineer directing that the construction stop until further directed.

6.15 CONSTRUCTION INSPECTION

All construction inspection is to be done in accordance to the City's most recent version of the City Council adopted *'Private Development Construction Inspection Manual'*. This manual provides the detail for City staff and the Developer and his consultants to provide for inspection during the construction phase of the work. This manual contains the following table of contents:

PRIVATE DEVELOPMENT
CONSTRUCTION INSPECTION
MANUAL

ABBREVIATED
TABLE OF CONTENTS

SECTION	TITLE
1.0	INTRODUCTION AND GENERAL POLICIES
2.0	PRECONSTRUCTION
3.0	CONSTRUCTION
4.0	PROJECT CLOSEOUT
5.0	WARRANTY INSPECTION/ACCEPTANCE REQUIREMENTS
6.0	FINAL INSPECTION/ACCEPTANCE REQUIREMENTS
	APPENDICES
	Appendix A – Reference Section
	Appendix B – Administration Checklists
	Appendix C – Preconstruction Checklists
	Appendix D – Construction Checklists
	Appendix E – Project Closeout Checklists
	Appendix F – Warranty Inspection/Acceptance Requirements Checklists
	Appendix G – Final Inspection/Acceptance Requirements Checklists
	Appendix H - Preconstruction Forms

Appendix I – Construction Forms
Appendix J – Project Closeout Forms
Appendix K – Warranty Inspection/Acceptance Requirements Forms
Appendix L – Final Inspection/Acceptance Requirements Forms

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SECTION 7.0

IMPROVEMENT BONDS & ACCEPTANCE

7.1 GENERAL

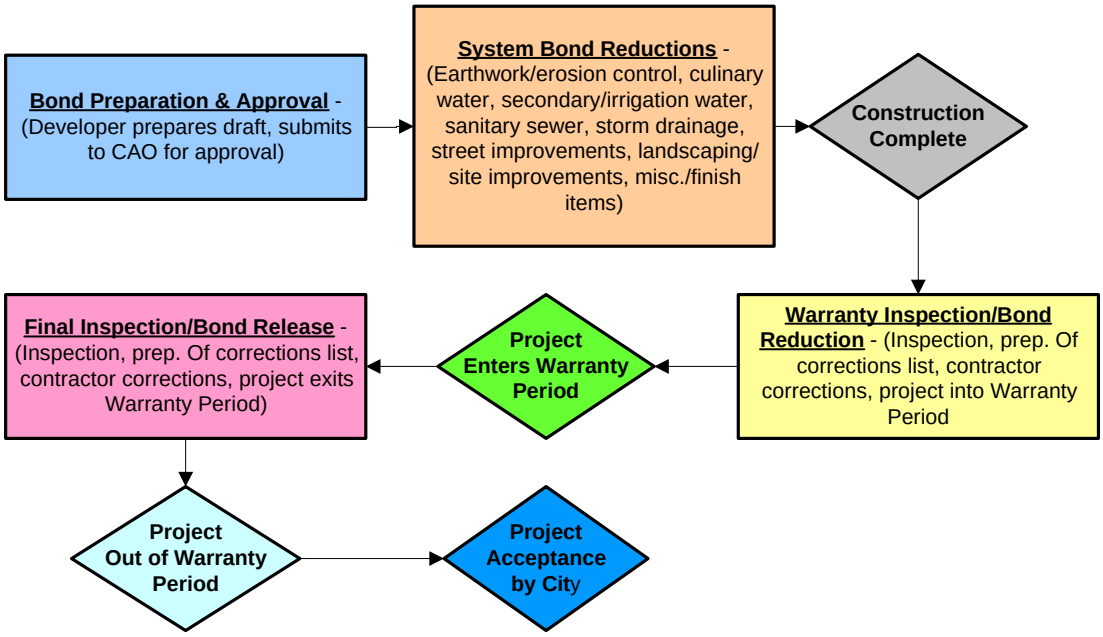
A. General – The purpose of this section is to address issues related to *the 'Public Improvement Bond'* and its various parts. There are four main parts to this process which include:

1. Bond preparation and approval *(7.3,7.4)**
2. System bond reductions *(7.5)**
3. Warranty inspection/bond reduction, *(7.6)** and
4. Final inspection/bond release *(7.7)**

**Note: Denotes subsection references.*

The *'Public Improvement Bond'* consists of processes as shown below:

Flowchart No. 8-01 Overall Public Improvement Bond Process



B. Municipal Code – As indicated above, bond preparation, establishment, reductions and releases are specified in various sections of the City Municipal Code. Developers, their contractors and staff are to be familiar with the various provisions of the Code and how they might apply to the various bonds described in *'Section 7.2 – Private Development Project Bonds – General'* (see Title 89-6-12).

C. Development Processing Manual (DPM) – The City has also adopted a *'Development Processing Manual'*, which is required to be followed in relation to this issue. Various sections of the DPM have been prepared to provide a step-by-step process for preparation, establishment, reductions and releases of various types of bonds. Please refer to this Manual for additional information.

D. Private Development Construction Inspection Manual (PDCIM) – The City has also adopted a *'Private Development Construction Inspection Manual'* which is required to be followed in relation to bond this issue. Various sections of the PDCIM have been prepared to provide a step-by-step process for preparation, establishment, reductions and releases of various types of bonds. In addition, the Manual contains appendices, which include inspection and certification checklists for the various systems to be released for the Public Improvement Bonds. Please refer to this Manual for additional information.

E. Acronyms and Definitions – The following acronyms and definitions apply to this section:

1. Acronyms
   a. CAO – City Attorney's Office
   b. CDD – Community Development Department
   c. DPM – Development Processing Manual
   d. ED – Engineering Department
   e. PDCIM – Private Development Construction Inspection Manual
   f. ODA – Office of Development Assistance
   g. PWD – Public Works Department
2. Definitions
   a. Bond estimate sheet – The spreadsheet used by the Private Development Projects Division of the Engineering Department to prepare cost estimates of the public infrastructure for which bonds will be prepared. Contact the City Engineer for the most current version of this document.
   b. Bond reduction – After the bond for the project has been established, the City will allow the bond to be reduced in its amount, as progress is made on constructing and inspecting those constructions. As the bond is reduced, this is called a bond reduction.
   c. Bond release – Once the *'system-by-system'* bond reductions have been performed, the project is complete, and the project has been through its *'Final Inspection'* and all correction items completed, then the project is ready for a complete release of all bond proceeds. This is called a *'bond release'*.
   d. Certification form – A City prepared form that is used by the Developer to certify the project has reached a certain stage in construction.
   e. Contractor – This is the general contractor for the project, or may be a subcontractor for a portion of the project. In either case, it is the entity that is responsible for the construction in question, and the entity to which the Developer looks to address a particular construction issue.
   f. Corrections list – A list of items needing to be completed or corrected for a given construction project. Is also referred to as a *'punchlist'*.
   g. Days – Unless otherwise so stated in this section, days refers to *'calendar days'*.
   h. Developer – The entity responsible from the private development side of the project, for due diligence, planning, designing, constructing, and getting the project accepted.

i. Final inspection – That inspection that comes at the end of the Warranty Period, once all City requirements have been met.
j. Final inspection bond release – That inspection and bond release that comes at the end of the Warranty Period, once all City requirements have been met.
k. Finish items – A category within the *'Public Improvement Bond'* list of items. It signifies those items, which are required to be completed in order to fully, complete the construction of the project, such as valve covers, street signs, etc. These are more fully defined on the *'bond estimate sheet'*.
l. Inspection checklist – These are the checklists used for inspection of the *'system'* improvements and are contained in the PDCIM in Appendices C, D, and E.
m. Manual – As used in this section, this refers to the Development Processing Manual.
n. Public infrastructure – Culinary water, secondary water, storm drainage, irrigation, roadways, fencing, etc. infrastructure construction which is to be dedicated to the City. This infrastructure is to be constructed in accordance with all requirements necessary to make them public facilities.
o. Project – The *'project'* is defined as the construction shown on the *'Released for Construction Drawings'*, and is also defined as the project reviewed and approved by the Planning Commission.
p. Punchlist – Please see *'Corrections List'*.
q. Released for Construction Drawings – This is the set of drawings reviewed and approved by the Engineering Department as part of the project approvals which are then signed by the Engineering Project Review Engineer, the City Engineer and other affected City departments.
r. System – These are the 8 items listed under *'Section 7.1 General, D. Public Improvement Bond'* which lists the 8 items considered to be *'systems'*.
s. Warranty bond reduction – This is the bond reduction, which comes after all City requirements have been met, after the Warranty Inspection has taken place.
t. Warranty inspection – The inspection performed at the time of completion of the project, and which is just prior to going into the Warranty Period.
u. Warranty period – That period of time between the Warranty Inspection and Final Inspection, when the City agrees that all items on these corrections lists have been completed, and the project meets all City requirements. The Warranty Period for the *'Public Improvement Bond'* is 2-years, and will be different for the other bonds.

F. <u>Developer's Role</u> – The Developer has the primary and an integral role in the preparation, establishment, reduction and release of these bonds. These responsibilities include:

1. Bond Estimate Sheet(s) - The Developer and his/her engineer, is to submit to the Engineering Department a complete bond estimate sheet(s), on the forms provided by the Engineering Department. The Engineering Department will review and either returns the bond estimate sheet(s) to the Developer and his/her engineer for additional work, or will approve the draft bond estimate sheet(s) for further processing. The Developer is responsible for submitting a reasonable listing of public improvements and '*non-public improvements in common* areas' and City staff will review this work. Developer delays in submitting a reasonable bond estimate sheet(s) will result in delays in completing the bond.
2. Bond Form Preparation - The Developer is to work with the City Attorney's Office in preparing the bond form(s). The Developer is responsible for this work, not City staff. The Developer and his/her bonding company must meet the City Attorney Office's

requirements prior to the bond being approved by the City Attorney's Office, and this approval being forwarded on to the Office of Development Assistance (ODA) and the Engineering Department. Developer delays in submitting the bond in the form required by the CAO will result in delays in completing the bond(s).

3. Developer/Contractor Certification for Bond Reduction/Release - The Developer is responsible for understanding and being involved with the progress on construction of his/her project, prior to submitting a written bond reduction or release request. Many times, the Contractor indicates he is ready for a bond reduction or release, when this is not the case. As such, the City has prepared a *'certification form'* for the various *'systems'*, which the Developer and his contractor are to complete as part of the written reduction/release request. This form must be properly completed and submitted to the Engineering Department before the Engineering Department inspection staff will initiate an inspection of the *'system'*, for which a reduction/release is being requested. Once the *'certification form'* is completed and submitted, an inspection by Engineering staff will be promptly completed. If it is found during the inspection that the *'system'* is not ready for inspection, the Engineering inspector will return a written response to the Developer indicating the items that are not complete. Subsequent inspections after the first inspection will be billed to the Developer on an hourly rate basis.
4. Timely Completion of Corrections List (Punchlist) - Once an inspection has been conducted by the Engineering Inspector, and a Corrections List (Punchlist) has been completed, the Developer and his Contractor are responsible for making the required corrections and notifying the Engineering Inspector that the corrections have been made within 30-calendar days, or the Corrections List becomes null and void and a new Corrections List will be required to be prepared. Again, additional inspection work required of the Engineering Inspector will be charged to the Developer for this additional work.

G. <u>City's Role</u> – The City also has an integral role in the review of the preparation, establishment, reduction and release of these bonds. These responsibilities include:

1. Bond Estimate Sheet – City staff are responsible for a timely and complete review of the bond estimate sheet, once it is provided to the Engineering Department by the Developer. The Engineering Department will review and either returns the bond estimate sheet to the Developer and his/her engineer for additional work, or will approve the draft bond estimate sheet for further processing.
2. Bond Form Preparation - The City Attorney's Office (CAO) is responsible for the review and approval of the bond agreement form. Once the CAO has completed its review, an approval of the bond will be forwarded to the ODA and ED for their information.
3. Developer/Contractor Certification for Bond Reduction/Release – City staff will review the *'certification form'* and perform an inspection on the *'system'* and will provide the Developer and Contractor a written response regarding their request within 7-days.
4. Timely Completion of Corrections List - Once the Developer has submitted a written indication that the Corrections List is complete; the Engineering Inspector will inspect the project again in relation to the Corrections List. The Engineering Inspector will provide a written response within 7-days as to whether the corrections list was completed, or whether items were not completed.

H. <u>Payment for Extra Inspections</u> – City inspection fee estimates include only one inspection for each type of inspection. The assumption is that the Developer and Contractor have

performed their own inspection based upon the City's inspection forms, that everything is complete, and that it is ready for City inspection. It is not the City's role to provide *'quality control/quality assurance'* for the developer's project, which we feel can be done in one inspection by City staff. Should the inspection require more than one inspection for a *'system'* bond reduction/release, the Developer will be charged on an hourly rate basis for the City's additional work effort.

I. Bond Estimate Unit Prices – The City Engineer is responsible for revising the City's bond estimate unit prices on at least a yearly basis (January or every year). The City Engineer may revise the bond estimate unit prices on a more frequent basis in cases where it is deemed necessary.

7.2 PRIVATE DEVELOPMENT PROJECT BONDS - GENERAL

A. There are also, several other different types of bonds used in the construction of private development projects. These bonds are generally described in this section so the Developer understands what each of these bonds are, what they are used for, who administers them, and where to find additional information concerning them. These bonds are:

1. Land disturbance activities and improvements bond
2. Revegetation bond
3. Restoration bond
4. Public improvement bond – landscaping & street lighting
5. Public improvement bond - infrastructure
6. Non-public improvement bond

B. Land Disturbance Activities and Improvements Bond, Revegetation Bond, and Restoration Bond – The Land Disturbance Activities and Improvements Bond, Revegetation Bond, and the Restoration Bond for the City of West Jordan are administered through *'Title 81, Chapter 4 – Bonds'*. Initiation, processing, reductions and releases of these bonds will be administered through this ordinance. The Developer is to be familiar with its particulars as the City will follow the provisions of the ordinance in administering these bonds.

The Engineering Department is responsible for establishing and releasing these three bonds related to land disturbance, grading, erosion control, revegetation, and restoration of areas disturbed as part of private development projects.

C. Public Improvement Bond – Landscaping & Street Lighting – This type of bond is required as its warranty period is different from the typical *'Public Improvement Bond - Infrastructure'* and it allows the *Public Improvement Bond – Infrastructure'* bond to be released more quickly As such, a separate, specific bond agreement is required to address issues specifically related to landscaping and street lighting.

D. Public Improvement Bond - Infrastructure – This type of bond addresses the public improvements required as part of the '*Released for Construction* Drawings', and only those public improvements shown on these drawings.

Public Improvement Bonds for the City of West Jordan are administered through *'Title 89, Chapter 6, Part 12 – Public Improvement Bonds'*. Initiation, processing, reductions and

releases of these bonds will be administered through this ordinance. The Developer is to be familiar with its particulars as the City will follow the provisions of the ordinance in administering these bonds.

The Engineering Department is responsible for establishing and releasing the Public Improvement Bond - Infrastructure related to public infrastructure improvements. This includes all of the items listed below, which are associated with public improvements.

1. Earthwork/erosion control
2. Culinary water
3. Secondary/irrigation water
4. Sanitary sewer
5. Storm drainage
6. Street improvements
7. Miscellaneous/finish items

Additional categories may be added if approved by the City Engineer. Reduction requests may be made only once every 30-days and no reduction is to be authorized until such time as the Engineering inspector has inspected the improvements and found them to be in compliance with the City's standards and specifications. Reductions are to be made only as they apply to the completion, satisfactory to the City Engineer, of entire systems.

The Warranty and Final bond reduction/release will be processed once all facilities have been completed, inspected and found to be acceptable by the City Engineer. The City will retain 10-percent of the bond amount plus the estimated cost of a one-inch thick asphalt concrete overlay for the roadways until Final Acceptance by the City Manager following the Warranty Period.

E. Non-public Improvement Bond – This bond is applied to projects where on-site, non-public, landscaping, or common area improvements is required as part of the Municipal Code or is conditioned by the Planning Commission. The Developer is to work with the Engineering Department, Community Development Department, and the City Attorney's Office in determining the amount of the bond. The Engineering Department is responsible for the administration of this bond with cooperation from the Community Development Department, which includes bond preparation, establishment, reductions and releases.

F. Planning Commission and Other Project Conditions – During the project review and approval process, a project may be conditioned to provide specified items as part of the project approval which does not fit into the bond categories indicated above. For instance, the Planning Commission may condition a project to construct a wall or landscaping which are on private property, which is not a common non-public improvement, and is not part of the already prepared *'Released for Construction Drawings'* set of drawings. In this situation, the Community Development Department may withhold the issuing of the *'Certificate of Occupancy'* for the project to ensure the completion of these conditions, or such improvements.

7.3 'RELEASED FOR CONSTRUCTION DRAWINGS'

A. General – These documents are mentioned in this section to indicate that it is from these documents that the bond estimate sheet and bond are to be prepared. Once these drawings are stamped and signed, then a final *'bond estimate sheet'* can be prepared.

B. Preparation and Finalizing – These drawings are initiated as part of a *'site plan'* project or the *'preliminary plat'* phase of a *'subdivision'* and are finalized as part of the *'final'* approval portions of these projects. The Developer and his/her engineer may submit draft *'bond estimate sheets'* from these preliminary reviews/approvals, however, only the finalized, stamped and signed version of these documents may be used to prepare the final *'bond estimate sheet'*, and subsequent final bond.

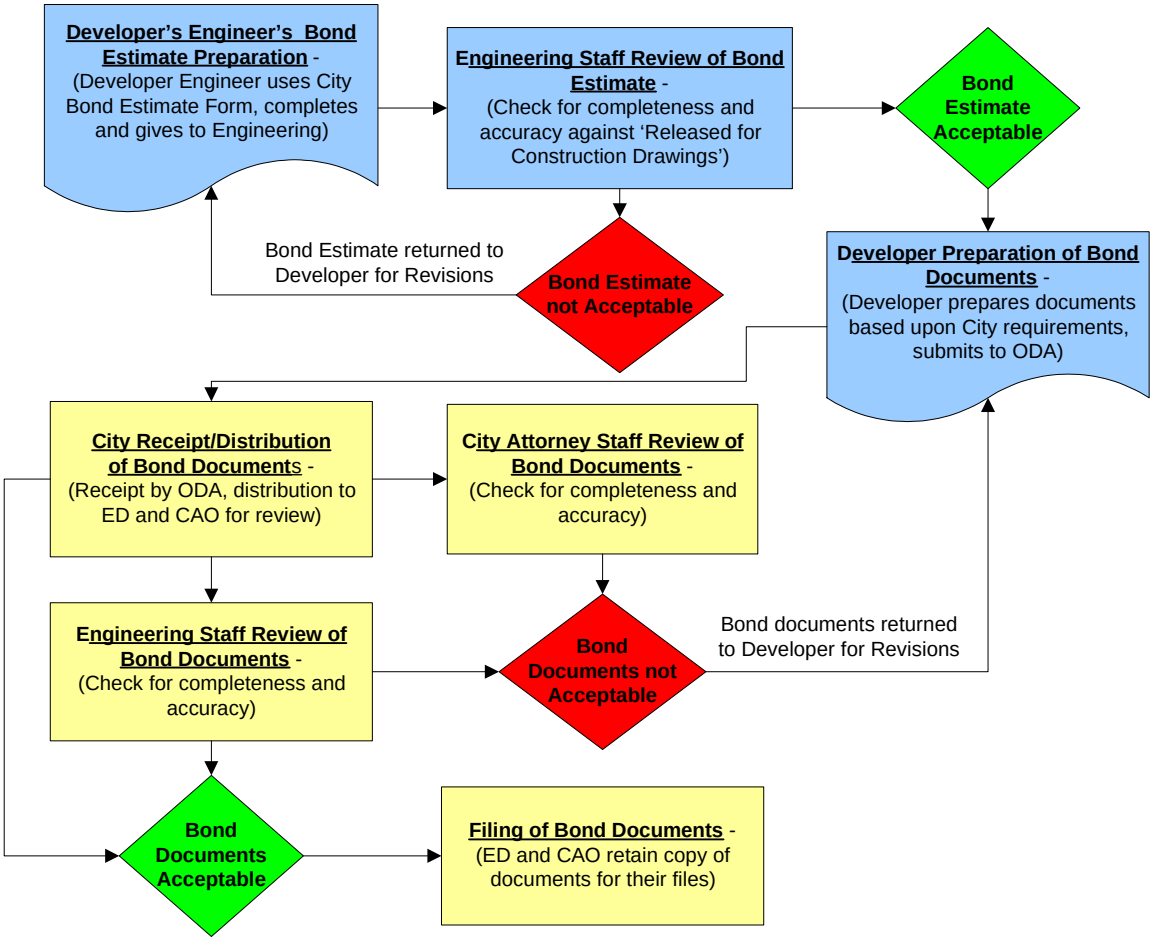
   In the case where items are changed during construction, the Developer and his/her engineer/contractor are to submit proposed revised changes, which the City Engineer will then review, approve or deny, and make part of the *'Released for Construction Drawings'*. If the changes are significant enough, the *'bond estimate sheet'* must also be revised, and a new Public Improvement Bond prepared for these revisions.

C. City *'Released for Construction Drawings'* - *'Released for Construction Drawings'* are a specific set of documents which are signed by the City Engineer and other affected City departments and agencies, which define the specific *'public improvements'* which are to be constructed as part of the project. These drawings are the originating documents used for the preparation of the bond estimate sheet and subsequent bond.

7.4 BOND DOCUMENTS PREPARATION AND APPROVAL

A. General – The Developer has primary responsibility for bond document preparation and submission to the City and the City is responsible for review of these documents to ensure they meet City requirements. Corrections of these documents are the Developer's responsibility as is coordination with his/her staff and/or consultants used in the preparation of these documents. In general, the process is graphically described as follows:

Flowchart 8-02 – Bond Documents Preparation and Approval Process



B. Developer Engineer's Bond Estimate Preparation – The first step in the preparation of the bond documents, is the Developer's preparation of a draft *'bond estimate sheet'*. This is accomplished by obtaining a blank *'bond estimate sheet'* from the City Engineer, and using the finalized *'Released for Construction Drawings'* for the project to prepare a draft *'bond estimate sheet'* for the project. This document is to be stamped and signed by the Developer's engineer and submitted to the City Engineer for his/her review and approval.

C. City Staff Review of Bond Estimate – Once the *'bond estimate sheet'* has been prepared by the Developer's engineer and submitted to the City Engineer, he/she will review the estimate for completeness, comparing it against the *'Released for Construction Drawings'* and will provide a written response to the Developer and his/her engineer. The Developer is responsible for ensuring the necessary corrections are made and the document returned to the City Engineer for approval.

D. Developer Preparation of Bond Documents – Once the *'bond estimate sheet'* is approved by the City Engineer, he will provide a written response of such to the Developer and his/her engineer with copies to the CAO and ODA. The Developer is to work with the CAO in ensuring all CAO requirements are met.

E. Developer Submission of Bond – The Developer and his/her bonding company are to contact the CAO, ensure they understand the CAO's requirements, and then work toward addressing the CAO's requirements. Once the Developer feels the documents meet the CAO's requirements, submit these documents to the CAO for review. If the documents are acceptable, the CAO will notify the Developer of such in writing.

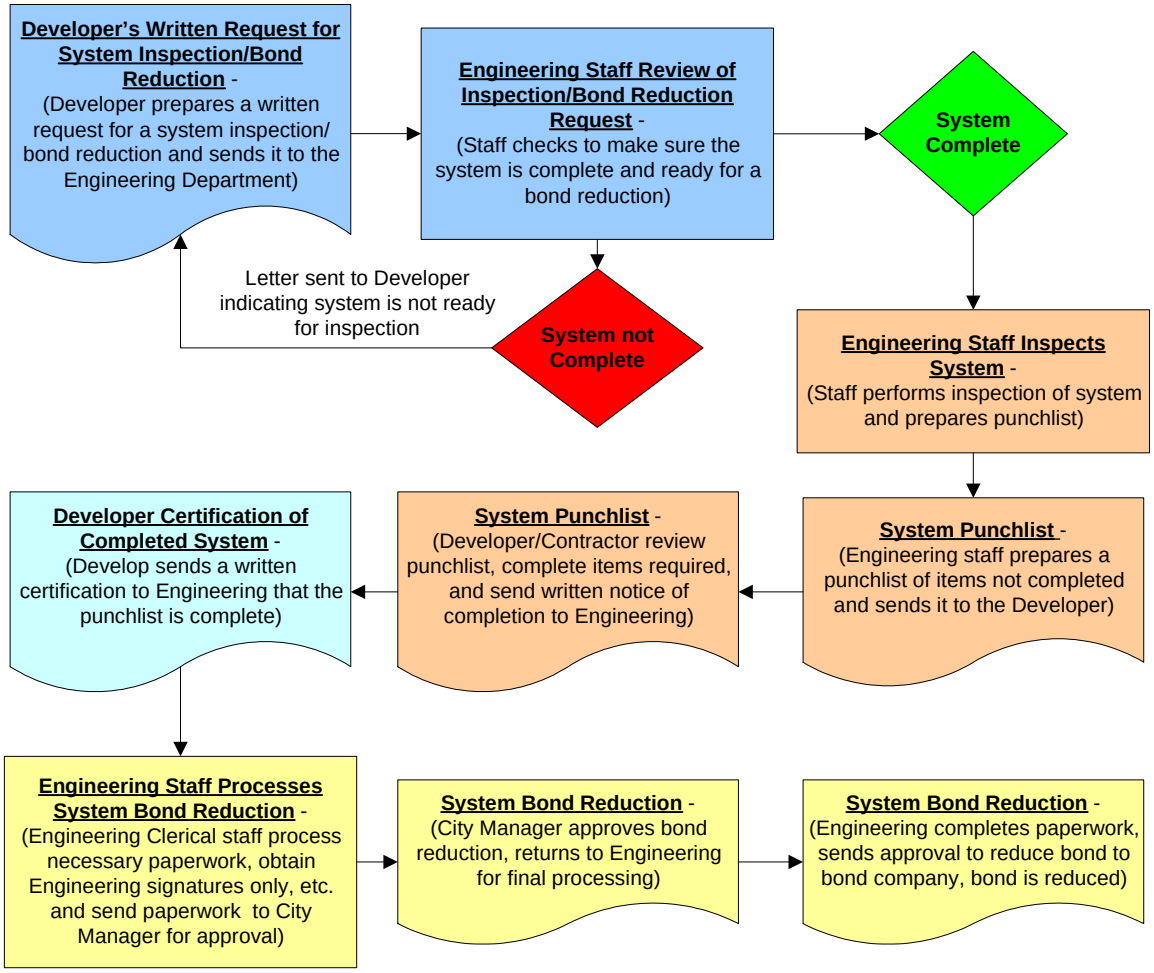
   If the documents are not acceptable, the CAO will also respond in writing to the Developer indicating what still needs to be provided and the ODA will be copied.

F. City Attorney Approval of Bond - Once the CAO is satisfied, it will stamp the documents as approved and send a written response to the Developer of their approval. Once all CAO requirements have been met, final documents will need to be submitted to the CAO and ODA for finalizing and filing with a copy to the ED.

7.5 SYSTEM BOND REDUCTIONS

A. General – The overall philosophy in requiring bond reductions on a *'system-by-system'* basis is ensure the quality of the end product and speed up the acceptance process. By doing this, the City can better ensure that each system, is complete and ready to be put into service, that fewer major fixes will be required at the end of the project, and that by requiring each *'system'* to be complete, that the Warranty Inspection and Final Inspections will be quicker and easier to accomplish, thereby saving. In general, the process is graphically described as follows:

Flowchart 8-03 – System Bond Reduction Process



B. Developer Written Request for System Inspection/Bond Reduction

1. General – The Developer is to provide the Engineering Department with a written request for a bond reduction/release and a certification that the *'system'* work is ready for inspection and reduction/release. A City form has been prepared for this purpose.

   The written request and certification sets the basis for the City inspecting the work, and ensures the Developer/his/her contractor understand what work must be completed and to what level this work must be completed in order to receive a bond reduction/release. It also ensures the City has *'systems'* which are ready to inspect, and results in a quicker reduction in bond proceeds.

   In the past, the City has reduced bond amounts based upon overall general completion of the project resulting a lot of work being delayed until the end of the project, and in not having completed *'systems'* until the very end of the project. This results in a number of difficulties in reducing or releasing bonds and completing items necessary to complete the Corrections List.

2. Developer written request – The Developer and his/her contractor are required to submit a written request for bond reduction/release along with a *'certification form'* for each *'system'* the Developer wishes to have a bond reduced/released. These forms are including in Appendix AA of the Development Processing Manual. The Developer and Contractor are to review the form and all of its provisions, sign and date the form certifying the *'system'* is ready for a bond reduction.
3. City staff review of request – City inspection staff will review the written request and certification and respond in writing to the Developer if the project is not ready for an inspection. If the request and certification are in order, the Engineering Inspector will complete the inspection.
4. City action – Once a completed *'certification form'* is received by the Engineering Department; the Engineering Inspector will schedule the project for an inspection.

C. <u>City Staff Review of System Inspection/Bond Reduction Request</u>

1. General – Once the Engineering Department has received a written request for a *'system'* bond reduction, Engineering inspection staff will review the request and project to ensure the project/system, is worthy of an inspection. If it is, an inspection will be performed. If it is not, the Developer and Contractor will be notified they have not sufficiently completed the project/system to allow an inspection to be completed.

D. <u>System Inspection and Punchlist Preparation</u>

1. General – Once it is determined the project/system is complete enough to inspect, an inspection will be performed, a punchlist prepared, and the punchlist will be sent to the Developer and Contractor.
2. Inspection checklists – City staff will be using the checklists contained in Appendices C, D, and E of the *'Private Development Construction Inspection Manual'* for inspection of the project. The Developer is required to have gone through these same checklists, and ensured each of the items is complete, prior to requesting a system release for that particular system.
3. Inspection of project – The Engineering inspection staff will use the *'system'* inspection checklist required, and will use it to inspect the *'system'* being requested to be released. If it appears the Developer and Contractor have not reviewed the checklist because there are so many items not completed, the Developer and Contractor will be notified of such. If the *'system'* is worthy of an inspection, then the inspection will be performed and a punchlist prepared.
4. Preparation and transmission of punchlist – Typically the Engineering Inspector and the Engineering Inspection Supervisor will be involved in the inspection. The inspection will be performed; a punchlist of uncompleted items prepared, and each person will sign the inspection form.

E. <u>Developer Punchlist Corrections</u>

1. General – The Developer/Contractor are required to complete all of the items indicated on the system/project punchlist and then notify the Engineering Department in writing through the use of the proper certification form, that the work is complete.
2. Developer completion of punchlist items – Once the punchlist has been prepared and sent to the Developer and Contractor, they are required to complete the items indicated on the

punchlist. If there are questions regarding any items on the punchlist, please contact the Engineering Inspector for additional information. The punchlist has a life of 30 calendar days. If items listed on the punchlist are not completed within the 30-day time period, the system/project will need to be reinspected and a new punchlist prepared, which will also have a life of 30-days. One inspection is included in the *'inspection fee'* and therefore, any inspections beyond the first inspection, must be paid for by the Developer in addition to the original inspection fee.

3. Developer Certificate of Completion – Once the Developer/Contractor has completed the City's inspection punchlist, the Developer is to certify the completion by the use of the forms contained in Appendix AA of the DPM. These forms are to be signed and dated, and then forward to the Engineering Department for processing.

F. Bond Reduction Processing

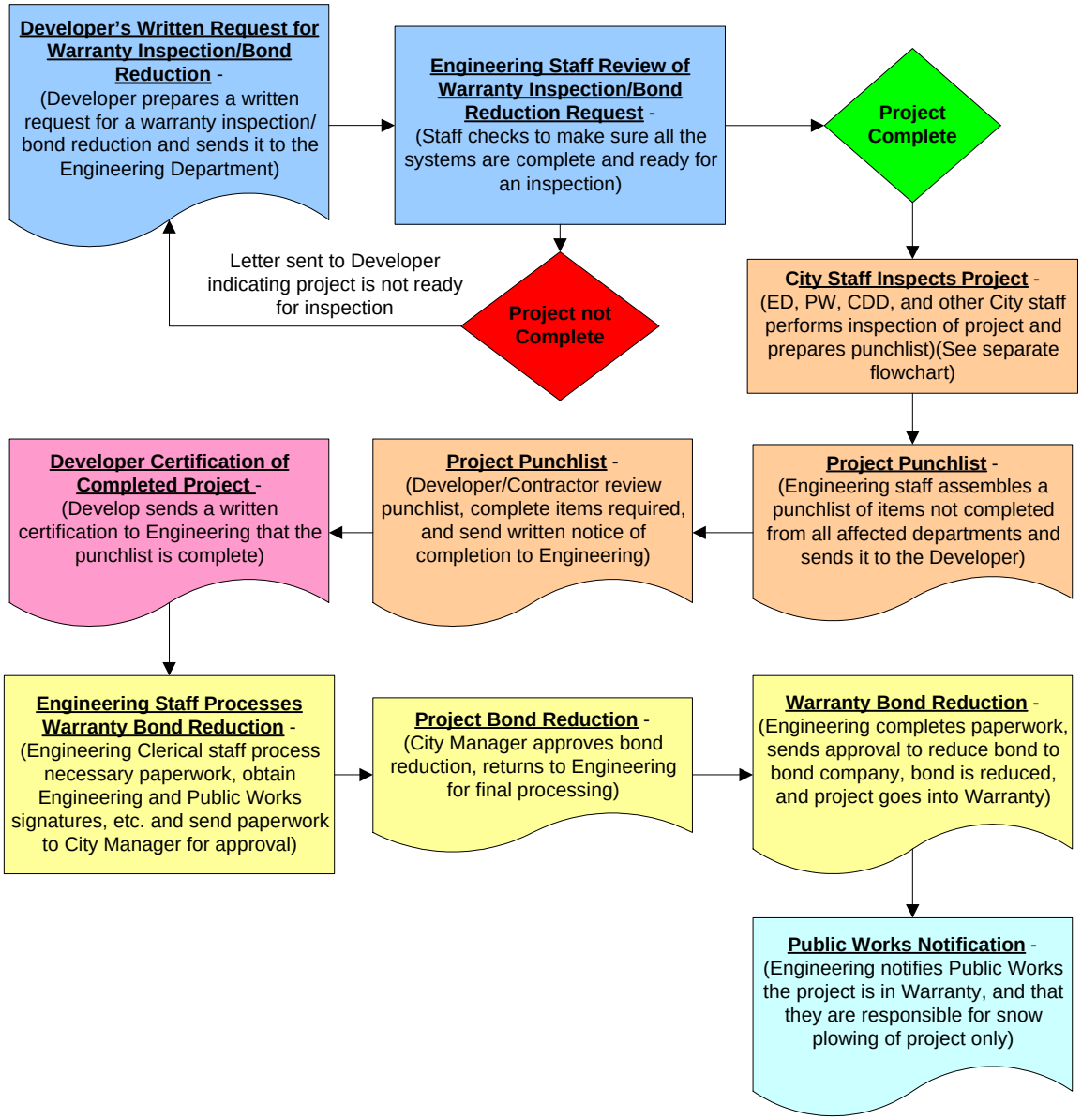
1. Certification of completion for system/project – Once the Engineering Department has received the Developer's/Contractor's certification that the punchlist has been completed, the Engineering inspection staff will reinspect the project and certify all items have been completed. If all items are complete, the Engineering Inspection Supervisor will forward his approval to the Engineering clerical staff for bond reduction processing.
2. Engineering clerical staff preparation of paperwork – With the receipt of certification from the Engineering inspection staff that the system/project is ready; the Engineering clerical staff will initiate the processing of the paperwork necessary to reduce the bond. This will require that the Engineering Inspector, Engineering Inspection Supervisor, and the City Engineer sign the form so the reduction can be processed.
3. Approvals by Engineering staff only – Bond reductions will require only the signatures of the Engineering Inspector, Engineering Inspection Supervisor, and the City Engineer for processing. Once the project reaches the Warranty Inspection, and Final Inspection stage, then other departments will be involved to ensure their concerns are also addressed. This is done in order to reduce the amount of time required to finalize a bond reduction.
4. Approval by City Manager – Once all items have been completed on the *'system'* bond reduction process applications and forms and have been reviewed by the City Engineer, and then the *'system'* bond reduction process documents are ready to be submitted to the City Manager for approval. If the documents are signed and approved by the City Manager, the Administrative Assistant will then copy the documents and distribute them to the Developer.

7.6 WARRANTY INSPECTION/BOND REDUCTION

A. General – The overall philosophy in requiring a Warranty Inspection is to set the time at which the Developer/Contractor and City agree the project is complete, and the Warranty Period can begin. It assumes that an inspection of the entire project will be performed, a punchlist prepared and given to the Developer/Contractor, and that the punchlist is completed. Once it is agreed that the punchlist is completed, then the Warranty Period can begin. In addition to the descriptions contained in this Manual, also please refer to the PDCIM, *'Section 5.0 – Warranty Inspection/Acceptance Requirements'* for additional details regarding this process.

As is described in the Ordinance, bond proceeds will be reduced on a *'system-by-system'* basis, and at the most, once monthly. Once all items under a given *'system'* description have been constructed, inspected and deemed completed by the Engineering Inspector, a written request from the Developer will initiate the processing of the necessary bond reduction. This will result in a 75-percent total reduction in the bond amount for each system prior to the beginning of the Warranty Period, minus the *'Finish Items'* portion of the bond. Once the Warranty Inspection has been completed, all Corrections List items completed and verified by the Engineering Inspector, the remaining *'systems'* amounts plus the 90-percent of the *'Miscellaneous Items'* portion of the bond will be released at this time. At the end of the Warranty Period, the remaining 10-percent of the *'Public Improvement Bond - Infrastructure'* will be released. The *'Public Improvement Bond – Landscaping & Street Lighting'* which has a longer warranty period will not be released until its requirements have been met. In general, the process is graphically described as follows:

Flowchart 8-04 Warranty Inspection/Bond Reduction Process



B. Developer Application for Warranty Inspection

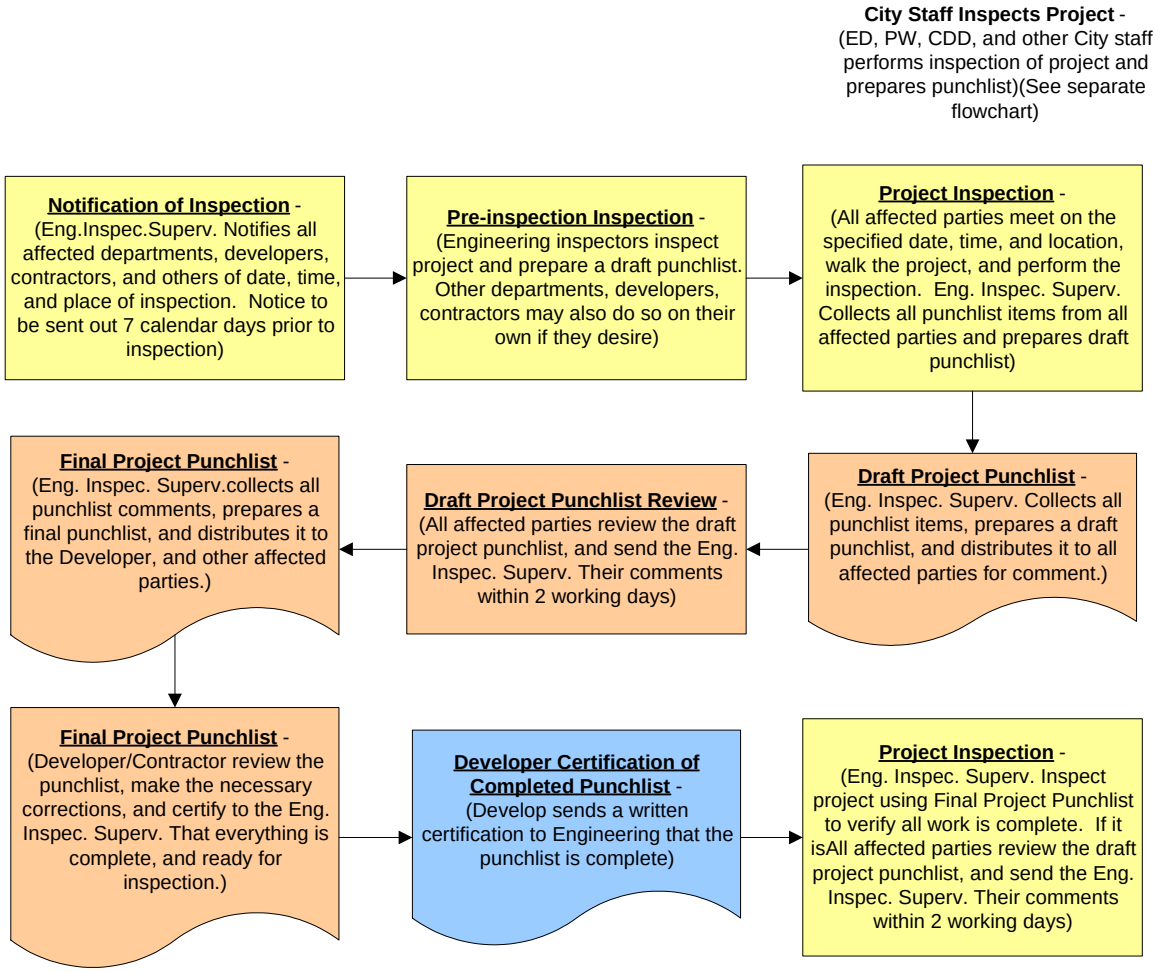
1. General – The Developer needs to provide the Engineering Department with a written request for a Warranty Inspection and a certification that the *'project'* work is ready for inspection and reduction/release. The written request and certification sets the basis for the City inspecting the work, and ensures the Developer/his/her contractor understands what work is to be completed and to what level this work needs to be completed in order to receive a Warranty Inspection. It also ensures the City has a project which is ready to inspect, and results in a quicker inspection, putting the project into the Warranty period, and reduction in bond proceeds.

2. Developer written request – The Developer and his/her contractor are to submit a written request for Warranty Inspection along with a *'certification form'* for each the 'project'. These forms are included in Appendix F of the Private Development Construction Inspection Manual. The Developer and Contractor are to review the form and all of its provisions, sign and date the form certifying the *'project'* is ready for a Warranty Inspection.
3. City staff review of request – City inspection staff will review the written request and certification and respond in writing to the Developer if the project is not ready for a Warranty Inspection. If the request and certification are in order, the Engineering Inspector will schedule a time for inspection of the project.
4. City action – Once a completed *'certification form'* is received by the Engineering Department; the Engineering Inspector will schedule the project for an inspection.

C. <u>Project Inspection and Punchlist Preparation</u>

1. General – Once it is determined the project/system is complete enough to inspect, an inspection will be performed, a punchlist prepared, and the punchlist will be sent to the Developer and Contractor. In general, the process is graphically described as follows:

Flowchart 8-05 Warranty and Final Inspection/Punchlist Preparation



2. Inspection checklists – Inspection checklists – City staff will be using the checklists contained in Appendices C, D, and E of the Private Development Construction Inspection Manual for inspection of the project. The Developer is to have gone through these same checklists, and ensured each of the items is complete, prior to requesting a system release for that particular system.
3. Inspection of project – The Engineering inspection staff will use the *'system'* inspection checklist required, and will use it to inspect the *'system'* being requested to be released. If it appears the Developer and Contractor have not reviewed the checklist because there are so many items not completed, the Developer and Contractor will be notified of such. If the *'system'* is worthy of an inspection, then the inspection will be performed and a punchlist prepared.
4. Preparation and transmission of punchlist – Typically the Engineering Inspector and the Engineering Inspection Supervisor will be involved in the inspection. The inspection will be performed; a punchlist of uncompleted items prepared, and each person will sign the inspection form.

D. Developer Punchlist Corrections

1. General – The Developer/Contractor is to complete all of the items indicated on the project punchlist and then notify the Engineering Department in writing through the use of the proper certification form, that the work is complete.
2. Developer completion of punchlist items – Once the punchlist has been prepared and sent to the Developer and Contractor, they are to complete the items indicated on the punchlist. If there are questions regarding any items on the punchlist, please contact the Engineering Inspector for additional information. The punchlist has a life of 30-calendar days. If items listed on the punchlist are not completed within the 30-day time period, the project will need to be reinspected and a new punchlist completed, which will also have a life of 30-days. One inspection is included in the *'inspection fee'* and therefore, any inspections beyond the first inspection must be paid for by the Developer in addition to the original inspection fee.
3. Developer Certificate of Completion – Once the Developer/Contractor has completed the City's inspection punchlist, the Developer is to certify the completion by the use of the forms contained in Appendix AA of the DPM. These forms must be signed and dated, and then forward to the Engineering Department for processing.

E. Warranty Bond Reductions Processing

1. Certification of completion for project – Once the Engineering Department has received the Developer's/Contractor's certification that the punchlist has been completed, the Engineering inspection staff will reinspect the project and certify all items have been completed. If all items are complete, the Engineering Inspection Supervisor will forward his approval to the Engineering clerical staff for Warranty inspection/bond reduction processing.
2. Engineering clerical staff preparation of paperwork – With the receipt of certification from the Engineering inspection staff that the project is ready, the Engineering clerical staff will initiate the processing of the paperwork necessary to put the project into the Warranty Period, and reduce the bond. This will require that the Engineering Inspector, Engineering Inspection Supervisor, the City Engineer, and Public Works Department Director sign the form so the reduction can be processed.
3. Approvals by Engineering and Public Works departments' staff – Bond reductions will require only the signatures of the Engineering Inspector, Engineering Inspection Supervisor, the City Engineer, and the Public Works Department for processing. Community Development Department concerns have already been addressed by either a separate bond, which they will administer, or through inclusion of their issues in the Public Improvement Bond, which will be inspected and processed by the Engineering Department. This is done in order to reduce the amount of time required to finalize a bond reduction.
4. Approval by City Manager – Once all items have been completed on the 'warranty' bond reduction process applications and forms and have been reviewed by the City Engineer, and then the 'warranty' bond reduction process documents are ready to be submitted to the City Manager for approval. If the documents are signed and approved by the City Manager, the Administrative Assistant will then copy the documents and distribute them to the Developer.

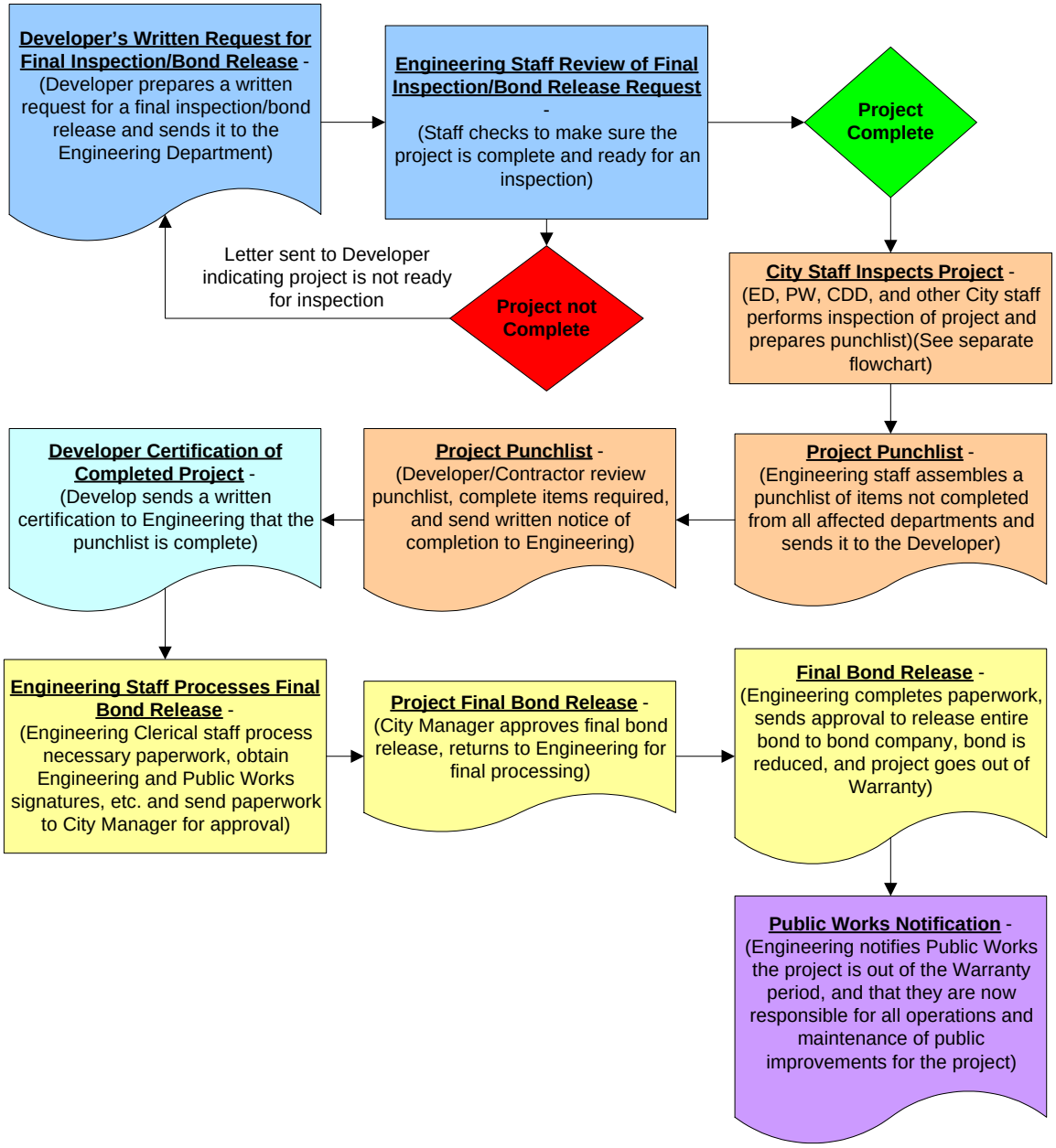
F. Public Works Department Notification

1. Engineering staff notifies Public Works they are responsible for now snow plowing for the project – Once the Warranty Inspection/bond reduction has been fully processed and approved by the City Manager, the City Engineer will notify the Public Works Department of such and inform them they are responsible for snow plowing operations of the project only. All other maintenance activities are still the responsibility of the Developer until the Warranty Period is complete, and the project accepted by the City.

7.7 FINAL INSPECTION/BOND RELEASE

A. General – The overall philosophy in requiring a Final Inspection is to set the time, at which the Developer/Contractor and City agree the project is complete, and the Warranty Period is complete, and the City is responsible for taking over the complete operations and maintenance of the public infrastructure. It assumes that an inspection of the entire project at the end of the Warranty Period will be performed, a punchlist prepared and given to the Developer/Contractor, and that the punchlist is completed. Once it is agreed that the punchlist is completed, then the Warranty Period is complete and the City assumes operation and maintenance activities. In general, the process is graphically described as follows:

Flowchart 8-06 Final Inspection Bond Release Process



B. Developer Application for Final Inspection

1. General – The Developer is to provide the Engineering Department with a written request for a Final Inspection and a certification that the *'project'* work is ready for inspection and release.

   The written request and certification sets the basis for the City inspecting the work, and ensures the Developer/his/her contractor understand what work must be completed and to

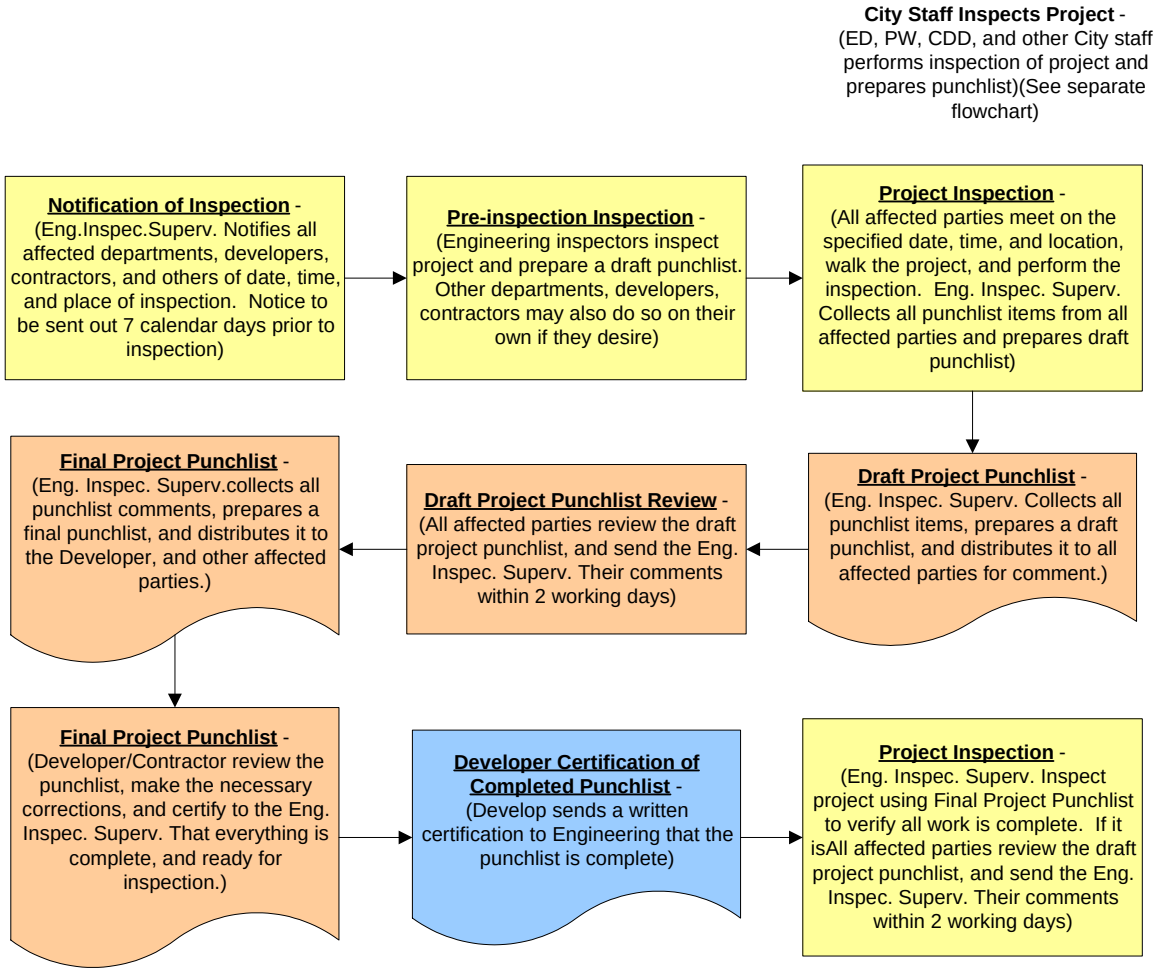
what level this work must be completed in order to receive a Final Inspection. It also ensures the City has a project which is ready to inspect, and results in a quicker inspection, taking the project out of the Warranty period, and release of the bond.

2. Developer written request – The Developer and his/her contractor are required to submit a written request for Final Inspection along with a *'certification form'* for each the 'project'. These forms are included in Appendix F of the Private Development Construction Inspection Manual. The Developer and Contractor are to review the form and all of its provisions, sign and date the form certifying the *'project'* is ready for a Final Inspection.
3. City staff review of request – City inspection staff will review the written request and certification and respond in writing to the Developer if the project is not ready for a Final Inspection. If the request and certification are in order, the Engineering Inspector will schedule a time for inspection of the project.
4. City action – Once a completed *'certification form'* is received by the Engineering Department; the Engineering Inspector will schedule the project for an inspection.

C. <u>Project Inspection and Punchlist Preparation</u>

1. General – Once it is determined the project is complete enough to inspect, an inspection will be performed, a punchlist prepared, and the punchlist will be sent to the Developer and Contractor. In general, the process is graphically described as follows:

Flowchart 8-05 Warranty and Final Inspection/Punchlist Preparation



2. Inspection checklists – Inspection checklists – City staff will be using the checklists contained in Appendices C, D, and E of the *'Private Development Construction Inspection Manual'* for inspection of the project. The Developer is required to have gone through these same checklists, and ensured each of the items is complete, prior to requesting a system release for that particular system.
3. Inspection of project – The Engineering inspection staff will use the *'system'* inspection checklist required, and will use it to inspect the *'system'* being requested to be released. If it appears the Developer and Contractor have not reviewed the checklist because there are so many items not completed, the Developer and Contractor will be notified of such. If the *'system'* is worthy of an inspection, then the inspection will be performed and a punchlist prepared.
4. Preparation and transmission of punchlist – Typically the Engineering Inspector and the Engineering Inspection Supervisor will be involved in the inspection. The inspection will be performed; a punchlist of uncompleted items prepared, and each person will sign the inspection form.

D. Developer Punchlist Corrections

1. General – The Developer/Contractor are required to complete all of the items indicated on the project punchlist and then notify the Engineering Department in writing through the use of the proper certification form, that the work is complete.
2. Developer completion of punchlist items – Once the punchlist has been prepared and sent to the Developer and Contractor, they are required to complete the items indicated on the punchlist. If there are questions regarding any items on the punchlist, please contact the Engineering Inspector for additional information. The punchlist has a life of 30-calendar days. If items listed on the punchlist are not completed within the 30-day time period, the project will need to be reinspected and a new punchlist completed, which will also have a life of 30-days. One inspection is included in the *'inspection fee'* and therefore, any inspections beyond the first inspection must be paid for by the Developer in addition to the original inspection fee. This will be done on an hourly rate basis of those involved in the inspection, or preparation of paperwork, in any way.
3. Developer Certificate of Completion – Once the Developer/Contractor have completed the City's inspection punchlist, the Developer must certify the completion by the use of the forms contained in Appendix AA of the DPM. These forms must be properly signed and dated, and then forward to the Engineering Department for processing.

E. Final Bond Release Processing

1. Certification of completion for project – Once the Engineering Department has received the Developer's/Contractor's certification that the punchlist has been completed, the Engineering inspection staff will reinspect the project and certify all items have been completed. If all items are complete, the Engineering Inspection Supervisor will forward his approval to the Engineering clerical staff for Final inspection/bond release processing.
2. Engineering clerical staff preparation of paperwork – With the receipt of certification from the Engineering inspection staff that the project is ready, the Engineering clerical staff will initiate the processing of the paperwork necessary to take the project out of the Warranty Period, and release the bond. This will require that the Engineering Inspector, Engineering Inspection Supervisor, the City Engineer, and Public Works Department Director sign the form so the reduction can be processed.
3. Approvals by Engineering and Public Works department's staff – Bond releases will require only the signatures of the Engineering Inspector, Engineering Inspection Supervisor, the City Engineer, and the Public Works Department for processing. Community Development Department concerns have already been addressed by either a separate bond, which they will administer, or through inclusion of their issues in the Public Improvement Bond, which will be inspected and processed by the Engineering Department. This is done in order to reduce the amount of time required to finalize a bond reduction.
4. Approval by City Manager – Once all items have been completed on the 'final' bond reduction process applications and forms and have been reviewed by the City Engineer, and then the 'final' bond reduction process documents are ready to be submitted to the City Manager for approval. If the documents are signed and approved by the City Manager, the Administrative Assistant will then copy the documents and distribute them to the Developer, the developer's bonding company, and others as noted on the documents.
5.

F. Public Works Department Notification

1. Engineering staff notifies Public Works they are responsible for all operations and maintenance for the project – Once the Final Inspection/bond release have been fully processed and approved by the City Manager, the City Engineer will notify the Public Works Department of such and inform them they are responsible for all operations and maintenance of the project.

   A more complete description of the transition to the Public Works Department is described in the PDCIM, *'Section 6.10 – Public Works Department Assumption of Maintenance Responsibilities'*.

7.8 ACCEPTANCE BY CITY

A. General – The *'project'* will not be accepted by the City until all of the City's requirements have been met. Acceptance requirements are fully described in *'Section 6.0 – Final Inspection, Acceptance Requirements'* of the PDCIM.

****

SECTION 8.0

ABANDONMENT

8.1 GENERAL

All existing sanitary sewer lines or structures which are to be abandoned shall be indicated on the Drawings by the developer's engineer along with the method of abandonment. In general, abandoned main lines that are in service will be replaced with a parallel line of equal or larger size, and the engineer shall demonstrate in any case that the abandonment does not adversely affect the sanitary sewer system.

All abandonment and construction techniques shall be discussed with the Engineering Department inspector and approved prior to any such work.

8.2 DEMOLITON/REPLACEMENT OF STRUCTURE(S) AND ABANDONMENT OF SANITARY SEWER LATERAL(S)

A. Demolition of Structure(s) and Abandonment of Sanity Sewer Lateral(s) - In cases where an existing structure is to be demolished and will not immediately be replaced with a new structure, the water service line and sanitary sewer lateral, and all appurtenances shall be removed and disconnected, at the respective main line.

The Applicant shall first coordinate with the Building and Safety Division of the City, to obtain a *'Building Permit'* and complete a *'Building Demolition(s)'* application.

As part of the *'Building Permit'* application, the Applicant shall also apply for a *'Public Right-of-Way Encroachment Permit'* (Appendix F) for the work in the City's right-of-way, and a *'Water/Sanitary Sewer Service Abandonment Permit'* (Appendix F), which are administered through the City's Engineering Department. The requirements of both of these Engineering Department permits shall be met, prior to the City Engineer issuing permits for this work. The *'Building Permit'* shall not be deemed to be complete

In processing and finalizing the *'Water/Sanitary Sewer Service Abandonment Permit'*, the following shall be complied with:

1. Demolition Plans – The Applicant shall submit drawings of the site that show the location of the structure(s), location and depth of all utilities including power, gas, water, sanitary sewer, and any other utility.
2. Termination Details – The Applicant shall provide detailed drawings and specifications of how the water and sanitary sewer services are to be terminated including methods and types of materials. New materials shall be used in all termination construction.
3. Inspection Prior to Covering - An Engineering Inspector shall see the work performed including the termination points at the main lines, prior to the Applicant or his Contractor covering these facilities. If these facilities are covered, and were not observed by the Engineering Inspector, they shall be uncovered for the Inspector's observation.

4. Encroachment Permit – All requirements of the City's *'Public Right-of-Way Encroachment Permit'* shall be met as part of this work.

B. Replacement of Structure(s) and Abandonment of Sanity Sewer - In cases where a structure is existing on a parcel, but the use of the property and types of building(s) are changing, the water service line and wastewater lateral, and all appurtenances shall be evaluated to determine whether the existing service line and lateral can be reused, or must be removed and replaced with another service line and lateral of a different material type and size.

The Applicant shall first coordinate with the Building and Safety Division of the City, to obtain a *'Building Permit'* and complete a *'Building Demolition(s)'* application.

As part of the *'Building Permit'* application, the Applicant shall also apply for a *'Public Right-of-Way Encroachment Permit'* for the work in the City's right-of-way, and a *'Water/Sanitary Sewer Service Abandonment Permit'*, which are administered through the City's Engineering Department. The requirements of both of these Engineering Department permits shall be met, prior to the City Engineer issuing permits for this work. The *'Building Permit'* shall not be deemed to be complete.

In evaluating whether the sewer lateral must be replaced or may remain in place, the information indicated below shall be submitted to the City Engineer for his/her evaluation. The City Engineer will determine the viability of the existing wastewater lateral and whether it can remain, or must be replaced. The Applicant shall provide the following information:

1. A video inspection tape of the lateral by a City approved contractor. City staff shall be present when the video inspection is being made.
2. Material type of the existing lateral.
3. Diameter of the existing lateral, and slope of the lateral if obtainable.
4. Indication of the proposed use of the property, type of building to be constructed, number of sewer fixtures in the building, any processes which will contribute to the sewer lateral.
5. The age of the existing sewer lateral.

Once the City Engineer has received and evaluated the information, he will make a finding of the lateral and provides his/her determination to the Applicant.

In processing and finalizing the *'Water/Sanitary Sewer Service Abandonment Permit'*, or the *'Sanitary Sewer Service Connection Permit'* (Appendix F) the following shall be complied with:

1. Structure Demolition/Replacement Plans – The Applicant shall submit drawings of the site that show the location of the structure(s), location and depth of all utilities including power, gas, water, wastewater, and any other utility.
2. Sewer Fixture Count/Processes which might contribute to sewer flows - The Applicant shall provide a detailed drawing of the proposed structure along with a fixture count of sewer fixtures for the proposed structure. The Applicant shall also identify any additional internal processes in the structure which might contribute flows to the sewer system along with anticipated flows, methods of operations, etc.
3. Inspection Prior to Covering - An Engineering Inspector shall see the work performed including the termination points at the main lines, prior to the Applicant or his Contractor

covering these facilities. If these facilities are covered, and were not observed by the Engineering Inspector, they shall be uncovered for the Inspector's observation.

4. Encroachment Permit – All requirements of the City's *'Public Right-of-Way Encroachment Permit'* shall be met as part of this work.

8.3 SANITARY SEWER LINES

Sanitary sewer lines to be abandoned shall be entirely filled by pumping concrete into them. The pump mix shall be a mixture sufficiently workable for the purposes intended and shall be a concrete mix of 2,000 psi minimum. Laterals to be abandoned shall be plugged at the property line or as directed by the Engineering Department.

8.4 STRUCTURES

Structures to be abandoned shall have all openings, inlets and outlets sealed off as set forth in Section 02719 – Sanitary Sewer System. The structure shall then be removed to a minimum depth of 9-feet below proposed finish grade and filled with imported sand (see materials section) if structure is within street right-of-way or filled with earth and compacted if outside of street right-of-way.

8.5 EASEMENTS OR RIGHTS-OF-WAY

All easement and right-of-way abandonments shall be provided for as part of the development processing, not during construction. If it is determined that easements or property must be abandoned during construction, the project will be put on hold until the property issues are resolved to the satisfaction of the City and the Salt Lake County Recorder's office.

8.6 SALVAGED MATERIALS

Disposal of salvaged metal castings such as frames and covers and other metal appurtenances, unless otherwise specified, shall be the Contractor's responsibility.

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APPENDIX B

SANITARY SEWER
CONSTRUCTION SPECIFICATIONS

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SECTION 01525A

TEMPORARY CONSTRUCTION AIDS
AND ENVIRONMENTAL CONTROLS
(Private Development Project)

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. The Developer/Contractor shall furnish temporary utilities, including electricity, lighting, telephone service, water and sanitary facilities; temporary controls, including barriers, protection of work and water control; and construction facilities, including parking, progress cleaning and temporary building as required for the project.

1.02 TEMPORARY UTILITIES

A. Temporary Electricity: Developer/Contractor shall provide, maintain and pay for all power required by the Developer/Contractor, including electrical service to the field office, if required.

B. Temporary Lighting: Developer/Contractor shall provide all temporary lighting required for prosecution of his work and for employee and public safety. As a minimum, lighting levels during working hours shall meet the requirements of UOSHA, subsection 1926.56 illumination.

C. Temporary Water Service
   1. The Developer/Contractor shall provide for all workers on the project, an adequate and reasonably convenient, uncontaminated drinking water supply. All facilities shall comply with the regulations of the local and State and County Departments of Health.
   2. Developer/Contractor shall be responsible to arrange for water, both potable and non-potable water.
   3. When water is taken from a City water system or any other potable water supply source for construction purposes, suitable precautions shall be taken to prevent cross connection and contamination of the water supply. This shall include properly obtaining a City construction water meter with attached backflow prevention devices through the City's Finance Department, Utility Billing Division.

D. Temporary Sanitary Facilities
   1. Developer/Contractor shall provide and maintain sanitary facilities for his employees and his Developer/Contractors' employees that will comply with the regulations of the local and State Department of Health.

1.03 TEMPORARY CONTROLS

A. Barriers: Provide barriers as necessary to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations.

B. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into the atmosphere. Give all unpaved streets, roads, detours, or haul roads used in the construction area an approved dust-preventive treatment or periodically water to prevent dust. Applicable environmental regulations for dust prevention shall be strictly enforced. Contact the Utah Department of Environmental Quality, Division of Air Quality for an appropriate permit and regulations.

C. Protection of Work: Developer/Contractor shall protect installed work and provide special protection where specified in individual specification sections. Developer/Contractor shall provide temporary and removable protection for installed products, and shall control activity in immediate work area to minimize damage.

D. Open Burning: No open burning or waste materials is allowed.

E. Explosives and Blasting: The use of explosives on the work is not allowed.

F. Noise Abatement: In inhabited areas, particularly residential, operations shall be performed in a manner to minimize unnecessary noise generation and shall comply with City ordinances and standards.

G. Storm and Ground Water:
1. The Developer/Contractor shall provide and maintain at all times during construction, ample means and devices with which to promptly remove and properly dispose of all water entering the excavation or other parts of the work, whether the water be surface or underground water.
2. In excavation, fill and grading operations, care shall be taken to disturb the pre-existing drainage pattern as little as possible. Particular care shall be taken not to direct drainage water into private property or into streets or drainage ways inadequate for the increased flow.
3. The Developer/Contractor shall maintain effective means to minimize the quantity of sediments leaving the work area either by storm water or the Developer/Contractor's own dewatering operations. These means and methods shall be approved by the City Engineer as part of the 'Released for Construction Drawings' review process.

1.4 CONSTRUCTION UTILITIES

A. Parking: Developer/Contractor shall provide temporary parking areas to accommodate use of construction personnel. Parking shall be located in an area approved by the City.

B. Progress Cleaning:
1. Developer/Contractor shall maintain areas free of waste materials, debris and rubbish. He shall also maintain the site in a clean and orderly condition. Upon completion of work, repair all damage caused by equipment and leave the project free from rubbish or excess materials of any kind.
2. Thoroughly clean all spilled dirt, gravel or other foreign materials caused by the construction operations from all streets, roads, and storm water facilities at the conclusion of each day's operation.
3. It shall be the responsibility of the Developer/Contractor to promptly clean up and remove any oil and or fuel spills caused by the Developer/Contractor or his subcontractors during the course

of the project. The Developer/Contractor shall properly dispose of contaminated soil according to local, State and federal laws. The Developer/Contractor shall be responsible for any damages resulting from the Developer/Contractor's actions in promptly cleaning up said spills.

1.5 REMOVAL OF UTILITIES, FACILITIES AND CONTROLS

A. Developer/Contractor shall remove temporary above grade or buried utilities, equipment, facilities and materials prior to application for Warranty Inspection. Clean and repair damage caused by installation or use of temporary work. Restore existing facilities used during construction to their original condition.

*** END OF SECTION ***

SECTION 01554A

TRAFFIC CONTROL
(Private Development Projects)

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. General. The work shall consist of establishing traffic control and maintaining safe, convenient use of public roads and rights-of-way.

B. This section covers Traffic Control Plan requirements and materials and labor necessary for its implementation. It also includes issues related to Traffic Control Maintainer and flagging, work zone traffic control devices, advance warning arrow panels and pilot cars.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01558 – Temporary Pavement Markings
B. Section 02842 – Delineators.
C. Section 02891 – Traffic Signs.
D. Section 02765 – Pavement Marking Paint.

1.03 REFERENCES

A. AASHTO Roadside Design Guide, current edition.
B. Manual of Uniform Traffic Control Devices (MUTCD), current edition.
C. ATSSA: American Traffic Safety Services Association.
   1. Quality Standards for Work Zone Traffic Control Devices
D. NCHRR – Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features.
E. OSHA Construction Industry Standards (29 CFR Part 1926), Subpart G, Signs, Signals, and Barricades.

1.04 SUBMITTALS

A. Submit traffic control plan in accordance with the Special Conditions and UDOT State Specifications. The traffic control concept shown on the plans is for bidding purposes and is intended to serve as a guideline only. The Developer/Developer/Contractor shall be responsible for the preparation and adequacy of any traffic control plan utilized, including this suggested plan, and shall submit the final traffic control plan (prepared, signed and sealed by a Utah licensed professional City Engineer) in drawing form to the City Resident Project Representative.

B. Submit to the City Resident Project Representative a detailed signing and traffic detouring plan in drawing form for each phase for approval. Post detour routes to provide clear guidance to traffic as approved by the City Resident Project Representative.

1.05 GENERAL

A. Control traffic at those locations indicated and in conformance with the plans approved by the City Resident Project Representative.

B. Furnish, install, construct, maintain, and remove detours, road closures, lights, temporary signals, signs, barricades, K-rail, fences, flares, miscellaneous traffic devices, flagmen, drainage facilities, paving, and such other items and services as are necessary to adequately safeguard the public from hazard and inconvenience. All such work shall comply with the ordinances, directives, and regulations of authorities with jurisdiction over the public roads in which the construction takes place and over which detoured traffic is routed by the Developer/Developer/Contractor.

C. After devices have been installed, maintain and keep them in good repair and working order until no longer required. Replace such devices that are lost or damaged, to such an extent as to require replacement, regardless of the cause of such loss or damage.

D. Prior to the start of construction operations, notify the City Resident Project Representative, City of West Jordan, UDOT, police and fire departments of the City, giving the expected starting date, completion date, and the name and telephone number of a responsible person who may be contacted at any hour in the event of a condition requiring immediate correction.

1.06 TRAFFIC CONTROL DEVICES AND SIGNS

A. Construction signing, striping, barricades, and other traffic control devices used for handling traffic and public convenience shall conform to the latest edition of the Federal Highway Administration "Manual on Uniform Traffic Control Devices for Streets and Highways" (MUTCD).

B. Signs shall be reflectorized when they are used during hours of darkness. Provide cones, pylons, barricades, or posts used in the diversion of traffic with flashers or other illumination if in place during hours of darkness.

C. Maintain a 24-hour emergency service to remove, install, relocate, and maintain warning devices and furnish to the authority having jurisdiction names and telephone numbers of three persons responsible for this emergency service. In the event these persons do not promptly respond or the authority having jurisdiction deems it necessary to call out other forces to accomplish emergency service, the Developer/Contractor will be held responsible for the cost of such emergency service.

D. During the duration of a detour, cover all signs not in accordance with the traffic control plan. Relocate existing signs to provide visibility from all relocated traffic lanes.

E. Temporary traffic striping, where used, shall be removable pavement marking tape. Pavement markings shall be white or yellow, weather and traffic resistant reflective film on conformable backing and pre-coated with a pressure-sensitive adhesive that does not require an activation process.

   Temporary pavement markings shall conform to the following minimum reflective values as specified. Express reflective values as candlepower per foot-candle per square foot measured on a 1 foot by 2 foot panel at 86 degrees incidence.

Divergence Angle	White	Yellow
0.20 0.50	0.20 0.18	0.18 0.16

Supply striping tape in rolls ready for application. Use pavement message tape 20 to 30 mils thick, that does not shrink or release prematurely, and that has an easily removable liner.

F. At the end of each workday, place temporary pavement markers on any roadway surfaces open to traffic. Apply pavement markers to a clean and dry surface during daylight hours. During winter shutdown, place permanent paint striping and pavement messages.

G. Press the tape into the surface until it adheres to the pavement surface.

1.07 VEHICULAR TRAFFIC CONTROL

A. Obtain a City Encroachment Permit through the Engineering Department for any activity being contemplated for City dedicated right-of-ways.

B. Reduce speed limit through the construction zone to 25 mph and post accordingly.

C. Traffic lane transitions from permanent lanes to construction zone patterns shall be transitioned in accordance with the requirements for the normal posted speed limit and as shown on the plans.

D. Where traffic is directed around or adjacent to the construction area, the Developer/Developer/Contractor shall provide, lights, signs, and other devices required for the control of traffic as required by the UDOT traffic regulations and said "Manual of Uniform Traffic Control Devices." The City Resident Project Representative shall have the right to relocate or direct the Developer/Contractor to relocate traffic control devices.

E. In the event the City Resident Project Representative finds the worksite to be improperly barricaded or delineated and the Developer/Developer/Contractor is either unavailable or unresponsive to requests for improvement, the City Resident Project Representative will furnish and set up barricades and delineators as required. Two hundred dollars ($200) will be charged the Developer/Developer/Contractor for each set-up event plus five dollars ($5) "rental" for each barricade or delineator for each day's or partial day's use.

F. All roadways and sidewalks shall be returned to unrestricted vehicle and pedestrian usage when construction is not underway.

G. Truck operations in and out of construction and staging areas shall be controlled by flagmen at all times.

H. The maximum delay to the public due to Developer/Contractor construction activities is four hours.

I. Construction in Intersections: Maintain at least one through lane in each direction on the following intersecting streets during working hours while constructing within the intersection

J. Detour Routing: Notify the City Resident Project Representative at least 2 calendar days in advance and complete coordination prior to the detouring of traffic along the affected streets.

1.08 ACCESS TO ADJACENT PROPERTIES

A. General: Maintain reasonable access from the project to all adjacent properties at all times during construction. Prior to restricting normal access from public streets to adjacent properties, notify each property owner or responsible person, at least three working days prior to the disruption, informing him of the nature of the access restriction, the approximate duration of the restriction, and the best alternative access route for that particular property.

1.09 SUBMITTAL REQUIREMENTS

A. The Developer/Contractor shall submit the following to the City Engineer for review:
   1. Submit three copies of the Traffic Control Plan to the City Engineer at the preconstruction meting. Submit plans in 11x17 format prepared using AutoCAD software. All plans must be signed and sealed by a professional City Engineer licensed in the State of Utah.
   2. Attend a mandatory meeting at the time and location as directed by the City Engineer with City staff and the following:
      a. Developer/Contractor's traffic control designer
      b. Developer/Contractor's traffic control maintainer
      c. Resident City Engineer
      d. City's Traffic Engineer or designated representative
   3. Ensure compliance with the plans and specifications. Modify plan if necessary to meet all applicable requirements.
   4. Do not begin work. Do not implement traffic control until written authorization is received from the City Engineer.

1.10 CERTIFICATIONS

A. After April 1, 2002, use devices and systems which meet NCHRP-350 Report crash test requirements as defined in the four categories by the Federal Highway Administration. Some exceptions will be acceptable as stated below.
   1. Category 1: Cones, tubular marker, delineators, and drums without lights must be certified by the manufacturer as meeting NCHRP-350 Report requirements.
   2. Category 2: portable sign stands with signs, Type I, II, and III barricades, vertical panels, Category 1 devices with light attachments and devices not expected to cause significant vehicle velocity change. These devices and systems must be certified by FHWA as meeting NCHRP-350 Report test requirements.
   3. Category 3: Portable/temporary precast concrete barrier manufactured after October 1, 2002 must be certified as meeting NCHRP-350 Report test requirements.
      a. Manufactured date to be stamped into top of each barrier section using a numeric format (ex: 10/2002) with 75 mm x 50 mm numerals, 6 mm deep).
      b. Portable/temporary precast concrete barrier manufactured prior to October 1, 2002 and meeting NCHRP-230 may be used until they are not longer serviceable.
   4. Category 3: Crash cushions and truck mounted attenuators must be certified by FHWA as meeting NCHRP-350 Report test requirements

a. The appropriate GREAT CZ, manufactured by Energy Absorption Systems, may be used until they have completed their normal service life.

5. Category 4: Advanced warning arrow panels and portable variable message signs do no have to meet NCHRP-350 Report test requirements.

1.11 TRAFFIC CONTROL PLAN REQUIREMENTS

A. Traffic Control Plan (TCP) Checklist and Guidelines – In preparing the Traffic Control Plan, the design professional will need to address the following items:

1. The Traffic Control Plan (TCP) shall be drawn on 24" x 36" or 11" x 17" sheets, unless otherwise approved by the City's Traffic City Engineer. TCPs prepared for work occurring on all streets shown on the Circulation Element of the General Plan shall be prepared by a Registered Civil City Engineer or Registered Traffic City Engineer.
2. Draw the TCP with ink using legible lettering and symbols.
3. Indicate Developer/Contractor's name, address and telephone number. Include name and telephone number of the 24-hour contact person presenting the Developer/Contractor.
4. Indicate a north arrow and scale on the drawings. If the drawing is NOT-TO-SCALE (N.T.S.), indicate so on the drawing.
5. Show all nearby streets with street names to assure proper orientation.
6. Show existing traffic signals and regulatory signs, as appropriate.
7. Show existing striping, pavement markings, painted crosswalks and bike lanes.
8. Show existing curbs, gutters, sidewalks, driveways and intersections in the construction work zone including areas affected by taper transition.
9. Indicate total roadway widths. Dimension existing striping form edges of pavement.
10. Indicate posted speed limits.
11. Show location and dimensions of the construction work zone.
12. Show staging areas and materials storage area, as appropriate.
13. Indicate locations of construction signs, barricades, and delineators.
14. Label all taper lengths and widths, delineator spacing and sign spacing.
15. Use a legend to define all symbols and designate them with UDOT nomenclature.
16. Show all parking restriction zones and signs, as appropriate.
17. Road closures will require approval from the City Engineering and the City Council.
18. Signs and barricades will be required to direct pedestrians through or around the construction work zone and shall be shown on the TCP.
19. Indicate the encroachment permit number or improvement plans number on the traffic control plan.
20. Indicate on the plan the duration of the construction work and subsequent traffic control

B. Traffic Control Plan General Notes – The following notes need to be attached to and adhered to in preparing and implementing the Traffic Control Plan.

1. All traffic control devices shall conform to the latest edition of the UDOT's Traffic Manual of Traffic Control Devices for Construction and Maintenance Work Zones and the Standard Specifications for Public Works Construction.
2. The City Engineer or his representative has the authority to initiate field changes to assure public safety.
3. All traffic control devices shall be removed from view when not in use.
4. Work hours shall be restricted to between 7:00 a.m. and 10:00 p.m. unless otherwise approved.
5. Trenches must be back filled or plated during non-working hours.
6. Pedestrian controls shall be provided as shown on the plans.

7. Temporary “NO PARKING” signs will be posted 24-hours prior to commencing work.
8. Access to driveways will be maintained at all times unless other arrangements are made.
9. The Developer/Contractor shall replace all traffic signal loop detectors damaged during construction within 72-hours of them being damaged.
10. All striping removed or damaged, will be replaced by the Developer/Contractor within 24-hours (or replaced with temporary tape).
11. All Workers shall be equipped with an orange vest (or a reflective vest at night). All flaggers shall also be equipped with a hard hat, C28 “Stop/Slow” paddle, shall be trained in the property fundamentals of flagging traffic, and be certified as indicated in this section
12. Any work that disturbs normal traffic signal operations shall be coordinated with the City of West Jordan’s Traffic City Engineer, 48-hours prior to beginning construction.
13. The Developer/Contractor shall maintain all traffic control devices 24-hours per day and 7-days per week.
14. A minimum of twelve (12) foot travel lanes must be maintained unless otherwise approved by the City Engineer.
15. All night work will require written approval from the City Engineer. Lane closures, road detours, road closures, and traffic signal modifications associated with overnight construction activities will require warning signs be placed at least one week in advance of starting construction.
16. A solar powered flashing arrow board shall be required on all arterial street land closures.

C. Design the traffic control plan resolving discrepancies between the various standards for traffic control in accordance with Section 00727 – Control of Work paragraph 1.5.B and the following:
   1. UDOT Standard Traffic Control Drawings 745-2 Series. UDOT Standards Drawing 745-60, 745-60A, 745-60B, and 745-60D for post mounted signs.
   2. Manual of Uniform Traffic Control Devices (MUTCD), latest edition.

D. Follow the requirements and limitations identified in the Traffic Control Special Provision (if included), Section 00555, Prosecution and Progress, paragraph 1.11. Limitation of Operations, Section 00725, Scope of Work, paragraphs associated with the maintaining of traffic and Section 00820 – Legal Relations and Responsibility to Public, paragraph 1.10 “Public Convenience and Safety – Traffic and Pedestrians”.

E. Consider the safe and efficient movement of traffic when land closures are proposed.
   1. Open lanes to traffic wherever and whenever practical.
   2. Minimize and restrict land closures to the locations and times essential for prosecution of work.

F. Provide for concrete barriers and attenuation to satisfy hazard mitigation according to UDOT Standard Drawing 745-2 Detail AA, and 745-2E Detail E-1.

G. Provide for delineation and temporary pavement markings and/or removal as needed for traffic control or as required in accordance with this section, paragraph 1.6, lines H and I.

H. Provide protection for all hazards (i.e.: bridge parapets, barrier blunt ends, poles, large equipment to include but not limited to cranes, pile drivers, etc.) when hazard is within AASHTO clear zone requirements for approach traffic.

I. Use the following format and provide the following documentation:
   1. Section I: Description of each phase

a. List phases, and corresponding bid items and elements of work to be accomplished in each phase.
b. Accounting for each contract bid item and element of work, reference the traffic control detail designed to provide for the safe and efficient movement of traffic and safety of workers.
c. All contract bid items and elements of work must be identified and included in the phasing.

2. Section II: CAD generated drawings showing detailed Traffic Control Plan for each phase:
   a. Adapt Standard Drawings and work zone traffic control examples contained in the MUTCD to reflect actual project conditions such as curves, grades, presence of ramps, intersections and accesses.
   b. Use basemap CAD files when supplied by the City as a basis for the Traffic Control Plan drawings.
   c. Use the same level of detail as in the MUTCD and UDOT Standard Traffic Control Drawings.
   d. Include the anticipated duration of the traffic control setup used in each phase.
   e. Provide for the safe passage of pedestrians and bicyclists through the work zone in accordance with the Americans with Disabilities Act and the MUTCD.
   f. Indicate clearly, the following:
      i. Proposed regulatory speed reductions in accordance with this Section, paragraph 3.6.
      ii. For all tapers; length of taper, device spacing, land or shoulder closures, amount of land shift in accordance with this Section, paragraph 3.3.A.
      iii. Length of buffer zone, in accordance with this Section, paragraph 3.3.A.
      iv. Device spacing used in tangents in accordance with this Section, paragraph 3.3.B.
      v. Lengths of work zones, land and shoulder widths and area available for vehicle recovery.
      vi. Proposed changes to be made to existing traffic signals including: timing changes, phase changes, etc.
      vii. Sign locations for required and existing signs.
      viii. Existing signs that are to be removed, covered, relocated or otherwise changed from the original configuration.
      ix. Worker parking, work vehicle and equipment access to and from work area, staging and material sites.
3. Section III: Emergency and Special Situations
   a. Identify procedures for dealing with emergencies and special situations.

J. Provide temporary pavement markings on newly constructed asphalt pavement and refresh as needed until the final surfacing is placed in accordance with Section 01558: Temporary Pavement Markings, as directed by the City Engineer.

K. Completely remove all existing traffic marking that conflict with the Traffic Control Plan, in accordance with Section 02765. Do not use paint or other material to cover markings.

1.12 TRAFFIC CONTROL MAINTAINER

A. Certified by the City or by the American Traffic Safety Services Association (ATSSA) as a Traffic Control Technician. Certifications are available through:
   1. Associated General Developer/Contractors
      1135 South West Temple
      Salt Lake City, Utah

Telephone: (801) 363-2753

2. American Traffic Safety Services Association (ATSSA)
   15 Riverside Parkway, Suite 100
   Fredericksburg, Virginia 22406-1022
   Telephone: (800) 272-8772
   Internet: www.atssa.com

B. Authority:
   1. Obtains and uses all labor, equipment, and materials necessary to maintain traffic control.
   2. Changes traffic control operations per the traffic control plan.

C. Responsibility and Duties:
   1. Oversees all traffic control operations.
   2. Implement the Traffic Control Plan.
   3. Remains available 24-hours a day, 7-days a week and can be on-site within 30-minutes of notification.
   4. Corrects deficiencies immediately upon verbal or written notification from the City Engineer or representative.
   5. Inspect and document inspections of traffic control on a from acceptable to the City Engineer at least four times each day as follows:
      a. Before beginning of shift.
      b. At mid-shift.
      c. Half-hour after evening shift ends.
      d. At the midpoint of the off-shift period.
   6. Coordinates project traffic control with emergency services and local law enforcement agencies.
   7. Inspect and document inspections of traffic control twice each day when no construction work is being done.
      a. One during light hours and one during nighttime hours.
      b. Conduct inspections a minimum of 8-hours apart.
   8. Completes a daily record of traffic control activities using a form acceptable to the City Engineer.
   9. Submit to the City Engineer, inspection and activities forms each week on a day and time acceptable to the City Engineer.
   10. Provide a daily report of all planned traffic control activities to the City Engineer by 7:00 AM each day. Provide the report each day during the contract.

1.13 TRAFFIC AND ACCESS

A. The Developer/Contractor's operations shall not cause unnecessary inconvenience to the public. The public right-of-way shall be maintained at all times unless the City authorizes interruption. The Developer/Contractor's desire to close and/or detour traffic is to be authorized through the preparation of the required plans, which will then be approved by the City's Engineer or authorized representative.

B. Safe and adequate access shall be provided and maintained to all public protection devices and to all critical utility locations. Facility access shall be continuous and unobstructed unless other approved by the City's Engineer.

1.14 STORAGE OF EQUIPMENT AND MATERIALS IN PUBLIC STREETS AND RIGHTS-OF-WAY

A. Construction materials and equipment shall not be stored or parked on public streets, roads, or highways. During any material or equipment loading and/or unloading activities that my temporarily interfere with traffic, acceptable detour(s) will be provided for the duration of the activity. Any associated expense for this activity will be the responsibility of the Developer/Contractor.

B. Excavated material, including suitable material that is intended for adjacent trench backfills or other earth backfill as specified in Section 5 of this specification, shall not be stored in the public streets, roads, or highways that remain in service for the public. Any waiver of this requirement must be obtained from the proper local authority and approved by the City Engineer. All excess and unsuitable material shall be removed from the site as soon as possible. Any spillage shall be removed from roadways prior to use by the public.

1.15 STREET CLOSURES, DETOURS, AND BARRICADES

A. The Developer/Contractor shall comply with the requirements of all applicable responsible units of government for closure of any street, road, or highway. The Developer/Contractor shall provide the required barriers, guards, lights, signs, temporary bridges, and flaggers together with informing the public of any detours and construction hazards by the most suitable means available such as local newspapers, local radio stations, etc. The Developer/Contractor shall also be responsible for compliance with additional public safety requirements that may arise during construction. The Developer/Contractor shall furnish and install, and upon completion of the work, promptly remove all signs, warning devices, and other materials used in the performance of this work.

B. Unless otherwise specified, not less than seven (7) days prior to closing, or partially closing, or reopening any street, road, or highway, the Developer/Contractor shall notify in writing, the Fire Chief, Police Chief, County Sheriff, State Highway Patrol, schools that operated school buses, or any other government official as may be appropriate.

C. Unless otherwise specified, the Developer/Contractor shall furnish to the City Engineer a written plan showing the proposed method of signing, barricading for traffic control, and safety for the street detours and closures.

D. All temporary detours will be maintained to ensure use of public rights-of-way is provided in a safe manner. This may include dust control, grading, graveling, etc., as required by the City's project manager and this specification.

1.16 MAINTENANCE OF WORK ZONE TRAFFIC CONTROL

A. Implement and maintain traffic control per the Traffic Control Plan. Implement changes to traffic control required in order to meet UDOT Standard Specifications. Drawings and MUTCD at no additional cost to the City. Coordinate changes to traffic control and the Traffic Control Plan with the City Engineer prior to implementation.

B. Meet all requirements of this Section, paragraph 1.7 when traffic control devices are required to be in place overnight or on weekends.

C. Meet the acceptable classification as identified by *Quality Standards for Work Zone Traffic Control Devices* published by American Traffic Safety Services Association (ATSSA) for traffic control devices.
   1. Wash devices weekly unless conditions warrant more frequent cleaning.

D. Maintain traffic control devices during and after all snow plowing operations at no additional cost to the City. Clear snow away from all traffic control devices so that the devices function as intended.

PART 2 -- PRODUCTS

2.01 PILOT CAR

A. Equip with a reflectorized sign:
   1. Comply with Section 02891: Traffic Signs.
   2. MUTCD sign G20-4

B. Equip with a minimum two rotating lights or strobe lights.
   1. Minimum 100-mm diameter and minimum 1830 mm mounting height
   2. Yellow color

2.02 FLAGGER EQUIPMENT AND CLOTHING

A. Comply with UDOT's "Flagger Training Handbook".

B. Comply with Standard Drawings 745-1.

C. Clothing:
   1. Flagger vest and hard hat: Orange, red-orange, or fluorescent version of these colors with:
      a. Minimum 83870 mm2 each on the front and back of strong yellow-green reflective tape, or
      b. Minimum of 41935 mm2 each on the front and back of strong yellow-green non-reflective tape, with 41935 mm2 white reflective tape placed on both sides of the non-reflective tape on the front and back.
      c. Orange or fluorescent orange hardhat with 6450 mm2 of white or strong yellow-green reflective tape placed around the base of the hard had and visible to traffic.

2.03 TRAFFIC CONTROL SIGNING AND DEVICES

A. Signs:
   1. Comply with paragraph 1.5.
   2. Comply with Section 02891 – Traffic Signs.
   3. Comply with Standard Drawing 745-1.
   4. Comply with Standard Drawings 745-60, 745-60A, 745-60B, and 745-60D when using post mounted signs.

B. Channelizing Devices:
   1. Comply with paragraph 1.5.
   2. Comply with Standard Drawing 745-1.
      a. Comply with Section 02891, paragraph 2.1.E. – Reflective Sheeting.

b. Use construction orange tubular markers and cone during daylight hours only.

C. Precast Concrete Barrier:
1. Comply with paragraph 1.5.
2. Comply with UDOT Standard Drawings 745-2, Detail AA, and 745-2E, Detail E-1.
3. Use an approved construction zone attenuator or permanent style end sections, as listed in UDOT Guidelines for Attenuators and End Section.
   a. Use a construction zone attenuator when approach ends of temporary precast barrier are within AASHTO clear zone.
      i. Use AASHTO Roadside Design Guide to determine proper clear zone distance requirements.
      ii. Install attenuators or end sections as per UDOT Standard Drawings 735-1 series and manufacturer's recommendations.
4. Do not use a truck-mounted attenuator (TMA) to protect temporary precast barrier end for more than 24-hours. Use properly rated TMA as directed in this Section, paragraph 2.3.D.

D. Use properly rated truck-mounted attenuator for the posted speed limit prior to construction.
1. NCHRP-350 Test Level 2 for speeds 45 mph or less.
2. NCHRP-350 Test Level 3 for speeds greater than 45 mph.

2.04 ADVANCE WARNING ARROW PANEL

A. Advance Warning Device:
1. Meet all standards as specified in the MUTCD, Section 6F.53 – Arrow Panels.
2. Perform all functions as specified in UDOT Standard Drawing 745-1 and the MUTCD.

PART 3 -- EXECUTION

3.01 MODIFICATION OF TRAFFIC CONTROL PLANS

A. Each phase of construction must use an authorized Traffic Control Plan. If a construction phase is proposed that is not covered by the Traffic Control Plan, submit a proposed plan to the City Engineer for review.
1. Submit proposed plans to the City Engineer 10 working days before the Traffic Control Plan is to be implemented.
2. Do not begin work until the new Traffic Control Plan is authorized for use and has been fully implemented.
3. Implement changes required to meet UDOT Standard Specifications, Standard Drawings and MUTCD at no additional cost to the City.
   a. Comply with this Section, paragraph 1.4.A.1.

3.02 FLAGGING

A. Flaggers must have a current flagging certificate and must present proof of certification upon request by the City.
1. Acceptable certifications
   a. UDOT Developer/Contractor Certification (Utah Valley State College).
   b. American Traffic Safety Service Association (ATSSA).

3.03 TRAFFIC CONTROL SIGNING AND DEVICES

A. Use posted speed limit prior to construction to compute sign spacing, taper lengths, buffer zones and construction clear zone.
   1. Use plastic drums for land closure taper devices for speeds 50 mph and greater.
   2. Do not use cone or tubular markers at night.

B. Use posted speed during construction to compute the tangent spacing for channelizing devices.

C. Remove all traffic control from site of work when not required within 24-hours.
   1. Remove traffic control devices from the roadway a distance twice that of the Construction Clear Zone (Table 1 – Standard Drawing TC 2A) if they will be used within 24-hours of the daily work stoppage and are not required for immediate traffic control.
      a. Obtain written permission from property owner prior to storing traffic control devices on private property.
   2. Cover post mounted signs when directed by City Engineer.
      a. Cover signs completely with an opaque and durable covering.

3.04 ADVANCE WARNING ARROW PANEL

A. May substitute Type C units for Type B units.
   1. Comply with UDOT Standard Drawing 745-1.

B. Do not substitute Type B units for Type C units.

C. Remove Advance Warning Arrow Panel from the site of work when not needed for the control of traffic within a 4-hour period.

3.05 TRAFFIC SIGNALS

A. Use uniformed police officers when construction activities are impacting an operating signalized intersection.

B. Use of flaggers at traffic signals is permitted when the signals have been turned to red flash mode.
   1. Each approach is to be controlled by a separate flagger(s).
      a. Flaggers can control only two lanes of approach traffic.
         i. Third land control permitted when left or right turn bays are present.

C. Changes to traffic signal operations will be done by the City.

3.06 CONSTRUCTION ZONE SPEED LIMIT REQUIREMENTS

A. Obtain approval from the City Engineer for regulatory speed reductions.
   1. See Standard Drawing 745-2, General Note 9.
   2. Use speed reduction only when construction activities impact traffic.

3. Restore regulatory speed limit at locations where construction activities are not impacting traffic.
4. See Standard Drawing 745-60, 745-60A, 745-60B, 745-60D for post-mounted sign requirements.

*** END OF SECTION ***

SECTION 02005

DIVERSION AND CARE OF STREAM DURING CONSTRUCTION

1.00 DESCRIPTION

A. This section describes materials for, and construction and maintenance of temporary diversion and protective works necessary for diversion and care of the stream during construction, including, but not limited to cofferdams, drains, diversion pipe, and sumps.

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Clearing, grubbing, and stripping: 02110.
B. Earthwork: 02200.
C. Trenching, backfilling and compacting: 02224.
D. Riprap: 02271.
E. Installation of cement - coated pipe: 15051.

1.02 SUBMITTALS

A. At least 40-days prior to beginning any work on the diversion and care of the stream, submit, for approval by the City Resident Project Representative, a water control plan showing the diversion features and plans for caring for the stream and its tributaries during construction, as well as describing the measures to be taken to meet the Clean Water Act permit requirements and water quality standards required in the general conditions. The water control plan shall show scour protection, and requirements for handling side drainages.

B. The water control plan may be placed in operation upon approval, but nothing in this paragraph shall relieve the Contractor from full responsibility for the adequacy of the diversion and protective works.

C. Water control plan shall include the following information at a minimum:

1. Proposed diversion method (a general statement) to include the location of diversion dams, type and location of water conveyance facilities and outlet work.
2. Explicit written explanation of sequence of operations.
3. Complete equipment/materials list.
4. Explicit written explanation and drawings showing types of installations (i.e., culverts, trenches), installation procedures, spacing, depths, capacities, etc., to be used for each component of the system.

1.03 GENERAL

A. Furnish all materials for and construct and maintain all cofferdams, channels, flumes, pipes, drains, sumps, and/or other temporary diversion and protective work; furnish all materials required therefor; furnish, install, maintain, and operate all necessary pumping and other equipment for removal of

water from the various parts of work; and be responsible for maintaining the foundations and other parts of work free from water as required for constructing each part of the work.

B. Except as otherwise provided below, do not interrupt and do not interfere with the natural flow of the creek through the worksite for any purpose without the prior written approval of the City Resident Project Representative.

C. The temporary diversion shall at all times pass the full flow of the stream through the stream inlet site, except that the Contractor will be permitted to reduce such flow by the amount of water used for construction purposes.

PART 2 -- MATERIALS

2.01 DIVERSION PIPE

A. Pipe for the diversion of the creek shall be submitted for approval by the City Resident Project Representative.

2.02 RIPRAP

A. Riprap shall be placed for erosion protection at the inlet and outlet of the diversion pipe(s). Riprap requirements shall be in accordance with Section 02271 except that bedding will not be required.

PART 3 -- EXECUTION

3.01 UPSTREAM CUTOFF

A. An upstream cutoff or diversion shall be provided for each structure to be constructed which crosses or encroaches on the creek in accordance with the requirements of the general conditions.

3.02 DIVERSION PIPE COFFERDAMS

A. Construct embankment cofferdams at the upstream and downstream ends of the diversion pipe(s) flume(s), channels, etc. Materials shall be selected from required excavation for the pipeline such that the material contains from 15 to 30 percent of material passing the No. 200 sieve. The embankments shall be compacted to maintain the diversion throughout the diversion period. Material placed around the diversion pipe shall be placed in accordance with the requirements of Section 02200 – Earthwork.

3.03 CLEANUP

A. Any damage to the foundations, structures, or any other part of the work caused by floods, water or failure of any part of the diversion or protective works shall be repaired by, and at the expense of the Contractor.

3.04 EXCAVATION FOR DIVERSION PIPING/WEIRS

A. Excavation for the diversion pipe(s), weir(s), or channel(s), handling of the diversion pipe (etc.), and backfilling shall be in accordance with the requirements of Section 02200 - Earthwork.

*** END OF SECTION ***

SECTION 02105

DUST CONTROL

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials and equipment as required to provide dust control for the project.

B. All materials and services shall comply with the requirements of the State of Utah, Department of Environmental Quality, Division of Air Quality and the City's Municipal Code.

1.02 REFERENCE DOCUMENTS

A. Commercial Specifications.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Water: Water shall be applied as required to meet UDEQ requirements.

B. Calcium chloride shall be added to the water used to provide dust control if required by the City.

PART 3 -- EXECUTION

3.01 WATER PLACEMENT FOR DUST CONTROL

A. The Contractor is responsible for placement of sufficient water to control dust on the project. Dust control is defined by the permit requirements of the State of Utah, Division of Environmental Quality, Division of Air Quality permit obtained by the Developer of the project. The Contractor is also responsible for meeting the dust control requirements of the City's Municipal Code. As a guide, the Contractor shall have one, 10,000-gallon water truck available for 3-acres of land disturbed.

3.02 WATER AND CALCIUM CHLORIDE MIXTURE FOR DUST CONTROL

A. In lieu of providing one, 10,000-gallon water truck available for every 3 acres of land disturbed, the Contractor may also use a water and calcium chloride solution to abate the dust for the project. The mixture of calcium chloride per 10,000-gallon truck shall be 10-pounds. The calcium chloride shall be added to the water truck container as the water is being put into the water truck in order to provide sufficient mixing.

B. In the absence of providing the water and calcium chloride mixture, the Contractor shall meet the

requirements of Subsection 3.01 of this document.

*** END OF SECTION ***

SECTION 02112

CLEARING, GRUBBING, AND STRIPPING

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. This section describes the work included in clearing, grubbing, stripping and preparing the project site for construction operations.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 - Earthwork
B. Section 02222 - Protecting Existing Underground Utilities
C. Section 02224 - Trenching, Backfilling and Compacting
D. Section 02900 - Revegetation Plan
E. State of Utah, Department of Environmental Quality, Division of Solid and Hazardous Waste, Solid Waste Permitting and Management Rules, R315-301 Through 320

1.03 CLEARING

A. Remove and dispose of only those trees, snags, stumps, shrubs, brush, limbs, and other vegetative growth not shown to be protected which are necessary for construction of the project. Remove all evidence of their presence from the surface including sticks and branches greater than 1-inch in diameter or thickness. Remove and dispose of trash piles, and rubbish, and fencing. Protect structures and piping above and belowground, trees, shrubs, and vegetative growth and fencing which are not designated for removal.

B. Preserve and protect the existing vegetation not required, or otherwise authorized, to be removed. Vegetation specifically shown on the drawings to be protected shall be protected from damage or injury caused by Contractor's construction operations, personnel, or equipment by the use of protective barriers or other methods approved by the City Resident Project Representative. Removal of existing vegetation within the designated R/W not specially required to be removed will require approval of the City Resident Project Representative.

C. Trees shall not be used for anchorages. If tree climbing is necessary, safety ropes shall be used, and the use of climbing spurs will not be permitted.

D. The Contractor shall be responsible for injuries to vegetation caused by Contractor's operations, personnel, or equipment. The term "injury" shall include, without exceptions, bruising, scarring, treating, and breaking of roots, trunks, or branches. Injured vegetation shall be repaired or treated without delay. Repairs or treatment shall be as recommended by and under the direction of, an experienced horticulturist or licensed tree surgeon provided by the Contractor and approved by the City Resident Project Representative. If vegetation cannot be treated or repaired, the Contractor will be responsible for replacing the damaged vegetation. The City Resident Project Representative must approve replacement vegetation. No noxious or non-native vegetation shall be planted or introduced

into the construction areas.

1.04 GRUBBING

A. After clearing, remove and dispose of wood or root matter, including stumps, trunks, roots, or root systems greater than 1-inch in diameter or thickness to a depth of 12-inches below the ground surface. Options available for disposal include burning (with appropriate permits and approvals), gathering and hauling material to an approved disposal site, or chipping and shredding the material according to City standards and mixing it with the topsoil. Further discussions of this item are included in the Land Disturbance Design and Construction Standards, Section 2.2.

1.05 TOPSOIL

A. Existing soil material containing sod, grass, or other vegetation and topsoil shall be removed to the existing topsoil depth or 12-inches, whichever is less, from all construction areas except existing pavement and slopes steeper than 1:1.

1. Strip, segregate, and stockpile existing topsoil from the following areas:
   a. Wetland areas
   b. Pipeline excavations and stockpile areas
   c. Road excavations
   d. All staging, service, and storage areas
2. Stripping shall be to the existing topsoil depth or 12-inches, whichever is less. All suitable topsoil materials, which are stripped, shall be used in accordance with the 'Released for Construction Drawings' and may be placed directly or else shall be stockpiles in areas designated by the City Resident Project Representative. Topsoil stripped from wetland areas and areas known to be occupied by endangered plant species will be stockpiled in separate areas designated by the City City Resident Project Representative and will be respread in the wetland and habitat areas from which they were removed to the depth of 12-inches.
3. Topsoil that has been stripped shall be placed at an approximate thickness of 6-inches or as directed by the City City Resident Project Representative, on all other areas which have been excavated or otherwise disturbed by construction activities except slopes greater than 1:1 unless otherwise instructed by the City Resident Project Representative. Areas to receive topsoil are as follows:
   a. Roadway excavation and embankment slopes
   b. Pipeline alignment
   c. Disturbed areas within staging, service and storage areas
   d. Other areas as directed by the City Resident Project Representative
   e. Disturbed Ute ladies-tresses habitat and wetlands areas shall receive topsoil removed from the original habitat, as described in 1.05.B.2 above.
4. Topsoil, which cannot be placed directly in the final location, shall be stockpiled temporarily in designated areas and later placed in the final location as directed by the City Resident Project Representative. The area over which topsoil is to be placed shall be clean of debris. The surface shall generally conform to smooth lines, slopes, and grades so that adequate control of thickness of topsoil placed can be maintained.

PART 2 -- PRODUCTS

2.01 TREES AND SHRUBBERY

A. Existing trees, shrubbery, and other vegetative material may not be shown in the 'Released for Construction Drawings'. Inspect the site as to the nature, location, size, and extent of vegetative material to be removed or preserved, as specified herein. Preserve in place, trees that are specifically shown in the drawings and designated to be preserved.

2.02 PRESERVATION OF TREES, SHRUBS, AND OTHER PLANT MATERIAL

A. Save and protect plant materials (trees, shrubbery, and plants) beyond the limits of clearing and grubbing from damage resulting from the work. No filling, excavating, trenching, or stockpiling of materials will be permitted within the drip line is defined as a circle drawn by extending a line vertically to the ground from the outermost branches of a plant or group of plants. To prevent soil compaction within the drip line area, no equipment will be permitted within this area.

B. When trees are close together, restrict entry to area within drip line by fencing. In areas where no fence is erected, protect the trunks of trees 2 inches or greater in diameter by encircling the trunk entirely with boards held securely by 12-gage wire and staples. This protection shall extend from ground level to a height of 6-feet. Cut and remove three branches where those required to affect the work to provide balanced appearances of any tree. Treat cuts with a tree sealant.

PART 3 -- EXECUTION

3.01 CLEARING AND GRUBBING LIMITS

A. Prior to actual, in-the-field clearing and grubbing efforts, the Contractor shall have a licensed land surveyor survey the clearing and grubbing limits for the project and mark the limits clearly. Once the surveying has been completed, the Contactor shall then install the silt fence prior to the main effort of clearing and grubbing the project. Clear and grub excavation and embankment areas associated with new structures, slabs, and roadways. Do not intrude into those areas designated as habitat for endangered plant species.

3.02 DISPOSAL OF CLEARING AND GRUBBING DEBRIS

A. Remove cleared and grubbed material from the worksite and dispose of in accordance with these design and construction standards, local laws, codes, and ordinances.

3.03 AREAS TO BE STRIPPED

A. Strip excavation and embankment areas associated with the project, new structures, slabs, walks, and roadways. Strip stockpile areas.

*** END OF SECTION ***

SECTION 02140

DEWATERING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall at all times during construction provide and maintain proper equipment and facilities to remove all water entering excavations, and shall keep such excavation dry so as to obtain a satisfactory undisturbed subgrade foundation condition until the fills, structures or pipes to be built thereon have been complete to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural levels.

1.02 CONTRACTOR SUBMITTALS

A. Prior to commencement of excavation, the Contractor shall submit a detailed plan and operation schedule for dewatering of excavations. The Contractor may be required to demonstrate the system proposed and to verify that adequate equipment, personnel and materials are provide to dewater the excavations at all the headings planned. The Contractor's dewatering plan is subject to the acceptance of the Engineer.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION

A. At all times, site grading shall promote drainage. After a storm all depressions shall be pumped out immediately and filled.

B. Surface runoff shall be diverted from excavations.

C. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

D. The Contractor shall maintain the water level below the bottom of excavation is all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.

E. Excavation subgrade shall be shaped and sealed to promote drainage to points where water can be pumped out.

F. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

*** END OF SECTION ***

SECTION 02160

EXCAVATION SUPPORT SYSTEMS

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall supply, place, and remove all sheeting, shoring and bracing necessary to safely support all excavations. All materials and methods shall conform with applicable rules, regulations and laws of the State of Utah.

B. The Contractor's attention is directed to the provisions of Subpart P, Section 1926.652 of the OSHA Safety and Health Standards for Construction which require that all banks and trenches over 5 feet high shall be shored or sloped to the angle of repose.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02140 - Dewatering
B. Section 02200 - Earthwork

1.03 CONTRACTOR SUBMITTALS

A. The Contractor, prior to beginning any trench or structure excavation 5 feet deep or over, shall submit to the Owner and shall be in receipt of the Owner's written acceptance of the Contractor's detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation. Such plan shall conform to the shoring system standards established by the State of Utah and shall be prepared by a civil or structural engineer licensed in the State of Utah.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

*** END OF SECTION ***

SECTION 02161

CARE OF WATER

PART 1 -- GENERAL

1.01 SCOPE

A. The work of this Section includes the furnishing, use, and care of water and all appurtenant work, during construction, all in accordance with the requirements of the 'Released for Construction Drawings'.

1.02 GENERAL

A. The Contractor shall construct and maintain in a satisfactory condition any dikes, channels, drains, sump, and/or other temporary protective works necessary and required to divert and handle water during the performance of the work under the Contract. Before final acceptance of the work, the Contractor, at its expense, shall remove all dikes and other temporary facilities as necessary and required so as to present a neat and orderly appearance.

1.03 CARE OF WATER

A. Runoff: All local runoff from adjoining areas shall be interrupted and disposed of to prevent interference with construction, or damage to partially completed excavations and structures.

B. Seepage: All seepage encountered in the foundation and other excavated areas, shall be dewatered to the extent necessary for placement of embankment materials and concrete in the dry.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

*** END OF SECTION ***

SECTION 02200

EARTHWORK

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. The work of this Section includes all earthwork required for construction of the Work. Such earthwork shall include, but not be limited to, the loosening, removing, loading, transporting, depositing, and compacting in its final location of all materials wet and dry, as required for the purposes of completing the work specified in the Contract Documents, which shall include, but not be limited to, the furnishing, placing, and removing of sheeting and bracing necessary to safely support the sides of all excavation; all pumping, ditching, draining, and other required measures for the removal or exclusion of water from excavation; the supporting of structures above and below the ground; all backfilling around structures and all backfilling of trenches and pits; the disposal of excess excavated materials; borrow of materials to make up deficiencies for fills; and all other incidental earthwork, all in accordance with the requirements of the Contract Documents.

1.02 CONTRACTOR SUBMITTALS

A. The Contractor's attention is directed to the provisions for "Shoring and Bracing Contract Documents" in Section 6705 of the Utah Labor Code. The Contractor, prior to beginning any trench or structure excavation 5 feet deep or over shall submit to the Owner and shall be in receipt of the Owner's written acceptance of the Contractor's detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation. If such plan varies from the shoring system standards established in the Construction Safety Orders of the State of Utah, such alternative systems plans shall be prepared by a civil or structural engineer licensed in the State of Utah.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Contract Documents, all work specified herein shall conform to or exceed the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section.

1. Commercial Standards:

ASTM D 422-63(1972)	Method for Particle-Size Analysis of Soils.
ASTM D 698-78	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5lb (2.49kg) Rammer and 12-in (304.8 mm) Drop.
ASTM D 1140-54(1971)	Test Method for Amount of Material in Soils Finer than the No. 200 (75 mm) Sieve.

ASTM D 1556-82	Test Method for Density of Soil in Place by the Sand Cone Method.
ASTM D 1663-84	Test Method for Compressive Strength of Molded Soil-Cement Cylinders.
ASTM D 2419-74(1979)	Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
ASTM D 2487-83	Classification of Soils for Engineering Purposes.
ASTM D 2901-82	Test Method of Cement Content of Freshly-mixed Soil Cement.
ASTM D 2922-81	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 4318-84	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.04 QUALITY ASSURANCE

A. General: All soils testing will be done by a testing laboratory of the Owner's choice at the Contractor's expense.

B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with ASTM D 698. Field density in-place tests will be performed in accordance with ASTM D 1556, ASTM D 2922, or by such other means acceptable to the Engineer.

C. In case the tests of the fill or backfill show non-compliance with the required density, the Contractor shall accomplish such remedy as may be required to insure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Owner and shall be at the Contractor's expense.

D. Particle size analysis of soils and aggregates will be performed using ASTM D 422.

E. Determination of sand equivalent value will be performed using ASTM D 2419.

F. Unified Soil Classification System: References in these specifications to soil classification types and standards set forth in ASTM D 2487 shall have to meanings and definitions indicated in the chart illustrated at the end of this Section. The chart is reproduced herein for the convenience of the Contractor only, and no limitation, amendment, or modification is intended thereby. The Contractor shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.

PART 2 -- PRODUCTS

2.01 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General: Fill, backfill, and embankment materials shall be suitable selected or processed clean, fine earth, rock or sand, free from grass, roots, brush, or other vegetation.

B. Fill and backfill materials to be placed within 6-inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3-inches.

C. Suitable Materials: Soils not classified as unsuitable as defined in paragraph entitled, "Unsuitable Material" herein, are defined as suitable materials and may be used in fills, backfilling, and embankment construction subject to the specified limitations. In addition, when acceptable to the Engineer, some of the material listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.

D. Suitable materials may be obtained from on-site excavations, may be processed on-site materials, or may be imported. If imported materials are required to meet the requirements of this Section or to meet the quantity requirements of the project the Contractor shall provide the imported materials at no additional expense to the Owner, unless a unit price item is included for imported materials in the bidding schedule.

E. The following types of suitable materials are designated and defined as follows:

1. Type A: Crushed rock, gravel, or sand with 100 percent passing a 1-inch sieve and a sand equivalent value not less than 50.
2. Type B: Crushed rock, gravel, or sand with 100 percent passing a ½-inch sieve and a sand equivalent value not less than 50.
3. Type C: Sand with 100 percent passing a 3/8-inch sieve, at least 90 percent passing a Number 4 sieve, and a sand equivalent value not less than 30.
4. Type D: Crushed rock or gravel with 100 percent passing a 1-inch sieve and not more than 10 percent passing a Number 4 sieve.
5. Type E: Crushed rock or gravel with 100 percent passing a ½-inch sieve and not more than 0 percent passing a Number 4 sieve.
6. Type F: Crushed rock or gravel meeting the following gradation requirements:

Sieve Size	Percentage Passing
2-inch	100
1½-inch	94-96
1-inch	20-40
¾-inch	4-8

7. Type G: Crushed rock aggregate base material of such nature that it can be compacted readily

by watering and rolling to form a firm, stable base for pavements. At the option of the Contractor, the grading for either the 1½-inch maximum size or ¾-inch maximum size shall be used. The sand equivalent value shall be not less than 22, and the material shall meet the following gradation requirements:

	Percentage Passing	
Sieve Size	1½-inch Max	¾-inch Max
1½-inch	90-100	-
1-inch	-	100
¾-inch	50-85	90-100
No. 4	25-45	35-55
No. 30	10-25	10-30
No. 200	2-9	2-9

8. Type H: Drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
¾-inch	90-100
3/8-inch	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

The drainrock shall have a sand equivalent value not less than 75. The surface of the drainrock immediately beneath reservoirs shall be stabilized with hot-applied asphalt after the surface of the drainrock has been finish-graded. The Contractor shall use, at its option, one of the asphalt types listed below:

	Type 1	Type 2
Designation	SC-70	SC-250
Spray Temperature (degrees F)	135-175	165-200
Coverage (gal/sq yd)	0.50	0.50

If the surface remains tacky, sufficient sand shall be applied to absorb the excess asphalt.

9. Type I: Any other suitable material as defined in Paragraph 2.01, herein.
10. Type J: Material which consists of Type H material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633.
11. Type K: Stockpiled topsoil material which has been obtained at the site by removing soil to a depth not exceeding 2 feet. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris as specified.

2.02 UNSUITABLE MATERIAL

A. Unsuitable soils for fill material shall include soils which, when classified under the standard method for "classification of Soils, for Engineering Purposes," ASTM D 2487, fall in the classification of Pt, OH, CH, MH, or OL.

B. In addition, any soil containing organic matter, having a plastic limit of less than 8-percent when tested in accordance with the requirements of ASTM D 4318 and containing more than 25 percent of material, by weight, passing the Number 200 sieve when analyzed according to the requirements of ANSI/ASTM D 1140; or any soil which cannot be compacted sufficiently to achieve the percentage of maximum density specified for the intended use, shall be classed as unsuitable material.

2.03 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

A. The Contractor shall use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.

B. Where these Specifications conflict with the requirements of any local agency having jurisdiction, or with the requirements of a material manufacturer, the Engineer shall be immediately notified. In case of conflict therewith, the Contractor shall use the most stringent requirement, as determined by the Engineer.

C. Fill and backfill types shall be used in accordance with the following provisions:

1. Embankment fills shall be constructed of Type I material, as defined in Paragraph 2.01E, herein, or any mixture of Type I and Type A through Type H materials.
2. Pipe zone backfill, as defined under "Pipe and Utility Trench Backfill" herein, shall consist of the following materials for each pipe material listed below.

a. Mortar coated pipe, concrete pipe, and asbestos-cement pipe shall be provided Type A, B, C, D, or E pipe zone backfill material.
b. Coal tar enamel coated pipe, polyethylene encased pipe, tape wrapped pipe, and other coated pipe shall be backfilled with Type C pipe zone backfill material.
c. Plastic pipe and vitrified clay pipe shall be backfilled with Types B, C, or E pipe zone backfill material.

3. Trench zone backfill for pipelines as defined under "Pipe and Utility Trench Backfill" shall be Type I backfill material or any of Types A through H backfill materials or any mixture thereof.
4. Final backfill material for pipelines under paved areas, as defined under "Pipe and Utility Trench Backfill" shall be Type G backfill material. Final backfill under areas not paved shall be the same material as that used for trench backfill, except that Type K material shall be used for final backfill in agricultural areas unless otherwise noted on the Contract Documents.
5. Trench backfill and final backfill for pipelines under structures shall be the same material as used in the pipe zone, except where concrete encasement is required by the Contract Documents.
6. Aggregate base materials under pavements shall be Type G material constructed to the thicknesses shown or specified.
7. Backfill around structures shall be Type I material, or Types A through Type H materials, or any mixture thereof.
8. Backfill materials beneath structures shall be as follows:
   a. Drainrock materials under reservoirs or other structures shall be Type H material.
   b. Under concrete reservoirs, Types G or H materials shall be used, except where concrete encasement is required by the Contract Documents.
   c. Under structures where groundwater must be removed to allow placement of concrete, Type F material shall be used.
   d. Under structures other than concrete reservoirs, Type D, E, G, or H material shall be used, except where concrete encasement is required by the Contract Documents.
9. Backfill used to replace pipeline trench over-excavation shall be Type F material for wet trench conditions or the same material as used for the pipe zone backfill if the trench conditions are not wet.
10. The top 6-inches of fill on reservoir roofs, embankment fills around reservoirs, and all other embankment fills shall consist of Type K material, topsoil.
11. Where required by the Contract Documents, pea gravel shall be Type E material.

PART 3 -- EXECUTION

3.01 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the work. The removal of said materials shall conform to the lines and grades shown or ordered. Unless otherwise provided, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or shall be removed from the site prior to performing any excavation or placing any fill. The Contractor shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations, and all pumping, ditching, or other approved measures for the removal or exclusion of water, including taking care of storm water, groundwater, and wastewater reaching the site of the work from any source so as to prevent damage

to the work or adjoining property. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Excavation Beneath Structures and Embankments: Except where otherwise specified for a particular structure or ordered by the Engineer, excavation shall be carried to the grade of the bottom of the footing or slab. Where shown or ordered, areas beneath structures or fills shall be over-excavated. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6-inches of native material and where such subgrade is sloped, the native material shall be benched at no additional cost to the Owner. When such over-excavation is shown on the Contract Documents, both over-excavation and subsequent backfill to the required grade shall be performed by the Contractor at its own expense. When such over-excavation is not shown but is ordered by the Engineer, such over-excavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or over-excavation has been completed, the exposed surface shall be scarified to a depth of 6- inches, brought to optimum moisture content, and rolled with heavy compaction equipment to 95-percent of maximum density.

C. Excavation Beneath Concrete Reservoir: Excavation under the reservoir shall extend to the bottom of the drainrock layer. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95-percent of maximum density and then graded to provide a reasonably smooth surface for placement of the drainrock. Areas under the reservoir upon which fill is to be placed shall be scarified to a depth of 6-inches, brought to optimum moisture content, and compacted to 95-percent of maximum density.

D. Excavation Beneath Paved Areas: Excavation under areas to be paved shall extend to the bottom of the aggregate base, if such base is called for; otherwise it shall extend to the paving thickness. After the required excavation has been completed, the exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to 95-percent of maximum density.

E. Notification of Engineer: The Contractor shall notify the Engineer at least 3 days in advance of completion of any structure excavation and shall allow the Engineer a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.02 PIPELINE AND UTILITY TRENCH EXCAVATION

A. General: Unless otherwise shown or ordered, excavation for pipelines and utilities shall be open-cut trenches. Trench widths shall be kept as narrow as is practical for the method of pipe zone densification selected by the Contractor, but shall be as shown on the typical trench detail.

B. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe. The trench bottom shall be given a final trim, using a string line for establishing grade, such that each pipe section when first laid will be continually in contact with the ground along the extreme bottom of the pipe. Rounding out the trench to form a cradle for the pipe will not be required.

C. Open Trench: The maximum amount of open trench permitted in any one location shall be 500- feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater. Special care shall be taken in late fall, winter and early spring to ensure material put back in the trenches is not frozen. All frozen material shall be removed from the trench prior to backfilling with non-frozen, appropriate material. All trenches shall be fully backfilled at the end of each day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each day. The above requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any travelled roadway or occupied structure. In such cases, however, barricades and warning lights meeting OSHA requirements shall be provided and maintained.

D. Trench Over-Excavation: Where the Contract Documents indicate that trenches shall be over-excavated, they shall be excavated to the depth shown, and then backfilled to the grade of the bottom of the pipe. Work specified in this Paragraph shall be performed by the Contractor at its own expense.

E. Over-Excavation: When ordered by the Engineer, whether indicated in the Contract Documents or not, trenches shall be over-excavated beyond the depth shown. Such over-excavation shall be to the depth ordered. The trench shall then be backfilled to the grade of the bottom of the pipe. All work specified in this Section shall be performed by the Contractor at its own expense when the over-excavation ordered by the Engineer is less than 6 inches below the limits shown. When the over-excavation ordered by the Engineer is 6-inches or greater below the limits shown, additional payment will be made to the Contractor for that portion of the work which is located below said 6-inch distance. Said additional payment will be made under separate unit price bid items for over-excavation and bedding if such bid items have been established; otherwise payment will be made in accordance with a negotiated price.

F. Where pipelines are to be installed in embankment or structure fills, the fill shall be constructed to a level at least one foot above the top of the pipe before trench is excavated.

3.03 OVER-EXCAVATION NOT ORDERED, SPECIFIED, OR SHOWN

A. Any over-excavation carried below the grade ordered, specified, or shown, shall be backfilled to the required grade with the specified material and compaction. Such work shall be performed by the Contractor at its own expense.

3.04 EXCAVATION IN LAWN AREAS

A. Where excavation occurs in lawn areas, the sod shall be carefully removed and stockpiled to preserve it for replacement. Excavated material may be placed on the lawn; provided, that a drop cloth or other suitable method is employed to protect the lawn from damage. The lawn shall not remain covered for more that 72 hours. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced in a manner so as to restore the lawn as near as possible to its original condition.

3.05 EXCAVATION IN VICINITY OF TREES

A. Except where trees are shown in the Contract Documents to be removed, trees shall be protected from injury during construction operations. No tree roots over 2-inches in diameter shall be cut without express permission of the Engineer. Trees shall be supported during excavation as may be directed by the Engineer.

3.06 ROCK EXCAVATION

A. Rock excavation shall include removal and disposal of the following: (1) all boulders measuring 1/3 of a cubic yard or more in volume; (2) all rock material in ledges, bedding deposits, and unstratified masses which cannot be removed without systematic drilling and blasting; (3) concrete or masonry structures which have been abandoned; and (4) conglomerate deposits which are so firmly cemented that they posses the characteristics of solid rock and which cannot be removed without systematic drilling and blasting.

B. Said rock excavation shall be performed by the Contractor at its own expense; provided, that should the quantity of rock excavation be affected by any change in the scope of the work, an appropriate adjustment of the contract price will be made under a separate bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price.

C. Explosives and Blasting: Blasting will not be permitted, except by express permission of the Engineer on a case-by-case basis. The use of explosives will be subject to the approval and regulations of all agencies having jurisdiction. If blasting is utilized at the site of the Work, the Contractor shall take all precautions and provide all protective measures necessary to prevent damage to property and structures or injury to person. Prior to blasting, the Contractor shall secure all permits required by law for blasting operations and shall provide any additional hazard insurance required by the Owner. The Contractor shall have a fully qualified and experienced blasting foreman in charge of all blasting operations.

D. The Contractor will be held responsible for all and shall make good any damage caused by blasting or resulting from its possession or use of explosives on the work.

E. All operations involving the handling, storage, and use of explosives shall be conducted in accordance with the requirements of the OSHA Standards for Construction, and in accordance with all local laws and regulations.

3.07 DISPOSAL OF EXCESS EXCAVATED MATERIAL

A. The Contractor shall remove and dispose of all excess excavated material at its own expense.

3.08 BACKFILL - GENERAL

A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

B. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall be placed after all water is removed from the excavation.

3.09 PLACING AND SPREADING OF BACKFILL MATERIALS

A. Backfill materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment, the layers shall be evenly spread so that when compacted each layer shall not exceed 6 inches in thickness. When compaction is achieved using flooding and jetting methods, each layer shall not exceed 3-feet in thickness after compaction.

B. During spreading each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.

C. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.

D. Where the backfill material moisture content is too high to permit the specified degree of compaction the material shall be dried until the moisture content is satisfactory.

3.10 COMPACTION OF FILL, BACKFILL, AND EMBANKMENT MATERIALS

A. Each layer of Types A, B, C, G, H, I, and K backfill materials as defined in Paragraph 2.01E, herein, where the material is graded such that at least 10 percent passes a Number 4 sieve, shall be mechanically compacted to the specified percentage of maximum density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content.

B. Each layer of Type D, E, F, and J backfill materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor, except when such materials are used for pipe zone, backfill vibratory compaction shall be used at the top of the pipe zone or at vertical intervals of 24 inches, whichever is least.

C. Fill on reservoir and structure roofs shall be deposited at least 30 days after the concrete roof slab has been placed. Equipment weighing more than 10,000 pounds when loaded shall not be used on a roof. A roller weighing not more than 8,000 pounds shall be used to compact fill on a roof.

D. Flooding ponding, or jetting shall not be used for fill on roofs, backfill around structures, backfill around reservoir walls, for final backfill materials, or aggregate base materials.

E. Pipe zone backfill materials that are granular, may be compacted by a combination of flooding and vibration using concrete vibrators or by jetting, when acceptable to the Engineer.

F. Pipeline trench zone backfill materials, containing 5-percent or less of material passing a No. 200 sieve, may be compacted using flooding and jetting or vibration if the Contractor uses effective procedures that yield the specified compaction test results. Flooding and jetting shall not be done in such a manner that the pipe or nearby utilities are damaged, in areas of poorly draining or expansive soils, or where the use of the procedure is prohibited by any agency having jurisdiction over the

street or right-of-way. Approved jet pipes or immersible vibrators shall be used so that each backfill layer is saturated and consolidated to its full depth before the next layer is placed. Jet pipes shall be kept at least 6 inches away from the pipe where the backfill is being consolidated and 2-feet away from other pipes or utilities.

G. Equipment weighing more than 10,000-pounds shall not be used closer to walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use heavier equipment is impractical or restricted due to weight limitations.

H. Compaction Requirements: The following compaction test requirements apply to Type A, B, C, G, H, I, and K materials. Type D, E, F, and J materials do not require testing. Where agency or utility company requirements govern, the highest compaction standards shall apply.

Location or Use of Fill	Percentage of Maximum Density
Pipe zone backfill portion above bedding for flexible pipe	90
Pipe zone backfill bedding and overexcavated zones under bedding/pipe for flexible pipe	90
Pipe zone backfill portion above bedding for rigid pipe.	90
Pipe zone backfill bedding and over-excavated zones under bedding/pipe for rigid pipe.	90
Final backfill, beneath paved areas or structures.	95
Final backfill, not beneath paved areas or structures.	90
Trench zone backfill.	90
Embankments	90
Embankments, beneath paved areas or structures.	95
Backfill beneath structures, reservoirs.	95
Backfill around structures, on reservoir or structure roof.	95
Topsoil (Type K material)	90
Aggregate base (Type G material)	95

I. The Contractor shall maintain the indicated trench cross section up to a horizontal plane lying 6-inches above the top of the pipe.

J. If, at any location, under said horizontal plane the Contractor slopes the trench walls or exceeds the maximum trench widths indicated in the Contract Documents, the pipe zone backfill shall be "improved" or the pipe class increased as specified herein, at no additional cost to the Owner. "Improved" backfill shall mean sand-cement backfill or other equivalent method acceptable to the Engineer.

K. If the allowable deflection specified for the pipe is exceeded, the Contractor shall expose and reround or replace the pipe, repair all damaged lining and coating, and reinstall the pipe zone material and trench backfill as specified at no additional expense to the Owner.

3.11 PIPE AND UTILITY TRENCH BACKFILL

A. Pipe Zone Backfill: The pipe zone is the defined as the trench cross-sectional area between a line 6-inches below the bottom of the pipe, i.e., the subgrade, to a level line 6 inches above the top of the pipe. The bedding for flexible pipe is defined as that portion of pipe zone backfill material between the subgrade and the bottom of the pipe zone backfill material between the subgrade and a level line which varies from the bottom of the pipe to the springline as shown on the Contract Documents.

B. Bedding shall be provided for all sewers, drainage pipelines, and other gravity flow pipelines. For other pipelines the bedding may be omitted if all the following conditions exist:

1. The pipe bears on firm, undisturbed native soil which contains only particles that will pass a one-inch sieve.
2. The trench excavation is not through rock or stones.
3. The trench conditions match those specified by the pipe manufacturer for installation of pipe directly on the subgrade.
4. The subgrade soils are classified as suitable fill and backfill materials per Paragraph 2.01.
5. The subgrade soils have, as a maximum, a moisture content that allows compaction.

C. Where bedding is required, after compacting the bedding the Contractor shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe.

D. The pipe zone shall be backfilled with the specified backfill material. The Contractor shall exercise care to prevent damage to the pipeline coating, cathodic bonds, or the pipe itself during the installation and backfill operations.

E. Trench Zone Backfill: After the pipe zone backfill has been placed as specified above, and after all excess water has completely drained from the trench, backfilling of the trench zone may proceed. The inches above the top of the pipe to a level line 18 inches below finished surface grade, or if the trench is under pavement, 18 inches shall be filled with water to prevent flotation.

F. Final Backfill: Final backfill is all backfill in the trench cross-sectional area within 18-inches of finished grade, or if the trench is under pavement, all backfill within 18-inches of the subgrade.

3.12 EMBANKMENT CONSTRUCTION

A. The area where an embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be moistened, scarified to a depth of 6 inches, and rolled or otherwise mechanically compacted to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.

B. Where embankment or structure fills are constructed over pipelines, the first 4-feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the

pipe.

*** END OF SECTION ***

SECTION 02222

EXCAVATION AND BACKFILL FOR STRUCTURES

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. This section covers excavating, backfilling and compacting for inlet structures, emergency spillway retaining wall, PDPE liner and manholes. Other structures may also conform to this section as directed by the City.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02292 – Embankment Construction
B. Section 02712 – Storm Drainage System
C. Section 02719 – Sanitary Sewer System
D. Section 03300 – Cast-in-Place Concrete

1.03 SUBMITTALS

A. If requested by the City, the Contractor shall furnish to the Soils Engineer, a certified test results from an approved laboratory showing that the free draining gravel material and structural fill material conforms to the Contract Document requirements. The test result will be paid for by the City.

PART 2 -- PRODUCTS

2.01 RETAINING WALL BACKFILL

A. Retaining wall backfill material shall be native material or shall be embankment fill material.

B. Wall backfill material shall be free from frozen lumps, rocks larger than 6-inches in the largest dimension, roots, trash, lumber and organic material. Suitability of material for wall backfill in accordance with these criteria will be as determined by the Soils Engineer.

PART 3 -- EXECUTION

3.01 EXCAVATION

A. Excavation shall be performed to the lines and grades indicated in the Contract Documents. During excavation, material satisfactory for backfilling shall be stockpiled in a safe manner. Excavated material not required or not satisfactory for backfill shall be removed from the site.
B. Excavations shall be so braced and supported as needed to prevent the ground, adjacent to the

excavation, from sliding or settling. Localized slides or settlements shall be promptly removed and corrected by the Contractor.

3.02 BACKFILL

A. Backfill material shall not be placed against concrete structure that has not been property cured. No backfill material shall be placed until concrete has cured for a minimum of 7-days or until the compressible strength is 3,000-psi, whichever is greater.

B. Backfill material shall be placed I no more than 6-inch loose lifts.

C. All backfill material shall be placed and compacted to at least 95-percent of Standard Proctor Density at a moisture content within plus 2-percent to minus 2-percent of optimum as determined by ASTM D-698.

D. Where the moisture content is not suitable and/or sufficient compaction has not been obtained, the fill shall be reconditioned to an approved moisture content and recompacted to the minimum required compaction, unless recommended otherwise by the Soils Engineer, prior to placing any additional fill material.

E. Unless otherwise specified, the Contractor shall be responsible for arranging for the placing and compacting of approved fill material in accordance with the Contract Documents. If the Soils Engineer should determine that the Contractor is failing to meet the minimum requirements, the Contractor shall stop operations and make adjustments as necessary to produce a satisfactorily compacted fill at no additional cost to the City.

F. Sufficient personnel, equipment, sumps or other means should be provided to maintain the site in an acceptable dry condition for the duration of construction and curing of the structure.

3.03 REMOVAL OF WATER

A. Dewatering shall be accomplished in accordance with Section 01525 and 01525A – Temporary Construction Aids and Environmental Controls. The Contractor shall provide and maintain at all times, ample means and devices with to remove promptly and to properly dispose of all water entering the excavation.

B. Water shall be disposed of in a suitable manner without damage to adjacent property or without being a menace to public health and convenience. No water shall be drained into work built under construction without prior approval of the City.

C. Dewatering shall be accomplished by well, points, sumping, or any other acceptable method, which will provide a dewatered excavation. Any dewatering method shall be subject to the approval of the City.

3.04 COMPACTION TESTS

A. Field density tests shall be made in accordance with ASTM D 698.

B. The cost of field density tests shall be borne by the Contractor.

*** END OF SECTION ***

SECTION 02224

TRENCHING, BACKFILLING, AND COMPACTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. This section covers all work associated with trenching for underground utilities including backfilling and compacting required for the project. Such trenching shall include, but not be limited, to the products required in trenching, materials to be used in its execution and execution of this effort for structures as shown on the drawings.

B. Coordinate work with other trades on the site.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02055 – Common Fill.
B. Section 02060 – Select Fill.
C. Section 02062 - Flowable Fill.
D. Section 02075 – Geotextile Fabric.
E. Section 02316 – Trench Backfill and Compaction.

1.03 REFERENCES

A. Use the latest issue of the reference standards as of the date of the Project.

B. American National Standards Institute (ANSI); Z535.1, Safety Color Code.

C. American Public Works Association (APWA): Uniform Color Code for Temporary Marking of Underground Utility Locations.

D. ASTM C33: Standard Specifications for Concrete Aggregates.

E. ASTM C94: Specification for Ready-Mixed Concrete.

F. ASTM C117: Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.

G. ASTM C136: Standard Test Method for Sieve Analysis of Fine and Course Aggregates; 1996a.

H. ASTM C150: Standard Specification for Portland Cement.

I. ASTM C 618: Standard Specifications for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

J. ASTM D 422: Standard Test Method for Particle-Size Analysis of Soils.

K. ASTM D698: Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft3(600 kN-m/m3)); 1991.

L. ASTM D 1140: Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve.

M. ASTM D 1556: Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 1990 (Reapproved 1996).

N. ASTM D 1557: Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)), 1991.

O. ASTM D 2167: Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 1994.

P. ASTM D 2487: Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System); 1993.

Q. ASTM D 2922: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 1991.

R. ASTM D 3017: Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 1988 (Reapproved 1993).

S. ASTM D 3776: Standard Test Method for Mass per Unit Area (Weight) of Fabric.

T. ASTM D 4253: Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

U. ASTM D 4264: Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

V. ASTM D 4318: Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 1995a.

W. ASTM D 4533: Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

X. ASTM D 4832: Standard Test Method for Preparation and Testing of Soil-Cement Slurry Test Cylinders.

Y. ASTM D 4991: Standard Test Method for Leakage Testing of Empty Rigid Containers by Vacuum Method.

Z. ASTM D 5034: Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

AA. Specification for Excavating on State Highways, latest edition.

BB. General Safety Orders Covering Utah Industries – Section 69, Trenches.

CC. United States Department of Labor OSHA Publication 2085 – "Employer – Employee, Safe Practice for Excavation and Trenching Operations".

DD. Utah Occupational Safety and Health Rules and Regulations – General Standard (UOSHA).

1.04 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding: That surface of the excavation or portion of the pipe zone below the pipe.

C. Bedding Zone: Granular material upon which pipes, conduits, cables, or duct banks are placed.

D. Drawings: Released for Construction Drawings approved by the City's Engineering Department.

E. Finish Grade Elevations: Top of pavement in paved areas, as indicated on Drawings.

F. Ground Elevations: Indicated on the Drawings.

G. Imported Material: Material obtained by the Contractor from sources(s) off-site.

H. Lift: Loose (uncompacted) layer of material.

I. Pipe Line Grades and Elevations: Indicated on Drawings.

J. Pipe Zone: Backfill zone that includes the full trench width plus 1-foot above the pipe barrel.

K. Prepared Trench Bottom: Graded and refinished trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

L. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D 1557. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the City Engineer.

M. Relative Density: As defined by ASTM D 4253 and ASTM D 4254.

N. Resident Project Representative (City's): Unless otherwise specified by the City, this will be the Engineering Department's Project Inspector.

O. Resident Project Representative (Developer's): The Developer is responsible for notifying the City's Engineering Department in writing, which will fill this role for the Developer.

P. Subgrade Elevations: Bottom of road base in paved areas, as indicated on Drawings.

Q. Trench Cross Sections: Indicated on standard drawings for trenches.

R. Trench Stabilization: Granular material wrapped in 10-oz. Geotextile fabric used to stabilize the trench bottom. To be used as directed by the Engineer.

S. Trench Zone: Granular backfill material that includes the full trench width and extends from the pipe zone top to either the bottom of landscaping or bottom of pavement section, as applicable.

T. Well Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.05 SUBMITTALS

A. Shop Drawings: Manufacturer's descriptive literature for marking tapes.

B. Samples:

1. Base Rock – 0.028 cm with gradation.
2. Trench stabilization material - 0.028 cm with gradation.
3. Bedding and pipe zone material - 0.028 cm with gradation.
4. Pipe zone material - 0.028 cm with gradation.
5. Trench zone material - 0.028 cm with gradation.
6. Top soil - 0.028 cm with analysis.
7. CLSM – lab strength tests and gradation.

C. Submit aggregate batch delivery tickets showing name of material source; serial number of ticket; date and truck number; name of supplier; job name and location; volume of material delivered; and aggregate classification.

D. Submit samples of proposed imported borrow material for review by the Soils Engineer prior to delivery to the Site.

E. Submit maximum laboratory dry density and optimum laboratory moisture content for:

1. Subgrade material, and
2. Each type of fill to be used in the Work.

F. Upon City's Resident Project Representative's request, submit a written quality control inspection and testing report describing source and field quality control activities performed by Developer and its suppliers.

G. Quality Control Submittals: Catalog and manufacturer's data sheets for compaction equipment.

1. Certified Gradation Analysis: Submit not less than 30-days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to the site.
2. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic meter for each component of mix.

1.06 STORAGE AND PROTECTION

A. Stockpile backfill materials in sufficient quantities for the work.

B. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.

C. Prevent erosion or deterioration of material.

D. Use means necessary to avoid displacement of, and injury to work while compacting or operating equipment.

E. Movement of construction machinery over work at any stage of construction is solely at the Contractors and Developer's risk.

1.07 QUALITY ASSURANCE

A. Testing and Observation: Excavation, filling and compaction shall be performed under the direct supervision and testing of the Soils Engineer retained and paid for by the Developer. Tests shall be submitted to the City's Engineering Inspector for review for compliance. Developer's Contractor and Consultants are responsible for compliance with City specifications and submitting documents to the Engineering Inspector showing compliance.

B. Allowable Tolerances:

1. Excavations shall not exceed 1/10-foot variation form dimensions and elevations indicated.
2. Place fill and backfill material within tolerance of plus or minus 1/10-foot.

C. Do not change material sources, or aggregate without City's Resident Project Representative's knowledge.

D. Reject backfill material that does not comply with requirements specified in this section.

1.08 SITE CONDITIONS

A. Unsuitable Weather: Do no place, spread, or roll any fill material until moisture content of material is satisfactory. If necessary, remove and replace damaged materials.

B. Existing Conditions – Maintain bench marks, monuments, and survey control references. If these are removed, the Developer is responsible for re-establishing and paying for these items.

C. Protection of Persons and Property

1. Conduct operations to prevent windblown dust and dirt from interfering with adjacent work.
2. Protect graded areas from traffic, erosion, and slides.
3. Control dust at the site by intermittent watering and sprinkling while the work is being performed.

D. Layout – If discrepancies are found between the Drawings and site conditions, the Engineer reserves the right to make minor adjustments in the work necessary to accomplish the intent of the Released for Construction Drawings.

E. Scheduling

1. Schedule operations to permit sufficient time for the Soils Engineer to take samples and perform laboratory work.
2. Notify the Soils Engineer and the City's Resident Project Representative a minimum of 72-hours prior to commencement of earthwork operations.

F. Contractor shall continuously control dust and other emissions arising as a result of the work to the full and complete satisfaction of the City and the City's Resident Project Representative.

1.09 TESTING AND ACCEPTANCE

A. One test per lot is required. The lot will not be accepted until the test criteria passes which is as follows:

Table 1
Lot Size for Trench Backfilling Operations

Material	Test	Lot Size
Subgrade	Density Section 02324	Each 100-lineal feet of trench
Common Fill	Density Section 02324	One lift per 100-lineal feet of trench
Select Fill	Density Section 02324	One lift per 100-lineal feet of trench One lift per 25-square feet of footing area
Flowable Fills	Compressive Strength Section 02062	50-cubic yards

NOTES: (a) Lift thickness above the pipe zone before compaction is 8-inches.

B. Refer to the following Sections for material acceptance:

1. Section 02055 – Common Fill.
2. Section 02060 – Select Fill.
3. Section 02062 – Cement Treated Fill.

1.10 WARRANTY

A. Any settlement noted in trench backfill or in structures built over the trench backfill will be

considered to be caused by improper compaction methods and shall be corrected at not cost to the City.

B. Restore structures damaged by settlement at not additional cost to the City.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. General - All fill and backfill material shall be observed, tested and approved in writing by the Soils Engineer prior to use. Test results are to be submitted to the City's Resident Project Representative for his/her records and comment.

B. Section 02055 – Common Fill.

C. Section 02060 – Select Fill.

D. Section 02062 – Flowable Fill.

2.02 ACCESSORIES

A. Water - Make arrangements for sources of water during construction and make arrangements for delivery of water to the site. Comply with City laws, ordinances and standards at not additional cost to the OWNER when securing water from the City.

B. Geotextile Fabric - Section 02075

C. Marking/Identification Tape: Permanent, bright colored, continuous-printed magnetic plastic type, intended for direct-burial service; not less than 6-inches wide by 4 mils thick. The tape shall ready: "CAUTION: BURIED INSTALLATION BELOW". Color of tape shall be as follows:

1. Color of tape:
   a. Red: Electric power lines, cables, conduit and lighting cables.
   b. Yellow: Gas, oil, stream, petroleum or gaseous materials.
   c. Orange: Communications, alarm, signal lines, cables, or conduits.
   d. Blue: Potable water.
   e. Purple: Reclaimed or secondary water, irrigation and slurry lines.
   f. Green: Sewer and storm drain lines.
2. Plastic tape:
   a. Inert polyethylene, impervious to know alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
   b. Thickness: Minimum 4 mils.
   c. Width: 0.1524 meters.
   d. Identifying Lettering: Minimum 25 mm high, permanent black lettering imprinted continuously over entire length.
   e. Manufacturers and Products:

i. Reef Industries; Terra Tape.
ii. Allen: Markline.

3. Metallic tape:
   a. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
   b. Foil Thickness: Minimum 5.5 mils.
   c. Width: 0.1524 meters
   d. Identifying Lettering: Minimum 2.5 cm high, permanent black lettering imprinted continuously over entire length.
   e. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
   f. Manufacturer and Products:
      i. Reef Industries; Terra "D".
      ii. Allen; Detectatape.

2.03 TRENCH STABILIZATION MATERIAL

A. Trench Stabilization Material shall be imported foundation stabilization rock as defined in Section 02315 – Fill and Backfill.

B. Trench stabilization material shall be wrapped in 10 oz. Geotextile fabric and overlapped at deges of 1-foot minimum.

2.03 TRENCH BACKFILL MATERIAL

A. Unfrozen, friable, and no clay balls, roots, other inorganic material or debris.

B. Rock refill shall be crushed or natural well-graded sands and gravel containing less than 1-percent asbestos by weight or volume, having the following gradations:

Sieve Size	Percent Passing by Weight
3-inches	100
1-1/2-inches	70-100
¾-inches	60-100
No. 4	25-50
No. 30	10-30
No. 200	0-10

2.04 IMPERVIOUS BARRIERS

A. Construct impervious barriers of concrete or soil cement slurry.

B. Concrete barriers shall consist of Class C concrete per Section 03000. Each barrier shall be 12-inches thick and shall consist of a collar cast around the pipe embedded at least 1-foot into the trench bottom and sides as shown on the contract drawings.

2.05 CONCRETE FOR PIPE ENCASEMENT AND THRUST BLOCKS

A. Concrete for pipe encasement shall be Class A per Section 03000, unless otherwise shown on the Drawings.

2.06 WATER FOR COMPACTION

A. Water used in jetting and compacting shall have a maximum chloride concentration of 500-mg/L, a maximum sulfate concentration of 500-mg/L, and shall have a pH of 7.0 to 9.0. Water shall be free of organic materials injurious to the pipe coatings.

PART 3 -- EXECUTION

3.01 EXAMINATION

A. Identify required lines, levels, contours, and datum locations.

B. Locate, identify, and protect utilities that remain and protect from drainage.

C. Notify utility company to remove and relocate utilities, where and as required.

3.02 COMPACTION REQUIREMENTS

A. Unless otherwise shown in the Released for Construction Drawings or otherwise described in the Policies & Design Criteria Manual for the particular type of pipe installed, relative compaction in pipe trenches shall be as follows:

1. Pipe Zone: 95-percent relative compaction or 80-percent relative compaction.
2. Backfill in trench zone not beneath paving: 90-percent relative compaction.
3. Backfill in trench zone below road zone in paved areas: 95-percent relative compaction.
4. Backfill in road zone in paved areas: 95-percent relative compaction.
5. Rock refill for foundation stabilization: 95-percent relative compaction or 80-percent relative density.
6. Refill for overexcavation: 95-percent relative compaction or 80-percent relative density.
7. All backfill placed.

B. Soil for compaction shall be at optimum moisture content, or within 2 percentage points above optimum moisture content.

3.03 MATERIAL REPLACEMENT

A. Remove and replace any trenching and backfilling material which does not meet the specifications, at the Developer's expense.

3.04 SHEETING, SHORING, AND BRACING OF TRENCHES

A. Trenches shall have sheeting, shoring, and bracing conforming to 29CFR1926, Subpart P--Excavations, OSHA requirements, and the Special Conditions.

3.05 PAVEMENT REMOVAL

A. Do not use for trench backfill.

3.06 TRENCH WIDTHS

A. Trench widths in the pipe zone shall be as shown in the contract drawings. If no details are shown, minimum width shall be 18-inches greater than the pipe outside diameter. Comply with 29CFR Part 1926 Subpart P--Excavations. Trench widths at the top of the trench will not be limited except where width of excavation would undercut adjacent structure and footings. In such case, width of trench shall be such that there are at least 2-feet between the top edge of the trench and the structure or footing.

3.07 TRENCH EXCAVATION

A. Excavate trenches as required to allow Project pipe to be installed to line and grade as indicated on the Drawings.

B. Notify City's Resident Project Representative of unexpected subsurface conditions and discontinue affected Work in area until notified to resume Work.

C. It is recommended that all trench excavation be done according to OSHA Standards and other applicable regulations.

D. Do not interfere with adjacent foundations.

E. Excavate the trench to the lines and grades shown in the drawings with allowance for pipe thickness, sheeting and shoring if used, and for pipe base or special bedding. If the trench is excavated below the required grade, refill any part of the trench excavated below the grade at no additional cost to the owner with foundation stabilization material. Place the refilling material over the full width of trench in compacted layers not exceeding 8-inches deep to the established grade with allowance for the pipe base or special bedding.

F. Hand trim excavations. Remove loose matter.

G. Remove large stones and other hard matter which could damage piping or impede consistent backfilling or compaction.

H. Construct trenches in rock by over-excavating rock to a minimum of 6-inches and backfilling with foundation stabilization material.

I. Potentially expansive materials, identified in Volume III as volcanic ashes, volcanic tuffs, claystones,

and their residual soils shall be prevented from drying upon excavation. Maintain excavated materials at their in-situ moisture condition.

J. The use of explosives will not be allowed, unless specifically reviewed and accepted by the City's Resident Project Representative and City Engineer. All blasting shall be done by a reputable, licensed contractor specializing in the use of explosives, who is acceptable to the City Inspector and City Engineer.

3.08 DEWATERING

A. Provide and maintain means and devices to remove and dispose of all water entering the trench excavation during the time the trench is being prepared for the pipe laying, during the laying of the pipe, and until the backfill at the pipe zone has been completed. These provisions shall apply during the noon hour as well as overnight. Dispose of the water in accordance with Section 02200. Do not drain trench water through the pipeline under construction. Do not allow groundwater to rise around the pipe until jointing compound has set hard and the pipe is backfilled.

B. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collection or run-off areas. Approval of these 'outside excavation or run-off areas' shall receive written prior approval of the Developer's Soils Engineer and the City's Resident Project Representative. Do not use trench excavations as temporary drainage ditches.

3.09 LOCATION OF EXCAVATED MATERIAL

A. During trench excavation, place the excavated material only within the working area. Do not obstruct any roadways or streets. Conform to federal, state, and local codes governing the safe loading of trenches with excavated material and equipment.

B. Topsoil excavated from the wetlands shall be removed and stored separately. Replace wetland topsoils in the top 12-inches of the trench zone. Backfill is complete

3.10 LENGTH OF OPEN TRENCH

A. Limit the length of open trench to 600-feet in advance of pipe laying or amount of pipe installed in one working day, except in the creek crossings where 1,000-feet is the maximum length of open trench allowable. Complete backfilling and temporary or first layer paving not more than 600-feet in the rear of pipe laying.

3.11 TRENCH EXCAVATION IN BACKFILL AND EMBANKMENT AREAS

A. Construct trench excavation for pipe, pipes, or conduit in backfill or embankment areas in accordance with the following procedures:

1. Construct and compact the embankment to an elevation of 1-foot minimum over the top of the largest pipe or conduit to be installed.
2. For areas where pipelines or culverts cross, construct the lower conduit, then backfill the area to

a level 1-foot above the top of the higher conduit before excavating the trench for the higher conduit.

3. Excavate trench in the compacted backfill or embankment. Place pipe base material, install pipe or conduit, and backfill with pipe zone material. Compact backfill above the pipe zone to the same relative compaction as the adjacent embankment as specified in Section 02200.

3.12 FOUNDATION STABILIZATION

A. After the required excavation has been completed, inspect the exposed subgrade to determine the need for any additional excavation. It is the intent that additional excavation is conducted in all areas within the influence of the pipeline where unacceptable materials exist at the exposed subgrade. Areas identified on the drawings are estimated and may not identify the full extent of unacceptable foundation material.

B. Overexcavation shall include the removal of all such unacceptable material that exists directly beneath the pipeline to a width 24-inches greater than the pipe outside diameter and to the depth required. Backfill the trench to subgrade of pipe base with rock refill material for foundation stabilization. Place the foundation stabilization material over the full width of the trench and compact in layers not exceeding 12-inches deep to the required grade.

C. Estimate depths and locations of trench overexcavation are shown on the plans. These are shown for estimation and bid purposes only. The actual amount of overexcavation and refill shall be determined per paragraph A above, and may be different from quantity, depth, and location than that indicated on the drawings.

D. The Proposal includes three items at a lumps sum cost of any quantity of additional rock refill differing as to total depth below the pipe foundation line, as shown by the bedding details on the drawings. Item (a) is for any additional bedding down to 12-inches and is estimated at 5,200 CY. Item (b) is for a total depth of 12-inches to 24-inches and is estimated at 400 CY. Item (c) is for a total depth of 24-inches to 36-inches and is estimated at 2,800 CY.

E. These items have been included in the schedule of values for work that is estimated to be required to complete the project. The extent of these cannot be firmly anticipated at this time and the Contract is encouraged to verify the required quantity of overexcavation required before submitting a bid. The lump sum cost shall be for any quantity installed, complete in place, including all earthwork, disposal of all excess or waste material, and placing the refill material. The Owner's representative shall be the sole judge as to the necessity, the amount, and the depth of additional refill material that may be required in any given situation.

F. Rock refill used by the Contractor for his convenience will not receive any additional payment.

3.13 INSTALLING BURIED PIPING

A. Backfill per the detailed piping specification for the particular type of pipe and per the following.

B. Handle pipe in such a manner as to avoid damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

C. Inspect each pipe and fitting before lowering the buried pipe or fitting into the trench. Inspect the interior and exterior protective coatings. Patch damaged areas in the filed with material recommended by the protective coating manufacturer. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after installation.

D. Grade bottom of the trench to the line and grade to which the pipe is to be laid, with allowance for pipe thickness and soil-cement slurry. Remove hard spots that would prevent a uniform thickness of bedding. Place the specified thickness of pipe base material over the full width of the trench. Grade the top of the pipe base ahead of the pipe laying to provide firm continuous, uniform support along the full length of pipe bedding, and compact to the relative compaction specified herein. Before laying each section of the pipe, check the grade with a straightedge and correct any irregularities. Provide "soil-pads" to support the pipeline before supply placement as shown on the drawings.

E. Excavate bell holes at each joint to permit proper assembly and inspection of the entire joint. Fill the area excavated for the joints with the bedding material specified or detailed in the drawings for use in the pipe zone.

F. When installing pipe, do not deviate more than 1 inch from line or ½-inch from grade. Elevation is reference to the pipe invert.

G. After the pipe has been bedded, place pipe zone material simultaneously on both sides of the pipe, in maximum 8-inch lifts, keeping the level of backfill the same on each side. Carefully place the material around the pipe so that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Use particular care in placing material on the underside of the pipe to prevent lateral movement during subsequent backfilling.

H. Compact each lift to the relative compaction specified herein.

I. Push the backfill material carefully onto the backfill previously placed in the pipe zone. Do not permit free fall f the material until at least 2-feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe. Do not operate heavy equipment over the pipe until al least 3-feet of backfill has been placed and compacted over the pipe.

J. When the pipe laying is not in progress, close the open ends of pipe. Do not allow trench water, animals, or foreign material to enter the pipe.

K. Remove and dispose of all water entering the trench during the process of pipe laying. Keep the trench dry until the pipe laying and jointing are completed.

3.14 INSTALLING IMPERVIOUS BARRIERS

A. Construct impervious barriers in the pipe and trench zones at 100-foot intervals on slopes exceeding 30-percent (16.7 degrees) and within 50-feet of vertical points of inflection on slopes exceeding 30-percent.

B. Construct concrete barriers such that the bottom of the collar extends at least 12-inches into the pipe

base, at least 12-inches into each side of the walls of the trench, and at least 12-inches above the top of the pipe zone.

C. Construct clay barriers as shown on the drawings.

3.15 BACKFILL COMPACTION

A. Compact per the detailed piping specification for the particular type of pipe and per the following.

B. Compact trench backfill to the specified relative compaction. Compact by using mechanical compaction, water jetting, or hand tamping. Do not use high impact hammer-type equipment except where the pipe manufacturer warrants in writing that such use will not damage the pipe. Do not use water jetting in areas where potentially expansive volcanic rock and soil are present.

C. Compact material placed within 12-inches of the outer surface of the pipe by hand tamping only.

D. Do not use any axle-driven or tractor-drawn compaction equipment within 5-feet of building walls, foundations, and other structures.

3.16 PLACEMENT OF CEMENT SLURRY

A. The aggregate, cement and water shall be proportioned either by weight or by volume. The water content shall be sufficient to produce a fluid, workable mix that will flow and can be pumped without segregation of the aggregate while be placed. Prepare cement slurry in accordance with ASTM C94.

B. Provide batching equipment to obtain the proper weights of soil, cement, water and admixtures. All measuring devices should be sensitive to a 2 percent variation above or below the actual weights required. Volumetric batching may be used, provided the same accuracy required for weight batching is maintained.

C. Design and operate the mixers used for mixing cement slurry bedding so that the cement slurry as discharged from he mixer is uniform in composition and consistency throughout each batch.

D. Place the cement slurry such that it flows easily into all openings between the pipe and the excavated trench. In some cases, such as trenches on a slope, a stiffer mix of cement slurry may be required to prevent the cement slurry from flowing down the trench. In this case, use vibration to ensure that the cement slurry completely fills all spaces.

E. Lay the pipe on the soil pads and place the cement slurry bedding as shown on the drawings. Cement slurry bedding shall be placed under pipe from one side and rodded or vibrated, as necessary, so that it flows under the pipe until it appears on the other side. Cement slurry shall then be added to both sides of the pipe and rodded or vibrated until it completely fills the space between the pipe and the excavated trench bottom. This operation shall follow as closely behind pipe laying operations as possible. Place slurry in such a sway as to prevent uplift or buckling of the pipe. Cement slurry shall be deposited as nearly as practicable in its final position and must in no way disturb the pipe trench or cause foreign material to become mixed with the cement slurry.

F. Do not place backfill above the pipe until the soil-cement bedding has reached the initial set. Place

and maintain a 6-inch cover of moist backfill cover until additional backfill is placed. If the ambient temperature is 50 degrees Fahrenheit or less, an additional 6-inch cover of loose backfill must be placed over the 6-inch moist backfill cover prior to the end of the working day.

G. Whenever freezing temperatures are imminent, maintain the soil-cement slurry at a temperature of not less than 50-degrees Fahrenheit for 24-hours after placement. The temperature of the soil-cement slurry mix must be 50-degrees Fahrenheit or greater at the time of placement. The temperature will be determined by placing a thermometer in the soil-cement slurry immediately after simply at the placement site. When freezing weather appears imminent, make ready at the placement site materials which may be required for protection of cement slurry. Placement of cement slurry shall be delayed until adequate provisions for protection against weather are made. No cement slurry bedding shall be placed in pipe trenches when the trench bottom or walls are frozen or contain frozen material. Backfill placed as cover over the cement slurry is prohibited from containing any frozen material.

3.17 FIELD QUALITY CONTROL

A. All on-site earthwork and excavation operations shall be observed by the Developer's Soil Engineer. The Soils Engineer will perform the following as a minimum:

1. Inspect the exposed subgrade in backfill areas and delineate areas requiring overexcavation.
2. Perform field density tests to monitor the quality of compacted fill and backfill.

B. <u>Field Density Test</u>

1. Based upon the project's geotechnical report, the Developer's Soil Engineer shall submit a proposed Field Density Test Program to the City's Resident Project Representative for his/her review.
2. The location and frequency of tests will be at the Soil Engineer's discretion with agreement of the City's Resident Project Representative.

C. Employ a licensed surveyor or civil engineer to lay out the work and establish the necessary markers, benchmarks, and stakes.

3.18 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Immediately remove excess excavated material, trash, debris and waste materials and dispose of it off the project site.

3.19 CLEANUP

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

C. The following shall be performed on a continuous basis to the full and complete satisfaction of the City's Resident Project Representative:

1. During progress of the work, keep premises free of debris and waste materials.
2. As directed during work progress, immediately remove all debris, rubbish, left over materials, tools and equipment from the site.

*** END OF SECTION ***

SECTION 02227

SAND-CEMENT SLURRY

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. The work of this Section includes the furnishing of all materials and mixing, for soil stabilization including the placing and curing of sand-cement slurry mix, and all appurtenant work, all in accordance with the requirements of the Contract Documents.

1.02 QUALITY ASSURANCE

A. General Inspection and Test Requirements: Sampling and preparation of sand-cement specimens shall be performed by the Contractor. Sand-cement tests will be performed by the [Engineer] and will be based upon obtaining not less than 150-psi at 7-days on 2 companion cylinders taken 2 times during each working shift. Material poured into cylinder molds shall not be vibrated or tamped.

B. Forty-eight hours before testing, cylinders shall be totally immersed in water. Twenty-four hours before capping and testing, cylinders shall be removed from the water and allowed to drain and air dry. Cylinders will otherwise be tested in accordance with ASTM Designation C 39-72.

C. Inspection: It is required that all sand-cement work specified herein shall be subject to full-time inspection, and no such work shall be scheduled or started without having made prior arrangements with said Inspector to provide for his required inspections. Not less than 24 hours' notice shall be provided to the [Engineer] for scheduling such inspections. Selection of the Inspector shall be by the [Engineer] and all costs therefor shall be paid by the Contractor.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. All sand-cement materials shall conform to the following requirements:

1. Cement shall be portland cement conforming to the requirements of ASTM Designation C 150-74. Cement shall be Type [II] or [V].
2. Water shall be fresh, clean, potable, and free of injurious amounts of mineral or organic substances.
3. Sand for sand-cement shall meet the following criteria:
   a. Not more than 10 percent of the material by weight shall be larger than 3/8-inch, and none of the material shall be larger than ¾-inch.
   b. The sand fraction passing the No. 200 sieve shall, in combination with the cement, be sufficient to insure that the sand remains in suspension while the mixture is being placed.
   c. Sand which contain considerable amounts of organic matter shall not be used.

PART 3 -- EXECUTION

3.01 PROPORTIONING AND MIXING

A. Sand, cement, and water shall be so portioned that the minimum compressive strength will be at least 150 psi in 7 days as determined on 2 companion cylinders taken 2 times during each working shift.

B. Sand cement slurry shall be thoroughly mixed, and the presence of lumps, clods, or foreign matter shall be minimized. Water added in the mixer shall not exceed that required to insure a fluid, readily pumpable mixture.

3.02 PLACING

A. Sand-cement slurry mix shall be placed as indicated on the drawings.

B. Curing of sand-cement slurry mix shall conform to the requirements for concrete curing in Section entitled, ["Minor Concrete"].

*** END OF SECTION ***

SECTION 02228

BLASTING

PART 1 -- GENERAL

1.01 DESCRIPTION

A. This section describes procedures for blasting for excavation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Earthwork: 02200.
B. Trenching, Backfilling, and Compacting: 02224.

1.03 PERMITS AND SAFETY ORDERS

A. Obtain blasting permits required by Salt Lake County, the State of Utah, and any applicable agency having jurisdiction.

B. Comply with the requirements specified in the General Industry Safety Orders of the Utah Division of Industrial Safety.

C. If the amount of explosives to be transported exceeds 1,000-pounds, secure a permit from the Utah Highway Patrol to transport.

1.04 CONTRACTOR'S SUBMITTALS

A. Submit copy of Blaster's License for each blasting supervisor.
B. Specific blasting plan.
C. Seismic monitoring procedure.

1.05 REPORTS AND RECORDS

A. The Contractor shall prepare and maintain on site all reports and records necessary for execution of the work, which shall be accessible to the Construction Manager during normal working hours, including the following:

1. Blast reports for any blasting work.
2. Ground motion vibration levels exceed specified limits of particle velocity or frequency.
3. Existing structural conditions are aggravated or adjacent improvements are damaged as a result of blasting.
4. Blasting methods endanger the stability of intact rock outside the prescribed limits of excavation.
5. Skilled operators and/or licensed foreman is not present.
6. All applicable health and safety reporting requirements.

Blasting operations shall not resume until modifications have been made to correct the conditions that resulted in the suspension. The Contractor shall not be entitled to any extension in time nor to any claim of damage nor excess costs by reason of the blasting suspension order.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Furnish materials and equipment as required for blasting operations. Materials shall conform to all applicable regulatory agency requirements.

PART 3 -- EXECUTION

3.01 BLASTING HOURS

A. Blast only between the hours of 9 a.m. and 4 p.m. during any weekday, Monday through Friday, unless special circumstances warrant another time or day and special approval is granted in writing by the Owner and the agency having jurisdiction.

3.02 BLASTING PROCEDURES

A. Control fly rock and debris to prevent damage to persons or structures. Use blasting mats in developed areas. Equipment used for drilling of holes shall have a positive means of dust control.

B. Do not perform blasting closer than 10-feet to existing water, gas, sewer, or other buried utilities.

C. Use controlled blasting techniques to keep the air blast overpressure, vibration, and noise within the limits herein specified.

D. Notify the Owner at least two workdays before blasting with 1,000-feet of a structure or 500-feet of a paved road.

E. Control fly rock and debris from blasting. Contain fly rock within the project rights of way so that it shall not represent a hazard to people, vehicles, existing improvements, or vegetation. Clean the blasting site of debris associated with the blasting operation at the end of each working day.

F. Blasting operations may be suspended by the Owner for any one or more of the following reasons:

1. Safety precautions are inadequate.
2. Ground motion vibration levels exceed specified limits of particle velocity or frequency.
3. Existing structural conditions are aggravated or adjacent improvements are damaged as a result of blasting.
4. Blasting methods endanger the stability of intact rock outside the prescribed limits of excavation.
5. Skilled operators and/or licensed foreman is not present.

G. Blasting operations shall not resume until modifications have been made to correct the conditions that resulted in the suspension. The Contractor shall not be entitled to any extension in time nor to any claim of damage nor excess costs by reason of the blasting suspension order.

3.03 MAXIMUM PARTICLE VELOCITIES

A. The maximum particle velocity at the nearest point to the pipelines shall be 6.0-inches per second at a minimum frequency of 10 hertz. In the event neither of these limitations is met, perform excavations, repair as necessary, and backfill the excavations whether damage is discovered or it is determined no damage has been incurred.

B. The maximum particle velocity at any other structure within 300-feet of the blast area shall be 0.5-inch per second at frequencies of 10 hertz or less and shall progress linearly to 2-inches per second at a frequency of 40 hertz or greater in accordance with the recommendations of the United States Bureau of Mines Publication RI 8507, Figure 11.14.

3.04 AIR BLAST OVERPRESSURE

A. Air blast overpressure at the property or right-of-way lines shall not exceed 0.03 psi and shall not exceed 0.03 psi at any structure within 300-feet of the blast area.

3.05 NOISE LEVELS

A. Impact or impulsive noise from blasting operations shall not exceed 140 dB measured a the nearest structure or property line.

3.06 FIELD MEASUREMENT

A. Measure peak particle velocity with a seismograph capable of producing a permanent record and capable of internal dynamic calibration. Record air blast overpressure with a peak impact recording instrument having linear frequency response. Place a seismograph at the nearest structure to the blast area to monitor the ground motion particle velocity and frequency during each blast.

*** END OF SECTION ***

SECTION 02276

STABILIZED CONSTRUCTION ENTRANCE

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials and equipment as required to the site entrance as shown in the Contract Documents. This includes grading and compacting the area and placing the riprap.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02275 - Riprap
B. Section 02272 – Fabrics, Erosion Control Mats and Geotextiles
C. Section 02112 – Clearing, Grubbing and Stripping
D. Standard Drawing No. 5105 – Temporary Gravel Construction Entrance/Exit

PART 2 -- PRODUCTS

2.01 STABILIZED CONSTRUCTION ENTRANCE

A. Riprap (No. 3) – Refer to Section 02275 – Riprap.
B. Filer fabric per Section 02272 – Fabrics, Erosion Control Mats and Geotextiles.

PART 3 -- EXECUTION

3.01 STANDARD PROCEDURES

A. Clear all vegetation, roots and all other obstructions in preparation for grading.

B. Prior to placing filter fabric, make sure that the entrance is properly graded and compacted.

C. To reduce maintenance and loss of aggregate, place filter fabric over the existing ground before placing the stone for the entrance.

D. Place riprap as shown in the Contract Documents.

3.02 MAINTENANCE

A. Inspect the entrance at the end of each shift, after significant truck traffic and after every storm event for riprap displacement and sediment buildup.

B. Apply additional rip when required.

C. Remove sediments from within the entrance when they prevent proper drainage of the facility.

D. Provide a vehicle wash-down area with appropriate facilities for vehicles that leave the site. Ensure that all vehicles leaving the site have been properly washed-down and are not tracking dirt, mud or other debris onto existing City streets.

E. Immediately remove sediment and other materials tracked off the site.

F. Maintain associate temporary erosion control measures per Section 02271 – Temporary Erosion Control.

*** END OF SECTION ***

SECTION 02313

TRENCH EXCAVATION

PART 1 -- GENERAL

1.01 SECTION INCLUDES

A. Trench Excavation for Project sanitary sewer pipes and appurtenances.

B. Trench Preparation for sanitary sewer pipe replacement.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02224 – Trenching, Backfilling and Compacting

1.03 REFERENCES

A. Use the latest issue of the reference standards as of the date of the Project.

B. ASTM C 136 – Standard Test Method for Sieve Analysis of Fine and Course Aggregates; 1996a.

C. ASTM D 698 – Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft3(600 kN-m/m3)); 1991.

D. ASTM D 1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 1990 (Reapproved 1996).

E. ASTM D 1557 – Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)), 1991.

F. ASTM D 2167 – Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 1994.

G. ASTM D 2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System); 1993.

H. ASTM D 2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 1991.

I. ASTM D 3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 1988 (Reapproved 1993).

J. ASTM D 4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 1995a.

K. Specification for Excavating on State Highways, latest edition.

L. General Safety Orders Covering Utah Industries – Section 69, Trenches.

M. United States Department of Labor OSHA Publication 2085 – "Employer – Employee, Safe Practice for Excavation and Trenching Operations".

N. Utah Occupational Safety and Health Rules and Regulations – General Standard (UOSHA

1.04 DEFINITIONS

A. Bedding: That surface of the excavation or portion of the pipe zone below the pipe.

B. Drawings: Released for Construction Drawings approved by the City's Engineering Department.

C. Finish Grade Elevations: Top of pavement in paved areas, as indicated on Drawings.

D. Ground Elevations: Indicated on the Drawings.

E. Pipe Invert Elevations: Indicated on the Drawings.

F. Pipe Line Grades and Elevations: Indicated on Drawings.

G. Pipe Zone: That zone in backfilling operations which supports, and surrounds the pipe barrel, and extends to 1-foot above the top of the pipe barrel.

H. Resident Project Representative (City's): Unless otherwise specified by the City, this will be the Engineering Department's Project Inspector.

I. Resident Project Representative (Developer's): The Developer is responsible for notifying the City's Engineering Department in writing, which will fill this role for the Developer.

J. Subgrade Elevations: Bottom of road base in paved areas, as indicated on Drawings.

K. Trench Cross Sections: Indicated on standard drawings for trenches.

1.05 PROJECT CONDITIONS

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

B. Verify locations and elevations of existing utility lines in the area of the Work. Protect all utility lines from excavating equipment and vehicular traffic.

C. Protect plants, lawns, and other features to remain.

D. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, curbs, and other improvements form excavating equipment and vehicular traffic.

PART 2 – PRODUCTS – NOT USED

PART 3 -- EXECUTION

3.01 EXAMINATION

A. Identify required lines, levels, contours, and datum locations.

B. Locate, identify, and protect utilities that remain and protect from damage.

C. Notify utility company to remove and relocate utilities, where and as required.

3.02 TRENCH EXCAVATION

A. Excavate trenches as required to allow Project pipe to be installed to line and grade as indicated on the Drawings.

B. Notify City Inspector of unexpected subsurface conditions and discontinue affected Work in areas until notified to resume Work.

C. It is recommended that all trench excavation be done according to OSHA Standards and other applicable regulations.

D. No not interfere with adjacent foundations.

E. Excavate trenches to width, depth and cross section as indicated on the trench detail drawings.

F. Hand trim excavations. Remove loose matter.

G. Remove large stones and other hard matter which could damage piping or impede consistent backfilling or compaction.

H. Remove excavated material that is unsuitable for re-use on the Project from site and dispose of in an acceptable manner.

I. Where approved by the City Inspector, stockpile excavated material to be re-used in area designated on site.

J. Remove excess excavated material from site and dispose of in an acceptable manner.

K. During construction, provide and maintain sufficient means and devices to promptly remove and properly dispose of all water entering excavations or other parts of the Work.

1. Dispose of water from work area in an acceptable manner, without damage to adjacent property.
2. No pipe, concrete footings, foundations or floors shall be installed in water.
3. Water shall not be allowed to rise over concrete unti it has set for at least 24 hours.
4. Water shall not be allowed to rise against walls and supporting beams for a period of 14-days

after completion of walls and beams.

5. Any damage to pipe work or concrete work cause by water shall be repaired by the Contractor, at Contractor's expense.

L. The use of explosives will not be allowed, unless specifically reviewed and accepted by the City Engineer. All blasting shall be done by a reputable Contractor specializing in the use of explosives, who is acceptable to the City Engineer.

M. Contractor shall provide, at no cost to the City, excavation and safety equipment for test holes used in quality assurance testing as directed by the City Engineer.

3.03 PREPARATION FOR WASTEWATER LINE REPLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with bedding material, Fill Type III, or stabilization material, Type V, or other acceptable material, as directed by the City Inspector.

B. Correct areas that are over-excavated.

1. Fill Type II or Fill Type III flush to required elevation, compacted to at least 96-perdent of the maximum dry density as determined by the standard Proctor method (ASTM D 698) or at least 91-percent of the maximum dry density as determined by the modified Proctor method (ASTM D 1557).

C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.04 CLEANUP

A. Remove unused stockpiled materials; leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

C. The following shall be performed on a continuous basis to the full and complete satisfaction of the City's Resident Project Representative:

1. During progress of the work, keep premises free of debris and waste materials.
2. As directed during work progress, immediately remove all debris, rubbish, left over materials, tools and equipment from the site.

*** END OF SECTION ***

SECTION 02316

TRENCH BACKFILL AND COMPACTION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. This section covers the materials and work associated with backfilling and compacting for Project pipe lines.

B. Coordinate work with other trades on the site.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02055 – Common Fill.
B. Section 02060 – Select Fill.
C. Section 02062 - Flowable Fill.
D. Section 02075 – Geotextile Fabric.
E. Section 02224 – Trenching, Backfilling and Compacting

1.03 REFERENCES

A. Use the latest issue of the reference standards as of the date of the Project.

B. ASTM C 136: Standard Test Method for Sieve Analysis of Fine and Course Aggregates; 1996a.

C. ASTM D 698: Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft3(600 kN-m/m3)); 1991.

D. ASTM D 1556: Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 1990 (Reapproved 1996).

E. ASTM D 1557: Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)), 1991.

F. ASTM D 2167: Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 1994.

G. ASTM D 2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

H. ASTM D 2487: Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System); 1993.

I. ASTM D 2922: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear

Methods (Shallow Depth); 1991.

J. ASTM D 3017: Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 1988 (Reapproved 1993).

K. ASTM D 4318: Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 1995a.

1.04 DEFINITIONS

A. Bedding: That surface of the excavation or portion of the pipe zone below the pipe.

B. Drawings: Released for Construction Drawings approved by the City's Engineering Department.

C. Finish Grade Elevations: Top of pavement in paved areas, as indicated on Drawings.

D. Ground Elevations: Indicated on the Drawings.

E. Pipe Invert Elevations: Indicated on the Drawings.

F. Pipe Line Grades and Elevations: Indicated on Drawings.

G. Pipe Zone: That zone in backfilling operations which supports, and surrounds the pipe barrel, and extends to 1-foot above the top of the pipe barrel.

H. Resident Project Representative (City's): Unless otherwise specified by the City, this will be the Engineering Department's Project Inspector.

I. Resident Project Representative (Developer's): The Developer is responsible for notifying the City's Engineering Department in writing, which will fill this role for the Developer.

J. Subgrade Elevations: Bottom of road base in paved areas, as indicated on Drawings.

K. Trench Cross Sections: Indicated on standard drawings for trenches.

1.05 SUBMITTALS

A. Submit aggregate batch delivery tickets showing name of material source; serial number of ticket; date and truck number; name of supplier; job name and location; volume of material delivered; and aggregate classification.

B. Submit samples of proposed imported borrow material for review by the Soils Engineer prior to delivery to the Site.

C. Submit maximum laboratory dry density and optimum laboratory moisture content for:

1. Subgrade material, and

2. Each type of fill to be used in the Work.

D. Upon City's Resident Project Representative's request, submit a written quality control inspection and testing report describing source and field quality control activities performed by Developer and its suppliers.

1.06 STORAGE AND PROTECTION

A. Stockpile backfill materials in sufficient quantities for the work.

B. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.

C. Prevent erosion or deterioration of material.

D. Use means necessary to avoid displacement of, and injury to work while compacting or operating equipment.

E. Movement of construction machinery over work at any stage of construction is solely at the Contractors and Developer's risk.

PART 2 -- PRODUCTS

2.01 GENERAL REQUIREMENTS

A. No frozen materials shall be used as backfill.

B. Backfill materials shall be free of organic materials.

C. No man made materials shall be used as backfill, unless otherwise approved by the City Engineer.

2.02 TRENCH BACKFILL MATERIALS

A. General Fill, Fill Type 1: Imported borrow or soil excavated on-site if acceptable to the City Engineer; conforming to Type A-2 of AASHTO Classification of Soils and Soil-Aggregate Mixtures.

1. Graded.
2. Free of lumps larger than 3-inches, rocks larger than 2-inches, and debris.

B. Fill Type II: Native or imported material meeting the following requirements:

1. Graded.
2. Free from lumps larger than 3-inches, rocks larger than 2-inches, organic material and debris.
3. No more than 20-percent of material passing No. 200 sieve.

C. Fill Type III: Angular crushed washed stone; free of shale; clay, friable material, organic material

and debris, meeting the following requirements:

1. Graded.
2. 100-percent passing the 2-inch sieve.
3. Not more than 5-percent of material passing the No. 200 sieve.

D. Fill Type IV: Natural stone; washed, free of clay, shale, and organic matter.

1. Graded in accordance with ASTM C 136, within the following limits:
   a. Minimum Size: ¼-inch.
   b. Maximum Size: 5/8-inch.

E. Fill Type V: Free draining granular backfill material; natural or crushed aggregate.

1. Graded in accordance with ASTM C 136, within the following limits:
   a. 2-inch sieve: 100-percent passing.
   b. 1-inch sieve: 95 to 100-percent passing.
   c. ½-inch sieve: 25 to 60-percent passing.
   d. No. 4 sieve: 0 to 10-percent passing.

F. Fill Type VI: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.

1. Graded in accordance with ASTM C 136; within the following limits:
   a. No. 4 sieve: 100-percent passing.
   b. No. 14 sieve: 10 to 100-percent passing.
   c. No. 50 sieve: 4 to 30-percent passing.
   d. No. 100 sieve: 4 to 30-percent passing.
   e. No. 200 sieve: 0-percent passing.

G. Fill Type VII: Topsoil excavated on-site.

1. Graded.
2. Free of roots, rocks larger than ½-inch, subsoil, debris, large weeks and foreign matter.
3. Acidity range (pH) of 5.5 to 7.5.
4. Containing a minimum of 4-percent and a maximum of 25-percent inorganic matter.
5. Conforming to ASTM D 2487 Group Symbol OL or OH.

H. Fill type VIII: Material excavated during trenching operations, not conforming to Type II requirements.

1. May only be used as trench backfill if recommend by the geotechnical engineer of record and approved by the City Inspector and City Engineer.
2. Geotechnical engineer of record shall define placement and compaction methods.
3. Contractor and/or Developer shall employ and pay for full-time quality control services of the geotechnical engineer of record.
4. Upon completion of the project, the geotechnical engineer of record shall prepare a letter

summarizing:

a. Testing methods, test frequencies and observations.
b. Any non-conforming condition(s) and corrective action(s) taken to remedy the non-conformity(ies).
c. Compliance of the work to the project specifications.

I. Concrete for Fill: Lean concrete.

1. Conforming to Flowable Fill, Section 605 of the Utah Department of Transportation's Standard Specifications.

2.03 QUALITY CONTROL

A. See Section 01400 – Quality Requirements, for general requirements for testing and analysis of soil material.

B. If tests indicate materials do not meet specified requirements, promptly change material and retest.

C. Provide materials of each type from same source throughout the Work.

PART 3 -- EXECUTION

3.01 EXAMINATION

A. Identify required lines, levels, contours, and datum locations.

B. Verify structural ability of unsupported walls to support imposed loads by the fill.

3.02 TRENCH BACKFILL

A. Fill to finish contours and elevations indicated.

B. Fill up to subgrade elevations where indicated.

C. Employ a placement method that does not disturb or damage other work.

D. Do not fill over porous, wet, frozen, or spongy subgrade surfaces.

E. Maintain moisture content of fill materials within 2-percent of optimum moisture as determined by ASTM D 698 or ASTM D 1557 to attain required compaction density.

F. Place and mechanically compact materials in equal continuous layers not exceeding 8-inches in compacted depth.

G. Reshape and re-compact fills subjected to vehicular traffic.
H. Pipe Zone

1. Use granular fill, Type III; or other acceptable material.
2. Fill under, around and over sewer pipe as indicated on the "Standard Sewer Trench Detail" drawing.
3. Use Lean Concrete fill material in areas of excessive cover over pipe, as directed by the City Inspector.
   a. Excessive cover shall be determined by pipe manufacturer and approved by City Inspector
4. Compact to at least 96-percent of the maximum dry density as determined by the standard Proctor method (ASTM D 698) or to at least 91-percent as determined by the modified Proctor compaction method (ASTM D 1557).

I. Trench Backfill above Pipe Zone

1. Use Fill Type II, Type VIII or local governing entities' specification if more stringent.
2. Fill up to subgrade elevations or finish grade, as indicated.
3. Compact at least 96-percent of the maximum dry density as determined by the modified Proctor compaction method (ASTM D 1557) or to local governing entities' specification, if more stringent.

J. Under curb and gutter, sidewalks, slabs-on-grade, and other concrete work:

1. Use granular fill, Fill Type II or III.
2. Compact to at least 96-percent of the maximum dry density as determined by the standard Proctor method (ASTM D 698) or to at least 91-percent of the maximum dry density as determined by the modified Proctor compaction method (ASTM D 1557).

K. At Landscaped Areas

1. Use general fill, Fill Type I or Fill Type VIII.
2. Fill up to 4-inches below finish grade elevations.
3. Compact to at least 91-percent of the maximum dry density as determined by the modified Proctor compaction method (ASTM D 1557).

L. After placement, compaction and testing of mechanically compacted backfill is completed, Contractor may utilize other compaction methods when accepted by the City Inspector and/or City Engineer.

3.03 SURFACE RESTORATION

A. Where required, restore surface to as near original condition as is reasonably possible.

3.04 QUALITY CONTROL

A. See Section 01400 – Quality Requirement, for general requirements for field inspection and testing.

B. All testing is to be done by an independent testing company for the Contractor and/or Developer,

test results for all tests will be sent to the City Inspector within 24-hours after the tests have been completed.

C. Perform compaction, moisture and density testing on compacted fill in accordance with ASTM D 1556, ASTM D2167, ASTM D 2922, or ASTM D 3017.

D. Evaluate results in relation to compaction curve determined by testing material in accordance with ASTM D 698 ("standard Proctor"), ASTM D 1557 ("modified Proctor").

E. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

F. Frequency of Tests: As directed by the City's Inspector with at least one test for each 200 CY of material.

G. The City Inspector shall have the right to determine when and where all soil testing shall be performed.

H. Contractor shall provide excavation and safety equipment for test holes used in quality assurance testing as directed by the City Inspector, at no cost to the City.

I. The City may perform additional quality assurance testing to verify conformance with these specifications.

   1. Contractor shall provide excavation and safety equipment for test holes used in quality assurance testing as directed by the City Inspector.

3.05 CLEANUP

A. Remove unused stockpiled materials; leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

C. The following shall be performed on a continuous basis to the full and complete satisfaction of the City's Resident Project Representative:

   1. During progress of the work, keep premises free of debris and waste materials.
   2. As directed during work progress, immediately remove all debris, rubbish, left over materials, tools and equipment from the site.

*** END OF SECTION ***

SECTION 02606

MANHOLES

PART 1 -- GENERAL

1.01 SECTION INCLUDES

A. Cast-in-place concrete manholes with masonry or precast transition to lid frame, covers, anchorage, and accessories.

B. Modular precast concrete manhole sections, with precast or cast-in-place bases, with tongue-and-groove joints, masonry or precast transition to lid frame, covers, anchorage, and accessories.

1.02 RELATED SECTIONS

A. Section 03300 – Cast-in-Place Concrete
B. Section 03302 – Concrete
C. Section 02204 – Earthwork
D. Section 02667 - Hydraulic Structures and Pipeline Testing
E. Section 02617 - Reinforced Concrete Pipe

1.03 REFERENCE DOCUMENTS

A. ASTM A 48: Standard Specification for Gray Iron Castings; 1994a.

B. ASTM C 478: Standard Specification for Precast Reinforced Concrete Manhole Sections; 1996.

C. ASTM C 923: Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals; 1996.

1.04 SUBMITTALS

A. See Section 01300 – Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate manhole locations, elevations, piping sizes and elevations of pipe inverts.

C. Product Data: Provide manhole covers, component construction, manhole steps, features, configuration, and dimensions.

1.05 QUALITY ASSURANCE

A. Manufacturer – Company specializing in manufacturing products specified in this Section with at least three years of documented experience.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. Amcor, Inc.
B. D&L Supply Company
C. Geneva Pipe Company
D. Olympic Foundry
E. Substitutions – See Section 01600 – Product Requirements

2.02 PRECAST SECTIONS

A. Manhole Base: Precast concrete manhole base of appropriate size.

1. Provide appropriate size flexible sleeves of synthetic rubber, with stainless steel clamps and bolts, for all pipe openings in base section.
2. Construct poured-in-place manhole base where manhole is to be constructed over existing wastewater pipeline, as directed by the City Inspector. Manhole base shall be constructed as indicated on the Drawings.

B. Manhole Rise Sections: Precast riser sections of appropriate size and length, extending from top of base section to bottom of top section.

C. Manhole Sections: Reinforced Precast concrete in accordance with ASTM C 478 (ASTM C 478M), with gaskets in accordance with ASTM C 923 (ASTM C 923M).

D. Manhole Top Section: Precast eccentric cone section of appropriate size, with 30-inch diameter top opening.

1. Flat slab top sections can be used only where indicated on the plan drawings and accepted by the City Inspector; designed for H-20 live loading.

E. Joints: Base section, riser sections, and top section shall have lipped male/female ends, which shall provide uniform and continuous interior wall surface.

1. Joints shall be sealed with pre-lubricated rubber gaskets, conforming to requirements of ASTM C 443 and C 361; Forsheda No. 114 Seal, manufactured by Forsheda Pipe Seal Company, or approved equal.

F. Grade Rings: Precast grade rings, as required, to adjust height of manhole lid and frame.

1. Grade rings shall use mastic sealer to insure watertight installation.

G. Lid and Frame: ASTM A 48 Class 30B Cast iron construction, machined flat bearing surface, removable lid with cleated surface and pick holes, lockable lid if indicated, vented lid design in improved areas and solid lid design in unimproved areas, H-20 highway load rating; lid molded with City of West Jordan imprinted on lid; Provide Model A-1180 manufactured by D & L Supply, or

approved equal.

H. Manhole Steps: Formed, copolymer polypropylene-encased, steel rungs; ¾-inch diameter minimum. Cast-in-place or vibrate into green concrete. Model PSI-FF manhole steps, manufactured by M.A. Industries, Inc. or approved equal.

I. Collars: Constructed of concrete or bituminous as indicated on the Drawings.

J. In locations with pipes 18-inches in diameter and larger and in locations where required by the City Engineer, concrete materials shall be manufactured with Dynastone in conformance with applicable specifications and standards.

2.03 INTERIOR COATING

A. Manhole Interior Coating: Coating shall be a polymorphic resin as manufactured by Integrated Environmental Technologies, or approved equal. Such coating system shall be as detailed in "Specification 3000" for "Manhole Renovation & Protection" as published by Integrated Environmental Technologies, a copy of "Specification 3000" is appended at the end of this specifications. Coatings shall be installed as indicated on Drawings.

2.04 CONFIGURATION

A. Manholes shall be constructed as indicated on the Standard Manhole Drawing.

B. Shaft Construction: Concentric with eccentric cone tope section; lipped male/female joints; sleeved to receive pipe sections.

C. Shape: Cylindrical.

D. Clear Inside Dimensions: 48-inch, 60-inch, or 72-inch diameter, as indicated.

E. Design Depth: As indicated.

F. Clear Lid Opening: 30-inch diameter, as indicated.

G. Pipe Entry: Provide openings for all pipes entering manhole, as indicated.

H. Steps: Install at 12-inches on center vertically, set into manhole wall directly under opening.

PART 3 -- EXECUTION

3.01 EXAMINATION

A. Verify items provided by other sections of the Work are properly sized and located.

B. Verify that built-in items are in proper location, and ready for roughing into Work.

C. Verify excavation for manholes is correct.

3.02 PREPARATION

A. Where native material encountered at foundation depth of manhole is considered unsuitable, remove unsuitable material; and place and compact bedding material to limits shown on the Drawings.

3.03 MANHOLES

A. Install precast manhole base level on a compacted foundation.

B. Construct cast-in-place manhole base over existing wastewater lines, as acceptable to the City Inspector. Manhole base shall be constructed as indicated on the Standard Drawings.

   1. After new manhole has been completed, saw-cut into top of existing wastewater pipe, remove section of pipe as required, and dispose of the removed material; construct watertight grout invert channels through new manhole between new pipe and existing pipe line, as directed. Invert channel shall be formed to direct wastewater flows through the manhole as directed.
   2. Divert existing wastewater flows around work area to allow connection to existing pipeline to be made.

C. Place manhole rise sections plumb and level, from the manhole base to the top section, as indicated and according to manufacturer's instructions; anchor to base; align steps perpendicular to wastewater line, and seal joints.

D. Place top section, cone section or flat slab, on top riser section, with opening positioned over steps. To of cone section or flat slab shall be from 10-inches to 18-inches below final surface elevation, as directed by the City Inspector.

E. Install grade rings, as required, to adjust top of lid and frame to match finish elevation. Maximum height of grade rings shall be 12-inches, unless otherwise approved by the City Engineer.

F. Connect pipe to manhole with appropriate type flexible coupling as recommended by manufacturer. Provide pipe joint or flexible coupling on all pipes approximately 18-inches from outside of manhole. Grout around pipe after installation is complete. Make connections watertight.

G. Provide wastewater pipe stubs for future connections of the same type of pipe used on the Project, and of the size indicated on the Drawings.

   1. Alignment and grade of stub to be determined by the Design Engineer.
   2. Install permanent, watertight plug or cap on end of stub, outside of the manhole.

H. Grout inside of manhole base sections to form channel between connected pipes, as indicated on the Drawings. Trowel smooth. Top of channel shall be the same elevation as top of outlet pipe.

I. Set cover frames and lids to match street elevation and slope. After placement, grout around the exterior of frame from top of concrete top section to top of frame, as indicated, to ensure watertight

condition.

J. After manhole base has been completed, furnish and install temporary pipe plugs to seal all interior pipe openings; plugs to be Brandt DuoSeal Pipe Plug by Burke Rubber Company, Cheme Pipe Plug by Cheme Manufacturing Company, or approved equal. Pipe plugs shall remain in place until final review and acceptance of completed wastewater system. Plugs shall then be removed; and shall be the property of the Contractor.

K. In paved areas, collars shall be constructed around manhole covers as indicated. Collars shall be constructed of either concrete or bituminous asphalt; and shall be constructed after new pavement has been placed and accepted by the City Inspector and/or Governing Agency. Concrete collars shall contain synthetic fiber reinforcement as per Section 03300 – Cast-in-Place Concrete.

L. Coordinate with other sections of Work to provide correct size, shape and location.

M. Drop manholes shall not be designed or constructed without written approval of the City Engineer. Where approved, drop manholes shall be constructed as indicate in the Standard Drawings.

N. One-foot manhole rise sections will not be allowed, unless previously approved by the City Engineer.

3.04 INTERIOR COATING

A. Manhole Interior Coating. The interior of all new manhole sections shall be lined with a polymorphic resin coating system. The application of this coating system shall be as detailed in "Specification 3000" for "Manhole Renovation & Protection" as published by Integrated Environmental Technologies, a copy of "Specification 3000" is appended at the end of this specifications. The specified mechanical application of the coating system may be waived providing skilled workmen, with prior experience in applications of polymorphic resin coatings, by other means, are used Documentation of workmen's' experience will be required.

3.05 QUALITY CONTROL

A. Manholes shall be tested, by an independent testing company, using vacuum test method to demonstrate the integrity of installed materials and construction procedures. Method and material for repair shall be as acceptable to the City Engineer.

1. Each manhole shall be tested after assembly and backfilling.
2. Plug all lift holes with an acceptable non-shrink grout.
3. Plug all pipes entering manhole; securely brace plugs during test.
4. Test head shall be placed at inside top of cast iron frame, or as accepted by the City Engineer; and the seal shall be inflated in accordance with manufacturer's recommendations.

B. Testing shall conform to ASTM C 1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test.

C. If manhole fails initial test, make all necessary repairs on the outside of manhole with non-shrink grout, or other acceptable material. Manhole shall be re-tested until satisfactory test is obtained.

D. Pour-in-place manholes to be constructed of Dynastone shall be overseen by the City Inspector and a quality assurance representative from the manhole supplier and/or manufacturer.

*** END OF SECTION ***

SECTION 02608

DIVERSION STRUCTURES

PART 1 -- GENERAL

1.01 SECTION INCLUDES

A. Cast-in-place concrete diversion boxes.

B. Pre-cast concrete diversion boxes.

C. Heavy duty sluice gates.

1.02 RELATED SECTIONS

A. Section 02312 – Trench Excavation

B. Section 02316 – Trench Backfill and Compaction

C. Section 02640 – Manholes and Covers.

D. Section 03300 – Cast-in-Place Concrete

1.03 SUBMITTALS

A. Product Data : Provide component construction data, configuration and dimensions.

B. Operations and Maintenance Manuals: Submitted upon completion of the Project.

1.04 QUALITY ASSURANCE

A. Manufacturer : Company specializing in manufacturing products specified in this Section with at least three years of documented experience.

1.05 PROJECT CONDITIONS

A. Coordinate the Work on existing wastewater lines and connections with the City.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Concrete: Specified in Section 03300.

B. Concrete Reinforcement: Specified in Section 03300.

2.02 COMPONENTS

A. Manhole Steps: As specified in Section 02640.

B. Lid and Frame: As specified in Section 02640.

C. Hatch: Shall be Safe-Hatch as manufactured by Flygt. Size and load capacity as indicated on the Drawings.

D. Sluice Gates: Shall be Fresno Valves & Castings Series 8200 fabricated 316 stainless steel slide gates. Gates shall have poly bars, "J" seals, flush bottom seals, and geared lifts. Gates shall have non-rising stems, stems shall not be in the water flow. Gates shall include a lift torque arm bracket compatible with the Waterman GMH-12 hydraulic operator. Proper design shall be used to withstand head pressures required for the Project. Manufacturer shall be established for more than 5-years with proven capabilities of design and performance.

E. Miscellaneous Components: Other items shall be corrosion resistant as approved by the City Engineer.

F. Where required by the City Engineer, all concrete materials shall be manufactured by Dynastone®, or approved equal.

2.03 INTERIOR COATING

A. Interior Coating: Coating shall be a polymorphic resin as manufactured by Integrated Environmental Technologies, or approved equal. Such coating system shall be as detailed in "Specification 3000" for "Manhole Renovation & Protection" as published by Integrated Environmental Technologies, a copy of "Specification 3000" is appended at the end of this specifications. Coatings shall be installed as indicated on Drawings.

2.04 CONFIGURATION

A. Diversion Boxes shall be constructed as par the approved Drawings.

B. Channels shall be constructed to minimize turbulence in flows.

PART 3 -- EXECUTION

3.01 EXAMINATION

A. Verify items provided by other sections of the Work are properly sized and located.

B. Verify that built-in items are in proper location, and ready for roughing into Work.

C. Verify excavation for diversion box(es) is correct.

3.02 PREPARATION

A. Where native material encountered at foundation depth of diversion box is considered unsuitable, remove unsuitable material; and place and compact bedding material to limits shown on the Drawings.

3.03 DIVERSION BOXES

A. Construct cast-in-place diversion box over existing wastewater lines, as shown on the Drawings.

B. Install sluice gates as per manufacturer's instructions.

C. Boxes shall be constructed to ensure the City can open and close gates easily with City's hydraulic operator.

3.04 INTERIOR COATING

A. Manhole Interior Coating: The interior of all new manhole sections shall be lined with a polymorphic resin coating system. The application of this coating system shall be as detailed in "Specification 3000" for "Manhole Renovation & Protection" as published by Integrated Environmental Technologies, a copy of "Specification 3000" is appended at the end of this specifications. The specified mechanical application of the coating system may be waived providing skilled workmen, with prior experience in applications of polymorphic resin coatings, by other means, are used Documentation of workmen's' experience will be required.

3.05 QUALITY CONTROL

A. Diversion Boxes shall be tested, by an independent testing company, using vacuum test method to demonstrate the integrity of installed materials and construction procedures. Method and material for repair shall be directed by the Design Engineer and acceptable to the City Engineer.

1. Each box shall be tested after assembly and backfilling.
2. Plug all lift holes with an acceptable non-shrink grout.
3. Plug all pipes entering diversion box; securely brace plugs during test.
4. Test head shall be placed at inside top of cast iron frame, or as accepted by the City Engineer; and the seal shall be inflated in accordance with manufacturer's recommendations.

B. Testing shall conform to ASTM C 1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test.

C. If diversion box fails initial test, make all necessary repairs on the outside of box with non-shrink grout, or other acceptable material. Box shall be re-tested until satisfactory test is obtained.

*** END OF SECTION ***

SECTION 02617

REINFORCED CONCRETE PIPE

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish, install, and test all reinforced concrete sewer, culvert and storm drain pipelines, complete in place, including connection to existing and new structures, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Construction of catch basins and headwalls shall conform to the requirements of Section 03300 entitled, "Cast-in-Place Concrete," Section 03304 "Minor Concrete," and Section 03480 "Precast Concrete Specialties," as applicable.

B. Trenching and backfilling shall conform to the requirements of Section 02316 "Trench Backfill and Compaction."

C. Manhole construction shall conform to the requirements of Section 02606 "Manholes."

D. Field testing shall conform to the requirement of Section 02750 "Storm Drainage System Testing."

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publication are in conflict with the requirements specified herein, the more stringent requirement shall apply.

1.04 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish certificates to the Engineer guaranteeing that the pipe furnished hereunder is in compliance with the requirements of these Specifications.

1. Commercial Standards:

ASTM C33	Specifications for Concrete Aggregate
ASTM C76	Specification for Reinforced Concrete Culvert Storm Drain and Sewer Pipe
ASTM C150	Specifications for Portland Cement
ASTM C443	Specifications for Rubber Gaskets

PART 2 -- PRODUCTS

2.01 PIPE MATERIALS

A. Reinforced Concrete Pipe: Reinforced concrete pipe shall conform to the requirements of ASTM Designation C 76-82b with Type V cement; provided that pipe shall have tongue and groove joint designated to be self-centering and to leave a recess on the inside of the pipe for pointing with mortar after jointing. Pipe shall be designated for an internal pressure of 25-feet of water, and an external load of 1500-D.

B. Cement Mortar: Cement mortar shall consist of a mixture of portland cement, sand, and water. Cement and sand shall first be combined in the proper proportions, and then thoroughly mixed with the required amount of water.

C. Cement mortar shall be designated by class and proportioned by loose volume in the proportion of 1 part cement and 2 parts sand.

D. The quantity of water to be used in the preparation of mortar shall be only that required to produce a mixture sufficiently workable for the purpose intended.

E. Mortar shall be used as soon as possible after mixing and shall show no visible signs of setting prior to use. Retempering of mortar will not be permitted.

F. Cement, sand, and water for cement mortar shall conform to the requirements of Section entitled, "Cast-in-Place Concrete."

G. Admixtures: No admixture shall be used in mortar unless otherwise specified or accepted by the Engineer.

H. Quick Setting Grout: Quick setting grout shall be a high strength, non-staining grout approved by the Engineer prior to use. It shall reach an initial set within 90 minutes at 70 degrees F (21 degrees C) and shall reach minimum compressive strength of 2,500 psi (17mPa) within 24 hours. Shrinkage shall be less than 0.1 percent when tested, using the test procedures of ASTM C 596-82. The grout shall be mixed, handled, and placed in accordance with the manufacturer's written instructions.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The pipe shall be placed with the minor axis of the reinforcement in a vertical position. Mortar for jointing pipe shall be composed of 1 part of cement and 2 parts of clean, well-graded sand of such size that all will pass a No. 8 sieve. The consistency of laying mortar shall be such that it will adhere to the ends of the pipe while being laid and be easily squeezed out of the joint when the pipe while being laid and be easily squeezed out of the joint when the pipe sections are pressed together. Pointing and bonding mortar shall be plastic and of such consistency that it will readily adhere to the pipe.

B. In advance of jointing sections of concrete pipe, the ends of each section shall be washed clean with a wet brush and, immediately prior to placing mortar and jointing the sections, the ends shall be thoroughly wetted. After laying, the joints on the inside shall be swabbed smooth, and all excess mortar shall be removed from the pipe, after which backfilling shall be performed.

C. Backfill over the pipe shall not be commenced within 16 hours of jointing pipe sections. Care shall be used to make sure that the bottom of the pipe is in contact with the bottom of the trench for the full length of each section.

*** END OF SECTION ***

SECTION 02618

REINFORCED CONCRETE PRESSURE PIPE

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall construct and test all reinforced concrete pressure pipe, ANSI/AWWA C302, non-cylinder type, complete in place, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Trench excavation and backfill and appurtenant earthwork shall conform to the requirements of Section entitled, "Earthwork," and the requirements specified herein.

B. Concrete for construction of anchor blocks and thrust blocks shall conform to the requirements of Section entitled, "Cast-in-Place Concrete," and "Minor Concrete," as applicable.

C. Field testing and disinfection shall conform to the requirements of Section entitled, "Water Pipeline Testing."

D. Fabricated pipe fittings, bends, and anchor bolts shall conform to the requirements of Section entitled, "Miscellaneous Metalwork."

E. Valve supports, flange bolts, and anchor bolts shall be as specified in Section entitled, "Steel Pipe - Fabricated Specials."

F. Valves and appurtenances shall conform to the requirements of the applicable Sections of Division 15.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced AWWA Standards to the extent that the requirements therein are not in conflict with the provisions of this Section.

B. References in these specification to "AWWA Standards" shall be as published by the American Water Works Association, Incorporated, 2 Park Avenue, New York, New York, 10016.

1.04 CONTRACTOR SUBMITTALS

A. The Contractor shall submit certificates, test reports, shop drawings and laying diagrams of all pipe, joints, and piping appurtenances in accordance with the requirements in Section entitled, "Contractor Submittals."

B. A certified affidavit of compliance shall be furnished for all pipe and other products or materials furnished under this section of the specifications.

C. If pipe is steam-cured, the Contractor shall furnish to the Engineer copies of recorder charts showing temperature and duration of the curing period.

1.05 QUALITY ASSURANCE

A. Shop Testing: All pipe shall be subject to a D-load test at the manufacturer's plant. The Engineer may select at random and test as specified one length of each class of pipe for the D-load test specified in ANSI/AWWA C302-81. The cost of the pipe and the tests shall be borne by the Contractor. Pipe will be acceptable under the test requirements specified herein when all test specimens conform to the test requirements. Should any of the test specimens fail to meet the test requirements, the manufacturer will be allowed to retest 2 additional specimens for each specimen that failed, and the pipe shall be acceptable only when all of the retest specimens meet the strength requirements.

B. Field Testing: Field testing shall conform to the requirements of Section entitled, "Water Pipeline Testing."

PART 2 -- PRODUCTS

2.01 REINFORCED CONCRETE PIPE

A. General: Reinforced concrete pressure pipe shall conform to ANSI/AWWA C302-81, "AWWA Standard for Reinforced Concrete Pressure Pipe, non-cylinder Type, for Water and Other Liquids," and the following provisions. Pipe shall have bell and spigot type joints with single rubber gaskets. Except where shorter lengths of special sections are required, pipe sections shall have a minimum length of 8 feet and a maximum length of 16 feet.

B. Pipe Design: Pipe shall be designed for an internal pressure of not less than 50 feet of water, and an external load of 1500-D.

C. Marking of Pipe: Each pipe section shall be identified by a stamp indicating:

1. Name of manufacturer
2. Date of manufacture
3. Design pressure in feet of head
4. D-loading in pounds.

2.02 PIPE MATERIALS AND FABRICATION

A. General: Materials used in the fabrication of reinforced concrete cylinder pipe shall conform to the following requirements:

B. Cement: Cement shall conform to ASTM C 150-83a, Type II.

C. Aggregate: All aggregates shall be obtained from approved pits, and shall conform to ASTM C 33-82.

D. Rubber Gasket: Rubber gaskets, for use with bell and spigot pipe, shall conform to ANSI/AWWA C303-78.

E. Cleanliness of Pipe: The interior of each pipe section and special shall be clean and free of foreign materials when they are delivered to the site of the work.

2.03 PIPE FITTINGS AND SPECIALS

A. Unless otherwise indicated in the Contract Documents, all pipe fittings and specials for reinforced concrete pipe shall meet the general requirements of Section entitled, "Steel Pipe Fabricated Specials."

B. Specials are defined as bends, reducers, wyes, tees, crosses, outlets, and manifolds wherever located, and all piping above ground or in structures.

PART 3 -- EXECUTION

3.01 PIPE HANDLING AND LAYING

A. General: All laying, jointing and testing for defects and for leakage under pressure shall be performed in the presence of the Engineer, and shall be subject to its approval before acceptance. All material found during the progress to have defects will be rejected and the Contractor shall promptly remove such defective material from the site of the work.

B. Handling of Pipe and Accessories: Necessary facilities shall be provided for lowering and properly placing the pipe sections in the trench without damage. All handling of reinforced concrete pipe shall be done with fabric slings which will not damage the pipe. Slings shall bear uniformly against the pipe. When not being handled, all pipe shall be supported on timber cradles, sand bags, or mounds of earth.

C. Alignment and Grade: The pipe shall be laid to the lines and grades shown on the drawings and the sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointing, the bedding for the pipe shall be checked for firmness and uniformity of surface.

3.02 INSTALLATION OF PIPING

A. General: Unless otherwise provided, the Contractor shall furnish and install all pipe, closure pieces, supports, gaskets, jointing materials, and all other appurtenances as shown and as required to provide a complete and workable installation. Where pipe support details are shown, the supports shall conform thereto and shall be placed as indicated; provided, that the support for all exposed piping shall be complete and adequate regardless of whether or not supporting devices are specifically shown. Where shown, concrete thrust blocks shall be provided. At all times when the work of installing pipe is not in progress, all openings into the pipe and the ends of the pipe in trenches or structures shall be kept tightly closed to prevent entrance of animals and foreign materials. The Contractor shall take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source, shall assume full responsibility for any damage due to this cause and shall at its own expense restore and replace the pipe to its specified condition and grade if it is displaced due to floating. The Contractor shall maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the Owner.

B. Handling Pipe: Pipe shall be lifted in such a manner as to minimize bending of the pipe section and prevent damage to the pipe. When being transported, pipe shall be supported in a manner that will prevent distortion or damage to the pipe. When not being handled, pipe shall be stockpiled on timber cradles or properly prepared ground with all rock points eliminated. Any pipe section that becomes damaged as a result of improper handling or stockpiling shall be repaired to the satisfaction of the Engineer or shall be replaced with a new unit at no additional cost to the owner.

C. Laying: Trenches shall be in a reasonable dry condition when the pipe is laid. Necessary facilities including slings shall be provided for lowering and properly placing the pipe sections in the trench without damage. The pipe sections shall be laid to the line and grade shown and they shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointing, the bedding for the pipe shall be checked for firmness and uniformity of surface.

D. Rubber Gasket Joints: The rubber gasket joint shall be made by properly lubricating the rubber gasket with a suitable vegetable compound soap before it is placed in the groove at the spigot end. The gasket shall be stretched over the spigot end of the pipe and carefully seated in the groove, with care taken to equalize the stress in the gasket around the circumference of the joint. The gasket shall not be twisted, rolled, cut, crimped, or otherwise injured or forced out of position during the closure of the joint. A feeler gage shall be used to check the position of the rubber gasket after the joint has been telescoped.

E. With pipe smaller than 24 inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with mortar containing 1 part of a non-shrink, non-metallic cement to 3 parts sand. The spigot end then shall be forced to the bottom of the bell and excess mortar on the inside of the joint shall be swabbed out.

F. With pipe 24 inches in diameter and larger, joints shall be pointed on the inside with mortar as specified above after the backfill has been placed.

G. After the pipe has been laid, but before backfill has been completed, the outside annular space

between pipe sections shall be completely filled with grout. Grout shall consist of 1 part cement to 3 parts sand, by weight, and shall be sufficiently fluid to permit it to be poured into the joint space. The outside mortar joints shall be properly formed by the use of heavy-duty diapers.

H. Curves, Angles, and Bends: Where curved alignments are indicated on the drawings, unsymmetrical closure of the spigot into the bell will be allowed up to ¾ inch on one side of the joint. Where a smaller radius of curvature is required than can be accommodated by unsymmetrical closure, sections of pipe with bevelled ends may be laid on curved alignment unless fabricated bends are shown on the drawings. The spigot end of beveled pipe may have a maximum bevel of 5 degrees measured from a plane perpendicular to the pipe axis. The center of the short side of the bevel shall be marked on the pipe rings.

*** END OF SECTION ***

SECTION 02621

REINFORCED CONCRETE CYLINDER PIPE

PART 1 -- GENERAL

1.01 SCOPE

A. The work of this Section, includes the construction and testing of reinforced concrete cylinder pipe, pretensioned type, complete in place, as indicated on the drawings and specified herein, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Trench excavation and backfill and appurtenant earthwork shall conform to the requirements of Section entitled, ["Earthwork,"] and the requirements specified herein.

B. Concrete for construction of anchor blocks and thrust blocks shall conform to the requirements of Section entitled, ["Cast-in-Place Concrete."]

C. Field testing and disinfection shall conform to the requirements of Section entitled, ["Testing and Disinfection."]

D. Protective coatings for exposed steel surfaces shall be as specified in Section entitled, ["Painting and Protective Coating."]

E. Cadwelding shall conform to the requirements of Section entitled ["Insulated couplings and Test Stations."]

F. Valve supports, flange bolts, and anchor bolts shall conform to the requirements of Section entitled, ["Miscellaneous Metalwork."]

G. Valves and appurtenances shall conform to the requirements of Section entitled, ["Valves and Appurtenances."]

1.03 REFERENCE SPECIFICATIONS AND STANDARDS

A. Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced AWWA Standards to the extent that the requirements therein are not in conflict with the provisions of this Section.

B. References in these specifications to "AWWA Standards" shall mean AWWA Standards as published by the American Water Works Association, Incorporated, 2 Park Avenue, New York, New York, 10016.

1.04 CONTRACTOR SUBMITTALS

A. The Contractor shall submit shop drawings and laying diagrams of all pipe, joints, bends, special fittings, and piping appurtenances in accordance with the requirements for ["Drawings Required to be Submitted by the Contractor"] in Section entitled, ["Contractor Submittals."]

1.05 QUALITY ASSURANCE

A. Shop Testing of Steel Plate Specials: Upon completion of the welding, but prior to lining and coating, each steel plate special shall be bulkheaded and tested under a hydrostatic pressure of 1½ times the design pressure; provided that if straight pipe used in fabricating the specials has been previously tested and meets the requirements of Paragraph 3.01(A), herein, no further hydrostatic testing will be required, provided that the transverse seams are tested by a dye-penetrant process using materials such as manufactured by Turco Products, Inc., Wilmington, California, or an approved equal. Any pin holes or porous welds which may be revealed by the test shall be chipped out and rewelded and the pipe fitting retested.

B. No outside mortar shall be applied over a seam prior to testing; however, mortar lining may be applied over a seam prior to hydraulic testing, but under such conditions said pressure test shall be held on the pipe or fitting for a period of not less than 30 minutes.

C. Shop Testing of Steel Pipe Cylinders: Each steel pipe cylinder, with joint rings welded to its ends but before lining and coating, shall be tested under hydraulic pressure to a stress of at least 22,000 psi, but not more than 25,000 psi and while under this stress the cylinder shall snow no leaks, undue distortion, or other defects.

D. After the pipe has been hydrostatically tested, longitudinal welds in the bell or spigot shall be tested by a dye-penetrant process such as Turco Dy-Check, or an approved equal. Any leaks shall be rewelded by hand and the pipe again tested. No caulking to stop leaks will be permitted.

E. Field Testing: Field testing shall conform to the requirements of Section entitled, ["Testing and Disinfection."]

F. A certified affidavit of compliance shall be furnished for all pipe, specials, fittings, and other products of materials furnished under this section of the specifications.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Reinforced concrete cylinder pipe shall conform to the requirements of AWWA Standard C303; except, that minimum cylinder wall thickness shall be 14 gage and shall conform to all the requirements specified herein and as indicated on the drawings. Minimum class of pipe shall be 150.

B. The pipe shall be manufactured in sections having nominal lengths of 24 to 40 feet, except where

shorter lengths are required on curves, or where closure or special sections are required. The pipe shall consist of a welded steel mortar lining, continuous reinforcing rod helically wound, under measured tension, around the lined cylinder, and a cement mortar coating. Each end of each pipe section shall be provided with two 2-inch by 4-inch wood struts placed at right angles with each other to prevent the pipe from becoming out-of-round prior to installation. Bracing shall limit the deflection in any pipe section to not more that ½ of one percent of the pipe diameter during both manufacture and field installation of the pipe.

C. While the pipe is stored in the manufacturer's yard and while in transit to the job site, the pipe ends shall be bulkheaded with heavy plastic or other suitable material to prevent the lining from drying out. The bulkheads shall remain in place until the pipe is installed. The pipe shall be furnished complete with rubber gaskets, buttstraps, and closure pieces where required.

2.02 MATERIALS

A. Materials used in the fabrication of reinforced concrete cylinder pipe shall conform to the following requirements:

1. Steel for pipe cylinders shall be hot-rolled carbon steel sheets conforming to the requirements of ASTM Designation A 36-74; or hot-rolled carbon steel sheets conforming to the requirements of ASTM Designation A 570-72, Grades, C, or D; or steel plates conforming to the requirements of ASTM Designation A 283-74, Grade D; except as modified herein. The minimum yield point of steel used for the fabrication of steel cylinders shall be 33,000 psi. The maximum carbon content of steel sheets shall be 0.25 percent.
2. Cement for mortar coating and lining shall be portland cement conforming to the requirements of ASTM Designation C 150-74.
3. Pipe coatings shall use Type V Cement; pipe linings shall use Type II or Type V cement.
4. Aggregates for cement-mortar lining and coating shall conform to the requirements of ASTM Designation C 33-74 for fine aggregate.
5. Water for use in cement mortar for lining and coating shall be potable, clean, fresh, and free from injurious amounts of mineral and organic substances.
6. Gaskets and lubricant for pipe and fittings shall conform to the requirements of AWWA Standard C300-64 and shall be of the size and configuration recommended by the pipe manufacturer.

2.03 FABRICATION

A. General: Pipe wall thickness to resist internal pressure shall be designed in accordance with the provisions of Chapter 6 of the AWWA M11 Steel Pipe Manual, "Steel Pipe Design and Installation": provided, that, unless otherwise shown on the drawings, wall thickness of the pipe shall be not less than the thickness required to resist an internal working pressure of 150 pounds per square inch or 14-gage, whichever is the greater. Pipe wall thickness shall also be designed to resist external pressures resulting from earth loads and HS-20-44 heavy trailer truck loads.

B. Maximum stress due to the rated working pressure in the steel pipe shall not exceed 50 percent of the yield point of the material used, nor 16,500 psi, whichever is less.

C. Fabrication of steel cylinder shall conform to the requirements of AWWA Standard C303 with the

following exceptions:

ASTM A 36-74 Plate
ASTM A 283-74 Plate, Grade D
ASTM A 570-72 Sheet, Grade C, or D

D. The nominal diameter of the pipe shall be the inside diameter of the pipe after the lining has been installed.

E. Steel Cylinders: One or more steel sheets may be used in fabricating each cylinder. Welds may be either straight or spiral. Full penetration welds will be required on butt welds. The welds when tested shall develop the full tensile strength of the adjoining sheets.

F. Joints: Joints shall be the steel bell and spigot joint rings, rubber gasketed type conforming to the requirements of AWWA C303; flanged joints shall conform to the straps for field fillet welding, as indicated on the drawings. All joints not flanged or welded shall be bonded in conformance with the details shown on the drawings. Cadwelding method and materials and required cable shall conform to the applicable requirements of Section, entitled "Insulated Couplings and Test Stations." Subject to the approval of the Engineer the Cadwelded Connections may be welded to a blocked-out area, a chipped-out area, or other approved method. [Requirements for bonded joints and Cadwelding shall apply between the _____ as shown on the drawings.]

G. The joints used shall have been thoroughly tested for water-tightness under pressure comparable to the design pressure. The pipe ends which have been formed to provide the bell and spigot ends necessary to accommodate the rubber gaskets or special joint or spigot rings may be welded to the ends of the pipe. The joint rings for rubber gasket joints shall be so designed that when the pipe is laid and the joint telescopes, the gaskets will be enclosed on all sides and will not be required to bear the weight of the pipe.

H. Lining: Cement mortar lining applied at the time of fabrication shall conform to the requirements of AWWA Standard C303 and the following supplementary requirements:

1. All reinforced concrete cylinder pipe shall be lined with a minimum cement mortar ½-inch in thickness for pipe 10 inches to 16 inches; and ¾-inch for pipe larger than 16 inches.
2. The thickness of the lining shall not vary more than 25 percent from that specified. The lining shall be applied centrifugally by a machine of a type that has been in approved commercial use for this purpose.
3. After the mortar has been placed in the cylinder, it shall be revolved at a speed which will allow the mortar to level out to a uniform thickness throughout the pipe. This packing speed shall be maintained until the lining is thoroughly compacted and all surplus water removed from the mortar.
4. The finished lining shall be smooth and uniform throughout. Gage rings shall be securely attached to the ends of the pipe to confine the mortar to the dimensions shown on the drawings.
5. When the pipe is removed from the spinning machine, it shall be supported by slings around the pipe, or other suitable supports, so spaced that there will be no appreciable bending throughout the length of the section and the pipe shall be carried by these slings or other supports to the curing yards and set on properly spaced supports set level to prevent bending.

6. While the lining is attaining its initial set, sufficient stiffener rings shall remain on the pipe to keep the deviation from the mean diameter at any section from exceeding ½ of one percent.
7. The lining shall be kept moist for a minimum period of 24 hours before applying the circumferential reinforcing rod and mortar coating. In the interim, the outside of the pipe shall be kept wet and the ends bulk headed. In lieu of water curing, steam curing may be used on a time-ratio basis of 4 hours water curing to 1 hour of steam curing.

I. Exterior Coating of Piping for Buried Service: All pipe and fittings for buried service, including bumped heads, shall be coated with a ¾-inch, minimum, thickness of cement mortar over the circumferential reinforcing rod or 1-inch over the steel cylinder, whichever is greater. Unless otherwise shown on the drawings, exterior surfaces of pipe or fittings passing through valve structure walls shall be coated from the center of the wall or from the wall flange to the end of the underground portion of pipe or fitting.

J. Cement-mortar coating on the exterior of the pipe shall be applied by the brush-coating machine process or other approved process. The mortar shall consist of a mixture of cement and sand with not less than one part of cement to 3 parts of sand. The machine for applying the mortar to 3 parts of sand. The machine for applying the mortar coating shall have an adjustable speed of operation and shall travel along the length of the pipe as the mortar is applied. Immediately prior to the application of the mortar coating, a fluid mixture or neat cement shall be applied to the surface of the wire-wrapped cylinder. The machine shall apply the mortar in either a vertical or a horizontal direction.

K. The mortar shall strike the outside circumference of the pipe about midway of the diameter as the pipe revolves on its axis. Rebound may be reclaimed and reused as sand. The coating may be built as to the required thickness in one or more passes of the machine. The finished coating shall be firm, shall adhere tightly to the outside surface of the pipe, and shall be free from flaws, holidays, or other surface imperfections.

L. Handling of pipe after application of mortar coating shall be done with belt slings or other suitable support, and shall not be done until a minimum period of 8 hours has elapsed. All pipe shall be handled carefully, and the dropping or bumping of pipe will not be permitted. Pipe injured during handling shall be recoated or repaired in a manner satisfactory to the Engineer. After the pipe has been coated, the lining and coating shall either be kept moist by continuous sprinkling for a period of 6 days before being moved to the trench or it shall be steamcured for 36 hours, after which time it may be moved to the trench. During the curing period, the ends of the pipe shall be kept closed with plastic sheet or other suitable material.

M. Provision shall be made to protect the coating from erosion of the mortar during sprinkling. The date of coating shall be plainly marked on the inside of each pipe length.

N. Steel Plate Specials: Steel plate specials are defined as bends, reducers, outlets, and in structures and other specials. Except as otherwise provided herein, steel plate specials shall be fabricated from steel plate having a minimum wall thickness as determined by the following formula; except, that in no case unless otherwise shown on the drawings shall the wall thickness be less than $^{3}/_{16}$-inch or less than that required to resist an internal pressure of 150 pounds per square inch, or the external loads previously specified.

$$T = \frac{D \times P}{2 \times 10{,}000}$$

Where: T = Wall thickness in inches
D = Inside diameter of steel cylinder
P = Design pressure in pounds per square inch

O. The design of all specials shall be submitted to the [Engineer] for review before fabrication is commenced. In all fabricated specials , a mark corresponding to the true vertical axis of the special shall be made on the top and bottom of each special.

P. Fabrication and testing of steel plate specials shall conform to the following requirements:

1. Dimensions for steel pipe fittings shall conform to the requirements of AWWA Standard C208, except as modified herein.
2. Outlets: Outlets shall be formed by welding cast or fabricated steel fittings, of suitable design, to the cylinder before the exterior mortar coating is placed around the fittings. Outlets 12-inch and smaller may at the option of the Contractor be fabricated from schedule 40 or heavier steel pipe in the standard outside diameters, i.e., 12¾ inch, 10¾ inch, 8_ inch, 6_ inch, and 4½ inch. Where so indicated, stiffener plates shall be provided designed according to the nomograph method described in the Journal of the American Water Works Association, Vol., 47, No. 6, June 1955, pp. 617 to 623. All other outlets shall be reinforced with steel collar pads designed for the specified pressure. The measurement from the outside of the pipe to the face of the flange shall be 12 inches, unless otherwise shown.
3. Bends: Except as otherwise shown, where bends are specified the radius of bends shall be not less than 2½ times the pipe diameter. At the option of the Contractor, a bend may be welded to the adjacent pipe section.
4. Materials: Except as otherwise provided herein, pipe material and methods of manufacture shall conform to the requirements of AWWA Standard C303 for "Reinforced Concrete Water Pipe - Steel Cylinder Type, Pretensioned."
5. Steel Welding Fittings: Steel welding fittings shall conform to the requirements of ASTM Designation A 234-74.
6. Flanges: Flanges shall be faced and drilled in accordance with ANSI dimensions, or in lieu thereof, shall meet the requirements of AWWA Standard C207 for the specific pressure rating of the adjacent pipe. All flanges shall be furnished with flat faces. All pipe flanges shall be attached such that the bolt holes will straddle the vertical axis of the pipe, unless otherwise shown on the drawings. Attachment of the flanges to the pipe shall conform to the applicable requirements of AWWA Standard C207, entitled, "Standard for Steel Pipe Flanges."
7. Welding: All hand welding shall be done by welders certified in accordance with the provisions of Appendix II of the "American Standard Code for Pressure Piping" or in accordance with the requirements of AWWA Standard C206, "Standard for Field Welding of Steel Water Pipe Joints."
8. Mortar Lining: Except as otherwise provided herein, steel plate specials , excepting bumped heads, shall be lined with cement mortar having a minimum thickness as specified for straight sections of pipe. A tolerance in the thickness of 25 percent, plus or minus, will be permitted.

Pipe shall be cleaned of all loose mill scale and rust and of all dirt, grease, or other objectionable matter. After cleaning the interior, the surface shall be coated with mortar. Wherever practicable, the plate specials shall be lined centrifugally. Fittings which are impracticable to line by the centrifugal process shall be coated by hand methods which will ensure a lining comparable to that obtained by the centrifugal process; the hand lining of such specials shall be reinforced with welded wire fabric as specified hereinafter. Cement, sand, and water meeting the requirements specified herein shall be mixed in the proportions of one part of portland cement to not more than 3 parts of sand. Just enough water shall be added for proper workability and to ensure uniform distribution around the circumference. The finished lining shall be smooth, dense, and uniform throughout. Immediately after lining, the pipe ends shall be bulkheaded and the pipe cured under sprinklers for not less than 7 days. The date of lining shall be plainly marked on the inside of each pipe length of pipe fitting.

9. Exposed Piping: Pipe and fittings which will be exposed to the atmosphere inside structures or above ground shall conform to the requirements of Section entitled, ["Mortar-Lined-and-Coated Steel Pipe,"] and shall be thoroughly cleaned and then given a shop coat of rust-inhibitive red lead primer and painted in conformance with the requirements of Section entitled, ["Painting and Protective Coating."]
10. Exterior Coating of Piping for Buried Service: All pipe and fittings for buried service, including bumped heads, shall be coated with a ¾-inch, minimum, unless otherwise shown on the drawings. Exterior surfaces of pipe or fittings passing through valve structure walls shall be coated from the center of the wall or from the wall flange to the end of the underground portion of pipe or fitting, unless otherwise shown on the drawings. The coating shall be reinforced with 2x4 inch - 12x12 gage welded wire fabric crimped so as to hold the wire approximately in the center of the mortar coating. The fabric shall be securely fastened to the pipe with welded clips or strips of steel. The wires spaced 2 inches on centers shall extend circumferentially around the pipe. The ends of reinforcement strips shall be lapped 4 inches and the free ends tied or looped to assure continuity of the reinforcement. Cement, aggregates, and water meeting the requirements of Section entitled, ["Cast-in-Place Concrete,"] shall be mixed in the proportions of one part of cement to not more than 3 parts of sand. No more than 4½ gallons of water shall be used per sack of cement. After the outside coating has been applied, the pipe shall be cured for 7 days after sprinkler. During the curing period, the ends of the pipe shall be kept closed with plastic sheet or other suitable material. Provision shall be made to protect the coating from erosion during sprinkling. The date of coating shall be plainly marked on the inside of each pipe length.

PART 3 -- EXECUTION

3.01 PIPE HANDLING AND LAYING

A. General: All laying, jointing, testing for defects and for leakage under pressure, and disinfection, shall be performed in the presence of the [Engineer,] and shall be subject to this approval before acceptance. All material found during the progress to have defects will be rejected and the Contractor shall promptly remove such defective material from the site of the work.

B. Handling of Pipe and Accessories: Necessary facilities shall be provided for lowering and properly placing the pipe sections in the trench without damage. All handling of reinforced concrete cylinder

pipe shall be done with fabric slings which will not damage the coating. Slings shall bear uniformly against the pipe. When not being handled, all pipe shall be supported on timber cradles, sand bags, or mounds of earth.

C. Alignment and Grade: The pipe shall be laid to the lines and grades shown on the drawings and the section shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointing, the bedding for the pipe shall be checked for firmness and uniformity of surface.

D. Minor changes of direction in the grade or alignment may be made by a deflection in the joint up to a maximum of ¾-inch on one side of the joint for pipe 20 inches in diameter and smaller, and up to a maximum of one inch on one side of the joint for pipe 24 inches in diameter and larger. For greater angular deflections, pipe with ends beveled up to a maximum of 5 degrees measured from a plane perpendicular to the pipe axis, may be used. Pipe lengths shorter than 40 feet may be used on curves. Where curves are required which have a shorter radius than can be accommodated by forming an angle in the joint sleeves, or where indicated on the drawings, special short-radius bends shall be provided.

E. Trenching: Trenches shall have a maximum width equal to the outside diameter of the pipe plus 16 inches for pipes 12 inches in diameter and smaller, a maximum width equal to the outside diameter of the pipe plus 20 inches for pipe from 14 to 21 inches in diameter, and a maximum width equal to the outside diameter of the pipe plus 24 inches for pipe 24 inches and larger in diameter. The bottom of the trench shall be excavated uniformly to the grade indicated on the drawings, or as ordered by the [Engineer.]

F. Laying: Exceptional care shall be taken in laying the pipe and making of field joints. Bumping of the pipe in the trench will not be permitted. Where indicated on the drawings, the joints shall be welded.

3.02 PIPE JOINTING

A. Field Welded Joints: All pipe shall have field welded joints where indicated on the drawings. All field welded joints shall conform to the requirements of AWWA Standard C206-62, and the following supplementary requirements:

1. The bell end shall be circumferentially welded to the spigot end of the adjoining pipe. The weld shall be continuous, and ample bell holes shall be dug to permit proper welding.
2. The field weld between the bell and spigot ends shall be made in 2 or more passes so as to build up a fillet weld having a minimum thickness of not less than the thickness of the steel cylinder. Size of filler rod shall be as indicated in the printed recommendations of the pipe fabricator.
3. Prior to welding, the joints shall be made up by inserting the spigot into the bell.
4. In the case of 20-inch pipe and smaller, before the spigot is inserted into the bell, the bell end of the pipe shall be daubed with mortar containing one part lumnite cement to not more than 3 parts of sand, inserting it into the bell, and forcing it to the bottom of the bell.
5. In the case of 24-inch pipe and larger, the joints shall be pointed on the inside with mortar after the backfill has been placed.

. Excess mortar on the inside shall be swabbed out.

B. After the welding has been completed, inspected, and approved by the [Engineer,] the outside annular space between pipe sections shall be completely filled with grout. The grout shall be poured in such a manner that all exposed portions of the metal joint shall be completely protected with cement mortar. Grout used on the outside of the joints shall be a mixture of one part of cement to 3 parts of sand, by weight, and shall be sufficiently fluid to permit it to be poured into the joint space. The outside mortar joints shall be properly formed by the use of heavy-duty diapers. Grout shall be poured in one side of the top opening of the diaper only, until it completely surrounds the pipe joint and rises around the circumference of the pipe joint and begins to come out of the opposite side. Under on circumstances shall grout be allowed to enter on both sides of the pipe at the same time.

C. Where buttstraps or closure pieces are used, both interior and exterior surfaces of the buttstraps, or closure pieces shall be given a coating equivalent to the factory-applied coating of the adjoining pipe sections. The exterior cement-mortar coating in such cases shall be similarly reinforced where the exposed length of the buttstrap or closure piece, as measured between the ends of the connected pipe sections, exceeds 4 inches. Pipes smaller than 24 inches in diameter shall have a 4-inch handhold provided at closure pieces so that the interior portions of the joints can be properly pointed.

D. Rubber Gasket Joint: The rubber gasket joint shall be made by properly lubricating the endless rubber gasket after the joint has been telescoped.

E. All pipe joints shall be pointed on the inside with mortar after the backfill has been placed. Excess mortar shall be removed from the inside of the pipe.

F. After the pipe has been laid, but before backfill has been completed, the outside annular space between pipe sections shall be completely filled with grout. The grout shall be poured in such a manner that all exposed portions of the joint shall be completely protected with cement mortar. Grout used on the outside of the joints shall be a mixture of one part of cement and 3 parts of sand, by weight, and shall be sufficiently fluid to permit it to be poured into the joint space. The outside mortar joints shall be properly formed by the use of heavy-duty diapers. Grout shall be poured in one side of the top opening of the diaper only, until it completely surrounds the pipe joint out of the opposite side. Under no circumstances shall grout be allowed to enter on both sides of the pipe at the same time.

G. Bonding: The pipe ends shall be carefully prepared for the bonding. Where pipe coating is removed, only enough to accommodate the welder shall be removed. Completed welds shall be tested for adherence after removing the slag. Connections to the pipe shall be thoroughly cleaned of slag and foreign material. The exposed metal shall be coated with epoxy putty and where required the mortar coating shall be repaired. All wiring shall be continuous without splices. Required length of slack shall be provided. Care shall be taken during backfilling to preserve bonding.

3.03 PIPE ANCHORAGE

A. Anchorage shall be by means of concrete thrust blocks (reaction backing) or welded joints at the Contractor's option. Anchorage shall be applied at all tees, dead ends, bends 11¼ degrees or greater, fire hydrants, and at points at reducers or in fittings where changes in pipe diameter occur.

Anchorage requirements shall be as indicated on the drawings.

*** END OF SECTION ***

SECTION 02625

DUCTILE IRON PIPE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install ductile iron pipe and all appurtenant work, complete in place, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Earthwork. 02200
B. Cast-in-Place Concrete 03300 and Minor Concrete 03305 for construction of anchor blocks and thrust blocks as applicable.
C. Water Pipeline Testing and Disinfection. 02666
D. Protective Coating 09800 for exposed steel surfaces.
E. Miscellaneous Metalwork 05500 for valve supports, flange bolts, and anchor bolts.
F. Valves and Appurtenances. 15100, 15101, 15104, 15105, 15107, 15109, 15110, 15112, 15113, 15115

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following documents to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. Commercial Standards:

ANSI/AWWA C104/A21.4-80	Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water.
ANSI/AWWA C105/A21.5-82	Polyethylene Encasement for Gray and Ductile Cast-Iron Piping for Water and Other Liquids.
ANSI/AWWA C110/A21.10-82	Fittings, 3 in. Through 48 in. for Water and Other Liquids, Gray-Iron and Ductile-Iron.
ANSI/AWWA C111/A21.11-80	Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
ANSI/AWWA C115/A21.15	Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges.
ANSI/AWWA C150/A21.50-81	Thickness Design of Ductile-Iron Pipe.

ANSI/AWWA C151/A21.51-81	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds for Water and Other Liquids.
ANSI/AWWA C209-84	Cold Applied Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.
ANSI/AWWA C214-83	Tape Coating Systems for the Exterior of Steel Water Pipelines.
ANSI/AWWA C600-82	Water Mains and Appurtenances, Installation of Ductile Iron.
ASTM C150-85	Specification for Portland Cement.

1.04 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements in Section entitled, "Contractor Submittals" 01300, the requirements of the referenced standards and the following supplemental requirements as applicable:

1. Certified dimensional drawings of all valves, fittings, and appurtenances.
2. Line layout and marking diagrams which indicate the specific number of each pipe and fitting in the completed line. In addition, the line layouts shall include: the pipe station and invert elevation at all changes in grade or horizontal alignment; the station and invert elevation to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment; and the limits of each reach of restrained and/or welded joints, or of concrete encasement.

B. Certification: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards and the following supplemental requirements:

1. Physical and chemical properties.
2. Hydrostatic test reports.

C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.05 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

D. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

E. In addition to these tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Mortar lined and polyethylene wrapped/tape coated ductile iron pipe shall conform to ANSI/AWWA C151, C104, C105, and C214, subject to the following supplemental requirements. The pipe shall be of the diameter and class shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents, and all specials and fittings shall be provided as required under the Contract Documents.

B. Markings: The Contractor shall legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All special pipe sections and fittings shall be marked at each end with top field centerline. The word "top" shall be painted or marked on the outside top spigot end of each pipe section.

C. Handling and Storage: The pipe shall be handled by use of wide slings, padded cradles, or other devices, acceptable to the Engineer, designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. All other pipe handling equipment and methods shall be acceptable to the Engineer. Tape-coated pipe shall have the following additional requirements:

   1. It shall be the responsibility of the manufacturer of tape-coated ductile iron pipe to prevent damage of the coating which might be caused by handling and/or storage of the completed pipe at low temperature.

D. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.

E. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling.

F. Strutting: Adequate strutting shall be provided on all specials, fittings, and straight pipe so as to avoid damage to the pipe and fittings during handling, storage, hauling, and installation.

G. Laying Lengths: Maximum pipe laying lengths shall be 20 ft. with shorter lengths provided as required by the Drawings.

H. Finish: The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing and roughness.

I. Bonding and Electrical Conductivity: All pipe joints shall be bonded for electrical conductivity in accordance with the details shown on the Drawings.

J. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing shown on the Drawings. The locations of correction pieces and closure assemblies are shown on the Drawings. Any change in location or number of said items shall be acceptable to the Engineer.

2.02 PIPE DESIGN CRITERIA

A. General: Ductile iron pipe shall be designed in accordance with the requirements of ANSI/AWWA C150 as applicable and as modified in this Section.

B. Pipe Wall Thickness for Internal Pressure: The pipe shall be designed with a net thickness to withstand the design pressure in accordance with the hoop stress formula.

C. Pipe Wall Thickness for External Load: The pipe shall also be designed with a net thickness to withstand internal loads using ANSI/AWWA C150 Design Equation (2) with the following constants:

E^1 = modulus of soil reaction 500
K_b = bending moment coefficient 0.128
K_x = deflection coefficient 0.085

D. The pipe deflection shall be checked using ANSI/AWWA C150 Design Equation (3) and the constants stated above. The allowable deflection shall not exceed 0.015 times the inside diameter.

E. In lieu of ANSI/AWWA C150 Design Equation (4), the earth loads will be computed using the following 2 equations for trench or embankment loading as applicable:

1. Trench condition: (Not Applicable)
   $W_b = C_d w B_d^2$,
   Where: C_d = Calculation Coefficient
   $Ku^1 = 0.13$
   $w = 120$ lb/ft^3
   B_d = Trench width at top of pipe, feet
2. Positive projecting embankment condition: (All Piping)
   $W_c = C_c w B_c^2$,
   Where: C_c = Calculation Coefficient (based on $r_{sd}p$ of 0.75)
   $Ku = 0.19$
   $w = 120$ lb/ft^3
   B_c = Outside diameter of pipe, feet

F. The above 2 formulas are based on a depth of cover of 10 feet or greater. For depths of cover of less

than 10 feet, HS-20 live load shall be included. For depths of cover of 3 feet or less, HS-20 live load plus impact shall be included. The determination of live load and impact factors shall be as recommended by AASHTO in "Standard Specifications for Highway Bridges."

G. If the calculated deflection, $Defl_x$, exceeds 0.015 times the inside diameter, the pipe class shall be increased.

H. Minimum Pipe Wall Thickness: In addition to the requirements of this Paragraph 2.02, the minimum wall thickness shall be in accordance with Table 50.5 of ANSI/AWWA C150.

2.03 MATERIALS

A. Ductile Iron Pipe: Pipe materials shall conform to the requirements of ANSI/AWWA C150 and ANSI/AWWA C151.

B. Cement: Cement for mortar lining shall conform to the requirements of ANSI/AWWA C104; provided, that cement for mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement.

C. Prefabricated Multi-layer Cold-Applied Tape Coating: Except as described below, the coating system for straight line pipe shall be in accordance with ANSI/AWWA C214. The system shall consist of at least four layers consisting of the following:

1. primer layer
2. inner layer tape - corrosion protective tape (20 mils)
3. outer layer tape - mechanical protective tape (30 mils) with white exterior
4. outer later tape - mechanical protective tape (30 mils) with white exterior

The total thickness of the tape coating shall be at least 80 mils.

D. Polyethylene Sleeve: Material for the polyethylene sleeve shall conform to the requirements of ANSI/AWWA C105.

2.04 SPECIALS AND FITTINGS

A. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C110/A21.10 for diameters 3-inch through 48-inch and shall have a minimum pressure rating of 250 psi. Ductile iron fittings larger than 48-inch shall conform to the above referenced standard with the necessary modifications for the larger size.

2.05 DESIGN OF PIPE

A. General: The pipe furnished shall be ductile iron pipe, mortar-lined-and polyethylene wrapped/tape-coated, with rubber gasketed joints as shown. The pipe shall consist of a centrifugally cast ductile iron, shop-lined with portland cement-mortar with a polyethylene sleeve or tape coating.

B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA

C151.

C. Pipe Dimensions: The pipe shall be of the diameter and class shown. The minimum wall thickness for each pipe size shall be as specified or shown.

D. Fitting Dimensions: The fittings shall be of the diameter and class shown.

E. Joint Design: Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, and restrained joints as required.

1. Mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11.
2. Flanged joints shall conform to ANSI/AWWA C115/A21.15.
3. Restrained joints shall be "Lok-Ring" Restrained Joint by American Ductile Iron Pipe, "TR FLEX" Restrained Joint by U.S. Pipe, or equal.

F. For bell-and-spigot ends with rubber gaskets, the clearness between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactory under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

G. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as shown on the Drawings or as otherwise acceptable to the Engineer.

2.06 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of all steel pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work and shall be approved by the Engineer. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications at no additional cost to the Owner.

B. The minimum lining thickness shall be as follows:

Nominal Pipe Diameter (inches)	Lining Thickness (inches)
Less than 24	$^{3}/_{16}$
24 or larger	¼

C. Protection of Pipe Lining/Interior: For all pipe and fittings with plant-applied cement mortar linings,

the Contractor shall provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings to prevent drying out of the lining. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.07 EXTERIOR COATING OF PIPE

A. Exterior Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section entitled "Protective Coating." 09800

B. Exterior Coating of Buried Piping: Prefabricated multi-layer cold-applied tape coating of pipe for buried service shall be applied in accordance with ANSI/AWWA C214 as modified by Paragraph 2.03C herein.

2.08 GLASS-LINED DUCTILE IRON PIPE

A. Glass-lined ductile iron pipe shall consist of ductile iron pipe with a glass lining fused to the metal base by firing the entire pipe or fitting to a temperature above 1400‹F and held at this temperature for a sufficient time to develop and smooth, vitreous lining which has a molecular bond with the metal. The lining shall be a minimum of 0.010-inch thick and shall withstand an instantaneous thermal shock of 350‹F differential, without crazing, blistering, or spalling. The lining shall be free of pinholes, which substantially expose the metal. The pipe and fittings shall be as specified in this Section. Buried pipe and fittings shall have mechanical couplings as indicated.

   Field installation of glass-lined pipe shall limit the cutting of the pipe to one cut per run of pipe. Field cut shall not spall back from the cut section greater than _-inch. All cutting of pipe shall be in accordance with the manufacturer's recommendations. Additional field cuts shall be subject to approval of the Resident Project Representative. Excessive spalling, splintering or other defects as determined by the Engineer shall be caused for rejection of the pipe materials.

PART 3 -- EXECUTION

3.01 INSTALLATION OF PIPE

A. Handling and Storage: All pipe, fittings, etc., shall be carefully handled and protected against damage, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. Pipe shall be handled and stored at the trench site in accordance with Paragraphs 2.01C and 2.01E, herein. No pipe shall be installed where the lining or coating show cracks that may be harmful as determined by the Engineer. Such damaged lining and coating shall be repaired, or a new undamaged pipe shall be furnished and installed.

B. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

C. The Contractor, shall inspect each pipe and fitting to insure that there are no damaged portions of the

pipe.

D. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work.

E. Pipe Laying: The pipe shall be installed in accordance with ANSI/AWWA C600.

F. Pipe shall be laid directly on the imported bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

G. Each section of pipe shall be laid in the order and position shown on the laying schedule. In laying pipe, it shall be laid to the set line and grade, within approximately one inch plus or minus. On grades of zero slope, the intent is to lay to grade.

H. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such changes shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint. In all cases the joint opening, before finishing with the protective mortar inside the pipe, shall be the controlling factor.

I. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown on the Drawings.

J. Pipe struts shall be left in place until backfilling operations have been completed for pipe 42 inches in diameter and larger. Struts in pipe smaller than 42 inches may be removed immediately after laying, provided, that the deflection of the pipe during after backfilling does not exceed that specified. After the backfill has been placed, the struts shall be removed and shall remain the property of the Contractor.

K. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

L. Pipe and Specials Protection: The openings of all pipe and specials where the pipe and specials have been cement mortar lined in the shop shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water or any undesirable

substance. The bulkheads shall be so designed to prevent drying out of the interior of the pipe. The Contractor shall introduce water into the pipe to keep the mortar moist where moisture has been lost due to damaged bulkheads. At all times, means shall be provided to prevent the pipe from floating.

M. Pipe Cleanup: As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contract shall completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying, pointing of joints and any necessary interior repairs prior to testing and disinfecting the completed pipeline.

3.02 RUBBER GASKETED JOINTS

A. Rubber Gasketed Joints: Immediately before jointing pipe, the spigot end of the pipe shall be thoroughly cleaned, and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the spigot groove. The volume of the gasket shall be "equalized" by moving a metal rod between the gasket and the spigot ring around the full circumference of the spigot ring. The bell of the pipe already in place shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted. After the pipe units have been joined, a feeler gage shall be inserted into the recess and moved around the periphery of the joint to detect any irregularity in the position of the rubber gasket. If the gasket cannot be "felt" all around, the joint shall be disassembled. If the gasket is undamaged, as determined by the Engineer, it may be reused, but only after the bell ring and gasket have been relubricated.

3.03 JOINT COATING AND LINING

A. General: The interior and exterior recesses shall be thoroughly wiped clean and all water, loose scale, dirt and other foreign material shall be removed from the inside surface of the pipe.

B. Joint Coating and Tape-Coated Pipe: Joints for tape-coated pipe shall be primed and wrapped with 2 thicknesses of 12 inch wide elastomeric joint tape, Type II per ANSI/AWWA C209. The total thickness of the tape wrap shall be at least 70 mils and shall be installed free of wrinkles will all laps bonded. All primer and joint tape shall be compatible with the line pipe coating.

C. All tape-coated joints will be tested by the Engineer with an electrical flaw detector capable of at least a 12,000 volt output, furnished by the Contractor. The tests shall be made using a voltage of 6,000 to 7,000 volts. Any holidays found shall be repaired by the Contractor at no expense to the Owner.

D. Coating Repair: Coating repair shall be made using tape and primer conforming to ANSI/AWWA C209. When visual inspection shows a portion of the tape-wrap system has sustained physical damage, the damaged area shall be subjected to an electrical holiday test of 6,000 to 7,000 volts.

E. Following repair of the damaged area if the holiday test indicates a holiday still exists, the inner wrap shall be exposed and the exposed area shall be wiped clean with xylol solvent, or equal, and the area coated with tape primer. A patch of 35-mil thick cold-applied tape of sufficient size to cover the damaged area, plus a minimum lap of 2 inches in all directions, shall then be applied. The patched area shall again be tested for holidays. If none are detected, a second layer of 35-mil thick tape shall

then be applied over the first patch. The second layer of tape shall overlap the first layer a minimum of 2 inches in all directions.

F. When the area tests showing no holiday, a notation shall be applied to the area indicating the test is satisfactory.

G. Coating of Fittings and Specials: Fittings and specials shall be coated in accordance with ANSI/AWWA C209. Prefabricated tape shall be Type II and shall be completely compatible with the tape system used for straight line pipe. The system shall consist of three layers consisting of the following:

1. primer layer
2. inner layer tape - corrosion protective tape (35 mils)
3. outer layer tape - corrosion protective tape (35 mils)

The joint thickness of the tape coating shall be at least 70 mils.

H. Joint Lining: After the backfill has been completed to final grade, the interior joint recess shall be filled with mortar of stiff consistency mixed in proportions of one part cement to 2 parts sand. The mortar shall be tightly packed into the joint recess and troweled flush with the interior surface, and all excess shall be removed. At no point shall there be an indentation or projection of the mortar exceeding $^{1}/_{16}$ inch. With pipe smaller than 24 inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with mortar containing one part cement to 2 parts sand. The spigot end then shall be forced to the bottom of the bell and excess mortar on the inside of the joint shall be swabbed out.

I. Polyethylene Sleeve: Where shown, buried pipe shall be polyethylene encased in accordance with the requirements of ANSI/AWWA C105/A21.5 in lieu of tape coating.

3.04 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where the jointing pipe is tape-coated, buried appurtenances shall be coated with cold-applied tape in accordance with ANSI/AWWA C209, Type II.

B. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to insure proper operation.

C. All buried valves shall be coated and protected in accordance with Paragraph 3.05A, herein.

D. All valves shall be installed so that the valve stems are plumb and in the location shown in the Drawings.

E. Joint Bonding: Except where otherwise specified, all joints shall be bonded in accordance with the details shown on the Drawings. The pipe shall be cleaned to bare bright metal at the point where the bond is installed.

F. Corrosion mitigation and testing materials, such as magnesium anodes, reference electrodes, and test lead wire shall be furnished and installed by the Contractor.

*** END OF SECTION ***

SECTION 02645

PVC SCHEDULE RATED PIPE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install all PVC schedule rated pipe complete in place, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Trenching and backfill appurtenant to the work shall be as specified in Section 02316 entitled, "Trench Backfill and Compaction."

B. Testing shall conform to the requirements shown on the piping schedule.

C Concrete for anchor blocks, if required, shall conform to the requirements of Section entitled, "Cast-in-Place Concrete," and "Minor Concrete," as applicable.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced Standards to the extent that the requirements therein are not in conflict with the provisions of this Section.

B. References in these specifications to "AWWA Standards" shall mean AWWA Standards as published by the American Water Works Association, Incorporated, 2 Park Avenue, New York, New York, 10016.

1.04 CONTRACTOR SUBMITTALS

A. Samples: The CONTRACTOR shall submit to the ENGINEER for approval, samples of all the materials proposed for use on the work. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions. All sample submittals shall conform to the requirements for "Samples" in Section entitled, "Contractor Submittals."

B. Shoring and Bracing Drawings: The CONTRACTOR's attention is directed to the provisions for the requirements for "Contractor Submittals," herein, which may require the submittal of shoring and bracing drawings by the CONTRACTOR.

C. The CONTRACTOR's attention is further directed to the provisions of Subpart P, Section 1926.652 of the OSHA Safety and Health Standards for Constructions, which require that all banks and trenches over 5 feet high shall be shored or sloped to the angle of repose.

D. Shop Drawings: The CONTRACTOR shall submit shop drawings and laying diagrams of all pipe, joints, bends, special fittings, and piping appurtenances in accordance with Section entitled, "Contractor Submittals."

E. Certificates: The CONTRACTOR shall provide manufacturer's certificates for all materials indicating conformance to the Contract Documents.

1.05 QUALITY ASSURANCE

A. Testing: All materials testing will be based upon applicable ASTM Test Methods and AWWA Standards referenced herein for the materials specified.

B. All costs of such inspection and tests shall be borne by the CONTRACTOR.

C. Certificates: Manufacturer's notarized certificates of compliance shall be furnished by the CONTRACTOR.

D. The pipe shall be subjected to the specified hydrostatic strength tests, flexure tests, and crushing tests. The crushing tests shall be made on samples taken from the center of full-length sections of pipe.

1.06 CLEANUP

A. In addition to the requirements of Section entitled, "Project Closeout," the CONTRACTOR, upon completion of backfilling and grading over trenches shall remove all excess materials and equipment from the site.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All PVC pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and pressure rating in psi.

B. The CONTRACTOR shall also require the manufacturer to mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.

2.02 PIPE

A. PVC pipe shall be made from all new rigid unplasticized polyvinyl chloride and shall be Normal Impact (Type I) Schedule 80 unless otherwise shown. Elbows and tees shall be of the same material as the pipe. Unless otherwise shown, joints shall be solvent-welded in accordance with the manufacturer's instructions. Expansion joints or pipe bends shall be provided to absorb pipe expansion over a temperature range of 100 degrees F.

2.03 FITTINGS

A. All fittings for PVC pipe shall conform to the requirements of ASTM D 2241-82. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile iron pipe fittings.

B. The strength class of the fittings shall be not less than the strength class of any adjoining pipe.

2.04 BEDDING MATERIAL

A. All materials used for pipe bedding shall conform to the requirements for "Embedment Materials" as specified in ASTM D 2321-74 (1980).

PART 3 -- EXECUTION

3.01 GENERAL

A. All laying, jointing, testing for defects and for leakage shall be performed in the presence of the ENGINEER, and shall be subject to his approval before acceptance. All material found during the progress to have defects will be rejected and the CONTRACTOR shall promptly remove such defective materials from the site of the work.

B. Installation shall conform to the requirements of ASTM D 2774 and to the supplementary requirements or modifications specified herein. Wherever the provisions of this Section and the requirements of ASTM D 2774 are in conflict, the more stringent provision shall apply.

3.02 TRENCHING

A. Trench excavation and backfill shall conform to the requirements of the Section entitled, "Earthwork" and as specified herein.

B. The maximum width of trenches shall be as specified in said ASTM D 2774, as supplemented or modified herein.

C. The minimum depth of cover over the top of the pipe shall be 36 inches unless otherwise shown on the Drawings.

3.03 BEDDING

A. General: Pipe bedding shall apply to that portion of the vertical section of the trench lying between a plane 6 inches below the design grade of the pipe invert and a plane at a point 12 inches above the top surface of the pipe.

B. Bedding Methods: Bedding of all PVC pipe hereunder shall conform to the requirements of ASTM

Designation D 2774 as supplemented or modified herein.

C. Bell Holes for Joints: When the pipe being installed is provided with bell joints, bell holes shall be excavated in the bedding material to allow for unobstructed assembly of the joint. Care shall be taken to assure that the bell hole is not larger than necessary to accomplish proper joint assembly. When the joint has been made, the bell hole shall be carefully filled with bedding material to provide for adequate support of the pipe throughout its entire length.

D. Use of Compaction Equipment: Care shall be taken to avoid contact between the pipe and compaction equipment. Compaction of initial backfill in the bedding area, and backfill material should generally be done in such a way so that impact type compaction equipment is not used directly above the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe.

E. Pipe Support: Couplings shall not be allowed to rest upon, nor settle down upon the original trench bottom, rocks, concrete, or underground structures.

3.04 LAYING PIPE

A. The pipe shall be installed in accordance with the requirements of ASTM D 2774 and as indicated on the drawings and the sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointings, the bedding for the pipe shall be checked for firmness and uniformity of surface.

B. The radius of curvature of the trench shall determine the maximum length of pipe section that can be used without exceeding the allowable deflection at a coupling. The deflection at any flexible joint shall not exceed that prescribed by the manufacturer of the PVC pipe. The manufacturer's printed installation guide outlining the radii of curvature that can be negotiated with pipe sections of various lengths shall be followed.

C. Proper implements, tools, and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the CONTRACTOR for safe and efficient execution of the work. All pipe, fittings, valves, and accessories shall be carefully lowered into the trench by means of derrick, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.

D. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, nor any other method that may fracture the pipe or will produce ragged, uneven edges.

E. The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the

pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

F. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the work shall be furnished by the CONTRACTOR at its own expense under the direction of the ENGINEER.

G. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstructions shall be permanently supported, relocated, removed, or reconstructed by the CONTRACTOR in cooperation with owners of such utility structures. Unless otherwise indicated, this work shall be performed at the CONTRACTOR's expense.

3.05 HANDLING

A. Handling of the PVC pipe shall be done with care to insure that the pipe is not damaged in any manner during storage, loading, transit, unloading and installation.

B. Pipe shall be inspected both prior to and after installation in the ditch and all defective lengths shall be rejected and immediately removed from the working area.

3.06 FIELD JOINTING

A. Each pipe compression type joint shall be joined with a lock-in rubber ring and a ring groove that is designed to resist displacement during pipe insertion.

B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. At this time a thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.

C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.

D. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the ENGINEER, the trench conditions or weather are unsuitable for such work.

3.07 INSTALLATION OF BENDS, TEES, AND REDUCERS

A. Cast-iron and PVC fittings shall be installed utilizing standard installation procedures. Fittings shall be lowered into trench by means of rope, cable, chain, or other acceptable means without damage to the fittings. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope or other device be attached through the fittings' interior for handling. Fittings shall be carefully connected to pipe or

other facility, and joint shall be checked to insure a sound and proper joint.

3.08 TESTING

A. Field testing of PVC schedule rated pipe shall conform to the requirements shown on the piping scheduled.

*** END OF SECTION ***

SECTION 02648

PVC SEWER FORCE MAINS

PART 1 -- GENERAL

1.01 SCOPE

A. The work of this Section includes the construction of underground PVC pressure pipe for sewer force mains, complete in place, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Trenching and backfill appurtenant to the work shall be as specified in Section entitled, "Trench Backfilling and Compacting."

B. Testing shall conform to the requirements of Sections entitled, "Hydraulic Structures and Pipeline Testing, and Sanitary and Storm Drainage System Testing."

C. Concrete for anchor blocks and thrust blocks, if required, as shown on the drawings, shall conform to the requirements of Section entitled, "Minor Concrete."

D. Valves, valve boxes and other appurtenances are specified in the Section entitled, "Valves and Appurtenances."

1.03 CONTRACTOR SUBMITTALS

A. Samples: The Contractor shall submit to the Engineer for approval, samples of all the materials he proposes to use on the work. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions. All sample submittals shall conform to the requirements for "Samples" in Section entitled, "Contractor Submittals."

B. Shoring and Bracing Drawings: The Contractor's attention is directed to the provisions for the requirements for "Shoring and Bracing Drawings" in Section entitled, "Contractor Submittals," herein, which may require the submittal of shoring and bracing drawings by the Contractor.

C. The Contractor's attention is further directed to the provisions of Subpart P, Section 1926.652 of the OSHA Safety and Health Standards for Construction, which require that all banks and trenches over 5 feet high shall be shored or sloped to the angle of repose.

D. Certificates: The Contractor shall provide manufacturer's certificates for all materials indicating conformance to these specifications.

1.04 QUALITY ASSURANCE

A. Testing: All materials testing will be based upon applicable ASTM Test Methods and AWWA

Standards referenced herein for the materials specified.

B. All costs of such inspection and tests shall be borne by the Contractor.

C. Certificates: Manufacturer's notarized certificates of compliance shall be furnished by the Contractor.

D. The pipe shall be subjected to the specified hydrostatic strength tests, flexure tests, and crushing tests. The crushing tests shall be made on samples taken from the center of full-length sections of pipe.

1.05 CLEANUP

A. In addition to the requirements of Section entitled, "Project Closeout," the Contractor, upon completion of backfilling and grading over trenches shall remove all excess materials and equipment from the site.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All PVC pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and pressure rating in psi.

B. The manufacturer shall also mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control taxes, raw material batch number, and other information deemed necessary by the manufacturer.

2.02 PIPE

A. All PVC pipe shall be joined by compression joints unless otherwise indicated or specified, and shall conform to the following requirements:

1. Polyvinyl chloride pipe (PVC) shall conform to the requirements of ASTM Designation D 2241-72, Class SDR 26. Material for PVC pipe shall conform to the requirements of ASTM Designation D 1784-69 for Class 12454-A as defined therein.
2. Flexible rubber rings for compression type joints for PVC pipe fittings shall conform to the printed recommendations of the pipe manufacturer and ASTM Designation 1869.

2.03 FITTINGS

A. All fittings for PVC pressure pipe shall be PVC conforming to the requirements of ASTM Designation D 2241-72. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile-iron pipe fittings.

B. The strength class of the fittings shall be not less than the strength class of any adjoining pipe.

2.04 LOCATOR WIRE

A. The locator wire shall be No. 14 wire gage, (0.064-inch), bare copper wire being the standard product of a manufacturer regularly engaged in the manufacture of such material.

2.05 BEDDING MATERIAL

A. All material used for pipe bedding shall conform to the requirements for "Embedment Materials" as specified in ASTM Designation D 2321-74.

PART 3 -- EXECUTION

3.01 GENERAL

A. All laying, jointing, testing for defects and for leakage under pressure, shall be performed in the presence of the Engineer, and shall be subject to his approval before acceptance. All material found during the progress to have defects will be rejected and the Contractor shall promptly remove such defective material from the site of the work.

B. Installation shall conform to the requirements of ASTM Designation D 2321-74 and to the Supplementary requirements or modifications specified herein. Wherever the provisions of this section and the requirements of ASTM Designation D 2321-74 are in conflict, the more stringent provision shall apply.

3.02 TRENCHING

A. Trench excavation and backfill shall conform to the requirements of the Sections entitled, [“Trench Excavation” and "Trench Backfill and Compaction" and as specified herein.

B. The maximum width of trenches shall be as specified in ASTM Designation D 2321-74, as supplemented or modified herein.

C. The minimum depth of cover over the top of the pipe shall be 48- inches unless shown otherwise on the drawings.

3.03 BEDDING

A. General: Pipe bedding shall apply to that portion of the vertical section of the trench lying between a plane [6] inches below the design grade of the pipe invert and a plane at a point [12] inches above the top surface of the pipe.

B. Bedding Methods: Bedding of all PVC pipe hereunder shall conform to the requirements of ASTM Designation D 2321-74.

C. Bell Holes for Joints: When the pipe being installed is provided with bell joints, bell holes shall be excavated in the bedding material to allow for unobstructed assembly of the joint. Care shall be taken to assure that the bell hole is not larger than necessary to accomplish proper joint assembly.

When the joint has been made, the bell hole shall be carefully filled with bedding material to provide for adequate support of the pipe throughout its entire length.

D. Minimum Cover for Load Application: At least 30-inches of cover over the top of the pipe shall be provided before the trench is wheel-loaded, and 48-inches of cover before utilization of a hydrohammer during compaction.

E. Use of Compaction Equipment: Care shall be taken to avoid contact between the pipe and compaction equipment. Compaction of initial backfill in the bedding area, and backfill material should generally be done in such a way so that impact type compaction equipment is not used directly above the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe.

F. Pipe Support: Couplings shall not rest upon, nor shall a coupling settle down upon the original trench bottom, rocks, concrete, or underground structures.

3.04 LAYING PIPE

A. The pipe shall be installed in accordance with the requirements of ASTM Designation D 2321-74 and as indicated on the drawings and the sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for joint, the bedding for the pipe shall be checked for firmness and uniformity of surface.

B. The radius of curvature of the trench shall determine the maximum length of pipe section that can be used without exceeding the allowable deflection at a coupling. The deflection at any flexible joint shall not exceed that prescribed by the manufacturer of the PVC pipe. The manufacturer's printed installation guide outlining the radii of curvature that can be negotiated with pipe sections of various lengths shall be followed.

C. Proper implements, tools, and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the Contractor for safe and efficient execution of the work. All pipe, fittings, valves, and accessories shall be carefully lowered into the trench by means of derrick, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.

D. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, nor any other method that may fracture the pipe or will product ragged, uneven edges.

E. The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged, or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

F. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the work shall be furnished by the Contractor at his own expense under the direction of the Engineer.

G. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated, this work shall be performed at the Contractor's expense.

3.05 HANDLING

A. Handling of the PVC pipe shall be done with care to insure that the pipe is not damaged in any manner during storage, loading, transit, unloading and installation.

B. Pipe shall be inspected both prior to and after installation in the ditch and all defective lengths shall be rejected and immediately removed from the working area.

3.06 FIELD JOINTING

A. Each pipe compression type joint shall be joined with a lock-in rubber ring and ring groove that is designed to resist displacement during pipe insertion.

B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. At this time a thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.

C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.

D. When pipe laying is not in progress, the open ends of the pipe shall be closed by approved means to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the [Engineer,] the trench conditions or weather are unsuitable for such work.

3.07 INSTALLATION OF BENDS, TEES, AND REDUCERS

A. Cast iron and PVC fittings shall be installed utilizing standard installation procedures. Fittings shall be lowered into trench by means of rope, cable, chain, or other acceptable means without damage to the fittings. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope or other device be attached through the fitting's interior for handling. Fittings shall be carefully connected to pipe or other facility, and joint shall be checked to insure a sound and proper joint.

3.08 THRUST AND ANCHOR BLOCKS

A. Thrust and anchor blocks shall be installed at all bends in accordance with the details shown on the drawings.

B. Thrust blocks and/or anchor blocks shall be installed at all valves, hydrants, tees, crosses, ends of lines, and at all changes of direction of the main of greater than 10 degrees deflection either vertically or horizontally.

C. Anchor blocks shall provide not less than the normal thrust bearing area to resist horizontal or downward thrust; and shall be of sufficient gross weight to resist upward thrust as tabulated on the drawings. The concrete shall be placed again wetted undisturbed soil, and the exterior of the fitting shall be cleaned and wetted to provide a good bond with the concrete. The concrete interface with the fitting shall be an area of not less than the projected area of the fitting normal to the thrust resultant and centered on the resultant.

3.09 INSTALLATION OF LOCATOR WIRE

A. All installations of PVC pipe shall have a locator wire laid on top of the pipe and fastened to the pipe as intervals of not more than 10-feet.

B. Locator wire shall be installed after all pipe and fittings are in place but before any backfilling is done.

C. The wire shall be continuous from valve to valve and shall be securely fastened to the body of each valve by welding.

*** END OF SECTION ***

SECTION 02649

PVC GRAVITY SEWERS

PART 1 -- GENERAL

1.01 SCOPE

A. The work of this Section includes the construction of underground PVC sewer pipe for gravity mains and all appurtenant work, complete in place, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Trenching and backfill appurtenant to the work shall be as specified in Section entitled, "Trench Excavation" and “Trench Backfill and Compaction”.

B. Testing shall conform to the requirements of Sections entitled, "Hydraulic Structures and Pipeline Testing" and “Sanitary and Storm Drainage System Testing”.

C. Concrete for anchor blocks and thrust blocks, if required, as shown on the drawings, shall conform to the requirements of Section entitled, "Minor Concrete."

1.03 CONTRACTOR SUBMITTALS

A. Samples: The Contractor shall submit to the Engineer for approval, samples of all the materials he proposes to use on the work. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions. All sample submittals shall conform to the requirements for "Samples" in Section entitled, "Contractor Submittals."

B. Shoring and Bracing Drawings: The Contractor's attention is directed to the provisions for the requirements for "Shoring and Bracing Drawings" in Section entitled, "Contractor Submittals," herein, which may require the submittal of shoring and bracing drawings by the Contractor.

C. The Contractor's attention is further directed to the provisions of Subpart P, Section 1926.652 of the OSHA Safety and Health Standards for Construction, which requires that all banks and trenches over 5-feet high shall be shored or sloped to the angle of repose.

D. Certificates: The Contractor shall provide manufacturer's certificates for all materials indicating conformance to these specifications.

1.04 QUALITY ASSURANCE

A. Testing: All materials testing will be based upon applicable ASTM Test Methods and AWWA Standards referenced herein for the materials specified.

B. All costs of such inspection and tests shall be borne by the Contractor.

C. Certificates: Manufacturer's notarized certificates of compliance shall be furnished by the Contractor.

D. The pipe shall be subjected to the specified hydrostatic strength tests, flexure tests, and crushing tests. The crushing tests shall be made on samples taken from the center of full-length sections of pipe.

1.05 CLEANUP

A. In addition to the requirements of Section entitled, "Project Closeout," the Contractor, upon completion of backfilling and grading over trenches shall remove all excess materials and equipment from the site.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All PVC pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and pressure rating in psi.

B. The manufacturer shall also mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2-years, covering quality control taxes, raw material batch number, and other information deemed necessary by the manufacturer.

2.02 PIPE

A. All PVC pipe shall be joined by compression joints unless otherwise indicated or specified, and shall conform to the following requirements:

1. Polyvinyl chloride pipe (PVC) shall conform to the requirements of ASTM Designation D 3034-74, Class SDR 35. Material for PVC pipe shall conform to the requirements of ASTM Designation D 1784-69 for Class 12454-A as defined therein.
2. Flexible rubber rings for compression type joints for PVC pipe fittings shall conform to the printed recommendations of the pipe manufacturer and ASTM Designation 1869.

2.03 FITTINGS

A. All fittings for PVC pressure pipe shall be PVC conforming to the requirements of ASTM Designation D 2241-72. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile-iron pipe fittings.

B. The strength class of the fittings shall be not less than the strength class of any adjoining pipe.

2.04 LOCATOR WIRE

A. The locator wire shall be No. 14 wire gage, (0.064-inch), bare copper wire being the standard product of a manufacturer regularly engaged in the manufacture of such material.

2.05 BEDDING MATERIAL

A. All material used for pipe bedding shall conform to the requirements for "Embedment Materials" as specified in ASTM Designation D 2321-74.

PART 3 -- EXECUTION

3.01 GENERAL

A. All laying, jointing, testing for defects and for leakage under pressure, shall be performed in the presence of the Engineer, and shall be subject to his approval before acceptance. All material found during the progress to have defects will be rejected and the Contractor shall promptly remove such defective material from the site of the work.

B. Installation shall conform to the requirements of ASTM Designation D 2321-74 and to the Supplementary requirements or modifications specified herein. Wherever the provisions of this section and the requirements of ASTM Designation D 2321-74 are in conflict, the more stringent provision shall apply.

3.02 TRENCHING

A. Trench excavation and backfill shall conform to the requirements of the Section entitled, "Trench Excavation" and "Trench Backfilling and Compaction"] and as specified herein.

B. The maximum width of trenches shall be as specified in ASTM Designation D 2321, as supplemented or modified herein.

C. The minimum depth of cover over the top of the pipe shall be 48-inches unless shown otherwise on the drawings.

3.03 BEDDING

A. General: Pipe bedding shall apply to that portion of the vertical section of the trench lying between a plane 6-inches below the design grade of the pipe invert and a plane at a point 12-inches above the top surface of the pipe.

B. Bedding Methods: Bedding of all PVC pipe hereunder shall conform to the requirements of ASTM Designation D 2321-74.

C. Bell Holes for Joints: When the pipe being installed is provided with bell joints, bell holes shall be excavated in the bedding material to allow for unobstructed assembly of the joint. Care shall be taken to assure that the bell hole is not larger than necessary to accomplish proper joint assembly.

When the joint has been made, the bell hole shall be carefully filled with bedding material to provide for adequate support of the pipe throughout its entire length.

D. Minimum Cover for Load Application: At least 30-inches of cover over the top of the pipe shall be provided before the trench is wheel-loaded, and 48-inches of cover before utilization of a hydrohammer during compaction.

E. Use of Compaction Equipment: Care shall be taken to avoid contact between the pipe and compaction equipment. Compaction of initial backfill in the bedding area, and backfill material should generally be done in such a way so that impact type compaction equipment is not used directly above the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe.

F. Pipe Support: Couplings shall not rest upon, nor shall a coupling settle down upon the original trench bottom, rocks, concrete, or underground structures.

3.04 LAYING PIPE

A. The pipe shall be installed in accordance with the requirements of ASTM Designation D 2321-74 and as indicated on the drawings and the sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for joint, the bedding for the pipe shall be checked for firmness and uniformity of surface.

B. The radius of curvature of the trench shall determine the maximum length of pipe section that can be used without exceeding the allowable deflection at a coupling. The deflection at any flexible joint shall not exceed that prescribed by the manufacturer of the PVC pipe. The manufacturer's printed installation guide outlining the radii of curvature that can be negotiated with pipe sections of various lengths shall be followed.

C. Proper implements, tools, and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the Contractor for safe and efficient execution of the work. All pipe, fittings, valves, and accessories shall be carefully lowered into the trench by means of derrick, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.

D. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, nor any other method that may fracture the pipe or will product ragged, uneven edges.

E. The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged, or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

F. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the work shall be furnished by the Contractor at his own expense under the direction of the Engineer.

G. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated, this work shall be performed at the Contractor's expense.

3.05 HANDLING

A. Handling of the PVC pipe shall be done with care to insure that the pipe is not damaged in any manner during storage, loading, transit, unloading and installation.

B. Pipe shall be inspected both prior to and after installation in the ditch and all defective lengths shall be rejected and immediately removed from the working area.

3.06 FIELD JOINTING

A. Each pipe compression type joint shall be joined with a lock-in rubber ring and ring groove that is designed to resist displacement during pipe insertion.

B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. At this time a thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.

C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.

D. When pipe laying is not in progress, the open ends of the pipe shall be closed by approved means to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the [Engineer,] the trench conditions or weather are unsuitable for such work.

3.07 INSTALLATION OF BENDS, TEES, AND REDUCERS

A. Cast iron and PVC fittings shall be installed utilizing standard installation procedures. Fittings shall be lowered into trench by means of rope, cable, chain, or other acceptable means without damage to the fittings. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope or other device be attached through the fitting's interior for handling. Fittings shall be carefully connected to pipe or other facility, and joint shall be checked to insure a sound and proper joint.

3.08 THRUST AND ANCHOR BLOCKS

A. Thrust and anchor blocks shall be installed at all bends in accordance with the details shown on the Drawings.

B. Thrust blocks and/or anchor blocks shall be installed at all valves, hydrants, tees, crosses, ends of lines, and at all changes of direction of the main of greater than 10-degrees deflection either vertically or horizontally.

C. Anchor blocks shall provide not less than the normal thrust bearing area to resist horizontal or downward thrust; and shall be of sufficient gross weight to resist upward thrust as tabulated on the drawings. The concrete shall be placed again wetted undisturbed soil, and the exterior of the fitting shall be cleaned and wetted to provide a good bond with the concrete. The concrete interface with the fitting shall be an area of not less than the projected area of the fitting normal to the thrust resultant and centered on the resultant.

3.09 INSTALLATION OF LOCATOR WIRE

A. All installations of PVC pipe shall have a locator wire laid on top of the pipe and fastened to the pipe as intervals of not more than 10 feet.

B. Locator wire shall be installed after all pipe and fittings are in place but before any backfilling is done.

C. The wire shall be continuous from valve to valve and shall be securely fastened to the body of each valve by welding.

3.10 TESTING

A. Field testing of gravity sewer pipe shall conform to the requirement6s of Section 02667 – Hydraulic Structures and Pipeline Testing.

*** END OF SECTION ***

SECTION 02667

HYDRAULIC STRUCTURES AND PIPELINE TESTING

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall perform all cleaning, flushing, and testing, including conveyance of test water from source to point of use, and including all disposal thereof, complete and acceptable, for hydraulic and appurtenant piping all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Testing of pipeline except appurtenant piping to the hydraulic structure(s) shall be tested according to the applicable provisions of the pipe schedule in the Drawings and by this reference thereto, said provisions shall be a part of this Section. The CONTRACTOR shall provide all temporary closure fittings necessary to test pipelines. This shall include plugs, bulkheads, valves, caps or welded plates on steel pipes.

B. Repair of hydraulic structures, as required, shall conform to the provisions of Section entitled, "Cast-in-Place Concrete."

1.03 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit minimum 48-hour advance written notice of its proposed testing schedule for review and concurrence of the ENGINEER. The Contractor's proposed plans for water conveyance, control, and disposal shall also be submitted in writing.

PART 2 -- PRODUCTS

2.01 MATERIALS REQUIREMENTS

A. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined by the CONTRACTOR subject to the Engineer's review. No material shall be used which would be injurious to the construction or its future function.

PART 3 -- EXECUTION

3.01 GENERAL

A. The CONTRACTOR shall make all necessary provisions for providing testing water for the project. CONTRACTOR shall also make all necessary provisions for conveying the water from

the source to points of use and for disposing of the water upon completion of testing.

B. All hydraulic structures and appurtenant piping shall be tested. All testing operations shall be done in the presence of the ENGINEER.

C. If industrial paint finishes or other protective coatings are to be applied to the surfaces of the hydraulic structure, such coatings shall be applied after all testing operations have been completed.

D. Release of water from structures, after testing has been completed, shall be approved by the ENGINEER.

3.02 PRELIMINARY CLEANING AND FLUSHING

A. Prior to testing, all hydraulic structures shall be cleaned by thoroughly hosing down all surfaces with high-pressure hoes and nozzle of sufficient size to deliver a minimum flow of 50-gpm.

3.03 TESTING OF HYDRAULIC STRUCTURES

A. General. Testing shall be performed prior to backfilling, except where otherwise permitted by the ENGINEER. Testing shall not be performed sooner than 14-day after all portions of structure walls have been completed. The test shall consist of filling the structure with water to the maximum operating water surface. The rate of filling shall not exceed 24-inches of depth per day.

B. Leakage Test and Repairs. After the structure has been filled, the leakage test shall be performed as follows: An initial water level reading shall be made. Seven days following the initial reading, a second reading shall be made. The structure shall be considered to have passed the test if water loss during the 7-day period, as computed from the 2 water level readings, does not exceed 0.7-percent of the total volume of water in the structure, after allowance is made for evaporation loss.

Should the structure fail to pass the test, the test shall be repeated for up to 3 additional 7-day test periods. If at the end of 28-days, the structure still fails to pass the leakage test, the CONTRACTOR shall empty the structure as approved by the ENGINEER and shall examine the interior for evidence of any cracking or other conditions that might be responsible for the leakage.

Any cracks shall be "vee'd" and sealed with rubber sealant in accordance with the manufacturer's recommendations. Any evidence of leakage through the joints shall be repaired. Following these operations, the CONTRACTOR shall again test the hydraulic structure.

3.04 TESTING OF APPURTENANT PIPING

A. Piping appurtenant to hydraulic structures shall be tested as specified in the Piping Schedule in the Contract Documents.

*** END OF SECTION ***

SECTION 02719

SANITARY SEWER SYSTEM

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. This section covers the materials and work associated with the following:

1. Sanitary sewerage piping, fittings, and accessories.
2. Casing pipe and accessories.
3. Connection of Project pipe to existing manholes.

B. Coordinate work with other trades on the site.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02312 – Trench Excavation: Excavation of trenches.
B. Section 02316 – Trench Backfill and Compaction: Pipe bedding and trench backfilling.
C. Section 02606 – Manholes.
D. Section 03300 – Cast-in-Place Concrete: Concrete for manhole base construction.

1.03 REFERENCES

A. Use the latest issue of the reference standards as of the date of the Project.

B. ASTM C 14: Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe; 1995.

C. ASTM C 76: Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 1995a.

D. ASTM C 443: Standard Specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets; 1994.

E. ASTM C 891: Standard Practice for Installation of Underground Precast Concrete Utility Structures.

F. ASTM C 923: Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

G. ASTM F 1803: Standard Specification for Poly (Vinyl Chloride) (PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter.

H. ASTM D 2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 1989 (Reapproved 1995).
I. ASTM D 3034: Standard Specification for Type PSM Poly (Vinyl Chloride)(PVC) Sewer Pipe and

Fittings; 1996.

J. ASTM F 477: Standard Specification for Elastometric Seals (Gaskets) for Joining Plastic Pipe.

K. ASTM F 679: Standard Specification for Poly (Vinyl Chloride)(PVC) Large-Diameter Gravity Sewer Pipe and Fittings; 18-inch through 24-inch smooth solid wall sewer pipe.

L. ASTM F 794: Standard Specification for Poly (Vinyl Chloride)(PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter; 21-inch through 48-inch ribbed or close profile sewer pipe with smooth interior wall.

M. ASTM F 714: Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter; 2000.

N. ASTM D 3350: Standard Specification for Polyethylene (PE) Plastic Pipe and Fittings Materials; 1999.

O. ASTM D 2657: Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings; 1997.

P. ASTM D 3262: Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.

Q. ASTM D 4161: Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced) Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.

R. ASTM D2412: Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

1.04 SUBMITTALS

A. See Section 01300 – Administrative Requirements, for submittal procedures.

B. Traffic Control Plan, if existing City streets are impacted.

C. Product Data: Provide data indicating pipe, pipe accessories, and fittings.

D. Manufacturer's Installation Procedures: Certify that products meet or exceed specified requirements.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Project Record Documents:

1. Record location of pipe lines, connections, manholes, sewer laterals, and invert elevations.
2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.05 REGULATORY REQUIREMENTS

A. Conform to applicable code for materials and installation of the Work of this Section.

1.06 PROJECT CONDITIONS

A. Coordinate the Work on sewer lines and connections to existing manholes with City.
B. Minimize neighborhood traffic interruptions. Barricade stockpiles.
C. Provide accesses to adjacent properties for local traffic and pedestrians.
D. Repair public and private facilities damaged by Contractor.

PART 2 -- PRODUCTS

2.01 SANITARY SEWER PIPE MATERIALS

A. Plastic Pipe: ASTM D 3034, Type PSM, Poly(Vinyl Chloride)(PVC) material inside nominal diameter larger than 4-inches, smooth solid wall sewer pipe, bell and spigot joint ends with gaskets.

B. Plastic Pipe: ASTM F 679, Poly(Vinyl Chloride)(PVC) material inside nominal diameter of 18-inches through 30-inches, smooth solid wall sewer pipe, bell and spigot joint ends with gaskets.

C. Plastic Pipe: ASTM F 794, Poly(Vinyl Chloride)(PVC) material, cell classification of 12454C or 12364A; ribbed pipe; inside nominal diameter of 21-inches through 48-inches, bell and spigot joint ends with gaskets.

D. Plastic Pipe: ASTM F 1803, Poly(Vinyl Chloride)(PVC) material, minimum cell classification of 12364, closed profile pipe; inside nominal diameter of 21-inches through 54-inches, bell and spigot joint ends with gaskets.

E. Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe (CCFRPM): ASTM D 3262, minimum stiffness rating of 465-psi (SN 46), nominal pipe diameter of 18-inches through 110-inches with FWC coupling, HOBAS or approved equivalent.

F. Joint Seals for Plastic Pipe: ASTM F 477 rubber compressing gaskets for positive seal.

G. Fittings: Wye branches and other fittings shall be of the same material as the pipe, molded or formed to suite the pipe size and end-design, in required configurations. DFW Brand Non Shear Couplings shall be used for coupling differing pipe materials.

H. Pipe Plugs: Burke Duo Seal Pipe Plugs as supplied by Burke Rubber Company or approved equivalent.

I. HDPE Sewer Pipe: PE 3408 striped high density polyethylene pipe manufactured in accordance with, and conforming to all requirements of ASTM D 3350 and ASTM F 714; including ASTM standards for PE 3408, Type III, Category 5, Class C, Grade P 34. Minimum wall thickness to be SDR 17 for Sewer Main Lines and SDR 11 for pressure Sewer Laterals. Exact wall thickness for force mains and pressure Sewer Laterals shall be determined based upon operating pressures. All HDPE sewer pipes shall be color coded according to the color striping codes developed by the Utility

Location and Coordination Council of the American Public Works Association (APWA).

J. HDPE Joints: HDPE pipe to be joined by butt fusion method conforming to ASTM D 2657 and manufacturer's recommendations; to provide heat weld as strong as pipe wall.

K. Electronic Marker: Omni Marker model 162 Electronic Marker as produced by Industrial Technology.

L. Geotextile Fabric: Non-biodegradable, non-woven, drainage fabric; Amoco No. 4547, Typar No. 3401, or approved equal.

2.02 CASING PIPE MATERIALS

A. Welded Steel Pipe: ASTM A53, Grade B or approved equivalent.

B. Casing Insulators: Stainless steel casing insulators with 12-inch wide band and 2-inch wide glass reinforced plastic runner; Model S12G-2, manufactured by Pipeline Seal and Insulator, Inc., or approved equal.

C. Casing End Seals: Flexible S-shaped seals fabricated of synthetic rubber with stainless steel bands and clamps; Model S Pull-On End Seals, manufactured by Pipeline Seal and Insulator, Inc., or approved equivalent.

D. Casing End Seals: Flexible S-shaped seals fabricated of synthetic rubber with stainless steel bands and clamps; Model C Pull-On End Seals, manufactured by Pipeline Seal and Insulator, Inc., or approved equivalent.

E. Casing Minimum Wall Thickness: The minimum wall thickness of casings shall be as follows:

1. 12-inch and under – 0.188-inch
2. 14 through 18-inch – 0.312-inch
3. 20 through 22-inch – 0.375-inch
4. 24 through 26-inch – 0.438-inch
5. 28 through 32-inch – 0.500-inch
6. 34 through 42-inch – 0.562-inch
7. Larger casings as directed by the City Engineer.

2.03 BEDDING AND COVER MATERIALS

A. Pipe Bedding Materials: As specified in Section 02316.

B. Trench Backfill Material: As specified in Section 02316.

PART 3 -- EXECUTION

3.01 INSTALLATION – SANITARY SEWER MAIN LINE PIPE

A. Sanitary sewer main lines shall be installed in public right-of-ways or within City easements.

B. Verify that trench cut is ready to receive Work and excavations, dimensions, and elevations are as indicated on Project Drawings.

C. Where required by the City's Resident Project Representative and/or City Engineer, install fabric encasement as indicated on Drawings and according to manufacturer's written instructions and recommendations.

D. Place spigots or groove ends facing upstream.

E. Insulate dissimilar metals from direct contact with each other using neoprene gaskets or asphalt coatings.

F. Install pipe, fittings, electronic markers and accessories, for sanitary sewer main lines, in accordance with appropriate ASTM standards and manufacturer's instructions. Seal joints watertight.

G. Install pipe to alignment and slope gradients noted on Drawings; with maximum variations from design alignment of 0.25-foot and from design elevations of 0.10-foot.

H. A minimum of 4-feet of cover shall be required over all main sanitary sewer lines.

I. Pipe plugs shall be installed during construction at the end of each length of pipe installed to prevent water and debris from entering pipe.

J. Install electronic markers over all HDPE and curved sanitary sewer lines, at intervals as per the manufacturer's recommendations and as directed by the City's Resident Project Representative but not more than 20-feet, and at depths no greater than 4-feet.

K. In locations with steep slopes (i.e. greater than 15-percent) concrete anchor restraints shall be installed on the pipe at a spacing and in a manner as indicated on the Standard Drawing No. SS-115.

3.02 INSTALLATION – SANITARY SEWER LATERALS

A. Sanitary sewer service lateral shall extend from a wye branch or other fitting as approved by the City's Resident Project Representative, installed in the main line, to a point at least 10-feet inside the property line, as indicated on the Drawings and as directed by the City's Resident Project Representative.

B. Verify that the trench cut is ready to receive Work and excavations, dimensions, and elevations are as indicated on Project plan and profile Drawings, and as directed by the City's Resident Project Representative.

C. Install pipe, fittings, and accessories, for sanitary sewer laterals, in accordance with appropriate ASTM standards and manufacturer's instructions. Seal joints watertight.

D. Install a 22-1/2 or 45-degree bend, or combinations of bends as required, on the wye, rotated so the proper alignment and grade are established.

E. Install pipe to alignment as director by the City's Resident Project Representative and with uniform slope, free of low spots or adverse grades. Recommended minimum slope shall be ¼-inch per foot (approximately 2.0-percent grade) where practical; but in no case less than 1/8-inch per foot (approximately 1.0-percent grade).

F. Where laterals are to be connected to a manhole, the manhole wall shall be core-cut with the appropriate size machine and the lateral pipe shall be connected to the manhole with the appropriate type flexible coupling.

G. Service laterals shall be cleaned, flushed and tested in accordance with applicable requirements of this Section. After flushing has been completed, the end of the service lateral shall be beveled and plugged, with a Burke Duo Seal Pipe Plug or approved equivalent. Prior to backfilling, a 2x4 shall be extended to the surface to indicate its location for future use.

H. A brass lateral marker shall be installed in the curb, directly above each lateral crossing, as per the City's Resident Project Representative's instructions. If curb and gutter is not available in a subdivision, brass lateral markers shall be installed as per the City's Resident Project Representative's instructions.

I. Four (4)-feet of cover is required over all sanitary sewer laterals, unless otherwise approved by the City Engineer.

J. The City recommends that no trees be planted in the proximity of sanitary sewer laterals.

K. Cleanouts shall be installed at no more than 100-foot spacing.

L. No more than two bends in excess of 45-degrees shall be installed without a cleanout.

M. Flows discharged from a sump shall be pumped, by automatic pumping equipment, via a pressure Sanitary sewer Lateral and discharged into a gravity flow Sanitary sewer Lateral, connected at a cleanout, or the Sanitary sewer Main, connecting in a manhole constructed of Dynastone with approved restrained coupling(s).

N. Pumping equipment and pressure Sanitary sewer Laterals shall be designed to meet or exceed the anticipated use requirements. Unless otherwise approved by the City Engineer, pressure Sanitary sewer Laterals shall be constructed of HDPE and constructed on a constant reverse grade. Professional advice should be obtained prior to installing pumping equipment and shall be done per manufacturer's recommendations.

3.03 INSTALLATION – CASING PIPES

A. See Section 02313 and 02316 for trench excavation, backfill, and additional requirements.

B. Install casing pipes by ramming process or open cut where indicated; method to be acceptable to the City's Resident Project Representative and any other governing authority. If open cut installation method is used under a canal, river or other applicable area, the impacted area shall be lined with concrete, conforming to the governing authority requirements.

C. Install casing pipes at he line and grade as required to allow carrier pipes to be installed within the casing pipes at the design line and grade, as indicated on the Drawings.

D. Place casing insulators on carrier pipes to properly center and position carrier pipe inside the casing pipes; space insulators as recommend by the pipe and/or insulator manufacturer.

E. Seal each end of casing with appropriate size flexible end seals; install according to manufacturer's instructions and recommendations.

F. Seal voids created by bore, around periphery of casing, with grout or impervious clay as approved by the manufacturer.

G. Contractor shall be solely responsible for the accuracy, safety and adequacy of construction methods and procedures for installing casing pipes, and for any damage, which may result from their failure. All operations of the Contractor for installation of casing pipes shall be subject to approval by the agency having jurisdiction over the item being crossed, such as the County Flood Control Department, Utah Department of Transportation, canal companies, railroad companies, etc.

H. Contractor shall enter any agreement with, and furnish any and all indemnity and other bonds that may be required by, the agencies listed above, for their protection against injury and interference with flow of water caused by the operations of the Contractor.

I. Contractor shall secure required permission from the agencies listed above before commencing with the installation of casing pipes and related Work along and across the respective areas.

3.04 CONNECTIONS TO EXISTING SANITARY SEWER MANHOLES

A. Connection of Project Pipe into existing manhole includes:

1. All excavating required for the connection; and backfilling excavations after the connections completed, and compacting backfill is required.
2. Removing existing pipes where and if required.
3. Cutting hole through wall and base of existing manhole with appropriate size coring machine, as required and as directed.
4. Installing new pipe in place and connecting to manhole wall with appropriate type flexible coupling, as recommended by the coupling manufacturer.
5. Reforming manhole floor and invert channel to provide smooth channel transitions to accommodate new connected pipes.
6. Sealing around new pipe where it intersects manhole wall; make connection watertight.
7. Perform all other operations necessary to restore existing manhole to condition acceptable to the

City's Resident Project Representative.

B. If existing manhole does not have steps, connection shall also include furnishing and installing new manhole steps. Steps shall be installed as described in Section 02606 – Manholes.

C. Connections to existing manholes shall not be completed until new pipelines have been cleaned, tested, and accepted by the City's Inspector.

D. No debris and rubbish from new pipelines or manholes shall be flushed into existing City sanitary sewer pipelines.

3.05 CONNECT PROJECT PIPE TO STUB AT EXISTING SANITARY SEWER MANHOLE

A. Connection of Project pipe to stub at existing manhole includes:

1. All excavating required for the connection; and backfilling excavations after the connections completed, and compacting backfill as required.
2. Removing plug from end of existing pipe stub and cleaning end of pipe as required.
3. Connecting new pipe to end of pipe stub with appropriate rigid type coupling; connection to be watertight.
4. Perform all other operations necessary to restore existing manhole to condition acceptable to the City's Resident Project Representative.

B. If existing manhole does not have steps, connection shall also include furnishing and installing new manhole steps. Steps shall be installed as described in Section 02606 – Manholes.

C. Connections to existing manholes shall not be completed until new pipelines have been cleaned, tested, and accepted by the City's Resident Project Representative.

D. No debris and rubbish from pipe lines or manholes shall be flushed into City's existing pipelines.

3.06 QUALITY CONTROL

A. Clean and flush new Sanitary sewer Main Lines as follows:

1. Take every precaution to prevent dirt, grease, and all other foreign matter from entering each length of pipe before making connection in field.
2. After each section of piping is installed, it shall be thoroughly cleaned to remove rocks, dirt, and other foreign matter by washing, sweeping, scraping or other methods that will not harm the pipe.
3. For safety and to prevent rocks and other foreign matter from entering pipe, all open ends of pipe shall be plugged when workmen are not on the job or in the immediate area.
4. All sections of sanitary sewer lines between manholes and sanitary sewer laterals extending from the sanitary sewer main shall be completely flushed.
   a. Pipe 12-inch in diameter and larger shall be flushed at a rate of 3.0-feet per second.
   b. Pipe under 12-inch diameter shall be flushed at a rate of 4.0-feet per second.
5. The Contractor shall furnish water required for flushing and testing.

6. All temporary cross-connections for flushing and drainage shall be furnished, installed, and subsequently removed by the Contractor after completion of the operation.
7. No debris and rubbish from pipe lines or manholes shall be flushed into existing City pipelines.

B. Perform field inspection and testing in accordance with Section 01400.
C. Prior to the backfilling of a trench, the City's Resident Project Representative shall inspect pipe installation; backfilling will be done only after the City's Resident Project Representative authorizes it.

1. The Contractor shall arrange for all inspections by calling the City's Engineering Department Inspection telephone number.

D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to City.

E. Test for Leakage: Test all pipe, fittings, and other items for leakage, in presence of City's Resident Project Representative, after items have been cleaned. Tests shall be done by independent testing company. All joints, couplings, and fittings shall be watertight.

1. Infiltration Test: Infiltration test required when pipe is below ground water level. Amount of water leaking into pipe shall be measured. Leakage of pipe shall not be more than 1-gallon per day per inch diameter per mile of pipe.
2. Air Test: Low-pressure air test may be performed. Section of pipe being tested shall be sealed; line under test shall be pressurized to approximately 4.0-psi; and pressure allowed to stabilize for a minimum of two minutes. During this period air shall be added if the pressure drops below 4.0-psi. After this stabilization period, timing shall begin. The time of test, in minutes, shall be equal to the pipe diameter in inches. The maximum allowable pressure drop during the specified time period shall be 0.5-psi.

F. Deflection Test, PVC Sanitary Sewer Pipe: After PVC sanitary sewer pipe has been cleaned, perform deflection test on each section of pipeline between manholes. The maximum allowable pipe deflection in vertical inside diameter, shall be 5-percent. Maximum allowable deflection shall be applied to the base inside diameters shown in Table 10.14, Base Inside Diameters For Deflection Measurements of ASTM D 3034 SDR35 PVC Sewer Pipe in the Uni-Bell "Handbook of PVC Pipe", to determine minimum permissible diameter, or other appropriate sources. Testing devices shall include deflectometer, calibrated television or photography, or properly sized mandrel.

G. Televised Inspection: After the sanitary sewer pipe has been installed and cleaned; and the trench has been filled, the City will televise the sanitary sewer pipe to locate defects in the sanitary sewer pipe.

1. The Contractor shall arrange for television inspection.
2. The Contractor shall ensure safe access to each manhole for the City's television trucks.
3. If the City is called for a televised inspection and cannot perform such inspections due to defects in Work by Contractor, i.e. inaccessible manholes, dirty sanitary sewer pipe, etc., the Contractor shall be charged a call-back fee according to the current City Fee Schedule.
4. Any Work not conforming to this Sanitary sewer Policies & Design Criteria Manual shall be

promptly removed, replaced and retested at not cost to the City.

H. Hydrostatic Test:

1. A hydrostatic test shall be performed on the following installed pipes:
   a. Force Sanitary sewer Main Lines
   b. Private pressure Sanitary sewer Laterals
2. Prior to the hydrostatic test, the line shall be flushed with an adequate flow volume and rate to remove any debris, silt, gravel or other material in the line.
3. Method of Test:
   a. The lines to be tested shall be filled with clean water.
   b. All air in the system shall be expelled before the test.
   c. The test pressure shall be the greater of 150-percent of the maximum design pressure or 100-psi.
   d. Leakage rate shall be less than determined by the formula:

$$Q = \frac{L \times D \times \text{square root of } P}{133{,}200}$$

Where:
Q = allowable leakage rate, in gallons per hour
L = length of pipe, in feet
D = nominal diameter of pipe, in inches
P = average test pressure, in psi (gauge)

   e. Locate and repair defective joints and retest until leakage rate is less than allowable.
   f. Repair any noticeable leakage even if total leakage is less than allowable.

3.07 PROTECTION

A. Protect pipe and bedding material from damage or displacement until backfilling operation is in progress.

*** END OF SECTION ***

SECTION 02750

SANITARY AND STORM DRAINAGE SYSTEM TESTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The CONTRACTOR shall perform all pipeline flushing and testing, complete, for sanitary sewerage and storm drainage system piping as specified herein and in accordance with the requirements of the Contract Documents.

B. The CONTRACTOR shall be responsible for conveying test water from the Owner-designated source to the point of usage and also for disposal, as required, of water used in the testing operations.

1.02 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit minimum 48-hour advance written notice of its proposed testing schedule for review and concurrence of the ENGINEER. The CONTRACTOR's proposed plans for water conveyance, control, and disposal shall also be submitted in writing.

PART 2 -- PRODUCTS

2.01 MATERIALS REQUIREMENTS

A. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined by the CONTRACTOR subject to the ENGINEER's review. No materials shall be used which would be injurious to pipeline structure and future function.

PART 3 -- EXECUTION

3.01 GENERAL

A. Unless otherwise provided herein, water for testing will be furnished by the OWNER; however, the CONTRACTOR shall make all necessary provisions for conveying the water from the OWNER-designated source to the points of use.

B. Release of water from pipelines, after testing has been completed, shall be performed as reviewed by the ENGINEER.

C. All testing operations shall be performed in the presence of the ENGINEER.

3.02 TESTING OF PIPING

A. General: All gravity sewer pipes and service laterals shall be tested for exfiltration and/or infiltration and deflection as specified herein. All manholes shall be tested for leakage as required herein. Manholes shall be tested prior to backfill placement, whereas all pipe shall be backfilled prior to testing. Any pipe, lateral or manhole found to be defective shall be repaired or replaced to the satisfaction of the ENGINEER.

B. Leakage Tests: All gravity sewer pipes shall be tested for leakage by one of the following three test methods as directed by the ENGINEER and following the specific procedures outlined in the referenced sections of the "Standard Specification for Public Works Construction" (SSPWC) 1985 edition:

1. Water Exfiltration Test Section 306-1.4.2
2. Water Infiltration Tes Section 306-1.4.3
3. Air Pressure Test Section 306-1.4.4

C. Deflection Test: All flexible and semi-rigid pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30-days after completion of the trench backfill, but prior to any resurfacing. The mandrel test shall comply with the specific procedures required in Section 306-1.4.6 of the SSPWC, except for the additional provision that the mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the ENGINEER as to design and manufacture.

D. Manhole Leakage: Manholes shall be tested for leakage after installation, but prior to being backfilled. All pipes entering the manhole shall be sealed at a point outside the manhole walls so as to include testing of the pipe-manhole joints. The manhole shall be filled with water to a level 2 inches below the top of the frame. The water shall be allowed to equilibrate for 24 hours and then the level should be readjusted and marked. The water-filled manhole shall be allowed to sit for 3 days, after which the water level shall be measured. The water loss, adjusted for evaporative loss, shall not exceed 0.5 percent of the total volume. The exterior of the manhole shall be inspected daily during this period for visible evidence of leakage. Visible moisture, sweating, or beads of water on the exterior of the manhole shall not be considered leakage, but any water running across the surface will be considered leakage and shall be repaired to the satisfaction of the ENGINEER regardless of the volume of water lost.

*** END OF SECTION ***

SECTION 03100

CONCRETE FORMWORK

PART 1--GENERAL

1.01 THE REQUIREMENT

A. The CONTRACTOR shall furnish all materials for concrete formwork, bracing, shoring, and supports and shall design and construct all falsework, all in accordance with the provisions of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Contractor Submittals. 01300
B. Reinforcement Steel. 03200
C. Joints in Concrete. 03290
D. Cast-in-Place Concrete. 03300
E. Grout. 03315
F. Precast Concrete Specialties. 03480
G. Sealants and Caulking. 07920

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes:
The Building Code, as referenced herein, shall be the Uniform Building Code (UBC), as specified in section entitled, "Reference Standards." 01090

B. Government Standards:
PS 1-74 U.S. Product Standard for Concrete Forms, Class I.

C. Commercial Standards:
ACI 347-78 Recommended Practice for Concrete Formwork.

1.04 CONTRACTOR SUBMITTALS

A. Falsework Calculations and Drawings: The CONTRACTOR's attention is directed to the provisions of Section 1717 of the Division of Industrial Safety, Construction Safety Orders, as revised November 1973, which requires that all falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14-feet, or where individual horizontal span lengths exceed 16 feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a civil engineer, registered in the State of California; provided further, that a copy of the falsework plan or shoring layout shall be available on the job site at all times.

B. The CONTRACTOR shall, in accordance with the requirements in Section entitled "Contractor Submittals," 01300 submit detailed plans of the falsework proposed to be used. Such plans shall be

in sufficient detail to indicate the general layout, sizes and members, anticipated stresses, grade of materials to be used in the falsework, and typical soil conditions.

1.05 QUALITY ASSURANCE

A. Tolerances: The variation from established grade or lines shall not exceed 1/4-inch in 10 feet and there shall be no offsets or visible waviness in the finished surface. All other tolerances shall be within the "Suggested Tolerances" specified in Section 203 of ACI 347.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Except as otherwise expressly accepted by the ENGINEER, all lumber brought on the job site for use as forms, shoring, or bracing shall be new material. All forms shall be smooth surface forms and shall be of the following materials:

1. Walls - Steel or plywood panel
2. Columns - Steel, plywood or fiber glass plywood
3. Roof and floor
4. Slabs - Plywood
5. All other work - Steel panels, plywood or tongue and groove lumber

2.02 FORM AND FALSEWORK MATERIALS

A. Materials for concrete forms, formwork, and falsework shall conform to the following specifications:

1. Lumber shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20.
2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine plywood manufactured, especially for concrete formwork and shall conform to the requirements of PS 1 for Concrete Forms, Class I, and shall be edge sealed.
3. Form materials shall be plywood or other approved material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade as shown. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Exterior Grade.

B. Unless otherwise shown, exterior corners in concrete members shall be provided with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise shown.

C. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 30 psf minimum.

2.03 FORM TIES

A. Form ties with integral waterstops shall be provided with a plastic cone or other suitable means of forming a conical hole to insure that the form tie may be broken off back of the face of the concrete.

The maximum diameter of removable cones for rod ties, or of other removable for-tie fasteners having a circular cross-section, shall not exceed 1-1/2 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming.

B. Form ties for water-retaining structures shall have integral water stops. Removable taper ties may be used when approved by the ENGINEER. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie.

PART 3 -- EXECUTION

3.01 GENERAL

A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The CONTRACTOR shall assume full responsibility for the adequate design of all forms, and amy forms which are unsafe or inadequate in any respect shall promptly be removed from he work and replaced at the CONTRACTOR's expense. A sufficient number of forms of each kind shall be provided to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework , and shoring shall comply with applicable local, state, and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by CONTRACTOR's personnel and by the ENGINEER and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.

B. Concrete forms shall conform to the shape, lines, and dimensions of members as called for on the Drawings, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

3.02 FORM DESIGN

A. All forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects int eh finished concrete. Plywood, 5/8-inch and greater in thickness, may be fastened directly to stuffing of the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of the wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of finds and paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2 inch diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable the ENGINEER.

3.03 CONSTRUCTION

A. Vertical Surfaces: All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is shown. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. Construction Joints: Concrete construction joints will not be permitted at locations other than those shown or specified, except as may be acceptable to the ENGINEER. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. Form Ties:

1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified for "Finish of Concrete Surfaces" in Section entitled "Cast-in-Place Concrete." 03300 Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded int he concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face of faces of the concrete.
2. Removable Ties: Where taper ties are approved for used, the larger end of the taper tie shall be on the wet side of walls, in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plumb shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls which are dry on both sides. Exposed faces of walls shall have the outer 2-inches of the exposed face filled with a cement grout which shall match the color and texture of the surrounding wall surface.

3.04 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the ENGINEER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the ENGINEER.

3.05 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28-day strength specified in Section entitled, "Cast-in-Place Concrete"; 03300 provided, that no forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or until has attained 75 percent of the specified 28-day strength and has been in place for a minimum of 7 days. The time required to establish said strength shall be as determined by the ENGINEER who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7-day minimum, then that time shall be used as the minimum length of time. Forms for all vertical walls and columns shall remain in place at least 2 days after the concrete has been placed. Forms for all parts of the WORK not specifically mentioned herein shall remain in place for periods of time as determined by the ENGINEER.

3.06 MAINTENANCE OF FORMS

A. Forms shall be maintained at all times in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Forms, when in place, shall conform to the established alignment and grades. Before concrete is placed, the forms shall be thoroughly cleaned. The form surfaces shall be treated with a non-staining mineral oil or other lubricant acceptable to the ENGINEER. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the CONTRACTOR shall perform the oiling at least two weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.07 FALSEWORK

A. The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, the requirements of the Construction Safety Orders of the California Division of Industrial Safety, and the requirements specified herein.

B. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.

C. Falsework shall be placed upon a solid footing, safe against undermining, and protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure which already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

*** END OF SECTION ***

SECTION 03102

GENERAL CONCRETE CONSTRUCTION

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. This section includes materials, installation, and testing of formwork, reinforcing steel, joints, concrete, insulation, and finishing and curing for general concrete construction.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 09820 - Crystaline Waterproofing
B. Section 09900 - Painting and Coating
C. Section 15142 - Wall Pipes, Seep Rings, and Penetrations

1.03 SUBMITTALS

A. Submit shop drawings in accordance with the Contract Documents.

B. Submit manufacturer's catalog data and descriptive literature for form ties, spreaders, corner forms, form coatings and curing compound, bond breakers, joint sealant, backing rod, joint filler, control joints, epoxy bonding compound, and floor hardener.

C. Submit mill test certificates identifying chemical and physical analyses of each load of reinforcing steel delivered. If mill test reports are unavailable and the quantity of steel for a structure exceeds 5 tons, provide a laboratory test to prove conformance with the specified ASTM standard.

D. Submit reinforcing bending lists and placing drawings for all reinforcing. Placing drawings shall indicate all openings (mechanical, electrical, equipment, and architectural) including additional reinforcing at openings and corner bar arrangements at intersecting beams, walls, and footings indicated in the typical detail and structural drawings. Placing drawings shall be coordinated with the concrete placing schedule. Each bending list and placing drawing submitted shall be complete for each major element of a structure (grade slabs, footings, walls, deck, floor, or roof slabs) including dowels and corner bars. Furnishing such lists shall not be construed that the lists will be reviewed for accuracy. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing reinforcing steel in accordance with the details shown on the plans and as specified.

E. Submit concrete mix design at least 15 days before placing concrete.

F. Submit insulation manufacturer's product data sheets confirming compliance with the physical properties specified herein, CFC compliance certification and 15-year limited thermal warranty certificate, samples of specified insulation, and adhesive manufacturer's product information confirming compatibility with polystyrene insulation.

PART 2 -- PRODUCTS

2.01 FORMWORK

A. Design forms according to ACI 347.

B. Class I Forms. Use steel forms, ply form, or smooth-surface plywood 3/4-inch minimum thickness for straight surfaces and 1/2-inch minimum thickness for curved surfaces.

C. Class II Forms. Use plywood in good condition, metal, or smooth-planed boards free from large or loose knots with tongue and groove or ship lap joints. Forms shall be oiled.

D. Class II forms may be used for exterior concrete surfaces, which are 1-foot, or more below finished grade. Use Class I forms for all other surfaces.

2.02 BOND BREAKER

A. Bond breaker shall be a nonstaining type which will provide a positive bond prevention, such as Williams Tilt-Up Compound, as manufactured by Williams Distributors, Inc., Seattle, Washington; Silcoseal 77, as manufactured by SCA Construction Supply Division, Superior Concrete Accessories, Franklin Park, Illinois; or approved equal.

2.03 FORM RELEASE AGENT

A. Form release agent shall effectively prevent absorption of moisture and prevent bond with the concrete. Agency shall be nonstaining and nontoxic after 30 days.

B. For steel forms, release agent shall prevent discoloration of the concrete due to rust.

2.04 REINFORCING STEEL

A. Reinforcement shall conform to ASTM A615, Grade 60.

B. Fabricate reinforcing in accordance with the current edition of the Manual of Standard Practice, published by the Concrete Reinforcing Steel Institute. Bend reinforcing steel cold.

C. Deliver reinforcing steel to the site bundled and tagged with identifying tags.

2.05 WELDED WIRE FABRIC

A. Welded wire fabric shall conform to ASTM A185.

2.06 TIE WIRE

A. Tie wire shall be 16-gauge minimum, black, soft, annealed.

2.07 BAR SUPPORTS

A. Bar supports in beams and slabs exposed to view after form stripping shall be galvanized and plastic coated. Use concrete supports for reinforcing in concrete placed on grade.

2.08 BAR COUPLERS

A. Reinforcing steel bar splicing couplers shall be a mechanical type as manufactured by Dayton Barsplice Inc. or approved equal. Use couplers, which do not reduce tensile or ultimate strength of bars.

2.09 JOINT SEALANT

A. Joint sealant shall be a multipart, gray, nonstaining, nonsagging, polyurethane sealant, which cures at ambient temperature to a firm, flexible, resilient, tear-resistant rubber. Sealant shall be RC 270 of Products Research and Chemical Corporation, Mameco International Vulkem 227, Multi-Chem Mc287, or approval equal.

Technical Requirements	
Consistency	Gun grade
Tack free time	24-hours at 75 degrees F and 50% R.H.
Pot life	1 to 3 hours
Hardness	35 Shore A,5
Elongation	700%
Tensile strength, ASTM D412	300 psi
Peel strength on concrete	No loss of bond after 24 hours at 150% elongation
Temperature service range	-40 degrees F to +175 degrees F
Immersion in water	Continuous

2.10 BACKING ROD FOR EXPANSION JOINTS

A. Backing rod shall be an extruded closed-cell polyethylene foam rod, such as Minicel backer rod, manufactured by Industrial Systems Department, Plastic Products Group of Hercules, Inc., Middletown, Delaware; Ethafoam SB, as manufactured by Dow Chemical Company, Midland, Michigan; or approved equal. The rod shall be 1/4-inch larger in diameter than the joint width. Where possible, provide full-length sections for the joint; minimize splices. Apply backup rod and bond breaker tape in expansion joints.

2.11 BOND BREAKER TAPE

A. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape, which will adhere to the premolded joint material or concrete surface. The tape shall be the same width as the joint. The tape shall be compatible with the sealant.

2.12 PREFORMED CONTROL JOINT

A. Preformed control joint shall be a one-piece, flexible, PVC joint former, such as Kold-Seal Zip-Per Strip, KSF-150-5--5-, manufactured by Vinylex Corp., Knowville, Tennessee, or a one-piece steel strip with preformed groove, such as Keyed Kold Retained Kap, manufactured by Burke Concrete Accessories, Inc., San Mateo, California, or approved equal. Provide the preformed control joint material in full-length unspliced pieces.

2.13 PREMOLDED JOINT FILLER

A. Joint filler shall be preformed, nonextruded type constructed of closed-cell neoprene conforming to ASTM D 1752, Type I, as manufactured by W.R. Grace Company of Cambridge, Massachusetts; W.R. Meadows, Inc., Elgin, Illinois; or equal.

2.14 STEEL EXPANSION JOINT DOWELS

A. Steel expansion joint dowels shall conform to one of the following:

1. Epoxy coated steel bar dowels with a 12-mil coating thickness. Steel bar dowels shall conform to ASTM A 36 or ASTM 615, plain rounds, Grade 40. Epoxy coating shall be in conformance with ASTM A 775; or approve equal.
2. Stainless steel bar dowels conforming to ASTM A 276, Type 302.

B. Exposed portion of expansion joint dowels shall be thoroughly greased prior to casting or adjoining wall or slab.

2.15 CEMENT

A. Cement shall conform to ASTM C150, Type II, with maximum tricalcium aluminate not to exceed 8 percent and shall be from a prequalified producer of cement (Corps of Engineers specifications). The maximum percent alkalis shall not exceed 0.6 percent.

2.16 AGGREGATES

A. Aggregates shall comply with ASTM C33 and shall contain less than 1 percent asbestos by weight or volume and be free from any substances, which will react with cement alkalis.

2.17 CONCRETE ADMIXTURES

A. Concrete shall contain an air-entraining admixture. Admixture shall conform to ASTM C260, except it shall be nontoxic after 30 days and shall contain no chlorides. Admixtures shall be Master Builders MB-AE 10, Sika AER (Sikamix 104), or approved equal.

B. Concrete shall contain a water-reducing admixture. The admixture shall conform to ASTM C494, Type A or D except it shall contain no chlorides, shall be nontoxic after 30 days, and shall be compatible with the air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations. Admixtures shall be Master Builders Pozzolith polymer-type normal setting, Plastocrete (Sikamix 160) Normal Set, Sika Chemical Corporation, or approved equal.

C. Do not use any admixture, which contains chlorides or other corrosive elements in any concrete.

2.18 GROUT

A. Nonshrink grout shall conform to the Corps of Engineers Specification for Nonshrink Grout, CRD-C621-83, and to these specifications. Use a nongas-liberating type, cement base, premixed product requiring only the addition of water for the required consistency. Grout shall be UPCON High Flow, Master Flow 713, or approved equal. Components shall be inorganic.

B. Ordinary type grout (dry pack) shall consist of one part portland cement to two parts sand (100 percent passing a No. 8 sieve). Add sufficient water to form a damp formable consistency.

C. Expansive Grout. Premixed, cementations mixture with a minimum 28-day strength of 3,500 psi. Provide air-entraining content as recommended by the manufacturer.

D. Epoxy Grout.

1. Mix the two components of epoxy bonding compound in compliance with the manufacturer's instructions.
2. Use sand, which is oven dry and meets the following gradation requirements for epoxy grout:

Sieve Size	No. 8	No. 50	No. 100
% Passing	100	30-15	55

2.19 MORTAR

A. Mortar or grout placed on horizontal construction joints shall be a mixture of cement, sand, and water in the same proportions used in the concrete but with coarse aggregate omitted.

B. Mortar used for repair of concrete shall be made of the same materials as used for concrete, except that the course aggregate shall be omitted and the mortar shall consist of not more than one part cement to two and one-half parts sand by damp loose volume. The quantity of mixing water shall be no more than necessary for handling and placing.

2.20 BONDING COMPOUND

A. Epoxy bonding compound shall be Concressive 1001 LPL, Adhesive Engineering Company, San Carlos, California; Sikadur Hi-Mod (Sikastix 370), Sika Chemical Corporation, Lyndhurst, New Jersey; Epoxtile 2391 by W.R. Grace and Company; Euco Epoxy 463 by Euclid Chemical Company;

or approved equal.

B. Nonepoxy bonding compound shall be Weldcrete by Larsen Products Corporation, Link by Sta-Dry Manufacturing Corp., Euco Weld by Euclid Chemical Company, or approved equal. The compound shall be rewettable for up to two weeks.

2.21 CONCRETE MIX DESIGN

A. Conform to ASTM C94, except as modified by these specifications.
B. Air content as determined by ASTM C231 shall be 4 percent to 1 percent.
C. Maximum water-cement ratio for Class A concrete shall be equal to 0.45 by weight.
D. Use classes of concrete as described in the following table:

Class	Type of Work	28-Day Compressive Strength (psi)	Minimum Cement Content (lbs/c.y.)
A	Concrete for all structures and concrete not otherwise specified. Concrete fill at structure foundations, cradle, supports across pipe trenches.	4,000	564
B	Pavement	3,000	500
C	Floor grout, miscellaneous unreinforced concrete.	2,000	376

E. Measure slump in accordance with ASTM C143. Slump shall be as follows:

Slab on grade or heavy sections wider (in plan view) than 3-feet	3-inches max.
Footings, walls, suspended slabs, beams, and columns	4-inches max.
Pavement	2-inches max.

Proportion and produce the concrete to have a maximum slump as shown. A tolerance of up to 1-inch above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

F. Aggregate size shall be 3/4-inch maximum for slabs and sections 8-inches thick and less. Aggregate size shall be 1-inch maximum for slabs and sections greater than 8-inches and smaller than 17-inches. Aggregate size shall be 1-1/2-inches maximum for all larger slabs and sections.

G. Combined aggregate grading shall be as shown in the following table:

	Maximum Aggregate Size		
	1 1/2-inch	**1-inch**	**3/4-inch**
Aggregate Grade per ASTM C33	467	57	67

H. Mix design for pumped concrete shall produce a plastic and workable mix. The percentage of sand in the mix shall be based on the void content of the coarse aggregate.

2.22 CONCRETE TESTS

A. Perform concrete quality testing on the concrete as follows:

1. Frequency of Sampling: Cast four concrete test cylinders from each 50 cubic yards of concrete, or fraction thereof, of each class of concrete placed in any one day. Sampling and curing of cylinders shall conform to ASTM C 31.
2. Strength Testing: Test cylinders in accordance with ASTM C 39. Test one cylinder at 7-days for information; test two cylinders at 28 days for acceptance; and hold one cylinder for verification. Strength acceptance will be based on the average of the strengths of the two cylinders tested at 28-days. If one cylinder of a 28-day test manifests evidence of improper sampling, molding, or testing, other than low strength, discard it and use the fourth cylinder for the test result.
3. Determine concrete slump by ASTM C 143 with each strength test sampling and as required to establish consistency.
4. Determine air content of the concrete using ASTM C 231 to verify the percentages of air in the concrete immediately prior to depositing in forms.
5. The average value of concrete strength tests shall be equal to or greater than the specified 28-day strength. Non-test shall be less than 90-percent of the specified 28-day strength.
6. If the 28-day strength tests fail to meet the specified minimum compressive strength, the concrete will be assumed to be defective and one set of three cores from each area may be taken as selected by the Construction Manager and in accordance with ASTM C42. If the average compressive strength of the set of three concrete cores fails to equal 90-percent of the specified minimum compressive strength or if any single core is less 75-percent of the minimum compressive strength, the concrete will be considered defective. The Owner may require additional coring, nondestructive load testing, or repair or removal of defective concrete. Costs of coring, testing of cores, load testing, and required repairing pertaining thereto shall be paid by the Contractor at no extra cost to the Owner.

B. To facilitate any Construction Manager-concrete sampling and testing:

1. Furnish labor to assist the Construction Manager in obtaining and handling samples at the project

site.

2. Advise the Construction Manager in advance of concrete placing operations to allow for scheduling and completion of quality testing.
3. Provide and maintain facilities for safe storage and proper curing of concrete test specimens on the project site, as required by ASTM C31.

2.23 CURING COMPOUND

A. Curing compound shall conform to ASTM C309, Type 1 or 1-D, Class B.
B. Curing compound shall be compatible with required finishes and coatings.

2.24 RIGID INSULATION

A. The insulation shall be 2-inch thick, HCFC-blown, extruded polystyrene with an R-value of 5-hour foot squared degree F/BTU per inch. The insulation shall meet ASTM C578, Type IV (25 psi). Insulation shall be STYROFOAM brand Square Edge insulation as manufactured by Dow Chemical, or approved equal.

B. The insulation shall be manufactured with a blowing agent, which provides at least 90-percent reduction in ozone depletion potential compared to standard CFC blowing agents. Other insulations are not acceptable.

C. The insulation shall be new, free from defects, and of uniform color.

D. The insulation shall have a limited thermal warranty stating that the R-value will not deviate more than 10-percent from its published value for a period of 15 years from the manufacturing date printed on the insulation boards.

2.25 ADHESIVE

A. Adhesive shall be as recommended by insulation manufacturer for use with polystyrene foam. Adhesive shall be formulated specifically to bond insulation to steel and concrete surfaces.

PART 3 -- EXECUTION

3.01 FORM TOLERANCES

A. Failure of the forms to produce the specified concrete surface and surface tolerance shall be grounds for rejection of the concrete work. Rejected work shall be repaired or replaced at no additional cost to the Owner.

B. The following table indicates tolerances or allowable variations from dimensions or positions of structural concrete work:

	Maximum Tolerance
Sleeves and inserts	+1/4" -1/4"
Projected ends of anchors	+1/4" -1/4"
Anchor bolt setting	+1/4" -1/4"
Finished concrete, all locations	+1/4" -1/4" in 10-feet max., 1" in total length

The planes or axes from which the above tolerances are to be measured shall be as follows:

Sleeves and inserts:	Centerline of sleeve or insert.
Projected ends of anchors:	Plane perpendicular to the end of the anchor as located on the drawings.
Anchor bolt setting:	Centerline of anchor bolt.
Finish concrete:	The concrete surface as located on the drawings.

Where equipment is to be installed, comply with manufacturer's tolerances if more restrictive than above.

3.02 FORM SURFACE PREPARATION

A. Clean form surfaces to be in contact with concrete of foreign material prior to installation.
B. Coat from surfaces in contact with concrete with a release agent prior to form installation.

3.03 FORM REUSE

A. Reuse only forms, which provide a uniform surface texture on exposed concrete surfaces. Apply light sanding or other surface treatment between uses for uniform texture. Plug unused tie rod holes with corks, shave flush, and sand the concrete surface side. Do not patch forms other than filling tie rod holes, except in the case of Class II forms, do not use metal patching discuss on Class I forms.

3.04 REMOVAL OF FORMS

A. Forms and shorting for elevation structural slabs or beams shall remain in place until the concrete has reached a compressive strength equal to the specified 28-day compressive strength as determined by test cylinders. Do not remove supports and reshore. The following table indicates the minimum allowable time after the last cast concrete is placed before forms, shoring, or wall bracing may be

removed.

Sides of footings and encasements	24 hours
Walls, vertical sides of beams, girders, columns, and similar members not supporting loads	48 hours
Slabs, beams, and girders	10 days (forms only)
Shoring for slabs, beams, and girders	Until concrete strength reaches specified 28-day strength
Wall bracing	Until to or roof slab concrete reaches specified 28-day strength

B. Do not remove forms from concrete, which have been placed with outside air temperature below 50-degrees F without first determining if the concrete has properly set without regard for time. Do not apply heavy loading on green concrete. Immediately after forms are removed, the surface of the concrete shall be carefully examined and any irregularities in the surface shall be repaired and finished as specified.

3.05 FORMED OPENINGS

A. Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure water tightness. Provide openings with continuous keyways and water stops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with reinforcement as indicated in the typical structural details. Reinforcing shall be at least 2-inches clear from the opening surfaces and encased items.

3.06 EMBEDDED ITEMS

A. Set anchor bolts and other embedded items accurately and hold securely in position until the concrete is placed and set. Check all special castings, channels, or other metal parts that are to be embedded in the concrete prior to and again after concreting. Check all nailing blocks, plugs, and strips necessary for the attachment of trim, finish, and similar work prior to concreting.

3.07 BEVELED EDGES (CHAMFER)

A. Form 3/4-inch beveled edges on exposed concrete edges and corners, beam soffit corners, and where indicated on the drawings. Reentrant corners in concrete members shall not have fillets, unless otherwise shown in the drawings. The top edges of slabs, walkways, beams, and wall may be beveled with an edging trowel in lieu of using chamfer strips.

3.08 CONSTRUCTION JOINTS

A. Provide construction joints in accordance with the following:

1. Slabs. Maximum spacing of 40-feet on center in each direction in plan.
2. Retaining Walls. Maximum spacing of 50-feet on center (vertical joints).
3. Box-Shaped (in plan) Structure (not culverts). Maximum total length of wall without construction joints is 80-feet.
4. Box Culverts. Maximum spacing of 50-feet for wall and slab joints transverse to the longitudinal axis of the culvert.

For purposes of maximum spacing requirements, expansion joints are considered to be construction joints.

B. Layout of construction joints shall be shown in the drawings and according to the following guidelines:

1. Provide horizontal construction joints at top of foundation members and slabs-on-grade and at the soffit of supported slabs and beams.
2. Space the construction joints at a maximum horizontal distance of 25-feet and a maximum vertical distance of 16-feet.
3. Space the corner vertical construction joints between 4 and 8-feet from the corner of walls or wall intersections.
4. Space horizontal construction joints at least 8-inches below bottom of slabs.

C. Construction joints shall be keyed, unless otherwise detailed. Form keyways by beveled strips or boards placed at right angles to the direction of shear. Except where otherwise shown on the drawings or specified, keyways shall be at least 1 1/2-inches in depth over at least 25-percent of the area of the section.

D. When it is necessary to make a joint because of an emergency, furnish and place reinforcing dowels across the joint. Embed dowels 48 bar diameters each side of the joint. Size and number of dowels shall match reinforcing in the member. Furnishing and placing such reinforcing steel shall be at the Contractor's expense.

E. After the pour has been completed to the construction joint and the concrete has hardened, thoroughly clean the entire surface of the joint of surface laitance, loose or defective concrete, and foreign material, and expose clean aggregate by sandblasting the surface of construction joints before placing the new concrete. Cover horizontal construction joints with mortar, spread uniformly and work thoroughly into all irregularities of the surface. The water-cement ratio of the mortar in place shall not exceed that of the concrete to be placed, and the consistency of the mortar shall be suitable for placing and working.

F. In case of emergency, place additional construction joints. (An interval of 45 minutes constitutes cause for an emergency construction joint.)

3.09 EXPANSION JOINTS

A. Provide expansion joints with continuous edge reservoirs, which shall be filled with a joint sealant. Leave the material used for forming the reservoirs in place until immediately before the grooves are cleaned and filled with joint sealant. After removing edge forms from the reservoir, remove grout, loose concrete, and fill; then sandblast the slots. Allow the reservoir to become thoroughly dry; then

flow out the reservoir and immediately prime and fill with the expansion joint sealant and backup materials. The primer used shall be supplied by the same manufacturer supply the joint sealant.

3.10 TIME BETWEEN CONCRETE POURS

A. At least 2-hours shall elapse after depositing concrete in the columns or walls before depositing in beams, girders, or slabs supported thereon. Place beams, girders, brackets, column capitals, and haunches monolithically as part of the floor or roof system, unless otherwise indicated on the drawings.

3.11 INSTALLATION OF PREMOLDED JOINT FILLER

A. Install in joint accurately as shown. Attach to concrete with a bonding agent recommended by the joint sealant and joint filler manufacturer for compatibility.

3.12 INSTALLATION OF JOINT SEALANTS

A. Install in joint accurately as shown. Attached to concrete with a bonding agent recommended by the joint sealant and joint filler manufacturer for compatibility.

B. After the joints have been prepared as described above, apply the joint sealant. Apply the primer, if required, and joint sealant only with the equipment and methods recommended by the joint sealant manufacturer. Application criteria for the sealant materials, such as temperature and moisture requirements and primer cure time, shall be in accordance with the recommendations of the sealant manufacturer.

C. Apply masking tape along the edges of the exposed surface of the exposed joints. Trowel the joints smooth with a tuck-pointing tool wiped with a solvent recommended by the sealant manufacturer.

D. After the sealant has been applied, remove the masking tape and any sealant spillage.

3.13 INSTALLATION OF STEEL EXPANSION JOINT DOWELS

A. Install parallel to wall or slab face, perpendicular to the joint face, and in true horizontal position. Secure tightly in forms with rigid ties, Orient dowels to permit joint movement.

3.14 PLACING REINFORCEMENT

A. Place reinforcing steel in accordance with the current edition of Recommended Practice for Placing Reinforcing Bars, published by the Concrete Reinforcing Steel Institute.

B. Place reinforcing in accordance with the following, unless otherwise indicated:

1. Reinforcement indicated on the drawings is continuous through the structure to the farthest extent possible. Terminate bars 2-inches clear from faces of concrete.
2. Splices may be used to provide continuity due to bar length limitations. Minimum length of bars spliced for this reason is 40-feet. Splicing of reinforcement, which is detailed to be continuous on the drawings, is not permitted.

C. Reinforcing steel, before being positioned and just prior to placing concrete, shall be free from loose mill and rust scale and from any coatings, which may destroy or reduce the bond. Clean reinforcing steel by sandblasting or wire brushing and remove mortar, oil, or dirt to remove materials, which may reduce the bond.

D. Do no straighten or rebend reinforcing steel in the field.

E. Position reinforcing steel in accordance with the drawings and secure by using annealed wire ties or clips at intersections and support by concrete or metal supports, spacers, or metal hangers. Do not place metal clips or supports in contact with the forms. Bend tie wires away from the forms to provide the specified concrete coverage. Bars additional to those shown on the drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position, shall be provided by the Contractor at his own expense.

F. Place reinforcement a minimum of 2-inches clear of any metal pipe or fittings.

G. Secure reinforcing dowels in place prior to placing concrete. Do not press dowels into the concrete after the concrete has been placed.

H. Roll wire mesh used for reinforcement flat before placing concrete. Support and tie wire mesh to prevent movement during concrete placement.

I. Position dowels for masonry walls to occur at reinforced block cells.

3.15 SITE MIXED CONCRETE

A. Conform to ACI 304.

3.16 READY-MIXED CONCRETE

A. Conform to ASTM C94.

3.17 PLACING CONCRETE

A. Conform to ACI 304.

3.18 PUMPING CONCRETE

A. Conform to ACI 304.2R-71.

3.19 WEATHER REQUIREMENTS

A. Conform to ACI 305 for placing during hot weather.

B. Conform to ACI 306 for placing during cold weather.

3.20 BONDING TO OLD CONCRETE

A. Coat the contact surfaces with epoxy bonding compound. The method of preparation and application of the bonding compound shall conform to the manufacturer's printed instructions and recommendations for specific application for this project.

3.21 BACKFILL AGAINST WALLS

A. Do no place backfill against walls until the concrete has obtained a compressive strength equal to the specified 28-day compressive strength. Where backfill is to be placed on both sides of the wall, place the backfill uniformly on both sides.

B. Do not backfill the walls of structures, which are laterally restrained or supported by, suspended slabs or slabs on grade until the slab is poured and the concrete has reached the specified compressive strength.

C. Do not use heavy equipment to compact backfill within 5-feet of vault walls. Compact by hand or other means which will not impose significant loads on the walls.

3.22 CONCRETE FINISHES

A. Complete concrete surfaces in accordance with the following schedule:

Finish Designation	Area Applied
F-1	Beams, columns, and exterior walls not exposed to view.
F-3	Beams, columns, and walls of structures exposed to view. Underside of formed floors or slabs.
F-4	Exterior and interior surfaces to be coated.
S-1	Slabs and floors to be covered with concrete or grout.
S-4	Slabs and floors of structures exposed to view.
E-1	Exposed edges. EXCEPTION: edges normally covered with earth.
E-2	Top of walls, beams, and similar unformed surfaces.

B. Finish F-1: Repair defective concrete, fill depressions deeper than 1/2-inch, and fill tie holes.

1. Finish F-3: In addition to Finish F-1, remove fins, fill depressions 1/4-inch or deeper, fill depressions and air holes with mortar. Dampen surfaces and then spread a slurry consisting of one part cement and 1 1/2 parts sand by damp loose volume, over the surface with clean burlap pads or sponge rubber floats. Remove any surplus by scraping and then rubbing with clean burlap.
2. Finish F-4: Repair defective concrete, remove fins, fill depressions 1/16-inch or deeper, fill tie

holes, remove mortar spatter, and remove bulges higher than 1/16-inch.

3. Finish S-1: Screed to grade without special finish.
4. Finish S-4: Steel trowel finish without local depressions or high points and apply a light hair-broom finish. Do not use stiff bristle brooms or brushes. Leave hair-broom lines parallel to the direction of slab drainage.
5. Finish E-1: Provide chamfer or beveled edges.
6. Finish E-2: Strike smoothly and float to an F-3 or F-4 finish.

3.23 CURING CONCRETE

A. Conform to ACI 308.

B. Water cure with burlap mats unless optional curing methods are permitted.

C. Do not use curing compound on surfaces, which are to be coated in accordance with Section 09820 and 09900.

D. It is the responsibility of the Contractor to select the appropriate curing method in response to climatical and/or site conditions occurring at the time of concrete placement. Take appropriate measures as described in ACI 305 and 306 for protecting and curing concrete during hot and cold weather.

3.24 REPAIR OF DEFECTS

A. Do not repair defects until concrete has been reviewed by the Construction Manager.

B. Surface Defects: Repair surface defects, which are smaller than 1-foot across in any direction and are less than 1/2-inch in depth.

Repair by removing the honeycombed and other defective concrete down to sound concrete, make the edges perpendicular to the surface and at least 3/8-inch deep, thoroughly dampen the surface, work into the surface a bonding grout (one part cement to one part fine sand), fill the hole with mortar, match the finish on the adjacent concrete, and cure as specified.

C. Severe Defects: Repair severe defects which are larger than surface defects but do not appear to affect the structural integrity of the structure.

Repair by removing the honeycombed and other defective concrete down the sound concrete, make the edges of the hole perpendicular to the surface, sandblast the surface, coat the sandblasted surface with epoxy bonding compound, place nonshrink grout, match the finish on the adjacent concrete, and cure as specified.

D. Major Defects: If the defects are serious or affect the structural integrity of the structure or it patching does not satisfactorily restore the quality and appearance to the surface, the Construction Manager may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section.

3.25 REPAIR OF CRACKS

A. Repair cracks in structures which are wider than 1/10-inch in width by cutting out a square edged and uniformly aligned joint 3/8-inch wide by 3/4-inch deep, preparing exposed surfaces of the joint, priming the joint, and applying polyurethane joint sealant.

B. If the cracks are serious or affect the structural integrity or function of the element, the Owner's Representative may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section.

3.26 CONCRETE SURFACES TO BE COATED

A. See Sections 09820 and 09900.

3.27 ALUMINUM SURFACES IN CONTACT WITH CONCRETE

A. See Section 09900

3.28 RIGID INSULATION

A. Install the insulation on the vault wall, roof slab, and access hatch with lemon-sized gobs of compatible adhesive or with non-corroding washers. Space the attachments on 22-inch centers in both directions. Fasteners on 24-inch centers in the joints are acceptable if they have 2-inch washers. Run the insulation to the line shown on the plans. Keep all joints and abutments tight. Do not apply adhesive to insulation, which will deleteriously affect it in any way.

B. Follow manufacturer's instructions on storing and handling the insulation.

1. Shield the insulation with an opaque, light-colored tarp if it will be store in direct sunlight.
2. Protect insulation from open flames and from heat sources over 165-degrees F.
3. Avoid contact with petroleum-based solvents or with molten asphalt or tar.

*** END OF SECTION ***

SECTION 03210

REINFORCEMENT STEEL

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall furnish, fabricate, and place all concrete reinforcement steel, couplers, and concrete inserts for use in reinforced concrete and masonry construction and shall perform all appurtenant work, including all the wires, clips, supports, chairs, spacers, and other accessories, all in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Contractor Submittals
B. Section 03300 - Cast-in-Place Concrete
C. Section 03100 - Concrete Formwork
D. Section 04232 - Reinforced Concrete Block Masonry
E. Section 03400 - Precast Concrete

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes:

1. The Building Code, as referenced herein, shall be the Uniform Building Code (UBC), as specified in section entitled, "Reference Standards." 01090

B. Commercial Standards

ACI 315-80	Details and Detailing of Concrete Reinforcement.
ACI 318-77	Building Code Requirements for Reinforced Concrete. WRI Manual of Standard Practice for Welded Wire Fabric
AWS Dl.4-79	Structural Welding Code - Reinforcing Steel.
ASTM A 82-79	Specification for Steel Wire, Plain, for Concrete Reinforcement.
ASTM A 185-79	Specification for Welded Steel Wire Fabric for Concrete Reinforcement.
ASTM A 615-82	Specification for Deformed and Plain Billet-Steel Bards for Concrete Reinforcement.

1.04 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish shop bending diagrams, placing lists, and drawings of all

reinforcement steel prior to fabrication in accordance with the requirements of section entitled, "Contractor Submittals." 01300

B. Details of the concrete reinforcement steel and concrete inserts shall be submitted by the CONTRACTOR at the earliest possible date after receipt by the CONTRACTOR of the Notice to Proceed. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 and the requirements specified and shown. The shop bending diagrams shall shown the actual lengths of bars, to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface. The shop drawings shall include bar placement diagrams, which clearly indicate the dimensions of each bar splice.

C. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, the CONTRACTOR shall submit manufacturer's literature which contains instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and shop drawings which shown the location of each coupler with details of how they are to be installed in the formwork.

D. If reinforced steel is spliced by welding at any location, the CONTRACTOR shall submit mill test reports, which shall contain the information necessary for the determination of the carbon equivalent as specified in AWS D1.4. The CONTRACTOR shall submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding, merely a statement that AWS procedures will be followed is not acceptable.

1.05 QUALITY ASSURANCE

A. If requested by the ENGINEER, the CONTRACTOR shall provide samples from each heat of reinforcement steel delivered in a quantity adequate for testing. The OWNER will pay costs of initial tests. The CONTRACTOR shall pay costs of additional tests due to material failing initial tests.

B. If reinforcement steel is spliced by welding at any location, the CONTRACTOR shall submit certifications of procedure qualifications for each welding procedure used and certification of welder qualifications, for each welding procedure, and for each welder performing the work. Such qualifications shall be as specified in AWS D1.4.

C. If requested by the ENGINEER, the CONTRACTOR shall provide samples of each type of welded splice used in the work in a quantity and of dimensions adequate for testing. At the discretion of the ENGINEER, radiographic testing of direct butt-welded splices will be performed. The CONTRACTOR shall provide assistance necessary to facilitate testing. The CONTRACTOR shall repair any weld, which fails to meet the requirements of AWS D1.4. The OWNER will pay the costs of testing; except, the CONTRACTOR shall pay the cost of all tests, which fail to meet specified requirements.

PART 2 -- PRODUCTS

2.01 REINFORCEMENT STEEL

A. All reinforcement steel for all cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar reinforcement shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel Reinforcement with supplementary requirement S-1, or as otherwise shown on the drawings.
2. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 and the details shown; provided, that welded wire fabric with longitudinal wire of W9.5 size wire shall be either furnished in flat sheets or in rolls with a core diameter not less than 10-inches; and provided further, that welded wire fabric with longitudinal wires larger than W9.5 size shall be furnished in flat sheets only.
3. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A 82.

B. Accessories:

1. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. Slab bolsters shall have gray plastic-coated legs.
2. Concrete blocks (dobies), used to support and position reinforcement steel, shall have the same or higher compressive strength as specified for the concrete in which it is located. Where the concrete blocks are used on concrete surfaces exposed to view, the color and texture of the concrete blocks shall match that required for the finished surface. Wire ties shall be embedded in concrete block bar supports.

2.02 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where shown and where approved by the ENGINEER. The couplers shall develop a tensile strength, which exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.

B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied. This shall apply to all mechanical splices, including those splices intended for future connections.

C. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection.

D. Couplers, which are located at a joint face, shall be a type, which can be set either flush or recessed from the face as shown. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement past from entering. After the concrete is placed, couplers intended for future connections shall be plugged and sealed to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged with plastic plugs, which have an O-ring seal.

E. Hot-forged sleeve type couplers shall not be used.

2.03 WELDED SPLICES

A. Welded splices shall be provided where shown and where approved by the ENGINEER. All welded splices of reinforcement steel shall develop a tensile strength, which exceeds 125 percent of the yield strength of the reinforcement bars, which are connected.

B. All materials required to perform the welded splices to the requirements of AWS D1.4 shall be provided.

PART 3 -- EXECUTION

3.01 GENERAL

A. All reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the requirements of the Building Code and the supplementary requirements specified herein.

3.02 FURNISHINGS

A. All reinforcing steel shall be furnished, fabricated, and installed by the CONTRACTOR. The CONTRACTOR shall also furnish all the wires, metal supports, clips, spacers, and other appurtenances necessary to fulfill the requirements of the Contract Documents.

B. Welded wire fabric, where required, shall be furnished as specified herein and where placed over the ground and shall be supported on wired concrete spacers or block supports spaced not more than 3-feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

3.03 FABRICATION

A. General: Reinforcement steel shall be accurately formed to the dimensions and shapes shown, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings. Stirrups and tie bars shall be bent around a pin having a diameter not less than 1-1/2 inch for No. 3 bars, 2-inch for No. 4 bars, and 2-1/2 inch for No. 5 bars. Bends for other bars shall be made around a pin having a diameter not less than 6 times the minimum thickness, except for bars larger than 1-inch, in which case the bends shall be made around a pin of 8 bar diameters. Bars shall be bent cold.

B. The CONTRACTOR shall fabricate reinforcement bars for structures in accordance with bending diagrams, placing lists, and placing drawings. Said drawings, diagrams, and lists shall be prepared by the CONTRACTOR as specified under Section entitled "Contractor Submittals." 01300

C. Fabricating Tolerances: Bars used for concrete reinforcement shall meet the following requirements for fabricating tolerances:

1. Sheared length: ± 1-inch
2. Depth of truss bars: +0, - 1/2-inch
3. Stirrups, ties, and spirals: ± 1/2-inch
4. All other bends: ± 1-inch

3.04 PLACING

A. Placing: Reinforcement steel shall be accurately positioned as shown, and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers that are strong and rigid enough to prevent any displacement of the reinforcement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. All concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties, which are embedded in the blocks. For concrete over formwork, the CONTRACTOR shall furnish concrete, metal, plastic, or other acceptable bar chairs and spacers.

B. The portions of all accessories in contact with the formwork shall be made of concrete, plastic, or steel coated with a 1/8-inch minimum thickness of plastic which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.

C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.

D. Bars additional to those shown which may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR at its own expense.

E. Placing Tolerances: Unless otherwise specified, reinforcement placing tolerances shall be within the limits specified in Section 7.5 of ACI 318 except where in conflict with the requirements of the Building Code.

F. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be as acceptable to the ENGINEER.

G. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters having gray, plastic-coated standard type legs as specified in Paragraph B herein. Slab bolsters shall be spaced not less than 30-inches on centers, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane shown.

H. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3-feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

3.05 SPACING OF BARS

A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall not be less than the nominal diameter of the bars nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.

B. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall not be less than one inch.

C. In columns, the clear distance between longitudinal bars shall be not less than 1-1/2 times the bar

diameter, nor less than 1-1/2 times the maximum size of the coarse aggregate, nor less than 1-1/2 inches.

D. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

3.06 SPLICING

A. General: Reinforcement bar splices shall only be used at locations shown. When it is necessary to splice reinforcement at points other than where shown, the character of the splice shall be as acceptable to the ENGINEER.

B. Splices of Reinforcement: The length of lap for reinforcement bars, unless otherwise shown shall be in accordance with ACI 318, Section 12.15.1 for a class C splice.

C. Laps of welded wire fabric shall be in accordance with the ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

D. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1-1/2 turns.

E. Bending or Straightening: Reinforcement shall not be straightened or rebent in a manner, which will injure the material. Bars with kinks of bends not shown shall not be used. All bars shall be bent cold, unless otherwise permitted by the ENGINEER. No bars partially embedded in concrete shall be field-bent except as shown or specifically permitted by the ENGINEER.

3.07 CLEANING AND PROTECTION

A. Reinforcement steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.

B. The surfaces of all reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be reinspected and, if necessary recleaned.

*** END OF SECTION ***

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall furnish all materials for concrete in accordance with the provisions of this Section and shall form, mix, place, cure, repair, finish, and do all other work as required to produce finished concrete, all in accordance with the requirements of the Contract Documents.

B. The following types of concrete shall be covered in this Section:

1. Structural Concrete: Concrete to be used in all cases except where noted otherwise in the Contract Documents.
2. Sitework Concrete: Concrete to be used for curbs, gutters, catch basins, sidewalks, pavements, fence and guard post embedment, underground duct bank encasement and all other concrete appurtenant to electrical facilities unless otherwise shown.
3. Lean Concrete: Concrete to be used for thrust blocks, pipe trench cut-off blocks and cradles, where the preceding items are detailed on the Drawings as unreinforced. Concrete to be used as protective cover for dowels intended for future connection.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Contractor Submittals
B. Section 03100 - Concrete Formwork
C. Section 03200 - Reinforcement Steel
D. Section 03290 - Joints in Concrete
E. Section 03315 - Grout
F. Section 03480 - Precast Concrete Specialties
G. Section 07920 - Sealants and Caulking
H. Section 16050 - Electrical General Provisions

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the requirements of the Building Code and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section; provided, that for Building Codes, the latest edition of the Code, as adopted as of the date of award by the agency having jurisdiction, shall apply to the WORK.

1. Codes and Standards: The Building Code, as referenced herein, shall be the Uniform Building Code (UBC), of the International Conference of Building Officials (ICBO). 01090
2. Federal Specifications: UU-B-790A (Int. Amd. 1)Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant).

3. Commercial Standards:

ACI 214-77	Recommended Practice for Evaluation of Strength Test Results of Concrete.
ACI 301-79	Specifications for Structural Concrete for Buildings.
ACI 315-80	Details and Detailing of Concrete Reinforcement.
ACI 347-78	Recommended Practice for Concrete Formwork.
ASTM C156-80a	Test Method for Water Retention by Concrete Curing Materials.
ASTM C31-84	Methods of Making and Curing Concrete Test Specimens in the Field.
ASTM C33-84	Specification for Concrete Aggregates.
ASTM C39-83b	Test Method for Compressive Strength of Cylindrical Concrete Specimens.
ASTM C94-83	Specification for Ready-Mixed Concrete.
ASTM C114-83b	Method for Chemical Analysis of Hydraulic Cement.
ASTM C136-84a	Method for Sieve Analysis of Fine and Coarse Aggregate.
ASTM C143-78	Test Method for Slump of Portland Cement Concrete.
ASTM C150-84	Specification for Portland Cement.
ASTM C157-80	Test Method for Length Change of hardened Cement Mortar and Concrete.
ASTM C192-81	Method of Making and Curing Concrete Test Specimens in the Laboratory.
ASTM C260-77	Specification for Air-Entraining Admixtures for Concrete.
ASTM C311-85	Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete.
ASTM C494-82	Specification for Chemical Admixtures for Concrete.
ASTM C618-85	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
ASTM D1751-83	Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
ASTM E119-83	Method for Fire Tests of Building Construction and Materials.

1.04 CONTRACTOR SUBMITTALS

A. Mix Designs: Prior to beginning the WORK, the CONTRACTOR shall submit to the ENGINEER, for review, preliminary concrete mix designs which shall show the proportions and gradations of all materials proposed for each class and type of concrete specified herein in accordance with the Section entitled "Contractor Submittals." 01300 The mix designs shall be designed by an independent testing laboratory acceptable to the ENGINEER. All costs related to such mix design shall be borne by the CONTRACTOR.

B. Certified Delivery Tickets: Where ready-mix concrete is used, the CONTRACTOR shall provide certified weighmaster delivery tickets at the time of delivery of each load of concrete. Each certificate shall show the public weighmaster's signature, and the total quantities, by weight of cement, sand, each class of aggregate, admixtures, and the amounts of water in the aggregate and added at the batching plant as well as the amount of water allowed to be added at the site for the specific design mix. Each certificate shall, in addition, state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to when the batch was dispatched, when it left the plant, when it arrived at the job, the time that unloading began, and the time that unloading was finished.

C. When a water reducing admixture is to be used, the CONTRACTOR shall furnish mix designs for concrete both with and without the admixture.

D. The CONTRACTOR shall furnish a Certificate of Compliance signed by the supplier identifying the type of fly ash and stating that the fly ash complies with ASTM C 618 and these Specifications, together with all supporting test data prior to the use of the fly ash the sample represents. The supporting data shall also contain test results confirming that the fly ash in combination with the cement and water to be used meets all strength requirements and is compatible with air-entraining agents and other admixtures.

E. The CONTRACTOR shall submit to the ENGINEER for review the design mix for fly ash concrete together with the design mix for portland cement (non-fly ash) concrete as specified in this Section.

1.05 QUALITY ASSURANCE

A. Tests on component materials and for compressive strength and shrinkage of concrete will be performed as specified herein. Test for determining slump will be in accordance with the requirements of ASTM C 143.

B. The cost of all laboratory tests on cement, aggregates, and concrete, will be borne by the OWNER. However, the CONTRACTOR shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications.

C. Concrete for testing shall be supplied by the CONTRACTOR at no cost to the OWNER and the CONTRACTOR shall provide assistance to the ENGINEER in obtaining samples, and disposal and cleanup of excess material.

D. Field Compression Tests:

1. Compression test specimens will be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the ENGINEER to insure continued compliance with these specifications. Each set of test specimens will be a minimum of 4 cylinders.
2. Compression test specimens for concrete shall be made in accordance with ASTM C 31. Specimens shall be 6-inch diameter by 12-inch high cylinders.
3. Compression tests shall be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and 2 at 28 days. The remaining cylinder will be held to verify test results, if needed.

E. Evaluation and Acceptance of Concrete:

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 318, Chapter 4 "Concrete Quality," and as specified herein.
2. A statistical analysis of compression test results will be performed according to the requirements of ACI 214. The standard deviation of the test results shall not exceed 640 psi.
3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.
4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the specified compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard of deviation.
5. All concrete which fails to meet the ACI requirements and these specifications, is subject to removal and replacement at the cost of the CONTRACTOR.

F. Shrinkage Tests:

1. Drying shrinkage tests will be made by the ENGINEER for the trial batch specified in Paragraph 2.07, herein, and during construction to insure continued compliance with these Specifications.
2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10 inches, fabricated, cured, dried and measured in accordance with ASTM C 157 modified as follows: Specimens shall be removed from molds at an age of 23 ±1 hours after trial batching, shall be placed immediately in water at 70 degrees F ±3 degrees F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F ±3 degrees F. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 days. This length at age 7 days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73 degrees F ±3 degrees F and 50 percent ±4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
3. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001-inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age

by more than 0.0004 inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as specified in Paragraph 2.08, herein.

G. Construction Tolerances: The CONTRACTOR shall set and maintain concrete forms and perform finishing operations so as to ensure that the completed work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown. Where tolerances are not stated in the specifications, permissible deviations will be in accordance with ACI 347.

H. The following construction tolerances are hereby established and apply to finished walls and slab unless otherwise shown:

Item	Tolerance
Variation of the constructed linear outline from the established position in plan	In 10-feet: ¼-inch, In 20-feet or more: 1/2 -inch
Variation from the level or from the grades shown on the drawings	In 10-feet: ¼-inch, In 20-feet or more: ½-inch
Variation from the plumb	In 10-feet: ¼-inch In 20-feet or more:1/2-inch
Variation in the thickness of slabs and walls	Minus ¼-inch; plus ½-inch
Variations in the locations and sizes of slab and wall openings	Plus or minus ¼-inch

I. For each class of fly ash, all testing and sampling procedures shall conform with these Specifications and ASTM C 311, including the restriction that one sample weighing 4 pounds shall be taken from at least each 200 tons of fly ash supplied.

J. Separate storage facilities shall be provided for fly ash. Fly ash shall be stored in such a manner as to permit ready access for the purpose of inspection and sampling and suitably protected against contamination or moisture. Should any fly ash show evidence of contamination or moisture or be otherwise unsuitable, the ENGINEER may reject it and require that it be removed from the site. Each class of fly ash used in concrete for this project shall be from the same source.

PART 2 -- PRODUCTS

2.01 CONCRETE MATERIALS

A. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Only one brand of cement shall be used. Cement reclaimed from cleaning bags or leaking containers shall not be used. All cement shall be used in the sequence of receipt of shipments.

B. All materials furnished for the work shall comply with the requirements of Sections 201, 203, and 204 of ACI 301, as applicable.

C. Storage of materials shall conform to the requirements of Section 205 of ACI 301.

D. Materials for concrete shall conform to the following requirements:

1. Cement shall be standard brand portland cement conforming to ASTM C 150 for Type V. Portland cement shall contain not more than 0.60 percent alkalies. The term "alkalies" referred to herein is defined as the sum of the percentage of sodium oxide and 0.658 times the percentage of potassium oxide ($Na_2 0 + 0.658\ K_2 0$). These oxides shall be determined in accordance with ASTM C 114. A single brand of cement shall be used throughout the work, and prior to its use, the brand shall be acceptable to the ENGINEER. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports for each shipment of cement to be used shall be submitted to the ENGINEER if requested regarding compliance with these Specifications.
2. Water shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (over 1000 mg/1 TDS) shall not be used.
3. Aggregates shall be obtained from pits acceptable to the ENGINEER, shall be non-reactive and shall conform to ASTM C 33. Maximum size of coarse aggregate shall be as specified in Paragraph 2.05B. Lightweight sand for fine aggregate will not be permitted.
   a. Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock or a combination thereof. The coarse aggregates shall be prepared and handled in two or more size groups for combined aggregates with a maximum size greater than 3/4-inch. When the aggregates are proportioned for each batch of concrete the two size groups shall be combined. See Paragraph 2.07A for the use of the size groups.
   b. Fine aggregates shall be natural sand or a combination of natural and manufactured sand that are hard and durable.
   c. Combined aggregates shall be well graded from coarse to fine sizes, and shall be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.
   d. When tested in accordance with "Potential Reactivity of Aggregates (Chemical Method)" (ASTM C289), the ration of silica released to reduction in alkalinity shall not exceed 1.0.
   e. When tested in accordance with "Organic Impurities in Sands for Concrete" (ASTM C40), the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.
   f. When tested in accordance with "Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine" (ASTM C131), the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions, or 10.5 percent after 100 revolutions.
   g. When tested in accordance with "Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate" (ASTM C88), the loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using sodium sulfate.
4. Ready-mix concrete shall conform to the requirements of ASTM C94.

5. Air-entraining agent meeting the requirements of ASTM C 260 shall be used. Sufficient air-entraining agent shall be used to provide a total air content of 3 to 5 percent; provided that, when the mean daily temperature in the vicinity of the worksite falls below 40 degrees F for more than one day, the total air content provided shall be 5 to 7 percent. The OWNER reserves the right, at any time, to sample and test the air-entraining agent received on the job by the CONTRACTOR. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement.
6. Admixtures: Admixtures shall be required at the Engineer's discretion or, if not required, may be added at the Contractor's option to control the set, effect water reduction, and increase workability. In either case, the addition of an admixture shall be at the Contractor's expense. The use of an admixture shall e subject to acceptance by the ENGINEER. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture. Admixtures specified herein shall conform to the requirements of ASTM C 494. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used. Admixtures shall contain no free chloride ions, be non-toxic after 30 days, and shall be compatible with and made by the same manufacturer as the air entraining admixture.
   a. Set controlling admixture shall be either with or without water-reducing properties. Where the air temperature at the time of placement is expected to be consistently over 80 degrees F, a set retarding admixture such as Sika Chemical Corporation's Plastiment, Master Builder's Pozzolith 300R, or equal shall be used. Where the air temperature at the time of placement is expected to be consistently under 40 degrees F, a set accelerating admixture such as Sika Chemical Corporation's Plastocrete 161 FL, Master Builder's Pozzolith 50C, or equal shall be used.
   b. Low range water reducer shall conform to ASTM C 494, Type A. It shall be either a hydroxylated carboxylic acid type or a hydroxylated polymer type. The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.
   c. High range water reducer shall be sulfonated polymer conforming to ASTM C 494, Type F or G.

      If the high range water reducing agent is added to the concrete at the batch plant, it shall be second generation type, Daracem 100, as manufactured by W.R. Grace & Co.; Pozzolith 430R, as manufactured by Masterbuilders; or equal. High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified.

      If the high range water reducer is added to the concrete at the job site, it shall be used in conjunction with a low range water reducer and shall be Pozzolith 400N and Pozzolith MBL82, as manufactured by Masterbuilders; WRDA 19 and WRDA 79, as manufactured by W.R. Grace & Co.; or equal. Concrete shall have a slump of 3 inches ± 1/2-inch prior to adding the high range water-reducing admixture at the job site. The high range water-reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system.

      Concrete shall be mixed at mixing speed for a minimum of 30 mixer revolutions after the addition of the high range water reducer.

7. Calcium Chloride: Except as otherwise provided in Paragraph 3.08B, calcium chloride will not be permitted to be used in concrete.
8. Fly ash/pozzolan shall conform to ASTM C 618, including the requirements of Table 1A, therein, and the following supplementary requirements:
   a. Class C fly ash
      - Loss on ignition, maximum 1 percent
      - S03 content, maximum 4 percent
      - Moisture content, maximum 1 percent
      - R = (CaO - 5%)/(Fe203), maximum 4.5
   b. Class F fly ash
      - Loss on ignition, maximum 1 percent
      - S03 content, maximum 3 percent
      - Moisture content, maximum 1 percent
      - R = (CaO - 5%)/(Fe203), maximum 1.5

2.02 CURING MATERIALS

A. Materials for curing concrete as specified herein shall conform to the following requirements:

1. Concrete curing compound shall be MB 429 as manufactured by Masterbuilders, Cleveland, OH; Hunt Process Clear ARB as manufactured by Hunt Process Co., Santa Fe Springs, CA; Select Cure CRB as manufactured by Select Products Co., Upland, CA; or equal. The curing compound shall contain a fugitive dye so that areas of application will be readily distinguishable.
2. Polyethylene sheet for use as concrete curing blanket shall be white, and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C 156 shall not exceed 0.055 gram per square centimeter of surface.
3. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, having a nominal thickness of 2 mils and permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A (Int. Amd. 1). The loss of moisture, when determined in accordance with the requirements of ASTM C-156, shall not exceed 0.055 gram per square centimeter of surface.
4. Polyethylene-coated burlap for use as concrete curing blanket shall be 4-mil thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.
5. Curing mats for use in Curing Method 6 as specified in Paragraph 3.09G herein, shall be heavy shag rugs or carpets or cotton mats quilted at 4 inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.
6. Evaporation retardant shall be used after initial screeding and floating when temperature, wind, and humidity condition may cause drying shrinkage cracks in slab and shall be a material such as Confilm as manufactured by Masterbuilders, Cleveland, OH; or equal.

2.03 NON-WATERSTOP JOINT MATERIALS

A. Materials for non-water stop joints in concrete shall conform to the following requirements:

1. Preformed joint filler shall be a non-extruding, resilient, bituminous type conforming to the requirements of ASTM D 1751.
2. Elastomeric joint sealer shall conform to the requirements of Section entitled "Sealants and Caulking." 07920
3. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement due to expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth hereinafter, if testing is required by the ENGINEER.

2.04 MISCELLANEOUS MATERIALS

A. Floor sealer/hardener shall be a colorless, aqueous solution of zinc and/or magnesium fluosilicate or of sodium silicate, and shall be as manufactured by Master Builders Company, W.R. Grace Co., or equal. The solution shall be delivered ready for use in the manufacturer's original sealed containers. Each gallon of the fluosilicate solution shall contain not less than 2 pounds of crystals.

B. Damp-proofing agent shall be an asphalt emulsion, such as Sonneborn Hydrocide 660, Flintkote C-13-E Foundation Coating, or equal.

C. Epoxy adhesives shall be the following products for the applications specified:

1. For bonding freshly-mixed, plastic concrete to hardened concrete, Sikadur Hi-Mod Epoxy Adhesive, as manufactured by Sika Chemical Corporation; Concresive 1001-LPL, as manufactured by Adhesive Engineering Company; or equal.
2. For bonding hardened concrete or masonry to steel, Colma-Dur Gel, Sikadur Hi-Mod Gel, or equal.

2.05 CONCRETE DESIGN REQUIREMENTS

A. General: Concrete shall be composed of cement, admixtures, aggregates and water. These materials shall be of the qualities specified. The exact proportions in which these materials are to be used for different parts of the work will be determined during the trial batch. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. Mix designs with more than 41 percent of sand of the total weight of fine and coarse aggregate shall not be used. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the OWNER. All changes shall be subject to review by the ENGINEER.

B. Water-Cement Ration and Compressive Strength: The minimum compressive strength and cement content of concrete shall be not less than that specified in the following tabulation.

Type of Work	Min. 28-day Compressive Strength (psi)	Max. Size Aggregate (in.)	Min. Cement per Cu.Yd. (sacks)	Max. W/C Ratio (hy.wt.)
Structural Concrete: Walls, slabs on grade and footing and all other concrete items not specified elsewhere	4,000	1-1/2	6.0	0.50
Structural Concrete: Roof, floor slabs, columns, sections 10-in. and less in thickness, and sections which require special placement due to shape or density of reinforcing or embedded items	4,000	1	6.0	0.50
Sitework Concrete	3,000	1	5.0	0.50
Lean Concrete	2,000	1	4.0	0.60

*Note: One sack of cement equals 94 lbs.

C. Adjustments to Mix Design: The mixes used shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish and the CONTRACTOR shall be entitled to no additional compensation because of such changes.

D. At the Contractor's option, fly ash/pozzolan may be used as a partial cement replacement in concrete as follows:

1. Fly ash shall replace not more than 15 percent by weight of the portland cement in the design mix. The design mix shall contain a minimum of 6 sacks of cement per cubic yard before the replacement is made.
2. Fly ash for hydraulic/liquid containing structures shall be Class C fly ash. Fly ash concrete for all other structures shall be Class C or F fly ash.

2.06 CONSISTENCY

A. The quantity of water entering into a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete which can be worked properly into place without segregation, and which can be compacted by the vibratory methods herein specified to give the desired density, impermeability and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature of moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as follows:

Part of Work	Slump (in.)
Footings and slabs	3-inches +1/2-inches, -1-inch
Other work	3 inches ±1 inch
With high range water reducer added	8-inches max.

2.07 TRIAL BATCH AND LABORATORY TESTS

A. Before placing any concrete, a testing laboratory designated by the ENGINEER shall prepare a trial batch of each class of concrete having a 28-day strength of 4,000 psi or higher, based on the preliminary concrete mixes submitted by the CONTRACTOR. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the properties in Paragraph 2.05A. If one size range produces an acceptable mix, a second size range need not be used. Such adjustments shall be considered refinements to the mix design and shall not be the basis for extra compensation to the CONTRACTOR. All concrete shall conform to the requirements of this Section, whether the aggregate proportions are from the Contractor's preliminary mix design, or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement and admixture proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage, and 6 compression test specimens from each batch. The cost of not more than 3 laboratory trial batch tests for each specified concrete strength will be borne by the OWNER but the CONTRACTOR shall furnish and deliver the materials in steel drums at no cost. Any additional trial batch testing required shall be performed at the expense of the CONTRACTOR.

B. The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured and tested in accordance with ASTM C 192 and ASTM C 39. Three compression test cylinders will be tested at 7-ays and 3 at 28-days. The average compressive strength for the 3 cylinders tested at 28-days for any given trial batch shall not be less than 125-percent of the specified compressive strength.

C. A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136. Values shall be given for percent passing each sieve.

2.08 SHRINKAGE LIMITATION

A. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age (as specified in Paragraph 2.07), shall be 0.036 percent or 0.043 percent, respectively. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch shrinkage requirements.

B. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirements by more than 25 percent.

C. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions, at no additional cost to the OWNER, for securing the specified shrinkage requirements. These actions may include changing the source or aggregates, cement and/or admixtures; reducing water content, washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

2.09 MEASUREMENT OF CEMENT AND AGGREGATE

A. The amount of cement and of each separate size of aggregate entering into each batch of concrete

shall be determined by direct weighing equipment furnished by the CONTRACTOR and acceptable to the ENGINEER; provided that, where batches are so proportioned as to contain an integral number of conventional sacks of cement, and the cement is delivered at the mixer in the original unbroken sacks, the weight of the cement contained in each sack may be taken without weighing as 94 pounds.

2.10 MEASUREMENT OF WATER

A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any specified amount of water to each batch of concrete, and the meter shall include a set-back register with a readily visible vertical face and double hands indicating in cubic feet and decimals thereof. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism must be such that leakage will not occur when the valves are closed.

2.11 READY-MIXED CONCRETE

A. At the Contractor's option, ready-mixed concrete may be used meeting the requirements as to materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94, including the supplementary requirements specified in Paragraphs 2.12B through 2.11F, herein.

B. Ready-mixed concrete shall be delivered to the site of the work, and discharge shall be completed within 75 minutes after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever is first. In hot weather, or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85 degrees F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 60 minutes.

C. Truck mixers shall be equipped with electrically actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

E. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus,

condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

F. Each batch of ready-mixed concrete delivered at the job site shall be accompanied by a certified weighmaster delivery ticket furnished to the ENGINEER in accordance with Paragraph 1.04B, herein.

G. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the ENGINEER.

PART 3 -- EXECUTION

3.01 PROPORTIONING AND MIXING

A. Proportioning: Proportioning of the concrete mix shall conform to the requirements of Chapter 3 (Proportioning" of ACI 301; provided, that the maximum slump for any concrete shall not exceed 4 inches except when the use of high range water reducer is permitted which increases the maximum slump to 8 inches.

B. Mixing: Mixing of concrete shall conform to the requirements of Chapter 7 of said ACI 301 Specifications.

C. Slump: Maximum slumps shall be as specified in Paragraph 2.06A, herein.

D. Retempering: Retempering of concrete or mortar which has partially hardened will not be permitted.

3.02 PREPARATION OF SURFACES FOR CONCRETING

A. General: Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud and debris at the time of placing concrete.

B. Joints in Concrete: Concrete surfaces upon or against which concrete is to be placed, where the placement of the old concrete has been stopped or interrupted so that, as determined by the ENGINEER, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted roughened surface for good bond. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of all laitance, loose or defective concrete, and foreign material. Such cleaning shall be accomplished by sandblasting followed by thorough washing. All pools of water shall be removed from the surface of construction joints before the new concrete is placed.

C. After the surfaces have been prepared all approximately horizontal construction joints shall be covered with a layer of mortar approximately one-inch thick. The mortar shall have the same proportions of cement and sand as the regular concrete mixture. The water-cement ration of the

mortar in place shall not exceed that of the concrete to be placed upon it, and the consistency of the mortar shall be suitable for placing and working in the manner hereinafter specified. The mortar shall be spread uniformly and shall be worked thoroughly into all irregularities of the surface. Wire brooms shall be used where possible to scrub the mortar into the surface. Concrete shall be placed immediately upon the fresh mortar. When casting deep walls (more than 6-feet high) over slabs or footings, in lieu of the one-inch thick mortar, a 6-inch lift of a rich pea gravel mix with the same water-cement ration as the wall concrete shall be placed and spread uniformly. Wall concrete shall follow immediately and shall be placed upon the fresh pea gravel mix.

D. Placing Interruptions: When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means, that will secure proper union with subsequent work; provided that construction joints shall be made only where acceptable to the ENGINEER.

E. Embedded Items: No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the ENGINEER at least 4 hours before placement of concrete. All surfaces of forms and embedded items that have become encrusted with dried grout from concrete previously paced shall be cleaned of all such grout before the surrounding or adjacent concrete is placed.

F. All inserts or other embedded items shall conform to the requirements herein.

G. All reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms where shown or by shop drawings and shall be acceptable to the ENGINEER before any concrete is placed. Accuracy of placement is the responsibility of the CONTRACTOR.

H. Casting New Concrete Against Old: Where concrete is to be cast against old concrete (any concrete which is greater than 60 days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by sand-blasting (exposing aggregate) prior to the application of an epoxy bonding agent.

I. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the work. No concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, will be subject to the review of the ENGINEER.

J. Corrosion Protection: Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

K. Openings for pipes, inserts for pipe hangers and brackets, and the setting of anchors shall, where practicable, be provided for during the placing of concrete.

L. Anchor bolts shall be accurately set, and shall be maintained in position by templates while being embedded in concrete.

M. Cleaning: The surfaces of all metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

3.03 HANDLING, TRANSPORTING, AND PLACING

A. General: Placing of concrete shall conform to the applicable requirements of Chapter 8 of ACI 301 and the requirements of this Section.

B. Non-Conforming Work or Materials: Concrete which upon or before placing is found not to conform to the requirements specified herein shall be rejected and immediately removed from the work. Concrete which is not placed in accordance with these Specifications, or which is of inferior quality, shall be removed and replaced by and at the expense of the CONTRACTOR.

C. Unauthorized Placement: No concrete shall be placed except in the presence of duly authorized representative of the ENGINEER. The CONTRACTOR shall notify the ENGINEER in writing of at least 24 hours in advance of placement of any concrete.

D. Placement in Wall Forms: Concrete shall not be dropped through reinforcement steel or into any deep form, whether reinforcement is present or not, causing separation of the coarse aggregate from the mortar on account of repeatedly hitting rods or the sides of the form as it falls, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, some means such as the use of hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. In no case shall the free fall of concrete exceed 4 feet below the ends of ducts, chutes, or buggies. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6 feet in horizontal direction. Concrete in forms shall be deposited in uniform horizontal layers not deeper than 2 feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in forms shall not exceed 5 feet of vertical rise per hour.

E. Casting New Concrete Against Old: An epoxy adhesive bonding agent shall be applied to the old surfaces according to the manufacturer's written recommendations. This provision shall not apply to joints where water stop is installed, see Section entitled, "Water stop Joints in concrete." 03290

F. Conveyor Belts and Chutes: All ends of chutes, hopper gates, and all other points of concrete discharge throughout the Contractor’s conveying, hoisting and placing system shall be so designed and arranged that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the ENGINEER. Chutes longer than 50 feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the specified consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. All conveyor belts and chutes shall be covered. Sufficient illumination shall be provided

in the interior of all forms so that the concrete at the places of deposit is visible from the deck or runway.

G. Placement in Slabs: Concrete placed in sloping labs shall proceed uniformly from the bottom of the slab to the top, fur the full width of the pour. As the work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

H. Temperature of Concrete: The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 40 degrees F in moderate weather, and not less than 50 degrees F in weather during which the mean daily temperature drops below 40 degrees F. Concrete ingredients shall not be heated to a temperature higher than necessary to keep the temperature of the mixed concrete, as placed, from falling below the specified minimum temperature. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the CONTRACTOR shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90 degrees F. The CONTRACTOR shall be entitled to no additional compensation on account of the foregoing requirements.

I. Cold Weather Placement: Earth foundations shall be free from frost or ice when concrete is placed upon or against them. Fly ash concrete shall not be placed when the air temperature falls below 50 degrees F.

3.04 PUMPING OF CONCRETE

A. General: If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

B. Pumping Equipment: The pumping equipment must have 2 cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the CONTRACTOR may have a standby pump on the site during pumping.

C. The minimum diameter of the hose (conduits) shall be 4-inches.

D. Pumping equipment and hoses (conduits) that are not functioning properly, shall be replaced.

E. Aluminum conduits for conveying the concrete will not be permitted.

F. Proportioning: Minimum compressive strength, cement content, and maximum size of aggregates shall be as specified in Paragraph 2.05, herein.

G. Gradation of coarse aggregates shall conform to ASTM C 33 and shall be as close to the middle range as possible.

H. Gradation of fine aggregate shall conform to ASTM C 33, with 15 to 30 percent passing the number 50 screen and 5 to 10 percent passing the number 100 screen. The fineness modulus of sand used shall not be over 3.00.

I. Water and slump requirements shall conform to Paragraphs 2.01D.2 and 2.05B for water and 2.06A for slump.

J. Cement and admixtures shall conform to Paragraph 2.01D, herein.

K. Field Control: Concrete samples for slump per ASTM C 143 and test cylinders per ASTM C 31 and C 39 will be taken at the placement (discharge) end of the line.

3.05 ORDER OF PLACING CONCRETE

A. The order of placing concrete in all parts of the work shall be acceptable to the ENGINEER. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 7 days before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 14 days.

B. The surface of the concrete shall be level whenever a run of concrete is stopped. To insure a level, straight joint on the exposed surface of walls, a wood strip at least 3/4 of an inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2 of an inch above the underside of the strip. About one hour after the concrete is placed the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and all laitance shall be removed.

3.06 TAMPING AND VIBRATING

A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete during placement. Vibrators shall be high-speed power vibrators (8000 to 10,000 rpm) of an immersion type in sufficient number and with (at least one) standby units as required.

B. Care shall be used in placing concrete around water stops. The concrete shall be carefully worked by rodding and vibrating to make sure that all air and rock pockets have been eliminated. Where flat-strip type water stops are placed horizontally, the concrete shall be worked under the water stops by hand, making sure that all air and rock pockets have been eliminated. Concrete surrounding the water stops shall be given additional vibration, over and above that used for adjacent concrete placement to assure complete embedment of the water stops in the concrete.

C. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against all surfaces. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly as specified. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the results herein specified within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall be kept from contact with the surfaces of the forms. Care shall be taken not to

vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.07 FINISHING CONCRETE SURFACES

A. General: Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions shown are defined as tolerances and are specified in Paragraphs 1.05G and 1.05H, herein. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.

B. Formed Surfaces: No treatment is required after form removal except for curing, repair of defective concrete, and treatment of surface defects. Where architectural finish is required, it shall be as specified in Section 3.08 herein, and as shown on the exterior elevations.

C. Unformed Surfaces: After proper and adequate vibration and tamping all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. The classes of finish specified for unformed concrete surfaces are designated and defined as follows:

1. Finish U1 - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.
2. Finish U2 - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where shown or as determined by the ENGINEER.
3. Finish U3 - After the floated surface (as specified for Finish U2) has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.
4. Finish U4 - Steel trowel finish (as specified for Finish U3) without local depressions or high points. In addition, the surface shall be given a light hairbroom finish with brooming perpendicular to drainage unless otherwise shown. The resulting surface shall be rough enough to provide a nonskid finish.

D. Unformed surfaces shall be finished according to the following schedule:

Unformed Surface Finish Schedule	
Area	**Finish**
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Slabs that are water bearing with slopes 10 percent	U3

and less	
Sloping slabs that are water bearing with slopes greater than 10 percent	U4
Slabs not water bearing	U4
Slabs to be covered with built-up roofing	U2
Interior slabs and floors to receive architectural finish	U2

E. Floor Sealer Hardener (Surface Applied):

1. Floors to receive hardener shall be cured, cleaned, and dry with all work above the completed. Apply zinc and/or magnesium fluosilicate evenly using 3 coats, allowing 24 hours between coats.
2. The first coat shall be 1/3 strength, second coat 1/2 strength, and third coat 2/3 strength. Each coat shall be applied so as to remain wet on the concrete surface for 15 minutes. If sodium silicate is used, it shall be applied evenly, using 3 coats, allowing 24 hours between coats, and the material shall be applied full strength at the rate of one gallon per 300 square feet. Approved proprietary hardeners shall be applied in conformance with the manufacturer's instruction. After the final coat is completed and dry, surplus hardener shall be removed from the surface by scrubbing and mopping with water.
3. Floor hardener shall be applied where shown.

3.08 ARCHITECTURAL FINISH

A. Smooth Concrete Finish: Immediately after the forms have been stripped, the concrete surface shall be inspected and any poor joints, voids, rock pockets, or other defective areas shall be repaired and all form-tie fastener holes filled as required in Paragraphs 3.12 and 3.13, herein.

B. After the concrete has cured at least 14 days, the surface shall be wetted, and a grout shall be applied with a brush. The grout shall be made by mixing one part portland cement and one part of fine sand that will pass a No. 16 sieve with sufficient water to give it the consistency of thick paint. The cement used in said grout shall be 1/2 gray and 1/2 white portland cement, as determined by the ENGINEER. White portland cement shall be Atlas white, or equal, furnished by the CONTRACTOR. Calcium chloride in the amount of 5 percent by volume of the cement shall be used in the brush coat. The freshly applied grout shall be vigorously rubbed into the concrete surface with a wood float filling all small air holes. After all the surface grout has been removed with a steel trowel, the surface shall be allowed to dry and, when dry, shall be vigorously rubbed with burlap to remove completely all surface grout so that there is no visible paint-like film of grout on the concrete. The entire cleaning operation for any area shall be completed the day it is started, and no grout shall be left on the surface overnight.

C. Surface Overnight: Cleaning operations for any given day shall be terminated at panel joints. It is essential that the various operations be carefully timed to secure the desired effect, which is a light-colored concrete surface of uniform color and texture without any appearance of a paint or grout film.

D. In the event that improper manipulation results in an inferior finish, the CONTRACTOR shall rub such inferior areas with carborundum bricks.

E. Before beginning any of the final treatment on exposed surfaces, the CONTRACTOR shall treat in a satisfactory manner a trial area of at least 200 square feet in some inconspicuous place selected by the ENGINEER and shall preserve said trial area undisturbed until the completion of the job.

F. All architecturally treated concrete surfaces shall conform to the accepted sample in texture, color, and quality. It shall be the Contractor's responsibility to maintain and protect the concrete finish.

3.09 CURING AND DAMPPROOFING

A. General: All concrete shall be cured for not less than 14 days after placing, in accordance with the methods specified herein for the different parts of the work, and described in detail in the following paragraphs:

Surface to be Cured or Damp-proofed	Method
Unstripped forms	1
Wall sections with forms removed	6
Construction joints between footings and walls, and between floor slab and columns	2
Encasement concrete and thrust blocks	3
All concrete surfaces not specifically provided for elsewhere in this paragraph	4
Floor slabs on grade in hydraulic structures	5
Roof and slabs not on grade	6
Exterior buried surfaces of roof slabs	7

B. Method 1: Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removed. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 14 days of placing the concrete, curing shall be continued in accordance with Method 6, Paragraph 3.09G, herein.

C. Method 2: The surface shall be covered with burlap mats, which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.

D. Method 3: The surface shall be covered with moist earth not less than 4 hours, nor more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.

E. Method 4: The surface shall be sprayed with a liquid curing compound.

1. It shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film, which will seal thoroughly.
2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the curing period. Should the seal be damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing

compound over the damaged portion.

3. Wherever curing compound may have been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, said compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.
4. Where curing compound is specified, it shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after removal of forms from contact with formed surfaces. Repairs required to be made to formed surfaces shall be made within the said 2-hour period; provided, however, that any such repairs which cannot be made within the said 2-hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound, following which repairs shall be made as specified herein.

F. Method 5: Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each work operation as necessary to prevent drying shrinkage cracks.

1. Immediately after each square foot of the concrete has been finished, it shall be given a coat of curing compound in accordance with Method 4, Paragraph 3.09E, herein. Not less than one hour nor more than 4 hours after the coat of curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3 inches and fastened together with a waterproof cement to form a continuous watertight joint.
2. The curing blankets shall be left in place during the 14-day curing period. A portion of the curing blankets may be temporarily removed for a maximum of 4 hours to allow placing of adjacent concrete work. The exposed slab shall be wetted with water delivered through a fog nozzle prior to placing the removed curing blankets back to the slab as specified in Section 3.09.F.1. Should the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections. During the first 3 days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces at all times.

G. Method 6: Concrete slabs shall be treated with an evaporation retardant as specified in Method 5. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 14 consecutive days beginning immediately after the concrete has been placed or forms removed. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held in place to prevent being dislodged by wind or any other causes. Until the concrete surface is covered with the curing medium the entire surface shall be kept damp by applying water-using nozzles that atomize the flow so that the surface is not marred or washed. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall

be removed and curing compound immediately applied in accordance with Method 4, Paragraph 3.09E, herein. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the work.

H. Method 7:

1. Method 6 shall be used for curing.
2. Immediately after completion of curing the surface shall be sprayed with a damp proofing agent consisting of an asphalt emulsion. Application shall be in 2 coats. The first coat shall be diluted to 1/2 strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the specified material, undiluted, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon. Damp proofing material shall conform to the requirements of Paragraph 2.04B, herein.
3. As soon as the asphalt emulsion, applied as specified herein, has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may be used which produces a uniformly coated white surface and which so remains until placing of the backfill. Should the whitewash fail to remain on the surface until the backfill is placed, the CONTRACTOR shall apply additional whitewash.

3.10 PROTECTION

A. The CONTRACTOR shall protect all concrete against injury until final acceptance by the OWNER. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever such precipitation is imminent or occurring. Immediately following the first frost in the fall, the CONTRACTOR shall be prepared to protect all concrete against freezing. After the first frost, and until the mean daily temperature in the vicinity of the worksite falls below 40 degrees F for more than one day, the concrete shall be maintained at a temperature not lower than 50 degrees F for at least 72 hours after it is placed.

3.11 CURING IN COLD WEATHER

A. Water curing of concrete may be reduced to 6 days during periods when the mean daily temperature in the vicinity of the worksite is less than 40 degrees F; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.

B. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise, the concrete shall be protected against freezing temperatures for 72-hours immediately following 72-hours protection at 50-degrees F. Concrete cured by water curing shall be protected against freezing temperatures for 3-days immediately following the 72-hours of protection at 50-degrees F.

C. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40-degrees F in 24-hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive days,

the specified 72-hour protection at a temperature not lower than 50-degrees F may be discontinued for as long as the mean daily temperature remains above 40-egrees F; provided that the concrete shall be protected against freezing temperatures for not less than 48-ours after placement.

D. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted by these Specifications.

3.12 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall have them repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. All repairs and replacements herein specified shall be promptly executed by the CONTRACTOR at its own expense.

B. Defective surfaces to be repaired as specified in Paragraph 3.12A, shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, and not less than 1/32-inch depth of the surface film from all hard portions, by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces under repair will remain moist, but not so wet as to overcome the suction upon which a good bond depends. The material used for repair proposed shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of Atlas white portland cement as is required to make the color of the patch match the color of the surrounding concrete.

C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.

D. All repairs shall be built up and shaped in such a manner that the completed work will conform to the requirements of Paragraph 3.08 or 3.09, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

E. Prior to filling any structure with water, all cracks that may have developed shall be "vee'd" as shown and filled with sealant conforming to the requirements of Section entitled "Joints in Concrete." 03290 This repair method shall be done on the water-bearing face of members. Prior to backfilling,

faces of members in contact with fill, which are not covered with a waterproofing membrane, shall also have cracks repaired as specified herein.

3.13 PATCHING HOLES IN CONCRETE

A. Patching Small Holes

1. Holes that are less than 12-inches in their least dimension and extend completely through concrete members, shall be filled as specified herein.
2. Small holes in members which are water-bearing or in contact with soil or other fill material, shall be filled with non-shrink grout. Where a face of the member is exposed to view, the non-shrink grout shall be held back 2-nches from the finished surface. The remaining 2-inches shall then be patched according to Paragraph 3.12B herein.
3. Small holes through all other concrete members shall be filled with non-shrink grout, with exposed faces treated as above, or completely filled according to Paragraph 3.12B.

B. Patching Large Holes

1. Holes which are larger than 12-inches in their least dimension, shall have a keyway chipped into the edge of the opening all around, unless a formed keyway exists. The holes shall then be filled with concrete as specified herein.
2. Holes which are larger than 24-inches in their least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in grout in drilled holes. The reinforcing added shall match the reinforcing in the existing wall unless shown.
3. Large holes in members which are water bearing or in contact with soil or other fill, shall have a bentonite type water stop material placed around the perimeter of the hole as specified in the Section entitled "Joints in Concrete," 03290 unless there is an existing water stop in place.

3.14 CARE AND REPAIR OF CONCRETE

A. The CONTRACTOR shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the OWNER. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at the Contractor's expense.

*** END OF SECTION ***

SECTION 03401

PRECAST CONCRETE VAULTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. General. The Contractor shall furnish and install prefabricated vaults of types shown on the drawings, for accommodating the meter and drainage facilities shown. The prefabricated vaults shall be the product of Quikset Utility Vaults, Inc., Santa Ana, California. Installation of the vaults shall include the necessary excavation, foundation preparation, vault erection, exterior piping installation and backfill.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Earthwork. 02200

PART 2 -- PRODUCTS

2.01 MATERIALS

A. General: Each vault consists essentially of a basic vault with the particular type of extensions and vault cover. The basic components and assembly thereof shall be as shown on the drawings.

B. Floor Slab: The floor slab of each vault shall be capable of resisting uplift resulting from a water table standing at the surface of the ground adjacent to the vault.

C. Roofs or Covers shall be constructed to withstand H-20 loading.

D. Piping Knockouts shall be provided to facilitate piping installation as shown on the drawings.

E. Grout used in the joints shall be composed of two parts of sand and one part of cement with sufficient water added to make the grout flow along the joint of its own weight.

F. Preformed Joint Sealant shall be Quik-Seal or approved equivalent.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Field Preparation: Prior to setting the floor section of each vault, the Contractor shall properly prepare the foundation thereof. A sand bed 6 inches minimum thickness shall be provided and shall be compacted and shaped to the proper elevation to receive the vault base section in proper relation to the elevation of the piping entering the walls of the vault.

B. Base Section: Setting of the base section on the prepared compacted sand shall be performed in a manner which will provide uniform bearing pressure over the base area. The base section as installed shall be level and shall prevent flow of grout along the groove once the groove is properly filled.

C. Joints: All joints shall be water tight and shall be made with the use of cement sand grout or with a preformed joint sealant.

D. Placing Grout: Prior to placing grout, the joint to be filled shall be thoroughly cleaned and then soaked but shall be free of standing water at the time of grout placement. The insertion of the tongue of the subsequent section shall be performed in a manner which will completely seal the joint. Excess grout flowing out of the joint on the inside of the vault shall be cleaned off for appearance.

E. Joint Sealant shall be installed as recommended by manufacturer.

*** END OF SECTION ***

SECTION 03480

PRECAST CONCRETE SPECIALTIES

PART 1 -- GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall construct all manholes, catch basins, neutralization pits, cleanouts, and other appurtenances complete and in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 – Earthwork
B. Section 02617 – Reinforced Concrete Pipe
C. Section 02625 - Ductile Iron Pipe
D. Section 03305 – Minor Concrete

1.03 REFERENCED SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality or other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publication are in conflict with the requirements specified here, the more stringent requirement shall apply.

1. Commercial Standards:
   ASTM A478 – Specification for Precast Reinforced Concrete Manhole Sections

1.04 CONTRACTOR SUBMITTALS

A. The Contractor shall submit drawings of precast concrete manhole sections showing details of reinforcement and joints in accordance with Section 01300 – Contractor Submittals.

PART 2 -- PRODUCTS

2.01 PRECAST CONCRETE MANHOLE SECTIONS

A. Precast concrete sections, 600-mm and larger, in diameter, used as manhole sections shall conform to ASTM C478, Class IV, Wall C. Sections shall have rebate joints. Top sections shall be of the shape as indicated in the Contract Documents. Design and manufacture shall be based on H-20 loading. Precast manhole shall be equal in all respects to those manufactured by Associated Concrete Products, or centrifugally spun manhole units as manufactured by Ameron, or approved equal.

2.02 JOINT SEALANT

A. The joint sealant compound shall be Quik-seal, a pre-formed, cold-applied, ready-to-use plastic joint sealing compound as supplied by Quickset Utility Vaults, Santa Ana, California, Ram-Nek by K.T. Snyder Company, or approved equal.

2.03 NON-SHRINK GROUT

A. Grout, where required, shall be of the non-shrink type. The Contractor shall use non-shrink grout, which produces a void filling action that counteracts shrinkage occurring in both the plastic and hardening states. Grout shall be proportional with and is accordance with the manufacturer's instruction for the use intended.

2.04 MANHOLE STEPS

A. Manhole steps shall be ½-inch steel reinforced, plastic steps as manufactured by M.A. Industries, Inc.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Precast concrete manhole sections shall be set so as to be vertical with sections and ladder rungs in true alignment. The joint of previously set section shall be covered with mortar and joint sealant before the new section is placed. Before the mortar is set, joints shall be pointed and exterior joints thoroughly tooled so as to be slightly concave with a hard polished surface free of cracks. Interior joints shall be tooled flush in a similar manner.

B. Connections to manhole structure shall be made by casting sections of pipe into the base, by using non-shrink grout as indicated in the Contract Documents, and/or using an approved resilient connector.

3.02 CONCRETE CATCH BASINS

A. Concrete catch basins shall be of the type and sizes at the locations as indicated in the Contract Documents.

*** END OF SECTION ***

West Jordan City Corporation
Public Works Department

Sanitary Sewer Model
&
Capital Facilities Plan

March 2003

J-U-B ENGINEERS, Inc.

J-U-B ENGINEERS, INC.
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Kaysville, Utah 84037
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www.jub.com

March 28, 2003

Mr. Roger Payne
Utility Manager, West Jordan City
8000 South Redwood Road
West Jordan, Utah 84088

RE: West Jordan City Sanitary Sewer Model and Capital Facilities Plan

Dear Roger:

We are pleased to submit to you the West Jordan City Sanitary Sewer Model and Capital Facilities Plan. This plan delineates several capital improvements that will likely be required during the next five to seven years in order to accommodate growth within the City. This plan also delineates long-range projects that may be necessary before build out. We have described these improvements in greater detail in the report.

Over a year ago, when we proposed on this project, we emphasized a collaborative approach to this work. It has been a pleasure to take this approach in creating the model and capital facilities plan. During this project we have had the opportunity to work several of the City staff. We have enjoyed all of these interactions. We are especially thankful to David Murphy, for his valuable contributions to this project. Dave provided much of the detailed information to make this project a success. We are also thankful to Drew Stevenson, for his coordination of survey information. Drew was responsive to our questions on survey data, and consistently followed up on our requests for detailed information from the field. This has indeed been a *collaborative* approach!

We have appreciated very much your own valuable input and direction during the creation of the model and capital facilities plan. We believe you will find this plan to be a valuable asset as the City of West Jordan grows in the coming years.

Sincerely,

J-U-B ENGINEERS, INC.

Paul E. Burnham, P.E.
Project Manager

West Jordan City Corporation

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EXECUTIVE SUMMARY

A master plan is an essential element in the development of any community experiencing significant commercial or residential growth. With a master plan, a community has a tool to steer infrastructure improvements. This sanitary sewer master plan provides direction for future growth, and provides a plan for the construction of sewer improvements to serve the residents of West Jordan City.

West Jordan City (City) is currently experiencing a relatively high growth rate. The City retained J-U-B ENGINEERS, Inc. (J-U-B) to develop a sanitary sewer master plan that evaluates the capacity of the existing collection system and proposes collection system improvements to accommodate projected growth.

The goals of the master plan are listed below:

- Complete flow monitoring in key trunk lines to obtain baseline flows.
- Evaluate existing lines for current level of service and available capacity.
- Evaluate existing lines for reserve capacity at 2010 (capital facilities plan) and 2030 (build out) conditions, using the most recent projected populations from the analysis zones.
- Determine build out sizes and locations of new lines.
- Estimate approximate timeline for phasing relief alternatives and related capital improvement costs.

Computer models were used to evaluate the existing and future collection systems. The computer model includes lines that are considered to be trunk lines. These trunk lines are typically the larger lines running east and west, but also include some of the larger lines running north and south. The modeled trunk lines also include some eight-inch lines that carry flow from relatively large service areas. Refer to Section 2-1 for a detailed discussion on modeled lines. The model utilizes Global Positioning System (G.P.S.) survey data and flow line elevations collected by the City; two-foot contour information; record drawings; flow monitoring data collected by City and J-U-B personnel; and site observation. The existing system model was calibrated by correlating the metered flows with existing land use conditions and the current
population (2002).

EXISTING SYSTEM SUMMARY

In general, the results of the existing system evaluation indicate that most of the system is currently functioning well. However, a few sections of lines have reached or are approaching capacity. The area requiring improvements are highlighted in red on Figure ES-1 following this Executive Summary. The numbers on Figure ES-1 correspond to the projects listed on the same figure and in Table E-2.

Infiltration (ground water) and inflow (surface storm water) appear to be low to moderate across most of the system. However, infiltration appears be higher along 1300 West and Redwood Road. This area was given higher rates of infiltration during calibration of the existing system. Also, the CRS Infiltration Study, completed in 1992, indicates that these areas have a relatively high volume of infiltration. These volumes are discussed in KEY ASSUMPTIONS. Although the City may not eliminate all infiltration, the City should still be able to eliminate some infiltration through various methods of pipe rehabilitation.

Inflow (surface storm water) appears to be low to moderate across most of the system. During the monitoring period, the flow meters registered one significant storm event. This event contributed a relatively small amount of inflow to the system. This event and inflow volumes associated with it are discussed in KEY ASSUMPTIONS.

FUTURE SYSTEM SUMMARY

Build out lines are divided into two categories: those lines that will need to be constructed to serve currently undeveloped areas toward the west side (future lines), and those lines that will need to be constructed to relieve existing lines (relief lines). Build out lines were located to take advantage of existing system capacity. They were also located in proposed roads or section lines where rights-of-way and easements may more easily be acquired. Figure 5-1 shows proposed locations and sizes of future lines to serve the undeveloped areas.

The system has been modeled to simulate projected growth at specific times in the future. These projections occur at 2010 (capital facilities plan) and 2030 (assumed build out). The 2030 population for the area served by West Jordan sanitary sewers is 169,104 people, as projected in the traffic analysis zones. The table below shows the populations used throughout this sanitary sewer master plan. The traffic zone numbers are directly from the previous traffic study, while the sanitary sewer master plan numbers are from populating the land use areas within the sewer service areas.

Table E-1 Current and Projected Populations

	TRAFFIC ANALYSIS ZONES	SANITARY SEWER MASTER PLAN
2002 POPULATION	75,054	75,156
2010 POPULATION	104,211	104,255
2030 POPULATION	169,104	169,225

The existing system was subjected to future flows to determine which existing lines may need to be relieved. The 2030 system model identified the lines that will not

have the capacity to convey build out flows (bottlenecks). Once the bottlenecks were identified, then relief measures were developed by re-routing flows through existing diversions, increasing existing line sizes, or adding parallel lines. There are isolated areas where existing lines are at capacity or even slightly under capacity at 2030. The flows in these lines are close enough to capacity that they do not necessarily warrant replacement. However, significant increases to current land use densities could create too much flow for these lines. Also, extremely high impact uses, such as those found at Fairchild Semiconductor, OSI, or Dannon could also create capacity deficiencies in current lines. Typical residential, commercial, and industrial flows have been assumed throughout the City, and are discussed in KEY ASSUMPTIONS. Current land use densities do not create problems with the isolated areas that will be at or very near capacity in 2030.

FUTURE RELIEF IMPROVEMENTS and CAPITAL IMPROVEMENT PLAN

To accommodate future growth, relief improvements need to be constructed in portions of the existing system. Figure ES-1 shows the relief lines (highlighted in red) to be constructed to accommodate growth before 2010. Figure ES-1 also shows the extension lines to the west (highlighted in green), which will likely be required before 2030. The following is a list of the relief alternatives and estimated project costs for the recommended relief lines and the future extensions shown in Figure ES-1. A description of improvements and detailed probable costs is shown as the end of Section 3-4. The costs listed below are from the costs in Section 3-4.

Table E-2 Capital Facilities Costs

1.	7800 SOUTH RECONSTRUCTION	$ 1,102,000
2.	7000 SOUTH, REDWOOD ROAD TO 2200 WEST	$ 361,716
3.	7800 SOUTH, GRIZZLY WAY TO AIRPORT ROAD	$ 828,240
4.	9000 SOUTH RELIEF TO OLD BINGHAM HWY	$ 938,040
5.	OLD BINGHAM HWY, EAST OF BAGLEY PARK	$ 663,420
6.	1300 WEST, 8050 SOUTH TO 8420 SOUTH	$ 348,336
7.	GRIZZLY WAY, 7800 SOUTH TO 8200 SOUTH	$ 1,070,052
	TOTAL CAPITAL FACILITIES 2010	$ 5,311,804

Table E-3 Extension Facilities Costs

8.	AIRPORT CROSSING	$ 659,520
9.	7000 SOUTH EXTENSION	$ 2,144,040
10.	7400 SOUTH EXTENSION	$ 1,307,280
11.	8600 SOUTH/U-111 EXTENSION	$ 2,349,600
12.	NEW BINGHAM HWY EXTENSION	$ 2,636,760
13.	OLD BINGHAM HWY EXTENSION	$ 954,960
	TOTAL EXTENSION FACILITIES	$ 10,052,160

LEGEND

1. 7800 SOUTH, 1300 WEST TO 3600 WEST
2. 7000 SOUTH, REDWOOD ROAD TO 2200 WEST
3. 7800 SOUTH, GRIZZLY WAY TO AIRPORT ROAD
4. 9000 SOUTH RELIEF EXTENSION TO OLD BINGHAM HWY
5. OLD BINGHAM HWY, EAST OF BAGLEY PARK
6. 1300 WEST, 8050 SOUTH TO 8420 SOUTH
7. GRIZZLY WAY, 7800 SOUTH TO 8200 SOUTH
8. AIRPORT CROSSING
9. 7000 SOUTH EXTENSION
10. 7400 SOUTH EXTENSION
11. 8600 SOUTH/U-111 EXTENSION
12. NEW BINGHAM HWY EXTENSION
13. OLD BINGHAM HWY EXTENSION

- DIVERSIONS
- SPLIT MANHOLES

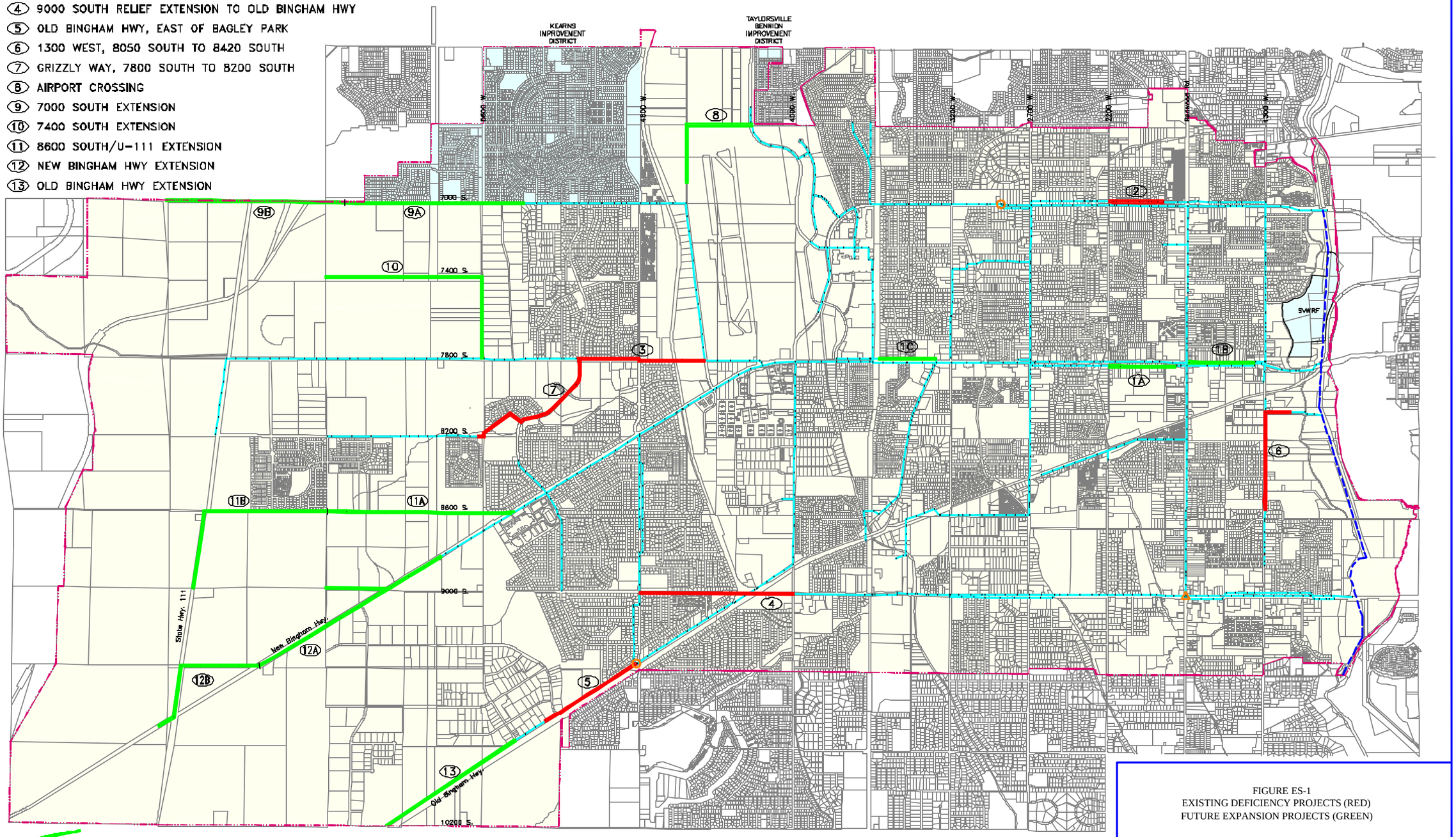

FIGURE ES-1
EXISTING DEFICIENCY PROJECTS (RED)
FUTURE EXPANSION PROJECTS (GREEN)

West Jordan City

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1 - INTRODUCTION

The West Jordan City sanitary sewer system currently serves areas that are experiencing rapid residential and commercial growth. As a result, West Jordan City needs to evaluate and improve sanitary sewer infrastructure to adequately accommodate this growth.

The City has chosen to take a proactive approach to handle the issues of evaluating sewer capacity in its existing system and planning for future growth in areas not yet served. As part of this proactive approach, the City retained J-U-B ENGINEERS, Inc. to study the existing system capacities and to propose the alignment and sizes of future trunk lines.

This report is divided into the following tasks:

- Evaluate the existing system (2002) to determine current capacity.
- Evaluate the build out system (2030) to size future lines and to determine status of existing sewers at build out conditions.
- Evaluate the Capital Improvement Plan system (2010) to delineate the improvements that may be necessary in the next 5 to 7 years, as part of an overall Capital Facilities Plan.
- Evaluate the current resources the City has for managing, maintaining, and operating the sanitary sewer system, for the purpose of making recommendations on how the City may meet the Environmental Protection Agency's Capacity, Management, Operation, and Maintenance (CMOM) Program requirements.

A central component of these tasks is the use of computer modeling software to simulate current and future sanitary sewer system capacity. The software and planning parameters (see KEY ASSUMPTIONS) used for this study are discussed in greater detail in the following sections.

By implementing the recommendations outlined in this master plan, West Jordan City will be better able to provide direction for future growth, and to provide adequate sanitary sewer service to the residents of the City. Future conditions have been created based on assumptions from the analysis zones (development patterns) and the draft future land use map (densities). Land use and other conditions may change and ultimately affect the master plan. The analysis and recommendations contained herein should be updated as necessary. This is especially true of the relatively undeveloped area on the west side of the City. This document should be used as a guide in providing for growth. The City should conduct an analysis during the detailed design of any sanitary sewer facilities to verify that growth is occurring according to the assumptions in this report.

2 - EXISTING SYSTEM EVALUATION

2-1 Introduction

The current system evaluation assesses the existing hydraulic conditions of the modeled trunk lines. Sanitary sewer lines were selected for modeling based on size and the amount of area they served. These modeled lines would be considered trunk lines since they carry flows from several smaller contributing lines. Smaller lines, or lines serving smaller areas were not modeled since the probability of those lines having sufficient capacity is very high. For example, an 8" line at minimum grade has sufficient capacity to serve 600 to 900 residential units, depending on the pipe location within the system. An 8" line serving less than 600 to 900 residential units will always have sufficient capacity, and may not need to be modeled. This does not completely rule out the need to model smaller lines, as was the case in West Jordan. A few sections of 8" line were modeled and even monitored for existing flows because these 8" sections served large areas. The existing lines that are evaluated in this report include the lines listed below and are shown on Figure 2-1.

- 7000 South
- 7300 South and 3200 West
- 7800 South
- 9000 South
- Sugar Factory Road
- Old Bingham Highway (West)
- Old Bingham Highway (East)
- New Bingham Highway
- Wheatcrest Drive (5290 West) and Grizzly Way (5100 West)
- Grizzly Way (5100 West)
- Airport Road (4500 West) and 7000 South
- 4800 West
- 4000 West
- Jordan Landing Area
- 2700 West
- 2700 West and 8600 South
- Redwood Road
- 1300 West and 8050 South

A computer model was developed to simulate the existing system using Pizer's Hydra® Version 6.1 sewer modeling software. Hydra® was chosen as the modeling software for this project for several reasons:

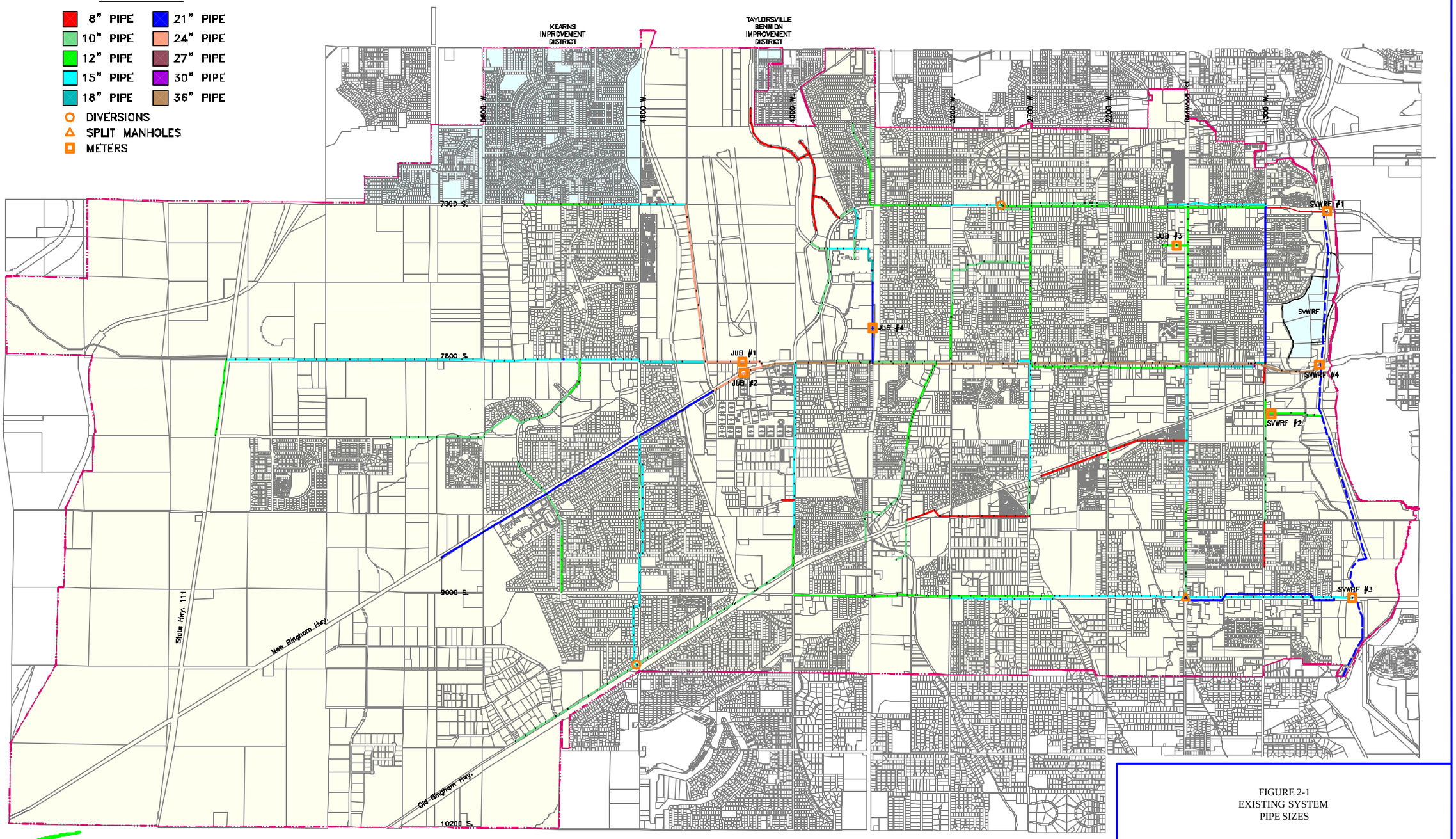

FIGURE 2-1
EXISTING SYSTEM
PIPE SIZES

West Jordan City

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- A previous partial model was created with this software. Hydra® was selected in order to run and analyze the previous model.
- Hydra® software interfaces well with G.I.S. (Geographic Information Systems). Other modeling software uses G.I.S. information, but does not interface as well with the G.I.S. database. West Jordan City currently has land use and zoning information stored in a G.I.S. database. J-U-B Engineers used this existing information to create land use map for the model.
- The sanitary system map was drawn in AutoCAD. Hydra® is able to search for information in a Microsoft Access database, which has been created directly from the AutoCAD system map.
- The cost of Hydra® software is competitive with other modeling software. West Jordan City desired to purchase a copy of the modeling software, and Hydra® appeared to have all of the necessary functions that the City needed. As noted above, Hydra® interfaces well with AutoCAD, G.I.S. software, and Microsoft Access and Excel, all of which West Jordan is currently using.

Hydra® uses data from three sources:

The **first source** of information is from direct input into the Hydra® software. This includes flow line and manhole rim elevations, groundwater infiltration and storm water inflow volumes, and daily use patterns for residential and commercial contributors. The manhole rim and flow line elevations came from data collected by West Jordan staff, and were provided to J-U-B Engineers in the form of spreadsheet files. The spreadsheet files were imported to an AutoCAD drawing, where the individual manholes appear as points with rim elevation, flow line elevation, and northing and easting coordinates.

The **second source** of information comes from Microsoft Excel spreadsheets containing the data that generates sanitary sewer flows. This data includes land use densities, household densities, gallons per person per day (residential), gallons per acre per day (commercial and industrial) and the percent of developed land in each land use area.

(A further explanation of land use areas and service areas is appropriate at this point: Service areas define the regions that are served by a single line or that are injected in the model at a single point. Because service areas may contain more than one land use area, and because the land use areas are the mechanisms of populating the model, Hydra® uses information from individual land use areas rather than entire service areas. This allows the model to be built and examined on the basis of the percentage of current development against the total build out development within smaller, more definitive areas. Figure A-2, in Appendix B, shows the breakdown of land use areas within service areas.)

A spreadsheet was created for each scenario reviewed in this report, i.e., existing system with existing flows, existing system with 2010 and 2030 flows, and 2030

improved system with 2030 flows. These spreadsheets were then imported into a Microsoft Access database file, where Hydra® reads the information to run the model. These spreadsheets are found in Appendix B.

The **third source** of information comes from AutoCAD. The service area boundaries, the land use area boundaries, and the pipe geometry are drawn in AutoCAD. This information is linked to a Microsoft Access database file that Hydra® uses to develop the geometry of the system.

Once the model is built from the preceding information, the model is then calibrated to represent existing flow conditions. To aid in calibration of the model, West Jordan City crews and J-U-B personnel installed flow monitoring equipment in strategic locations. The South Valley Water Reclamation Facility also provided monitor information that was used for calibration.

These monitors were installed in August 2002, a period corresponding to seasonal high ground water. The monitor sites are identified in Figure 2-2. The monitoring results were graphed and are included in Appendix A. The size and shape of these graphs were used to calibrate the model. Further discussion of the hydrographs and model calibration is included in the following sections.

2-2 Key Assumptions

A computer model of a sewer system is based on assumptions that characterize the area and system components. The key assumptions used in the Existing System Model are as follows:

- Current and future land use densities were determined from the West Jordan Draft Land Use Map. The build out population was derived from the traffic analysis zones, provided by the City.

- For the current and future system analysis, the lines that belong to the Kearns Improvement District and the Taylorsville Bennion Improvement District have been omitted from this model. The population of the area served by these districts was included while calibrating to the current total population, but was not included in the flow calculations for West Jordan City sanitary sewer lines.

- Infiltration consists of groundwater that enters into the sewer system through open joint pipes, cracks in pipes, faulty service connections, leaky manhole joints and poor seals at the connections between pipes and manholes. The West Jordan Sanitary sewer system was divided into two categories of existing infiltration based on flow monitoring data and based on the previous infiltration study completed in 1992:

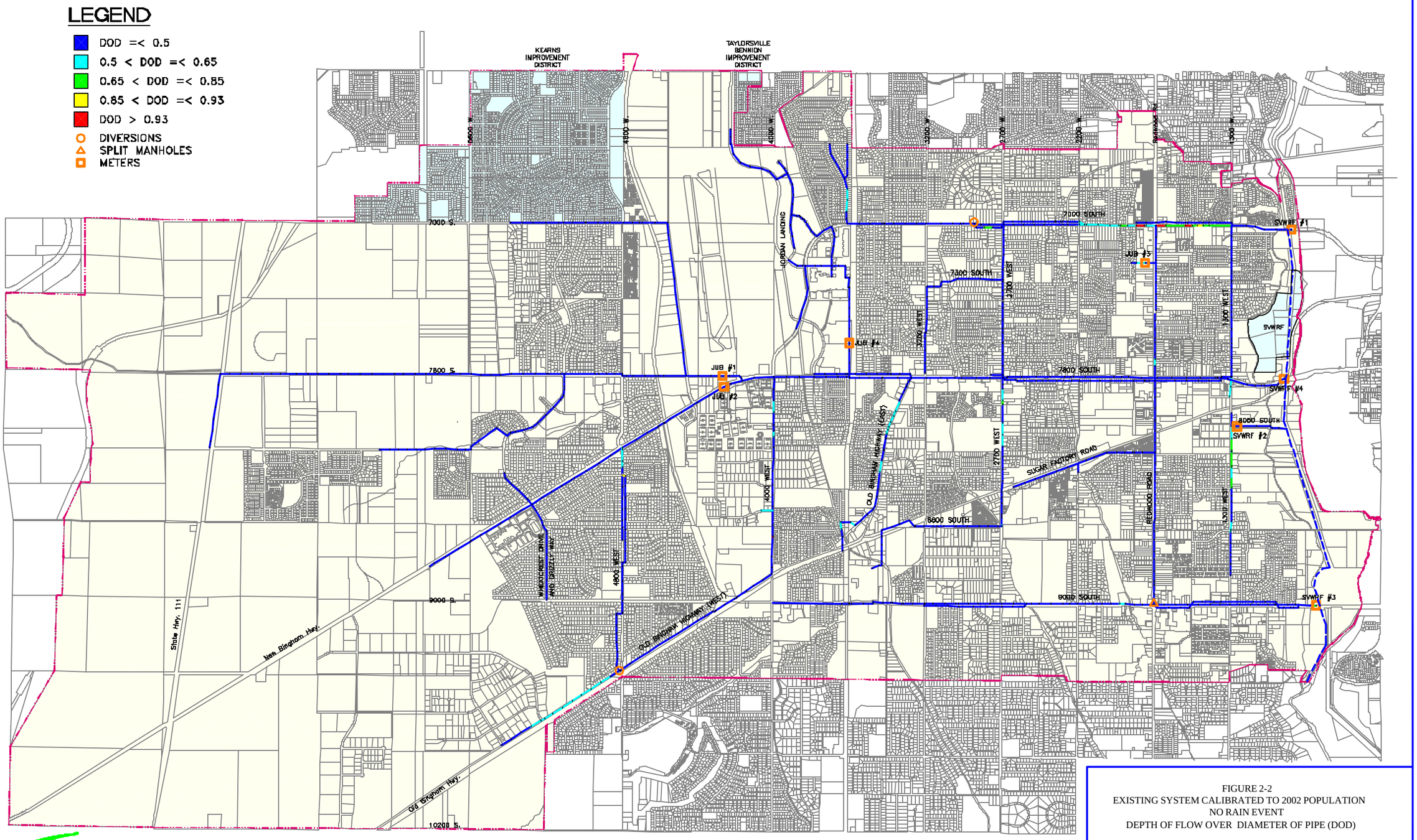

FIGURE 2-2
EXISTING SYSTEM CALIBRATED TO 2002 POPULATION
NO RAIN EVENT
DEPTH OF FLOW OVER DIAMETER OF PIPE (DOD)

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Low – 0 GPAD (gallons per acre per day)
Medium – 412 GPAD

The lines where low infiltration is applied tend to be the newer lines in the upper reaches of the system, or lines where the monitors showed low infiltration. The areas of medium infiltration tend to be older lines in 1300 West and Redwood Road.

- Inflow is surface storm water that enters into the sewer system through manhole covers and direct connections such as roof drains, foundation drains, and storm sewer connections which have not been identified and disconnected from the sanitary sewer. The storm event in August 2002 showed that on average the system receives 70 gallons per acre per day. The return period of this storm is unknown. This value does not correspond to a particular rainfall event, such as a 50 or 100-year rain event. This is due to the fact that the larger sources of inflow should be eliminated so that the sewer system does not act as a storm drain system.

- Each dwelling unit houses an average of 3.3 people, based on the traffic analysis zones. These zones use 3.24 to 3.30 people per household. In some of the very high density areas, we have assumed a lower people per household number, creating a citywide average between 3.24 and 3.30.

- The average wastewater flow per person per day was estimated to be 85 gallons per person per day for typical residential units. These values are based on flow monitoring results at West Jordan flow meters and at South Valley Water Reclamation Facility (SVWRF) meters, and typical domestic water use patterns in this region. The current model flows calibrated to within 5% on nearly all the meters, using 85 gallons per person per day. Six of the eight meter locations calibrated to between 1% and 5%. SVWRF #4 (7800 South) calibrated to within 7%. JUB #4 (Jordan Landing) calibrated to 15%, i.e., modeled flows were 15% higher than actual flows. This larger discrepancy may have occurred for various reasons – the current number of commercial contributors may be lower than calculated, the commercial contributors may be using less water than assumed, or the residential household densities may be lower in this area than those assumed for the rest of West Jordan City. This later scenario is likely. In any case, the departure between metered and modeled flows creates an additional factor of safety of 1.15 in the Jordan Landing area. This factor of safety is in addition to the factor of safety that is commonly applied through depth over diameter (DOD) values. For example, the 10” pipe in Jordan Landing has a 2030 modeled DOD value between 0.65 and 1.0, but may have a lower 2030 actual DOD value 15% less than those indicated in the model (0.55 and 0.85).

- Commercial, industrial, and mixed-use areas contribute approximately 800 gallons per acre per day (GPAD). The commercial and industrial areas that contribute to the 90th South trunk were given GPAD values of 850. Figure 2-3 shows the areas that drain to each of the four main sewer trunks within West Jordan City. This average flow was applied to areas where no other information was available. Where information was available on individual consumption, we used those numbers in the current model calibration. Those individual contributors included Fairchild Semiconductor, Dannon, OSI, Jordan Valley Hospital, Rivendell, National Guard, Sysco, and many of the very high density residential developments.

2-3 Existing System Model Development

The modeling software used for this model was Pizer's Hydra® Version 6.1, which interfaces with AutoCAD and ArcView GIS software. The model input consists of three layers: the system layer, the service area layer, and the land use layer.

System

The system layer contains a geometrical map of the sewer system and a database that holds information about the sewer system, such as pipe length, pipe diameter, infiltration, rim elevation, invert (flow line) elevation, and diversion location and geometry. All of this information is contained in the City's copy of the Hydra® model. The rim and invert elevations were collected with a G.P.S. rover unit and a measuring rod, by West Jordan City personnel. The sizes of the lines were taken from record drawings, existing West Jordan City sanitary sewer base maps, and were field verified as needed.

Area topography was taken from 2-foot contour information provided by West Jordan City.

Service Areas

Flow is routed into the system through the service area layer. The service areas were determined based on the current layout of the sewer system and area topography. All of the flow contributed by a service area is injected into the sewer line or the manhole indicated in the service area database. This database contains information imported from the Excel spreadsheets shown in the Appendix B. Because the service area layer injects all of the flows from a specific service area at a particular point, the tabulated model results indicates zero flow for some lines. These lines appear on the west side of the City. This should not be interpreted to mean there is no flow in the actual lines upstream of the injection points.

Land Use Areas

The land use layer generates the flows. It contains the flow generating information such as population, contribution per capita, commercial and

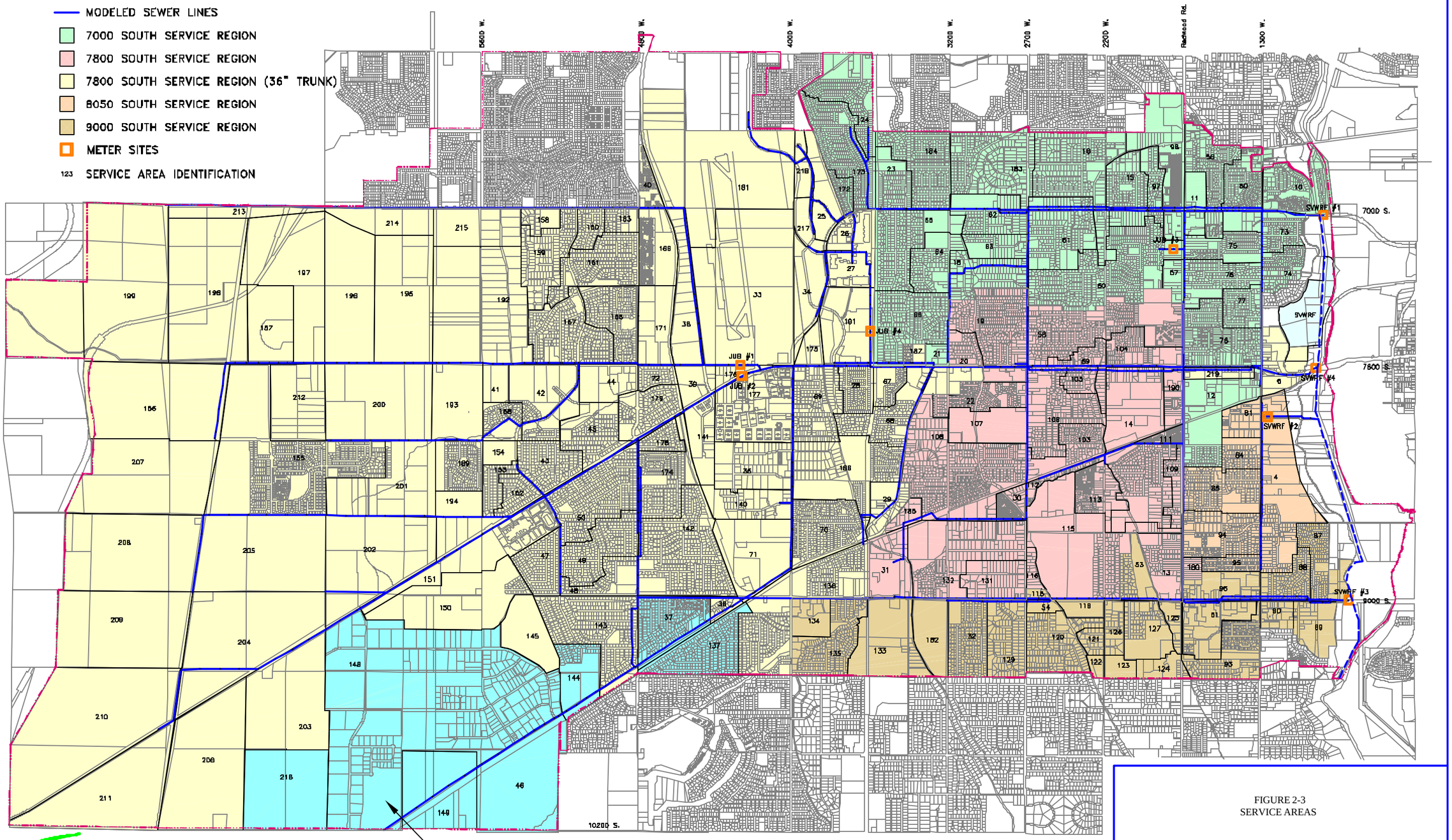

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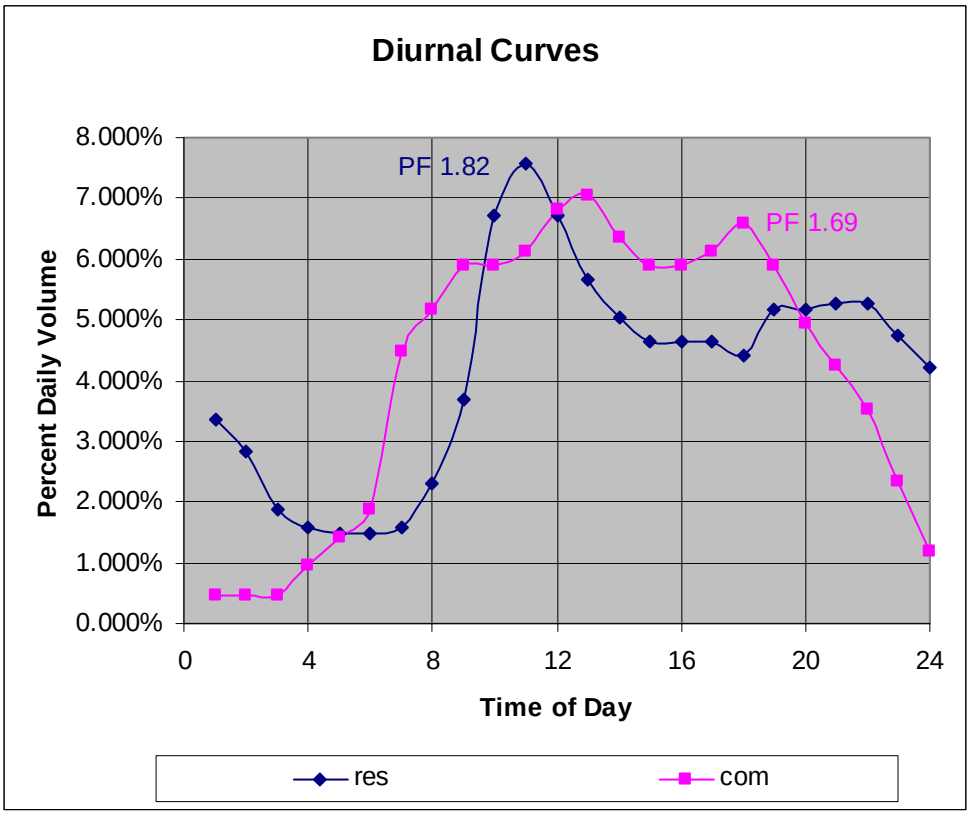
FIGURE 2-3
SERVICE AREAS

West Jordan City

industrial contribution, and daily use patterns (diurnal curves). Inflow and infiltration are attributed to specific lines in the system layer. The land use information is derived from the West Jordan City Draft Land use Map. These land use divisions are shown on Figure A-1 and Figure A-2, in Appendix B.

Sewer flows vary differently throughout the day with each land use type. The shapes that are formed as a result of graphing land use flows verses the time of day are known as diurnal hydrographs or diurnal curves. The diurnal curves shown in Table 2-3 below were derived from flow monitoring at the locations shown on Figure 2-2. These diurnal curves are consistent with empirical data from the monitoring information (Appendix A and Figure 2-2), and were inserted into the land use layer in this model.

Table 2-3 Diurnal Curves



The unit diurnal curve allows the Hydra® software to quantify the flow throughout the day for the various types of land use. For example, residential diurnal curves tend to have two peaks throughout the day, 1) mid-morning, and 2) later in the evening. These peaks are due to similar lifestyles. Most people wake up and begin to use water by taking showers and preparing breakfast in preparation for work, school, or church at approximately the same time. As these morning flows are combined, the first and highest peak is formed. The second and lower peak occurs

in the evening when most people come home and prepare dinner. The second peak is lower, broader, and less pronounced because people tend to prepare dinner and use water at more varied times throughout the evening. The curves in Table 2-3 represent weekend flows. The commercial/industrial curve has similar trends to the residential curve, but differs significantly in the sharpness of the peak flows; the commercial curve remains as broad peaks throughout the working hours of the day. The commercial and industrial entities also tend to generate relatively small mid-morning or evening flows, compared to the higher residential flows at these same times.

The modeled sewer lines convey flow from all types of land use and, therefore, represent a combination of the above-described diurnal curves. As seen in the actual flow monitoring graphs in Appendix A, the residential flows tend to dominate the shape for the areas monitored. The information from monitor JUB #3 (in Appendix A and Figure 2-2) is a good representation of an isolated residential area.

The peaking factors designated with a PF, and ranging from 1.69 to 1.82 on the above graph, are ratios of peak hourly flow divided by average daily flow. The metered and modeled peaking factors are consistent with typical peaking factors for cities with similar populations (See Linsley, Franzini, Freyberg, Tchobanoglous. *Water-Resources Engineering*, fourth edition, p. 663).

2-4 Calibration

The existing system model was calibrated to simulate measured existing flow conditions. These conditions were determined by measuring flows at eight trunk line locations during August 2002. Flow monitoring locations are shown on Figure 2-2, and the results can be found in Appendix A. West Jordan City used the Marsh-McBirney Flo-Dar System to monitor flows in selected lines. This equipment provided continuous 24-hour monitoring over a period of two weeks at each site. The monitors were installed for two weeks in order to pick up two weekends. Weekend peak flows tend to be higher than weekday peak flows.

It should be noted that weekend flow monitoring does not correspond with school enrollment numbers. Therefore, the model was run without flows from schools. All other types of contributors (residential, commercial, industrial, mixed-use) have been included in the total model flows. As seen in Appendix A, West Jordan sanitary sewer lines generally have higher weekend flows than weekday flows. Therefore, the model was calibrated to the weekend flows.

The time of day that the peak flows occur varies depending on location in the system. The lines in the western reaches of the system tend to have earlier peak flows than the lines closer to the outfalls below 1300 West. This is due to the time it takes for flows to travel down the system, with flows from several upper system lines combining into one lower line. Also, the peak flows tend to occur at different

times from a weekday to a weekend. For example, at Site JUB #3, weekday peak flows tend to occur around 8:00 a.m. to 9:00 a.m., whereas weekend peak flows tend to occur around 11:00 a.m. to 12:00 p.m. During the week, many people prepare for work and school early in the morning, while weekends are structured around religious services and leisurely activities.

Calibration involved superimposing the graphs of the monitored flow over the model-generated diurnal curves. Then the model parameters (contribution per capita, contribution per acre of commercial and industrial areas, infiltration) were adjusted to match field conditions. During the calibration process, the land use parameters of the model were adjusted globally, which fine-tuned the model to simulate the measured flows. For instance, the residential diurnal curve was modified globally so that all of the land use areas with residential flows would take the same shape. As a result, the model curve took a shape that more closely reflected field conditions. In some cases, where commercial volumes for individual users were available, the contribution per acre was modified on an individual basis. These commercial users included Fairchild Semiconductor, Dannon, OSI, Jordan Valley Hospital, Rivendell, National Guard, and Sysco. Appendix A contains comparison charts for each flow-monitoring site showing modeled flows verses actual field measured flows. As seen in the graphs, the model calibrated closely with the monitoring sites.

The flow monitoring information was also used to determine the location and volume of infiltration occurring in the system. The system was divided into the two categories of infiltration mentioned previously in Key Assumptions. A detailed study of groundwater infiltration is beyond the scope of this report; the results from flow monitoring were generally consistent with the locations and volumes indicated in the 1992 infiltration study.

2-5 Existing System Model Analysis

Once the model was calibrated, it was adjusted to account for inflow in the system from precipitation. The inflow was added to the entire system in the amounts described in Key Assumptions.

This adjustment developed the existing system model. The existing system model simulates flows on a weekend, during seasonal high groundwater periods, with a rainfall event. We recommend that the City periodically monitor sanitary sewer flows to identify the possible sources of inflow, and then implement a plan to eliminate the identified sources.

Figure 2-4 shows the modeled sewer lines under current conditions, with a rain event. Figure 2-5 shows the current system at 2010 populations, with a rain event. Figure 2-6 shows the current system at 2030 populations, with a rain event.

From the model, and from field observations, the lines listed below are at capacity or do not have sufficient capacity at this time.

- 7800 South, 1300 West to 3600 West
- 7000 South, 1300 West to 2200 West

Other lines in the system will be near or at capacity before 2010. These are listed below.

- Grizzly Way (5100 West), 7800 South to 8100 South
- 7800 South, Grizzly Way (5100 West) to Airport Road
- Old Bingham Highway 5600 West, East of Bagley Park Road
- 1300 West, 8050 South to 8420 South (Slip Line Project)
- 9000 South Relief Extension to Old Bingham Highway (Future Extension)

The last line listed above (9000 South Relief) is not an existing line. This line should be constructed to relieve the 4000 West line if extremely large flows are generated from the Bagley Industrial Park, or other areas that would contribute to the 4000 West line. The 9000 South Relief could extend to 4800 West to relive the 4800 West Line and the 4000 West lines if land use densities change drastically to the west (Bagley Industrial Park, Old Bingham Highway area). The model does not indicate that any of the 9000 South Relief Line is necessary. However, as mentioned previously, if land use densities increased dramatically or if extremely large wastewater contributors developed in the Bagley Park area, this relief line would allow some of these flows to be diverted to 9000 South instead of up 4800 and 4000 West. Figure 2-7 shows the condition of the lines if the extension is taken only to Old Bingham Highway. Figure 2-8 shows the condition of the lines if the extension is taken to 4800 West. The existing lines in 9000 South, to the east of Old Bingham Highway, will have sufficient capacity at build out to carry approximately 70% of all flows from the Bagley Park area. Figure 2-3 shows the area that could be diverted to 4800 West, 4000 West, or 9000 South. Figures 2-4, 2-5, 2-6 show depth of flow over diameter for the existing model, 2010 model, and 2030 model, respectively. The depth of flow over diameter of pipe (DOD) is a typical measure of how a sewer is accommodating existing flows. Figure ES-1 shows the lines that will need to be improved before 2010 (in red), as well as the lines that will be constructed with the western expansion (in green).

2-6 Conclusion of Existing System Evaluation

Results of the existing system evaluation indicate that the most of the lines have capacity to handle the existing flows with a moderate rainfall event and they have some reserve capacity for growth.

Figure 2-4 shows the ratio of depth of flow over the diameter of the pipe (DOD) for the existing lines. The ratio of depth of flow over diameter of pipe is a typical

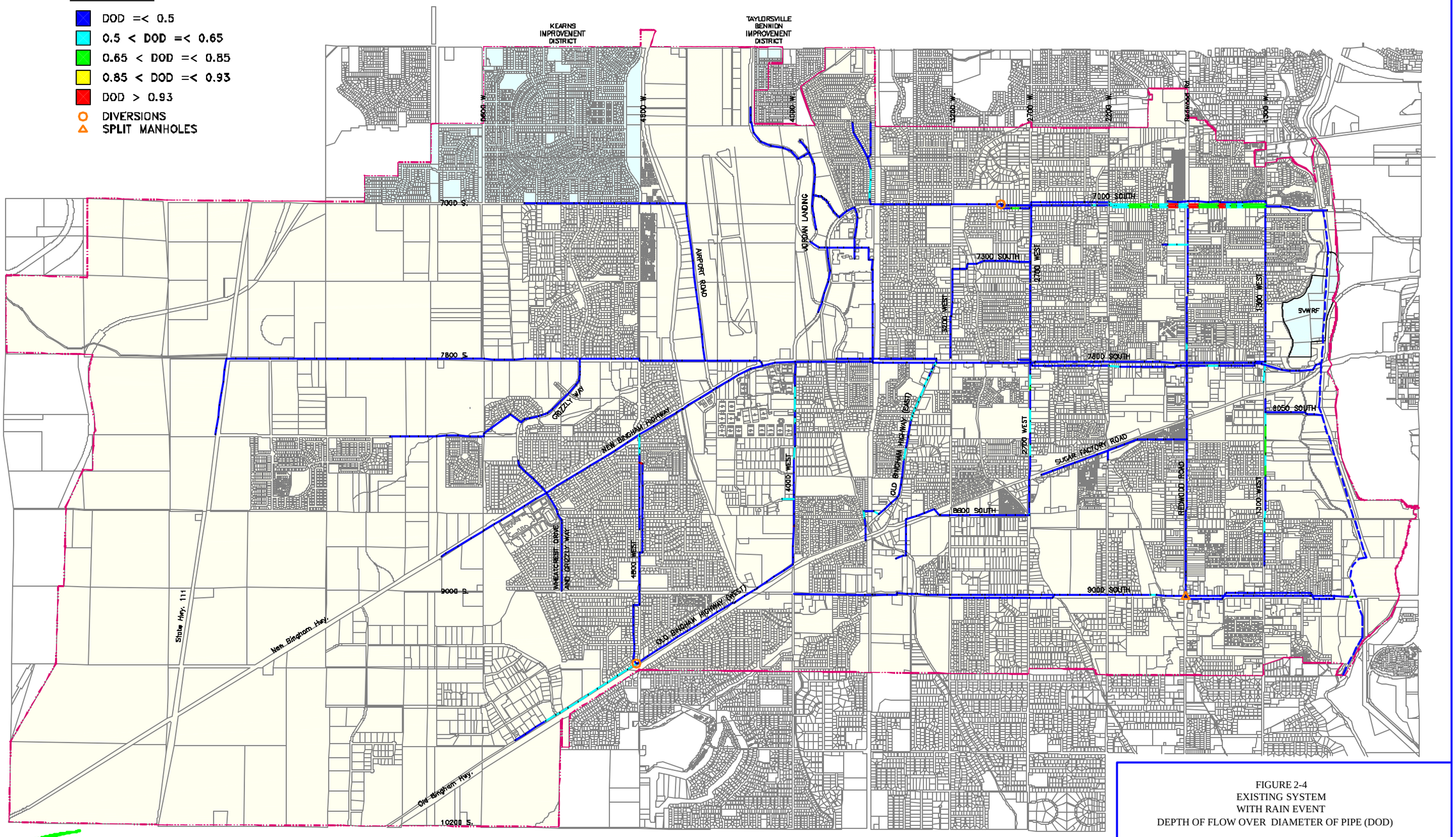


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FIGURE 2-4
EXISTING SYSTEM
WITH RAIN EVENT
DEPTH OF FLOW OVER DIAMETER OF PIPE (DOD)

West Jordan City

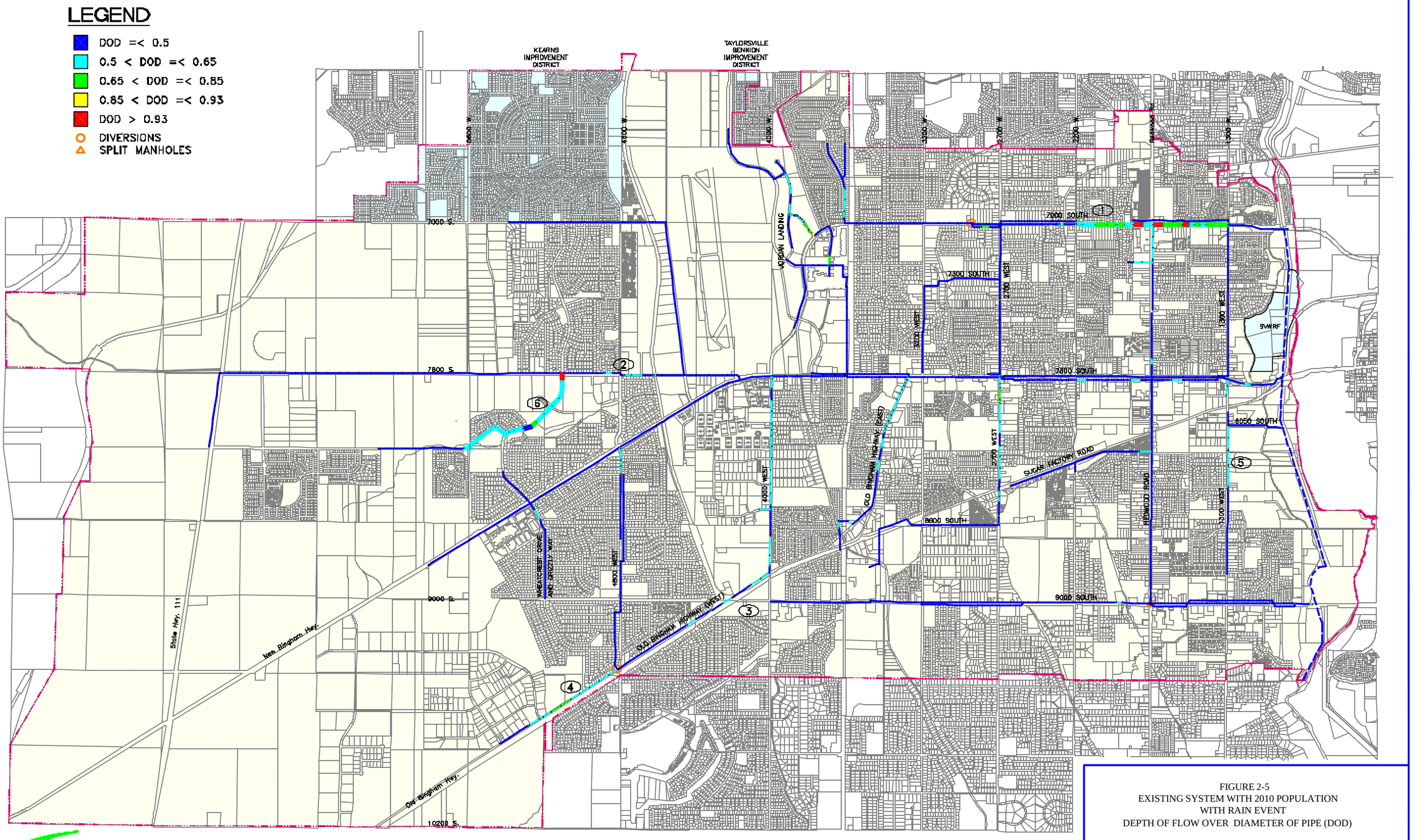

FIGURE 2-5
EXISTING SYSTEM WITH 2010 POPULATION
WITH RAIN EVENT
DEPTH OF FLOW OVER DIAMETER OF PIPE (DOD)

West Jordan City

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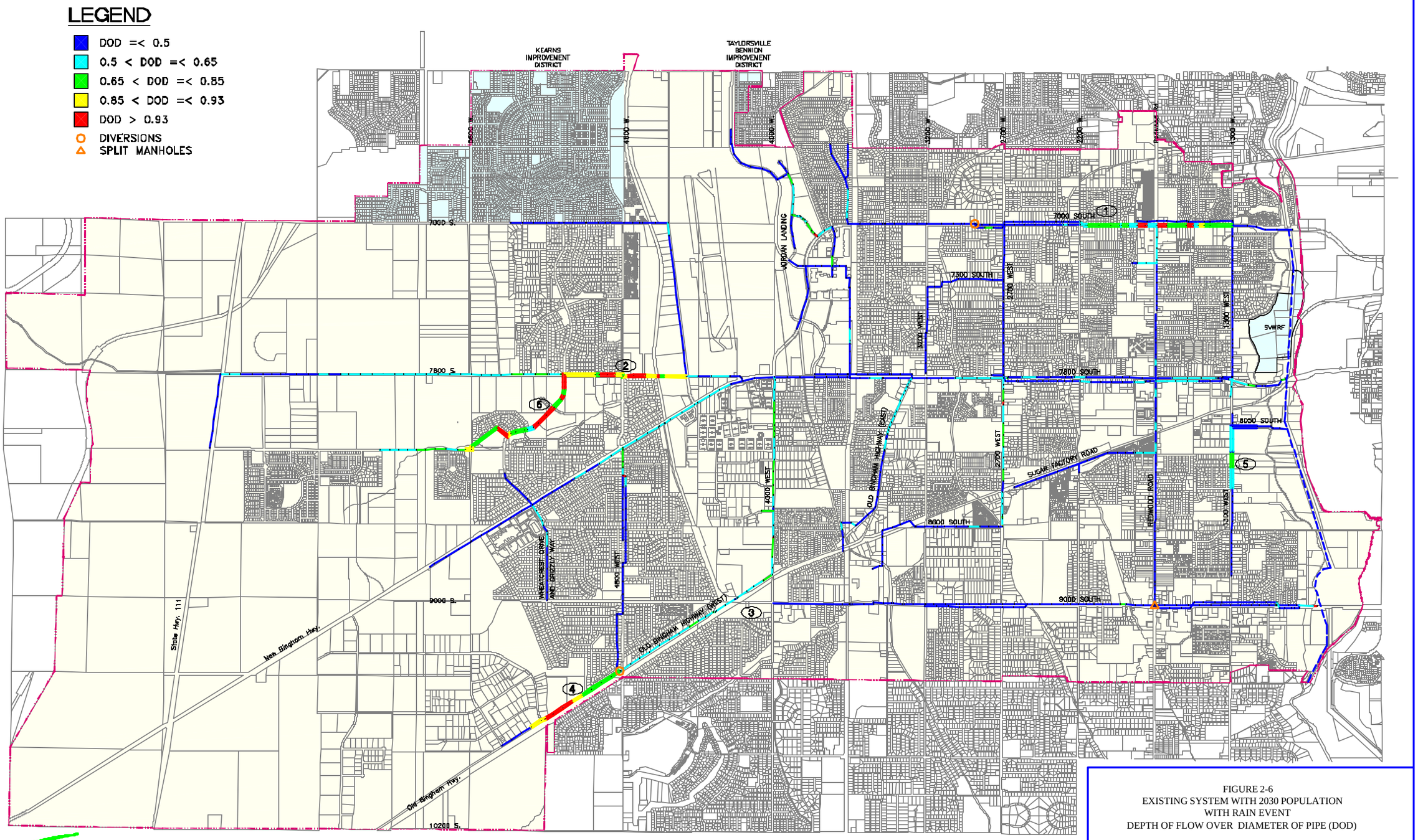

FIGURE 2-6
EXISTING SYSTEM WITH 2030 POPULATION
WITH RAIN EVENT
DEPTH OF FLOW OVER DIAMETER OF PIPE (DOD)

West Jordan City

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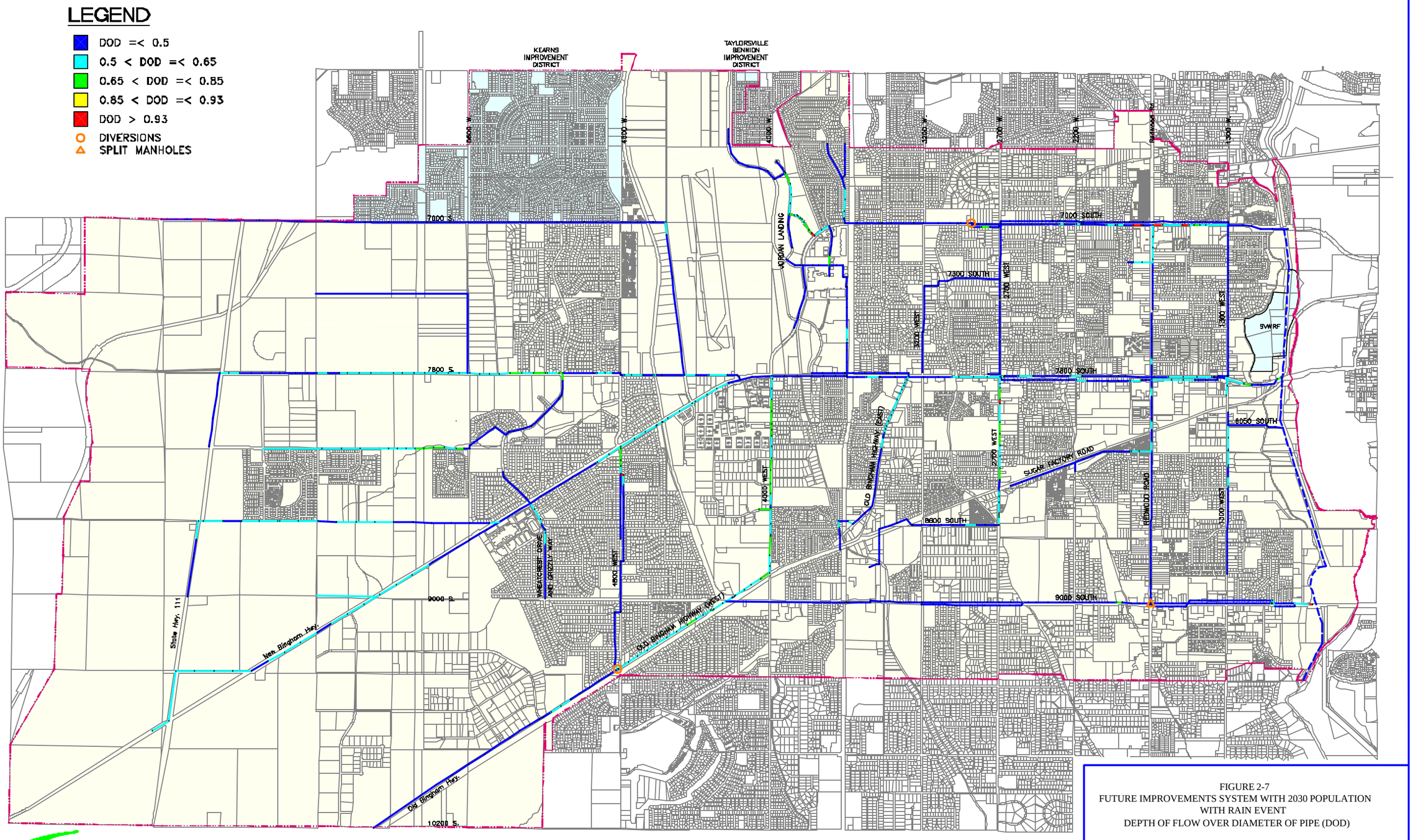

FIGURE 2-7
FUTURE IMPROVEMENTS SYSTEM WITH 2030 POPULATION
WITH RAIN EVENT
DEPTH OF FLOW OVER DIAMETER OF PIPE (DOD)

West Jordan City

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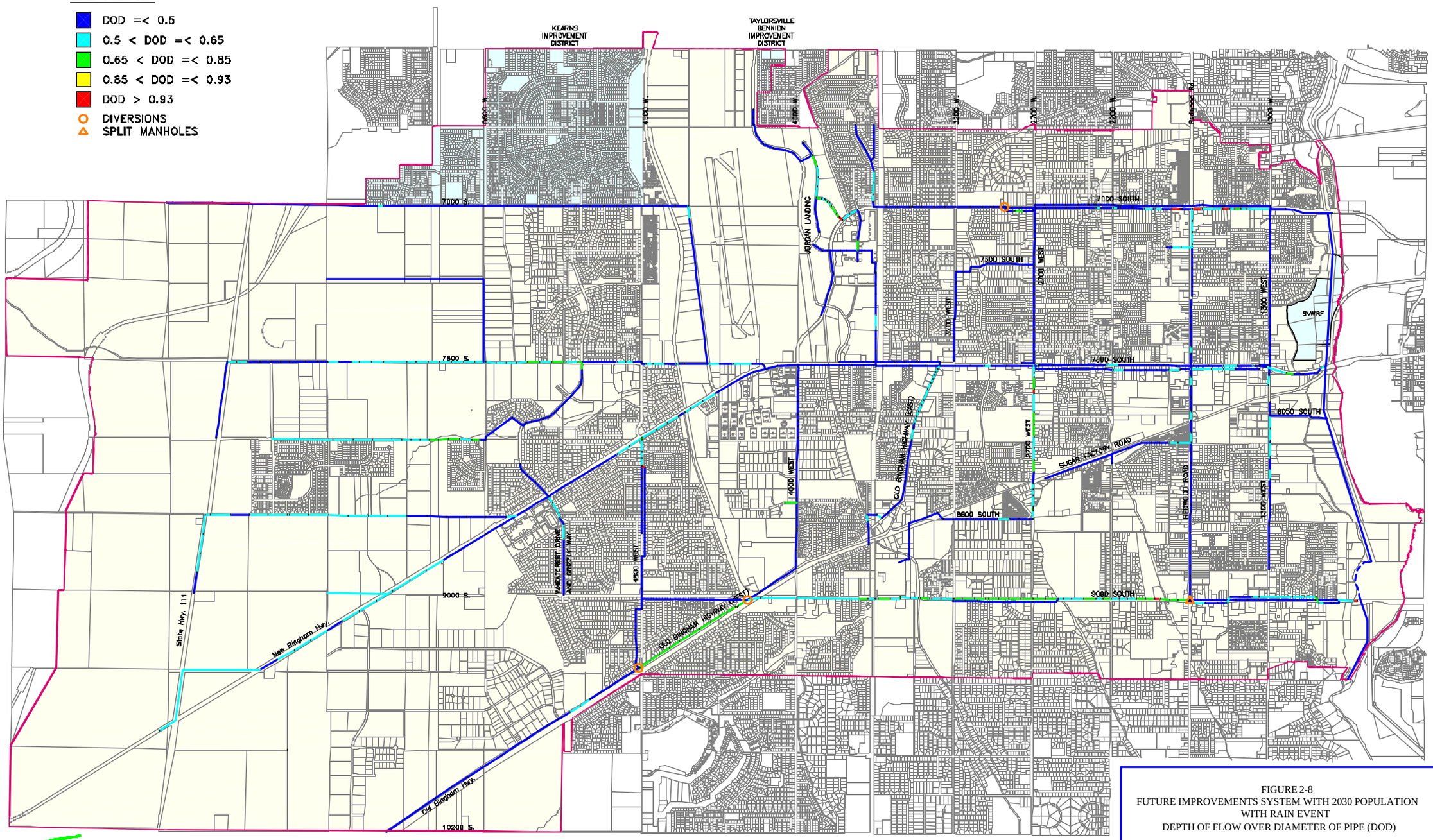

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FIGURE 2-8
FUTURE IMPROVEMENTS SYSTEM WITH 2030 POPULATION
WITH RAIN EVENT
DEPTH OF FLOW OVER DIAMETER OF PIPE (DOD)

West Jordan City

indicator of sewer pipe capacity. A full pipe would have a DOD value of 1.0, and would have no reserve capacity. While a pipe flowing half full would have a DOD value of 0.5, and would have some reserve capacity.

As shown in Figure 2-4, a few sections of lines have a DOD value of greater than 0.5. Larger lines are able to handle more flows than are smaller lines, at equivalent DOD values, i.e., the larger lines have more reserve capacity per increment of DOD value. Typically, trunk lines from 18" to 30" are designed for an allowable DOD value of 0.75. Smaller lines may require a DOD value as low as 0.50, while larger trunk lines (36" and larger) may have an allowable DOD of 0.80 and greater. Table 3-2 shows allowable DOD design values for all line sizes within the West Jordan City system.

With the exception of a few isolated segments, all trunk lines have a current DOD value of less than 0.65. This indicates a well functioning system, with sufficient capacity for current flows. The lines that currently require relief are shown in Figure 2-4. The lines that will require relief prior to 2010 (capital facilities model) or 2030 (build out model) are shown in Figure ES-1, highlighted in red and green, respectively.

The City has scheduled to complete the 7800 South Reconstruction Project (1300 West to 3600 West) during the 2003/2004 fiscal year. Once this project is complete, it is recommended that the City complete the 7000 South project as soon as possible. The 7800 South and Grizzly Way projects do not need to be completed immediately. However, these projects should be completed while construction is still occurring in this area, or while any road reconstruction may be occurring in the area. Other areas to review are the isolated lines where a reverse grade may exist. These were listed previously in FUTURE RELIEF IMPROVEMENTS and CAPITAL IMPROVEMENT PLAN.

In order to increase the reserve capacity for sanitary flows, it is recommended that the City identify sources of infiltration within the trunk lines in high ground water areas, particularly in the lines along 1300 West and Redwood Road. It is also recommended that the City identify sources of inflow, such as low-lying manholes and storm and roof drain connections, through smoke testing or video taping with a remote sewer camera.

The City should also begin to budget and plan for the proposed relief lines for the Capital Facilities plan, and to take advantage of concurrent road replacement or repair projects.

This section has addressed the current system, and current necessary improvements. The next section will address the build out system, and which projects may need to be completed in the next 5 to 7 years (2010 Capital Facilities Plan).

3 – CAPITAL FACILITIES PLAN & RELIEF ALTERNATIVES

3-1 Introduction

The master-planning portion of the study involves creating a conceptual layout of the future sewer trunk system to serve (currently) undeveloped portions of West Jordan City. The master plan study area covers approximately 32 square miles.

A master plan model was utilized as a tool for sizing future trunk lines (lines that will be extended to the western portion of the City), and for sizing relief lines (lines that will be constructed to relieve or replace existing lines). The results of the master plan model identify conceptual alignments and required line sizes to accommodate future conditions within the City boundary.

3-2 Key Assumptions

The following is a list of key assumptions and flow parameters used in the master plan, many of which are consistent with the development of the existing model described in the previous section:

- The inflow rates, in gallons per acre per day (GDAD), have been applied to the 2010 and 2030 models to reflect medium inflow throughout the entire system. The **inflow** (surface storm water) volumes were assumed to be as follows:

  Low – 0 GPAD
  Medium – 70 GPAD (this volume was assumed over the entire system)

  The **infiltration** (groundwater) rates were assumed to be as follows:

  Low – 0 GPAD
  Medium – 412 GPAD (assumed at along 1300 West and Redwood Road)

  The infiltration rates used in the 2010 and 2030 models are the same as the current model, but have been removed from the area along 1300 West, discussed previously. This assumes that improvements will be made to the line in 1300 West. Infiltration improvements (slip lining and similar improvements) in other areas along 1300 West and Redwood Road will likely occur before 2010 and 2030. The model should be updated to reflect those improvements, when those improvements are completed.

- Currently undeveloped areas were assumed to ultimately develop as shown in Figure A-1 and in Appendix B (Refer to Figure A-1 and Appendix B for Land Use Identification Number (G_ID) location).

- All land areas were assumed to be at build out or fully developed conditions in 2030. The traffic analysis zones show all but a few areas as being 100 percent built out. For the purpose of creating a built out sanitary sewer model, the City is shown as 100 percent built out in 2030.

- Each dwelling unit houses an average of 3.3 people, based on the traffic analysis zones, calibrated to the current population.

- The average weekend sanitary flow per person was estimated at 85 gallons per capita per day (GPCD) for future development areas, which is consistent with monitoring data used in the existing model.

- Future commercial and industrial areas were assumed to contribute an average weekend flow of 800 gallons per acre per day. This flow value is based on the assumption that most new businesses will be retail establishments, restaurants, and light industrial contributors, and will be open evenings and weekends.

- Master plan trunk lines will be limited by the following sizing parameters in Table 3-2:

Table 3-2 Design Slope Parameters

D diam (in)	d/D Maximum Allowed depth/diam	Minimum Pipe Slope [1]
8	0.50	0.40%
10	0.55	0.28%
12	0.60	0.22%
15	0.65	0.15%
18	0.75	0.12%
21	0.75	0.10%
24	0.75	0.10%
27	0.75	0.10%
30	0.75	0.10%
36	0.80	0.10%

[1] Ten State Standards allows for pipe slopes less than 0.10% (S=0.0010). However, practical construction tolerances do not warrant lesser slopes.

3-3 Master Plan Development

System

The master plan system was laid out to take advantage of the natural slope of the land and low-lying areas. The final decision on sewer service to these areas will be determined by West Jordan City policy and land development activity. For the purpose of the master plan, the entire area of West Jordan City was assumed to be

served at build out conditions, with the exception of defined open space areas and areas served by the Kearns Improvement District.

The routes of the master plan lines may be slightly altered without affecting service depths or reducing pipe capacities. A "meander" factor is built into the system layout, which permits line length to be increased between modeled manholes, while maintaining design slopes. This factor is applied to the future expansion lines by adding additional drop in the model manholes, which are spaced at intervals of approximately 660 feet. (Capital cost estimates are based on manhole spacing of 350 feet.) Model manholes have a drop of 0.6 feet, which provides additional drop if a future line diverges from locations in the model. These manhole drops were not applied to the relief lines, as these lines will likely follow the slopes of the existing pipes.

Large deviations from the master plan may affect line capacity and serviceability of some areas. The effects of changing the master plan should be thoroughly studied before allowing significant deviations.

For relatively flat areas of the City (lines running north and south), minimum design slopes listed above were used for sizing the master plan lines. However, in most areas of the City the existing grade is greater than the minimum required pipe slopes. In these areas, the master plan lines were modeled to maintain a minimum depth of 10 feet below the surface. The lines run deeper in some areas, namely, as the 8600 South line turns onto U-111, and where the 7000 South line runs through some of the hills and knolls to the west. In these areas, the lines may be as deep at eighteen feet for short sections, depending on how the future roads are graded.

Service Areas

The service areas were delineated based on natural and land use boundaries. The service areas divide the study area into parcels that drain naturally to the trunk lines.

One aspect of the modeling software is that the service area layer injects all of the flows generated within that service area into the system at a particular point. This is not an exact representation of how flows are injected into the system. In an actual system, the flows are generated by individual households or commercial entities and routed through 8" collector lines that eventually tie into a trunk line at various points. As a result of this software constraint, design pipes serving large service areas may be prematurely upsized when a smaller interceptor may have the capacity to serve the upper reaches of the service area. As flows are added downstream, the line must be upsized in accordance with the master plan model as needed to allow for additional flow. It is recommended that this shortfall in the software be considered during the detail design of trunk lines.

Land Use Areas
The land use areas of the existing system were made 100 percent active, i.e., the current undeveloped areas were assumed to be completely developed. Other parameters, such as the diurnal curves, remained the same as in the existing system. The numbers shown in land use areas correspond to the Land Use Identification number (G_ID) in the Land Use Database in Appendix B, and on Figure A-1.

3-4 Master Plan Results and Relief Alternatives

There are three isolated areas in the system where the flow line depth information appears to be incorrect, or where there actually may be a reverse grade in the line. These are listed below:

2700 West 7900 South - This 15" line appears to contain a flat section for 160'. At build out conditions, this line produces a d/D of approximately 1.0. We recommend further investigation into the geometry of this line.

4000 West 8600 South - This 12" line appears to contain a reverse grade for 23'. At build out conditions, this line produces a d/D of approximately 1.0. We recommend further investigation into the geometry of this line.

4800 West 8340 South - This 15" line appears to contain a reverse grade for 31'. At build out conditions, this line is surcharged and creates a substantial backwater in the first upstream pipe (from geometry information provided by the City, and used in the model). We recommend further investigation into the geometry of this line.

These lines should be reviewed further to determine if the grades are indeed reversed, or if the flow line elevation simply needs to be correctly measured.

The master plan model indicates several existing lines will not have capacity at build-out conditions without the implementation of relief lines. As illustrated in Figure 2-6, the majority of the lines that are projected to need relief are located on the west side of the City.

The methodology used in developing the 2010 relief lines consisted of applying the projected population for 2010 to the existing system. Figure 2-5 shows the capacity of the system at 2010. Generally, where relief lines are proposed, they have been sized to *replace* the existing lines, rather than run parallel to existing lines. The exception to this general trend is 7000 South, where a new 15" line is currently scheduled to run parallel to the existing 12" line. The lines that will need relief within a 5 to 7 year period (2010) are described below and are highlighted in red in Figure ES-1. The descriptions below are of the capital facilities that may be required in these locations.

7800 South, 1300 West to 3600 West – This reconstruction project is currently scheduled for completion in the 2003/2004 fiscal year. The majority of the existing line in this reconstruction project is 12" pipe. This will be replaced with a 15" pipe. For modeling purposes this line was shown as 15" in the current and future models. The costs associated with this project are taken from the City's 7-Year Implementation Plan. The total estimated cost is $1,102,000.

7000 South, Redwood Road West to 2200 West – The 12" line is currently surcharged from 1800 West to 1300 West. A design was completed in 1997 to construct a relief line in this area. The proposed relief line connects to the existing 15" line at 1800 West. This proposed line continues to 2200 West, where it will receive nearly all flows from above 2200 West. The new 15" relief line will have the capacity to carry nearly all flows above 2200 West, and should be constructed with a diversion at 2200 West to divert flows from both lines above 2200 West. Once this line is constructed, the lines that are currently surcharged between Redwood Road and 1300 West will have sufficient capacity. The proposed line has been included in the 2010 and 2030 models. The total estimated cost is $362,000.

7800 South, Grizzly Way (5100 West) to Airport Road – This 15" line currently has sufficient capacity, and will have sufficient capacity at 2010. However, it will be severely surcharged at build out. This line, or combined lines, will need to have the capacity of a 21" line at current grades. While this line will have sufficient capacity at 2010, proposed road construction in this area warrants this project to be completed before 2010, concurrent with the road expansion. The total estimated cost is $828,000.

9000 South Relief Extension to Old Bingham Highway and 4800 West – The lines that this extension would relieve appear to have sufficient capacity at 2010 and 2030. However, if land use densities or water uses increased dramatically in the southwest portion of the City, creating much larger flows that expected, this line would have capacity to relieve the Old Bingham Highway line and the 4000 West Line. This line extension could be constructed at any time before 2030. Any road construction or road rehabilitation in this area would warrant completing this project before 2010. The total estimated cost is $938,000.

Old Bingham Highway, East of Bagley Park Road - This 12" line currently has sufficient capacity, and will have sufficient capacity at 2010. This line will be slightly surcharged at build out. The amount of surcharging will be low. The 12" line will need to be replaced with a 15" line. This line could be improved at any time before 2030. Any road construction or road reconstruction in this area would warrant completing this project before 2010. The total estimated cost is $664,000.

1300 West, 8050 South to 8420 South - This 10" line will be nearly surcharged at build out. The amount of surcharging will be low. This line could be improved at any time before 2030. High groundwater infiltration in this line has decreased this line's capacity to carry sanitary sewer flows. Although the line has sufficient capacity at 2030, the City should consider slip lining 6520' of this line to eliminate infiltration. This would reduce overall flows in this line, and flows at the South Valley Water Reclamation Facility. This line appears to have the most infiltration in this area. Other areas along 1300 West and along Redwood Road are also candidates for slip lining projects. A groundwater report was completed in 1992, and could be used for a guide in determining which lines need to be improved. The total estimated cost for slip lining and reconnecting existing services along the 1300 West section is $349,000.

Grizzly Way (5100 West), 7800 South to 8200 South - These 10" and 12" lines currently have sufficient capacity, but will not have sufficient capacity at 2010. These lines will need to be replaced with 15" and 18" lines. From a capacity standpoint, these lines could be improved closer to 2010. However, these lines should be improved with any road construction that may occur in this area before 2010. The total estimated cost is $1,070,000.

Table 3-4 Capital Facilities Cost Breakdown

1a.	**7800 SOUTH, 1700 WEST TO 2700 WEST**	*Unit*	*Qty*	*Unit Cost*	*Amount*
	CURRENTLY PROPOSED RECONSTRUCTION PROJECT				
	TOTAL				**$ 517,000**
1b.	**7800 SOUTH, 1300 WEST TO 1700 WEST**	*Unit*	*Qty*	*Unit Cost*	*Amount*
	CURRENTLY PROPOSED RECONSTRUCTION PROJECT				
	TOTAL				**$ 260,000**
1c.	**7800 SOUTH, 2700 WEST TO 3600 WEST**	*Unit*	*Qty*	*Unit Cost*	*Amount*
	CURRENTLY PROPOSED RECONSTRUCTION PROJECT				
	TOTAL				**$ 325,000**
2.	**7000 SOUTH, REDWOOD ROAD TO 2200 WEST**	*Unit*	*Qty*	*Unit Cost*	*Amount*
	15" PVC	LF	1990	$ 137.00	$ 272,630.00
	60" DIA. MANHOLE	EA	6	$ 4,800.00	$ 28,800.00
	ENGINEERING & CONTIGENCIES (20%)				$ 60,286.00
	TOTAL				**$ 361,716**

3.

7800 SOUTH, GRIZZLY WAY TO AIRPORT ROAD	Unit	Qty	Unit Cost	Amount
21" PVC	LF	4300	$ 146.00	$ 627,800.00
60" DIA. MANHOLE	EA	13	$ 4,800.00	$ 62,400.00
ENGINEERING & CONTIGENCIES (20%)				$ 138,040.00
TOTAL				**$ 828,240**

4.

9000 SOUTH RELIEF TO OLD BINGHAM HWY	Unit	Qty	Unit Cost	Amount
12" PVC	LF	5300	$ 133.00	$ 704,900.00
60" DIA. MANHOLE	EA	16	$ 4,800.00	$ 76,800.00
ENGINEERING & CONTIGENCIES (20%)				$ 156,340.00
TOTAL				**$ 938,040**

5.

OLD BINGHAM HWY, EAST OF BAGLEY PARK	Unit	Qty	Unit Cost	Amount
15" PVC	LF	3650	$ 137.00	$ 500,050.00
60" DIA. MANHOLE	EA	11	$ 4,800.00	$ 52,800.00
ENGINEERING & CONTIGENCIES (20%)				$ 110,570.00
TOTAL				**$ 663,420**

6.

1300 WEST, 8050 SOUTH TO 8420 SOUTH	Unit	Qty	Unit Cost	Amount
10" PVC SLIP LINE	LF	6520	$ 39.00	$ 254,280.00
60" DIA. MANHOLE REHABILITATION	EA	18	$ 2,000.00	$ 36,000.00
ENGINEERING & CONTIGENCIES (20%)				$ 58,056.00
TOTAL				**$ 348,336**

7.

GRIZZLY WAY, 7800 SOUTH TO 8200 SOUTH	Unit	Qty	Unit Cost	Amount
18" PVC	LF	2280	$ 142.00	$ 323,760.00
15" PVC	LF	3550	$ 137.00	$ 486,350.00
60" DIA. MANHOLE	EA	17	$ 4,800.00	$ 81,600.00
ENGINEERING & CONTIGENCIES (20%)				$ 178,342.00
TOTAL				**$ 1,070,052**

TOTAL CAPITAL FACILITIES 2010 $ 5,311,804

The previous descriptions were for relief lines that will need to be built within the existing system. The descriptions below are for future lines that will need to be constructed in the western portion of the City. These future lines will need to be constructed as development generates flows in currently undeveloped areas. The schedule for these future lines may be dependant on City policy regarding utility cost-sharing, as well as on developmental pressures in these areas.

Airport Crossing – This 8" line will serve the area at the north end of the airport. This line was not modeled, but will likely be an 8" line. The downstream line that this proposed line connects to is also an 8" line. The total estimated cost is $660,000.

7000 South Extension – This 12" and 10" line will mostly serve a small area on the south side of 7000 South. This project is divided into two phases, 9a and 9b, as shown on Figure ES-1. As growth occurs in the western reaches of 7000 South, the City will need to evaluate when to construct various portions of these phases. The total estimated cost for both phases is $2,144,000.

7400 South Extension – This 12" and 10" line will serve an area west of 5600 West. As growth occurs in this area, the City will need to review the specific location of this line, and the specific point at which the line transitions from 12" to 10". The total estimated cost is $1,307,000.

8600 South/U-111 Extension – This line will be 15", 12" and 10", and will mostly serve the area to the south of 8600 South and to the west of U-111. This project is divided into two phases, 11a and 11b, as shown on Figure ES-1. The total estimated cost for both phases is $2,350,000.

New Bingham Highway Extension – This 15" and 12" line will extend along the New Bingham Highway just past U-111. The 10" line will branch at 9000 South, as shown on Figure ES-1. The area has sufficient slope to allow this line to take various routes, depending on the configuration of proposed roadway alignments. The current alignment, along the New Bingham Highway, 9400 South, and U-111, reflects one possible route for this line. This project has been divided into two phases to anticipate gradual growth in the south west area of the City. The total estimated cost for both phases is $2,637,000.

Old Bingham Highway Extension – This 10" line will extend past Bagley Industrial Park, to the City limits, and will cross the railroad. The total estimated cost is $955,000.

Table 3-5 Extension Facilities Cost Breakdown

8.

AIRPORT CROSSING	Unit	Qty	Unit Cost	Amount
8" PVC	LF	4000	$ 123.00	$ 492,000.00
60" DIA. MANHOLE	EA	12	$ 4,800.00	$ 57,600.00
ENGINEERING & CONTIGENCIES (20%)				$ 109,920.00
TOTAL				**$ 659,520**

9a.

7000 SOUTH EXTENSION	Unit	Qty	Unit Cost	Amount
12" PVC	LF	6100	$ 133.00	$ 811,300.00
60" DIA. MANHOLE	EA	18	$ 4,800.00	$ 86,400.00
ENGINEERING & CONTIGENCIES (20%)				$ 179,540.00
TOTAL				**$ 1,077,240**

9b.

7000 SOUTH EXTENSION	Unit	Qty	Unit Cost	Amount
12" PVC	LF	3200	$ 133.00	$ 425,600.00
10" PVC	LF	2900	$ 130.00	$ 377,000.00
60" DIA. MANHOLE	EA	18	$ 4,800.00	$ 86,400.00
ENGINEERING & CONTIGENCIES (20%)				$ 177,800.00
TOTAL				**$ 1,066,800**

10.

7400 SOUTH EXTENSION	Unit	Qty	Unit Cost	Amount
12" PVC	LF	2640	$ 133.00	$ 351,120.00
10" PVC	LF	5280	$ 130.00	$ 686,400.00
60" DIA. MANHOLE	EA	23	$ 4,800.00	$ 110,400.00
ENGINEERING & CONTIGENCIES (20%)				$ 159,360.00
TOTAL				**$ 1,307,280**

11a.

8600 SOUTH/U-111 EXTENSION	Unit	Qty	Unit Cost	Amount
15" PVC	LF	6240	$ 137.00	$ 854,880.00
60" DIA. MANHOLE	EA	18	$ 4,800.00	$ 86,400.00
ENGINEERING & CONTIGENCIES (20%)				$ 188,256.00
TOTAL				**$ 1,129,536**

11b.

8600 SOUTH/U-111 EXTENSION	Unit	Qty	Unit Cost	Amount
15" PVC	LF	2100	$ 137.00	$ 287,700.00
12" PVC	LF	3440	$ 133.00	$ 457,520.00
10" PVC	LF	1350	$ 130.00	$ 175,500.00
60" DIA. MANHOLE	EA	20	$ 4,800.00	$ 96,000.00
ENGINEERING & CONTIGENCIES (20%)				$ 203,344.00
TOTAL				**$ 1,220,064**

12a.

NEW BINGHAM HWY EXTENSION	Unit	Qty	Unit Cost	Amount
15" PVC	LF	7200	$ 137.00	$ 986,400.00
10" PVC	LF	2100	$ 130.00	$ 273,000.00
60" DIA. MANHOLE	EA	27	$ 4,800.00	$ 129,600.00
ENGINEERING & CONTIGENCIES (20%)				$ 277,800.00
TOTAL				**$ 1,666,800**

12b.

NEW BINGHAM HWY EXTENSION	Unit	Qty	Unit Cost	Amount
12" PVC	LF	5500	$ 133.00	$ 731,500.00
60" DIA. MANHOLE	EA	16	$ 4,800.00	$ 76,800.00
ENGINEERING & CONTIGENCIES (20%)				$ 161,660.00
TOTAL				**$ 969,960**

13.

OLD BINGHAM HWY EXTENSION	Unit	Qty	Unit Cost	Amount
10" PVC	LF	5300	$ 130.00	$ 689,000.00
60" DIA. MANHOLE	EA	16	$ 4,800.00	$ 76,800.00
RAILROAD CROSSING (BORE & JACK CASING)	LS	1	$ 30,000.00	$ 30,000.00
ENGINEERING & CONTIGENCIES (20%)				$ 159,160.00
TOTAL				**$ 954,960**

TOTAL EXTENSION FACILITIES $ 10,052,160

3-5 Conclusion of Capital Facilities Plan and Relief Alternatives

For the City to serve the entire area encompassed by the current boundaries, several improvements will be required in the way of relief measures and future lines to convey future flows. This master plan will provide West Jordan City with a planning tool to guide development of the sewer collection system throughout the City. Some of the relief and future projects may not be necessary until after 2010, from a capacity standpoint. However, the City may want to install relief and future lines concurrent with road construction or road reconstruction.

The three areas, discussed at the beginning of Section 3-4, should be investigated to determine if there are any reverse grade problems, or if the flow line measurements simply need to be revised and modified in the model.

The City is currently following an infiltration reduction program, and will want to continue with this program past the existing contract time. Continuing to rehabilitate these lines (where infiltration is occurring) will increase the capacity of the existing system to convey sanitary flow. This may not necessarily delay or eliminate the need for relief lines. However, this would decrease the volume of flows going to the South Valley Water Reclamation Facility.

4 – CAPACITY ASSURANCE, MANAGEMENT, OPERATION AND MAINTENANCE EVALUATION

4-1 What is the Capacity Assurance, Management, Operation and Maintenance Program (CMOM)?

The CMOM Program, managed by the Environmental Protection Agency (EPA), establishes minimum requirements for managing, operating, and maintaining any part of a sanitary sewer system.

At the heart of the CMOM program is the Environmental Protection Agency's proposed Sanitary Sewer Overflow (SSO) Rule, which will require municipalities, service districts, and other entities to apply for a permit to operate any part of a sanitary sewer system. The provisions of this rule are contained in the proposed Capacity Assurance, Management, Operation, and Maintenance Program (CMOM or C.M.O.M.). The EPA estimates that the SSO Rule may be published in the Federal Register in the Spring of 2004. This rule will establish minimum requirements that system operators will need to meet.

The EPA classifies West Jordan's sanitary sewer collection system as a satellite system, i.e., West Jordan does not operate its own treatment plant, but conveys effluent through a City-operated system to a wastewater treatment facility. The EPA considers West Jordan to be a satellite system of the South Valley Water Reclamation Facility (SVWRF). Other satellite systems contribute to the treatment loads at SVWRF, including South Valley Sewer District, Salt Lake City Suburban Sanitary District #2, Sandy Suburban Improvement District, and Midvale City.

The South Valley Water Reclamation Facility holds a Utah Pollutant Discharge Elimination System (UPDES) permit to discharge treated wastewater to the waters of the State. This permit is issued by the Water Quality Board of the State of Utah. The permits issued under the proposed SSO Rule may be issued as Utah Pollutant Discharge Elimination System (UPDES) permits, or as National Pollutant Discharge Elimination System (NPDES) permits directly through the EPA. Under the proposed CMOM requirements, West Jordan City may be required to obtain a discharge permit on the State (UPDES) or National (NPDES) level.

These requirements, summarized below, may not be enforced until 2004, or later. However, the Environmental Protection Agency has indicated its desire to provide guidance and direction to those systems that are indeed attempting to meet all proposed C.M.O.M. requirements.

As a condition of obtaining a permit to operate a system, West Jordan City will likely need to:

1. Properly manage, operate and maintain, at all times, the parts of collection system that the permittee owns or over which it has operational control;

2. Provide adequate capacity to convey base flows and peak flows;

3. Take all feasible steps to stop, and mitigate the impact of, sanitary sewer overflows;

4. Provide notification to parties with a reasonable potential for exposure to pollutants associated with the overflow event; and

5. Develop a written summary of their CMOM program, and make the program and required program audits available to the public upon request.

Currently West Jordan City appears to be meeting conditions 1-4. Condition 5 will require that the City create a written summary of the CMOM program. In meeting with the Sewer Superintendent, it became clear that West Jordan City has already started to keep a record of maintenance and operational procedures and activities. As part of item 5 above, a written summary of the CMOM program may include the following items:

1. Goals of the CMOM program;

2. The organization responsible for implementing the CMOM program, and the chain of communication for reporting SSOs to the [EPA] authority;

3. Legal authorities for implementing the CMOM program;

4. Measures and activities the permittee intends to implement as part of its CMOM program;

5. Design and performance requirements and/or standards

6. How the permittee would monitor implementation of the CMOM program and, where appropriate, measure the performance or effectiveness of specific program elements; and

7. How the permittee would communicate with interested stakeholders about the implementation and performance of the CMOM program.

These requirements are taken directly from the existing draft of the SSO Rule. As this rule approaches adoption, West Jordan City will need to review these items, and determine the City's adherence to this proposed rule.

The following sections, 4-2, 4-3, and 4-4, provide a description of the four areas of the CMOM program: Capacity Assurance, Management, Operations and Maintenance.

4-2 Capacity Assurance

West Jordan City retained J-U-B Engineers, Inc. to create a model of the existing sanitary sewer collection system, and to expand the model to study the future system capacity at 2010 and 2030. Except for a few isolated areas, the West Jordan sanitary sewer system is functioning well, and has adequate capacity for current flows. Much of the system has sufficient capacity for large amounts of commercial and residential growth. However, some existing lines only have capacity for limited growth, and will need to be improved ahead of this growth. This report provides information regarding all areas of varying capacity:

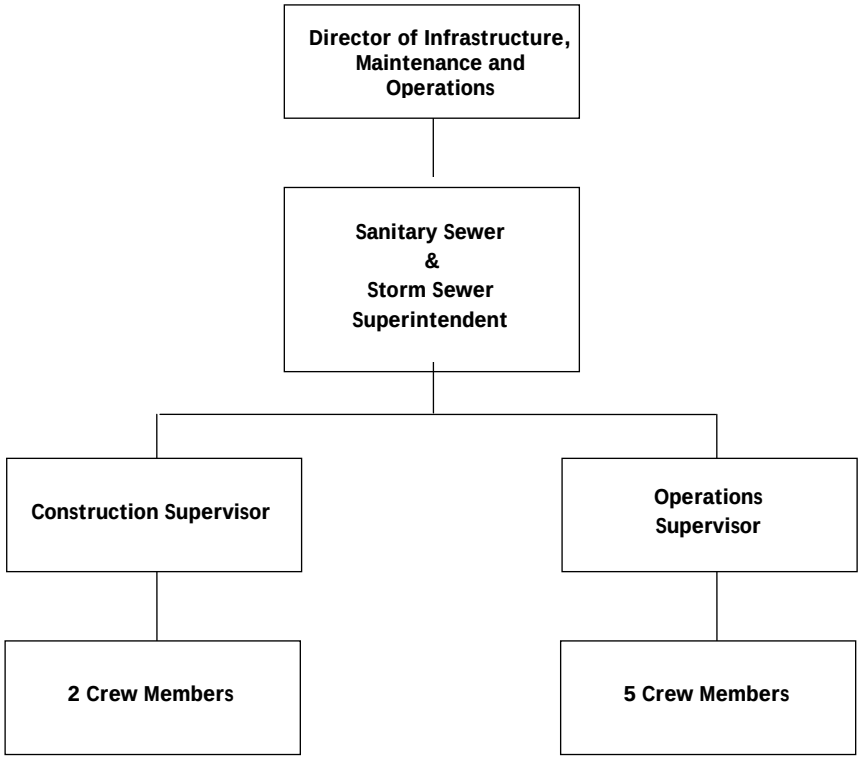
- Isolated areas of the system that need immediate attention
- Existing lines that will need to be improved concurrent with projected growth
- Future lines that will be required to handle growth in currently undeveloped areas to the west

All of these areas, and associated cost estimates, are listed in Section 3-4 of this report. The results of the existing and future models are discussed in detail in sections 1, 2, 3, and 5 of this report.

4-3 Management

Personnel

The collection system within West Jordan City limits is managed by the Sanitary Sewer and Storm Sewer Superintendent. A small portion of the City is provided with sanitary sewer service from the Kearns Improvement District and the Taylorsville Bennion Improvement District. The sewer system superintendent in West Jordan has the dual tasks of overseeing both the sanitary and storm sewers. The superintendent, in turn, has two supervisors: the construction supervisor and the operations supervisor. The primary responsibilities of each supervisor are listed below.



- Respond to Blue Stakes calls
- Respond to customer service issues
- Perform repairs to pipes and manholes
- Verify accuracy of existing system maps
- New construction inspection

- Clean and jet lines
- TV and camera lines
- Review line and manhole conditions
- Respond to customer service issues

Equipment and Tools

The City currently has a list of all equipment and tools, including vehicles, used for sanitary sewer operations. These resources are stored at the Infrastructure Maintenance Operations complex.

Sewer Ordinance

The South Valley Water Reclamation Facility (SVWRF) has adopted sewer regulations that cover the area of West Jordan. These regulations include a pretreatment program which prohibits the discharge of certain substances to system, including grease, oil, toxic pollutants, and other substances. The SVWRF also has specific regulations regarding the requirements for grease interceptors and grease traps.

Engineering

West Jordan City currently has a detailed map of all sanitary sewer lines and manholes. City staff are consistently updating the map to reflect new development and revisions to the existing maps and records. This map is available electronically in AutoCAD, and is also printed and bound for field crews and others to have on hand.

Design
West Jordan City has current construction standards for sanitary sewer projects. The new developments are evaluated for impact to the sanitary sewer system, and the Hydra® model is used to determine current capacity in the affected lines.

Construction
New construction is inspected by West Jordan City. The inspection is coordinated through the Engineering Construction Manager. New construction is pressure tested and pipes are televised and recorded on video tape. After the system has been functioning for at least 12 months, the total bond on the sanitary sewer improvements is released.

Management Information Systems
The crews in charge of operating and maintaining the sanitary sewer system create reports for any work performed on the system. These reports include necessary information regarding location, nature of work, condition of existing facilities, probable causes of malfunction, duration of work, and any follow-up work done after the initial work. Reports are generated for the following areas and are archived electronically and as a hard copy:

- Sewer Line and Manhole New Construction
- Sewer Line and Manhole Maintenance
- Sewer Line and Manhole Repair
- Sewer Backup Remediation

West Jordan utilizes various computer programs to manage the sanitary sewer system. These include the following programs:

- Pizer Hydra® Modeling Software
- Microsoft Excel
- Microsoft Word
- Microsoft Access Database
- AutoCAD Drafting and Mapping Software
- Marsh-McBirney Flo-Ware Monitoring Software
- Cartagraph Infrastructure Management Software

Complaints and Public Relations
Public complaints are handled by the Construction Supervisor or the Operations Supervisor. These supervisors may have crew members respond to public complaints. The most common complaints are from residents who cannot locate service lateral cleanouts. Although West Jordan City does not have jurisdiction over the service laterals (these are the responsibility of the individual property owner), the construction or operations crews often assist residents in locating cleanouts. The City crews assist residents in locating service lines and cleanouts in an effort to create better public relations. The other complaint received by the City relates to

sanitary sewer odor. These complaints are received infrequently, perhaps 1 or 2 times per year.
West Jordan City notifies the public regarding sanitary sewer projects several days in advance of the beginning of construction. Where work must be done on short notice, City crews notify the public as soon as possible about work in an area.

Emergency Maintenance and Contingency Plans
The City does have an emergency maintenance plan in place, and has personnel trained to respond to various emergencies. One person is on call 24 hours a day, seven days a week. West Jordan maintains the necessary parts to make most repairs to the sanitary sewer system. These parts are stored at the Infrastructure Maintenance Operations complex. The City completes an annual inventory on all emergency parts. Two large suppliers of pipe and parts are located within a few minutes of the operations complex.

4-4 Operation and Maintenance

Maintenance Scheduling
The City currently follows a schedule for maintaining the sanitary sewer system. The items on the schedule are prioritized based on formal reports from the Operations and Construction Crews and from video recordings of lines and manholes.

Sewer Cleaning
The Public Works Department has two vacuum trucks used for cleaning sanitary sewer and storm drain lines. Each of these trucks is operated by two crew members. The City began a systematic approach to cleaning sanitary sewer lines in 1998. Since then, over 330 miles of sewer line have been cleaned. The City of West Jordan contains approximately 360 miles of sanitary sewer pipe. In the past five years the cleaning crews have cleaned much of the system. In the EPA's proposed CMOM/SSO Rule the Urban Institute reported that the average cleaning times for systems throughout the United States varies between seven to twelve years. This indicates that West Jordan is doing slightly better than average on cleaning the sanitary sewer system. However, the Urban Institute found that average systems of similar size (to West Jordan) experience roughly 160 sewer backups per year. That West Jordan experienced a single backup in 2001, and only one again in 2002, is an indication of the general good condition of the system, and the good maintenance that crews have performed on this system.

4-5 Recommendations and Summary

Equipment
The equipment currently used for sanitary sewer maintenance is also used for storm drain maintenance. The City may consider obtaining additional equipment devoted solely to storm drain maintenance. The crews that clean storm and sanitary sewer lines are covering the sanitary sewer system approximately every five years. One of the most effective ways of discovering obstructions or breaks in lines or manholes is

through cleaning the system. If an area is not cleaned for over five years, that area has a greater probability of having problems that could lead to a sanitary sewer overflow or a backup. As the sanitary sewer system ages, it will be more critical to clean and observe lines and manholes in order to catch these obstructions or breaks early.

Personnel

The Manual on Uniform Traffic Control Devices (MUTCD), which the Utah Department of Transportation (UDOT) has adopted, recommends that one person be responsible for assuring that all crew members are protected from vehicle traffic in and around the work zone (See MUTCD Section 5G and 6D). This recommendation applies to the vacuum trucks and the TV truck, which frequently stop in lanes of traffic to perform routine work. The National Institute for Occupational Safety and Health (NIOSH) document Building Safer Highway Work Zones also recommends that one person in a work crew is given the responsibility to monitor traffic conditions in and around the work area (See NIOSH Publication 2001-128, Injury Prevention Measures).

As growth occurs in West Jordan City, the City will need to review current personnel needs. Additions to the sanitary sewer system will require more attention to system cleaning and maintenance. Sanitary sewer crews currently respond to maintenance issues on the storm drain system. As the sanitary sewer system grows, these crews may need to devote all of their time to that system, with additional crews being assigned to storm drain maintenance.

Flow Monitoring

The City currently owns five portable flow meters. As this initial study and report is implemented, West Jordan City should continue to monitor sanitary sewer lines. This monitoring can indicate areas of excessive infiltration in the system, and can be used to further calibrate the system as the model changes with growth.

4-6 Conclusion of CMOM Evaluation

West Jordan City appears to be well on the way to meeting proposed CMOM requirements. As the CMOM requirements are put into effect in 2004 or later, the City will want to look at three areas to meet these requirements:

1. Review the proposed requirements for a written summary of the CMOM program. The SSO Rule is still being reviewed by the EPA. However, the requirements for a written summary will likely be the seven items listed in Section 4-1.

2. Formalize an ongoing review of the City's existing resources (personnel, equipment, software) on a basis that will allow the City to stay ahead of growth.

3. As the NPDES Storm Drain Phase II regulations are implemented, the City will want to assure that sufficient resources are being dedicated to both the storm drain system and the sanitary sewer system. As discussed previously, the storm drain and sanitary sewer systems currently share personnel and equipment resources.

5 – CONCLUSIONS & RECOMMENDATIONS

The following conclusions and recommendations are based on the foregoing analysis:

Conclusions

- The existing system has adequate capacity in most lines. However, portions of the system are at or nearing capacity. These areas are delineated in Section 2-5 and are shown in Figure 2-4.

- Infiltration and Inflow appear to be low to moderate for *most* of the system. However, in some portions of the system (1300 West and Redwood Road) infiltration appears to be high. Refer to the first recommendation below.

- Several relief improvements to existing trunk lines will be required. These improvements are shown in Section 3-4, at the end of the Executive Summary, and in Figure ES-1 (highlighted in red). Figure 5-1 shows all of the future improvements (heavy lines), as well as future required line sizes.

Recommendations

- Continue to implement an infiltration elimination program in areas that appear to have relatively high levels of groundwater, as delineated in the 1992 report.

- Maintain and protect future alignment corridors from future utilities that may impact construction of the future trunks, and coordinate road construction with future and relief projects.

- Flow monitoring of critical lines described above should be done on an annual basis. In addition, proposed development should be added to the existing system model to help determine the flow conditions of existing lines.

- The west side of the City, in largely undeveloped areas, will need to be analyzed throughout the next planning period as land uses may change and development occurs. In most areas of the City the modeled densities are taken directly from municipal land use maps. In the case of the possible residential development that may be constructed at Jordan Landing, a higher density was used, in anticipation of a land use change in this area. The model should be updated frequently to reflect such changes, or potential changes, to the land use plan. Line sizing may be consequently affected by any changes in the planning densities. However, small changes to the land use map may not require size changes to build out lines.

- The current model of the sanitary sewer collection system encompasses lines that were anticipated to have capacity concerns. These are the major trunk lines throughout the City, and represent approximately 48 miles of the collection system. As discussed in Section 2-1, the modeled lines were selected based on the assumption that lines serving larger areas may have capacity issues, and lines serving relatively small areas would always have sufficient capacity. As development occurs to the west, the City will want to review the modeled system, and determine if other lines need to be included in the model. Proposed lines to the west have been modeled in the future system model. As these are built, they should be surveyed and included in the current model.

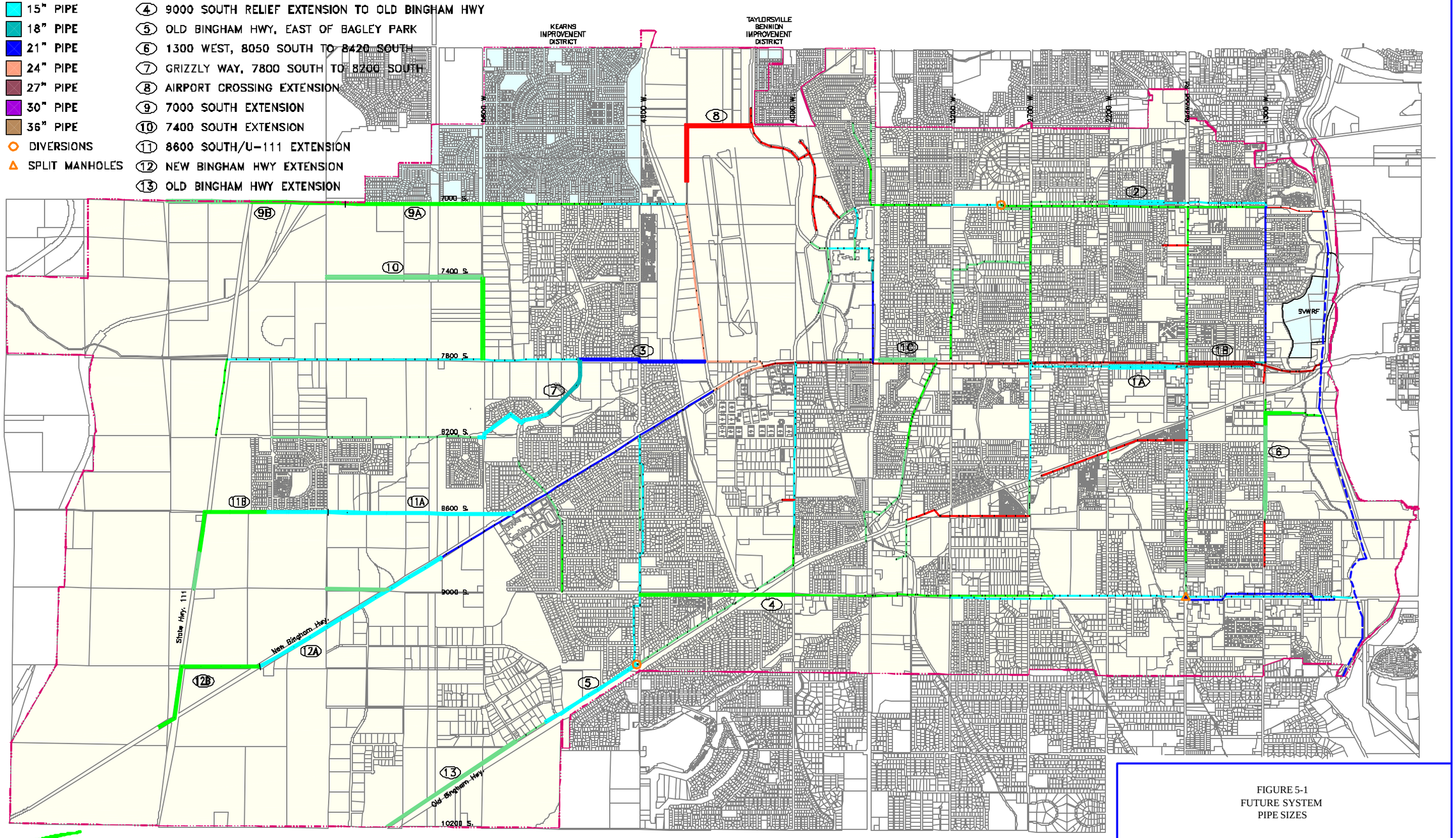
- Lines that do not need to be modeled may need to be surveyed for maintenance records. These would include smaller lines in subdivisions. The survey and flow line information from these lines and manholes will allow the City to track maintenance on the entire system.

In summary, we recommend that West Jordan City continue to take a proactive approach to sewer monitoring and modeling. Land use may change as undeveloped areas begin to fill in; these changes should be examined often to determine the accuracy of the current model. The model should be updated to reflect any changes to the land use within the City, and should also be updated to reflect residential and commercial growth in the individual service areas. By keeping the model current, West Jordan City will have a useful tool to create and maintain the capital facilities necessary for a well-functioning system.

LEGEND

- 8" PIPE
- 10" PIPE
- 12" PIPE
- 15" PIPE
- 18" PIPE
- 21" PIPE
- 24" PIPE
- 27" PIPE
- 30" PIPE
- 36" PIPE
- DIVERSIONS
- SPLIT MANHOLES

1. 7800 SOUTH, 1300 WEST TO 3600 WEST
2. 7000 SOUTH, REDWOOD ROAD TO 2200 WEST
3. 7800 SOUTH, GRIZZLY WAY TO AIRPORT ROAD
4. 9000 SOUTH RELIEF EXTENSION TO OLD BINGHAM HWY
5. OLD BINGHAM HWY, EAST OF BAGLEY PARK
6. 1300 WEST, 8050 SOUTH TO 8420 SOUTH
7. GRIZZLY WAY, 7800 SOUTH TO 8200 SOUTH
8. AIRPORT CROSSING EXTENSION
9. 7000 SOUTH EXTENSION
10. 7400 SOUTH EXTENSION
11. 8600 SOUTH/U-111 EXTENSION
12. NEW BINGHAM HWY EXTENSION
13. OLD BINGHAM HWY EXTENSION



J-U-B
ENGINEERS • SURVEYORS • PLANNERS

FIGURE 5-1
FUTURE SYSTEM
PIPE SIZES

West Jordan City

West Jordan City Corporation
Public Works Department

Sanitary Sewer Model & Capital Facilities Plan

Appendix A

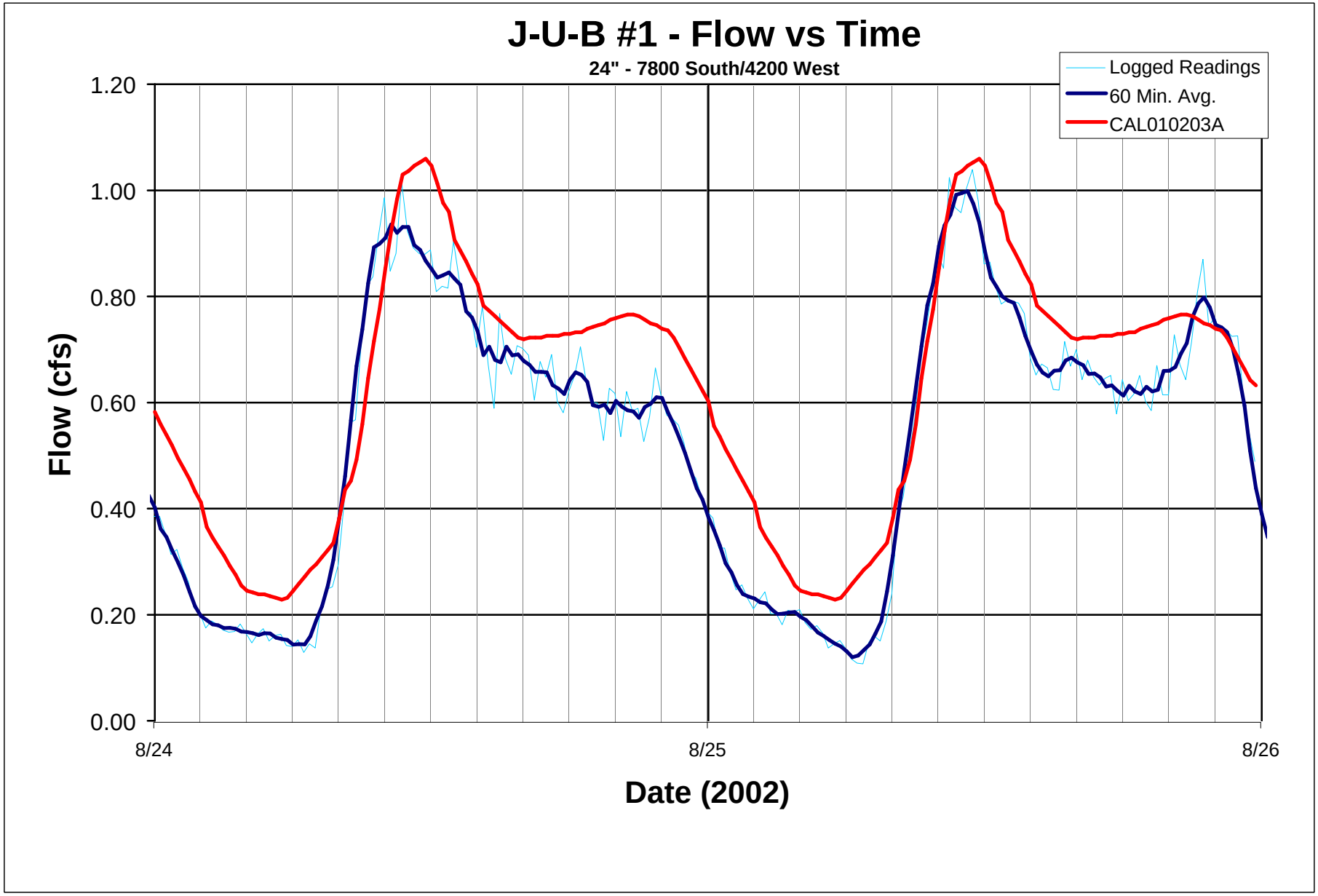
March 2003
J-U-B Engineers, Inc.

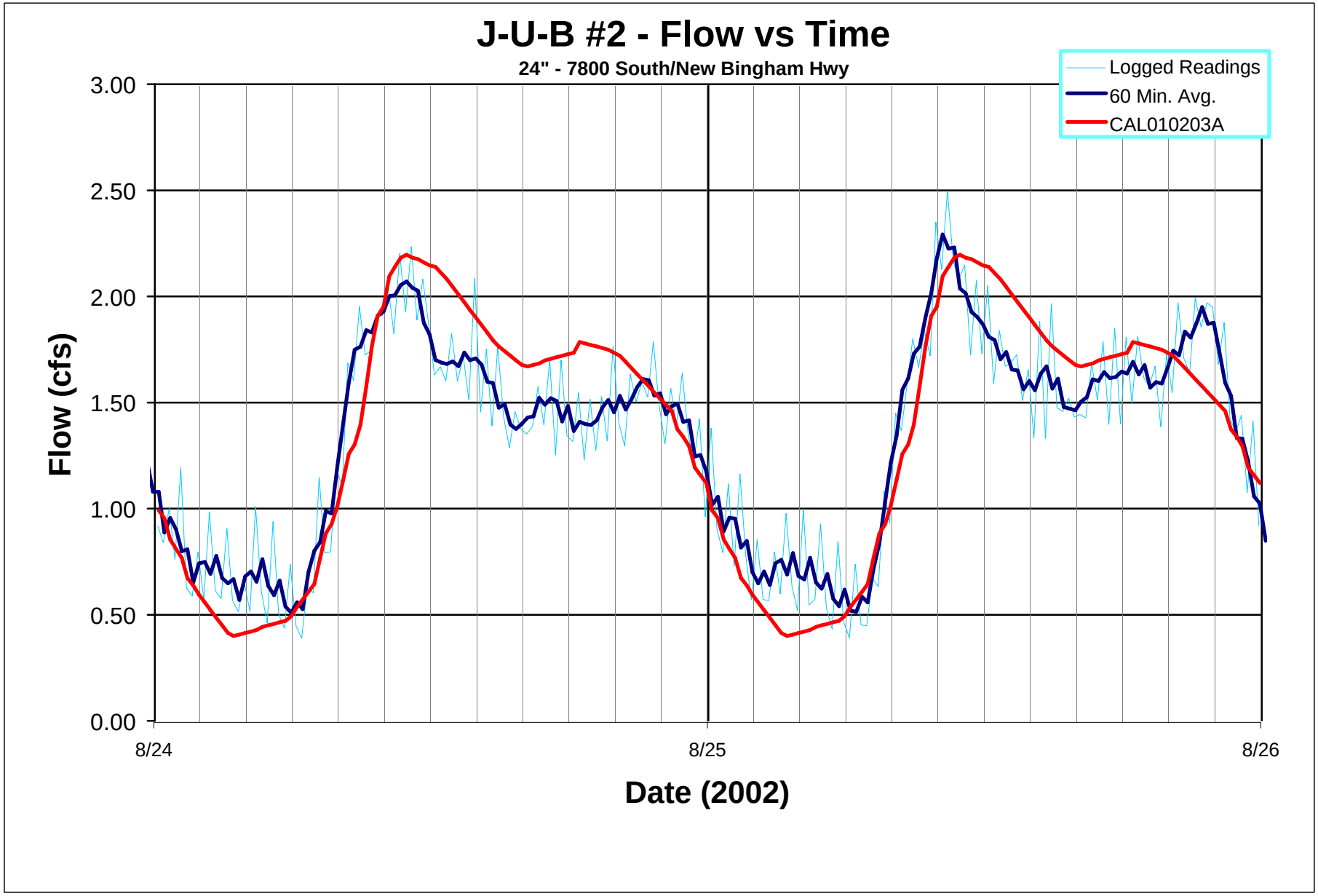
FLOW MONITOR RESULTS

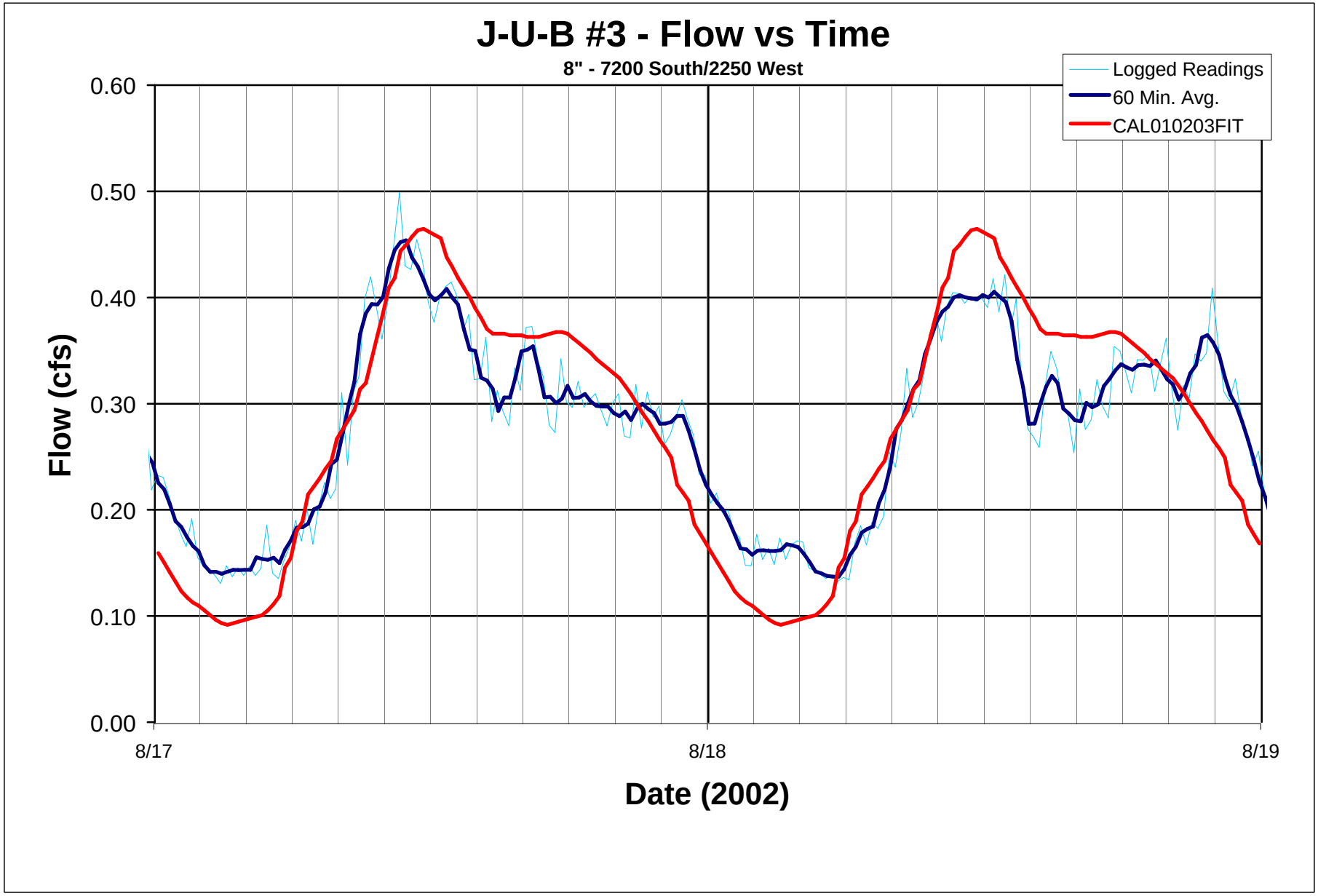
Model Calibration and Diurnal Curves

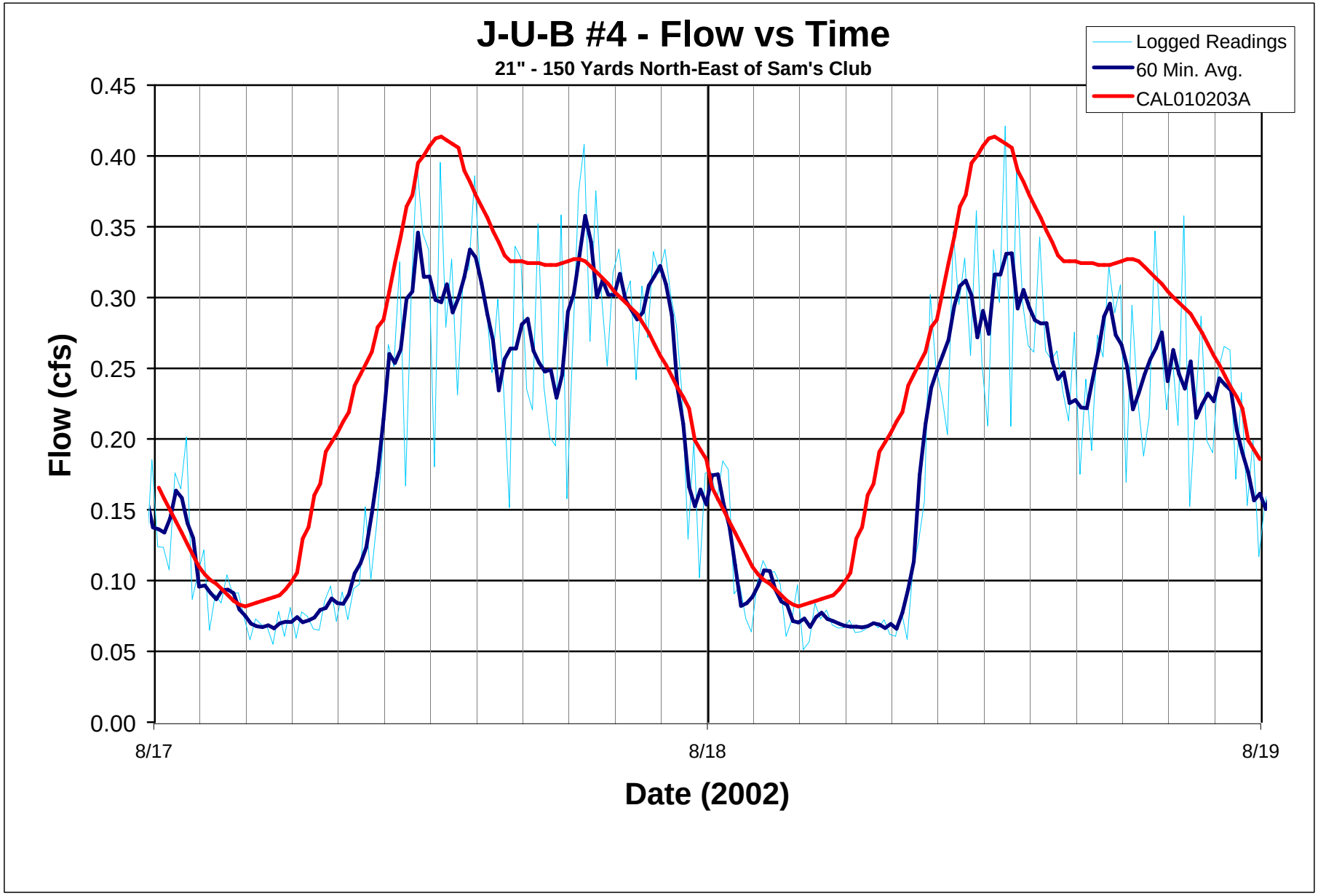
MODEL LOCATIONS

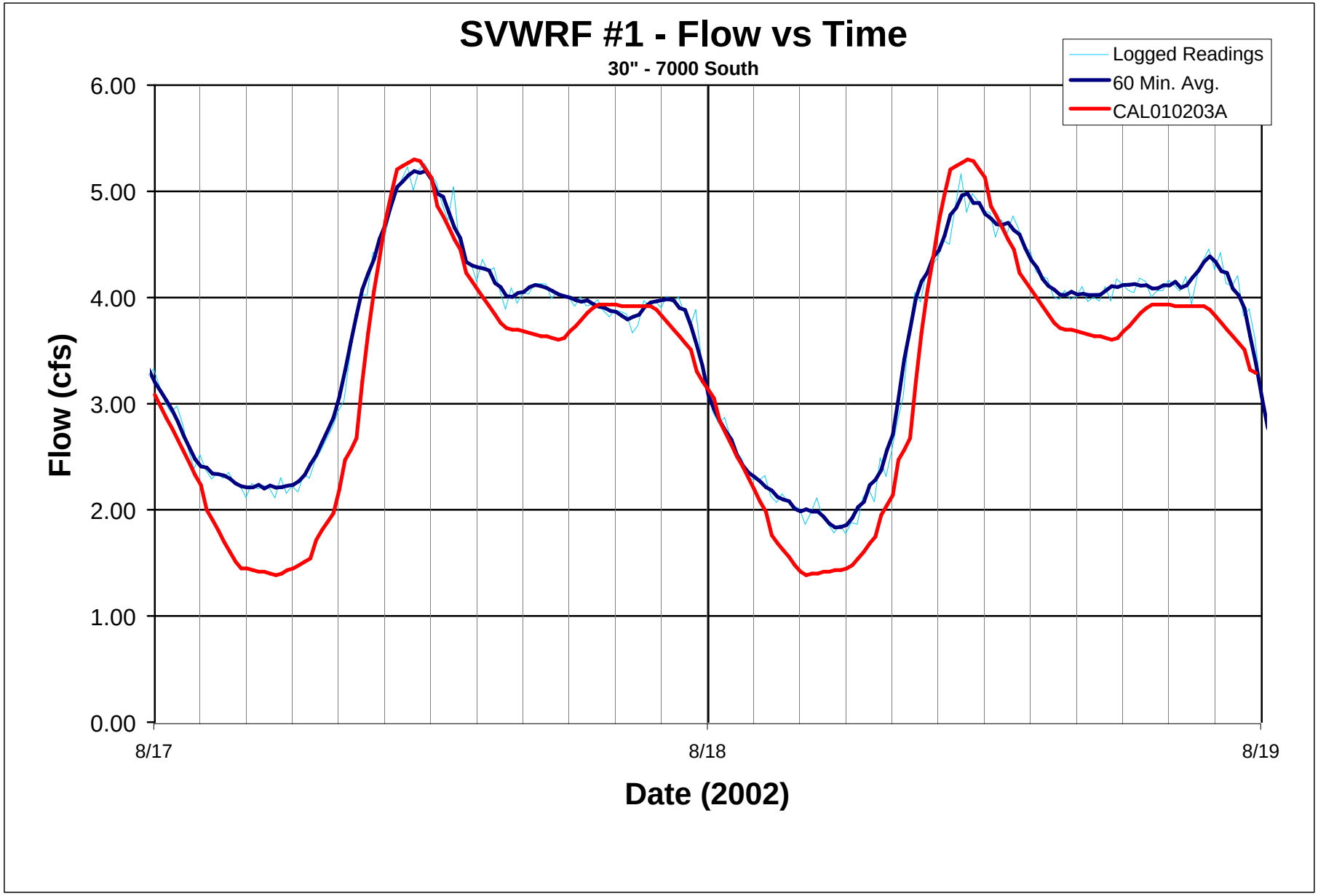
J-U-B #1	7800 South/4200 West
J-U-B #2	7800 South/New Bingham Hwy
J-U-B #3	7200 South/2250 West
J-U-B #4	150 Yards North-East of Sam's Club
SVWRF #1	7000 South
SVWRF #2	8000 South
SVWRF #3	9000 South
SVWRF #4	7800 South

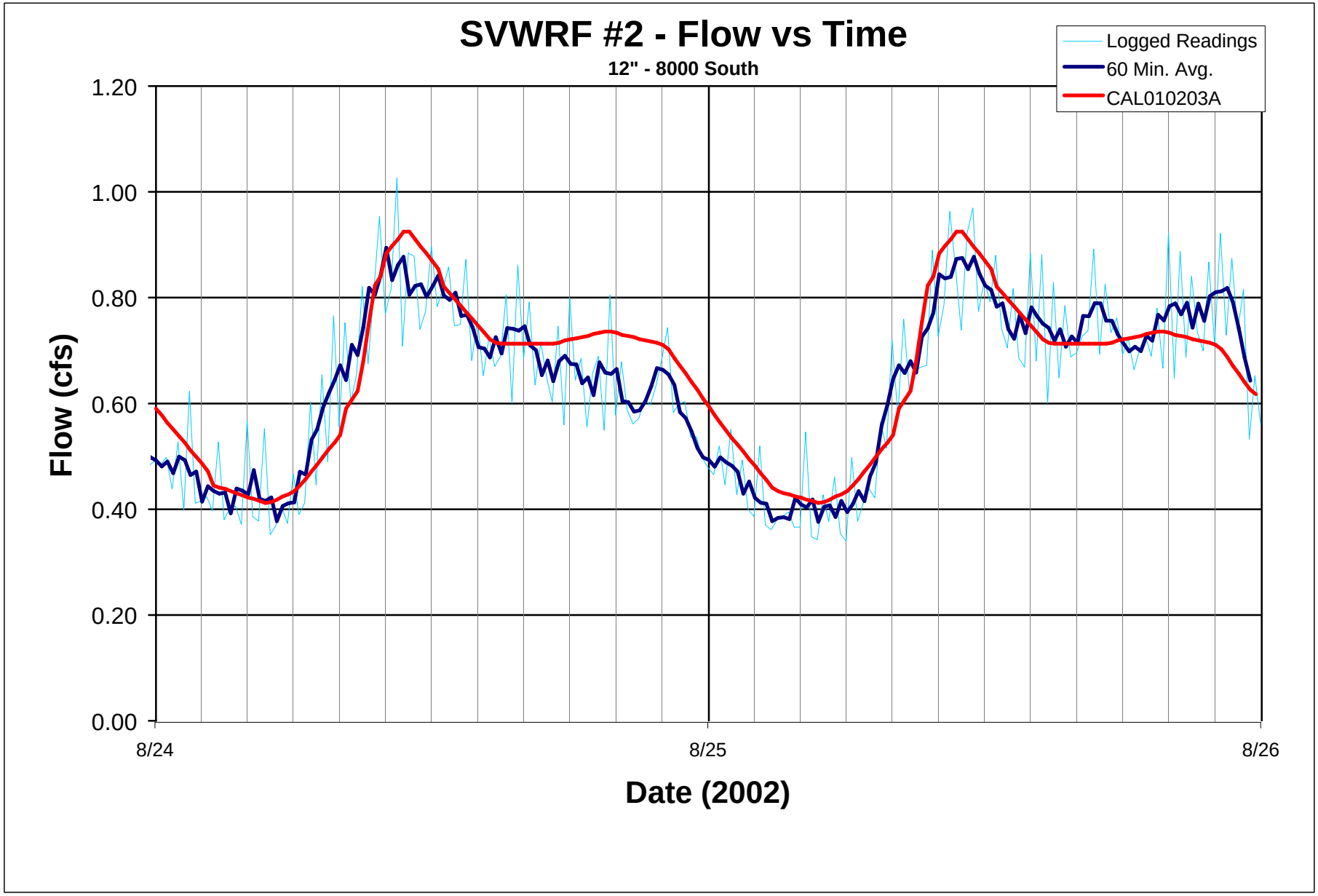

J-U-B #1 - Flow vs Time
24" - 7800 South/4200 West
Logged Readings
60 Min. Avg.
CAL010203A
Flow (cfs)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
8/24
8/25
8/26
Date (2002)

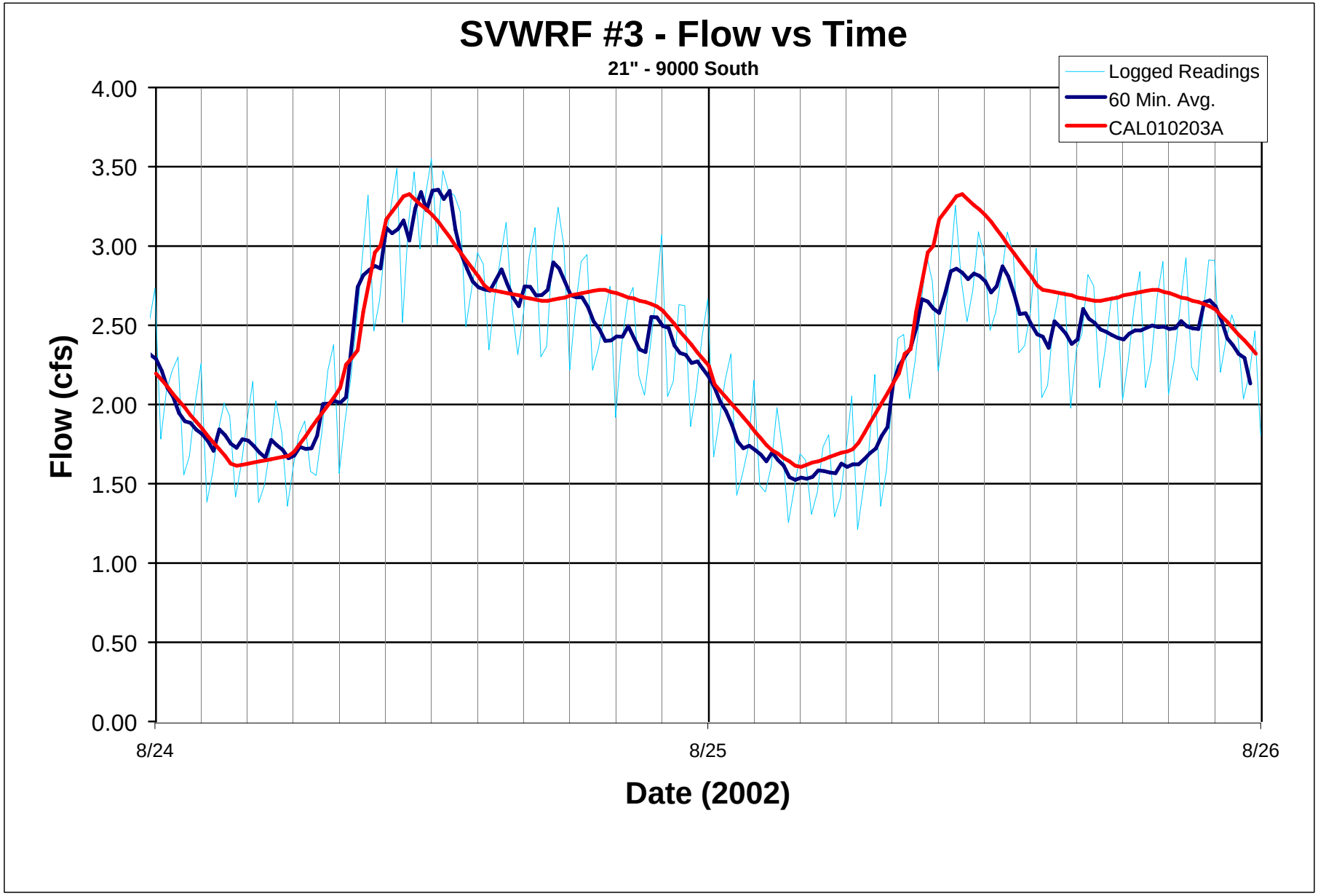

J-U-B #2 - Flow vs Time
24" - 7800 South/New Bingham Hwy
Logged Readings
60 Min. Avg.
CAL010203A
Flow (cfs)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
8/24
8/25
8/26
Date (2002)

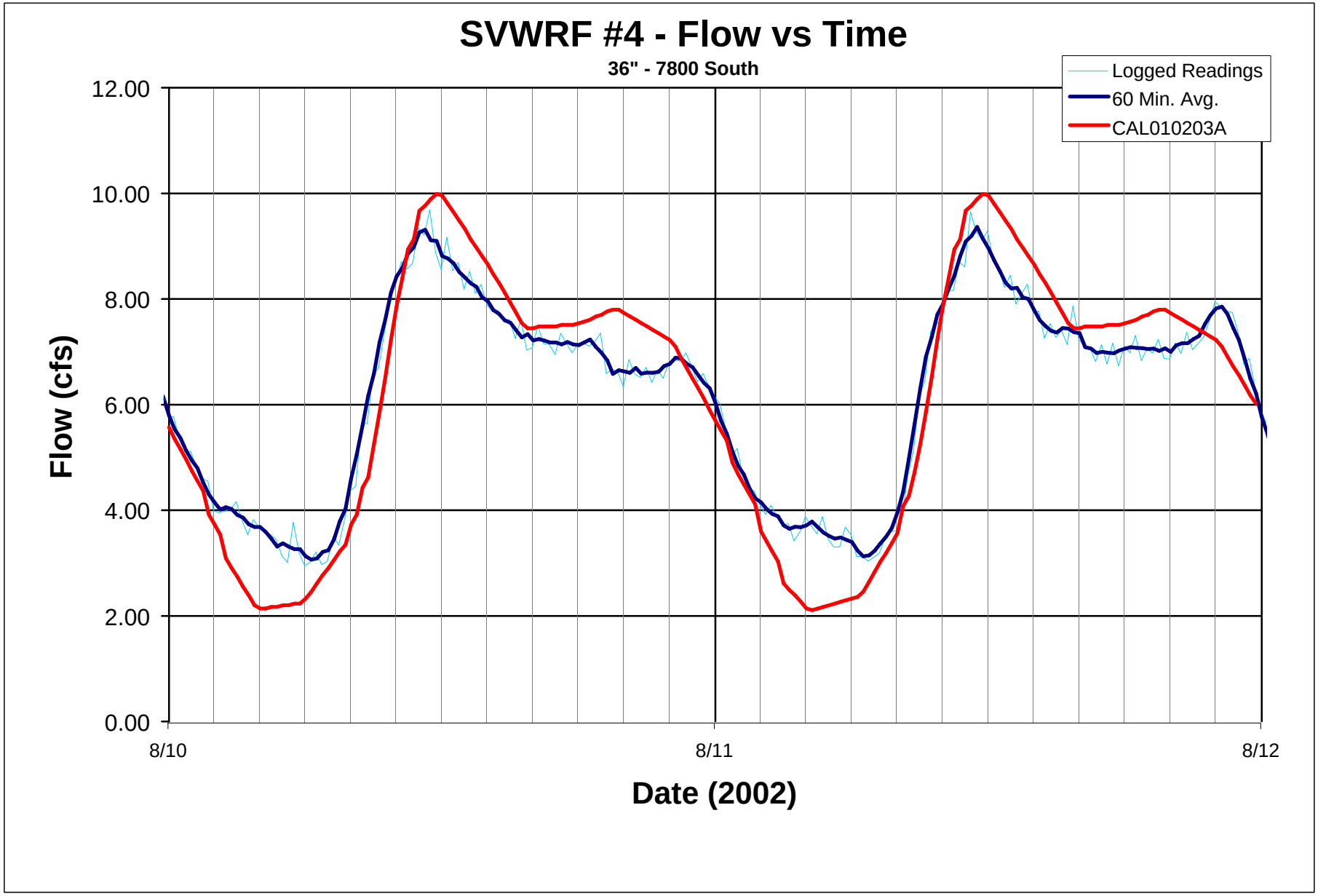

J-U-B #3 - Flow vs Time
8" - 7200 South/2250 West
Logged Readings
60 Min. Avg.
CAL010203FIT
Flow (cfs)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
8/17
8/18
8/19
Date (2002)


J-U-B #4 - Flow vs Time
21" - 150 Yards North-East of Sam's Club
Logged Readings
60 Min. Avg.
CAL010203A
Flow (cfs)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
8/17
8/18
8/19
Date (2002)


SVWRF #1 - Flow vs Time
30" - 7000 South
Logged Readings
60 Min. Avg.
CAL010203A
Flow (cfs)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
8/17
8/18
8/19
Date (2002)


SVWRF #2 - Flow vs Time
12" - 8000 South
Logged Readings
60 Min. Avg.
CAL010203A
Flow (cfs)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
8/24
8/25
8/26
Date (2002)


SVWRF #3 - Flow vs Time
21" - 9000 South
Logged Readings
60 Min. Avg.
CAL010203A
Flow (cfs)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
8/24
8/25
8/26
Date (2002)

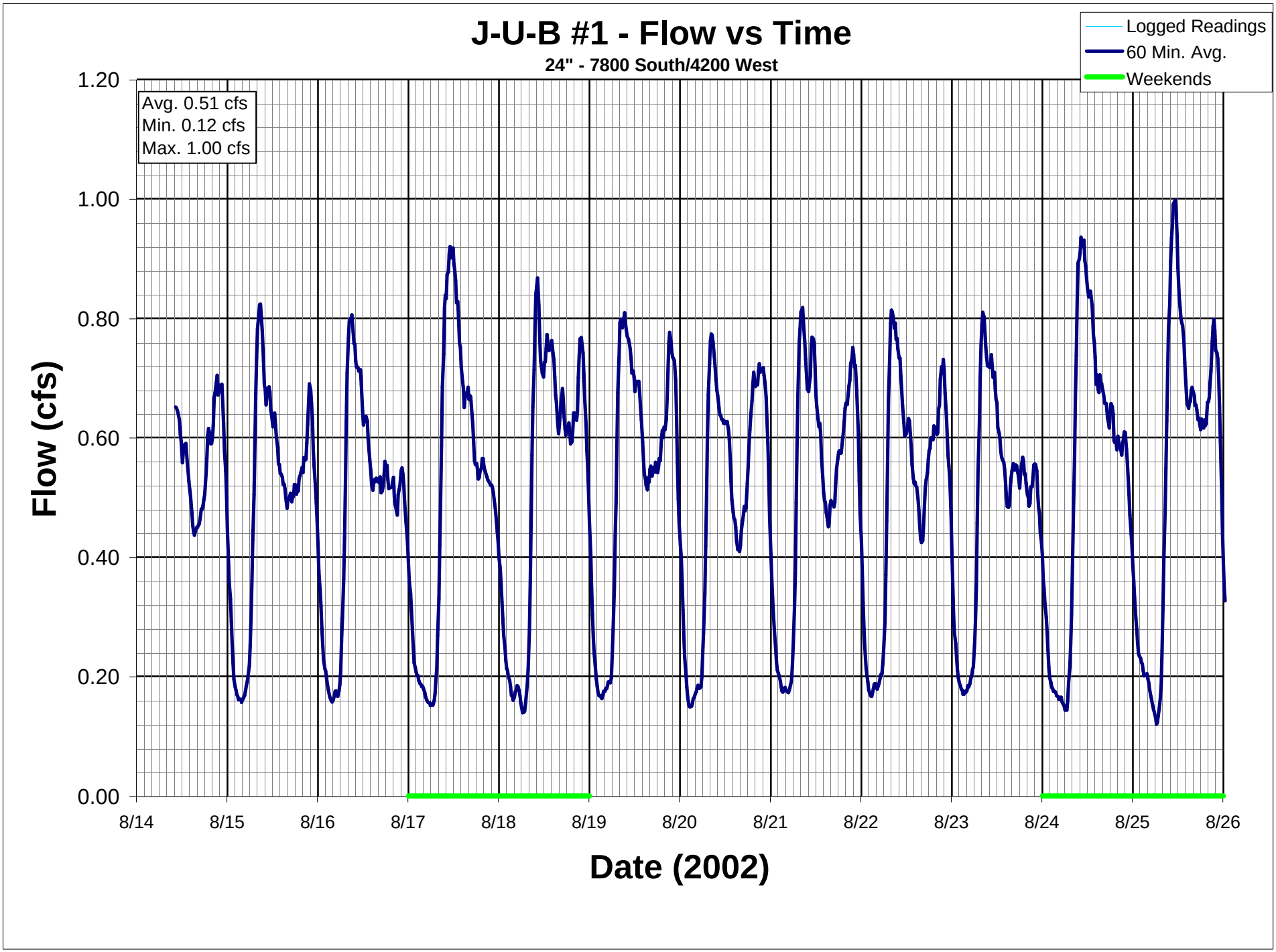

SVWRF #4 - Flow vs Time
36" - 7800 South
Logged Readings
60 Min. Avg.
CAL010203A
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Flow (cfs)
8/10
8/11
8/12
Date (2002)

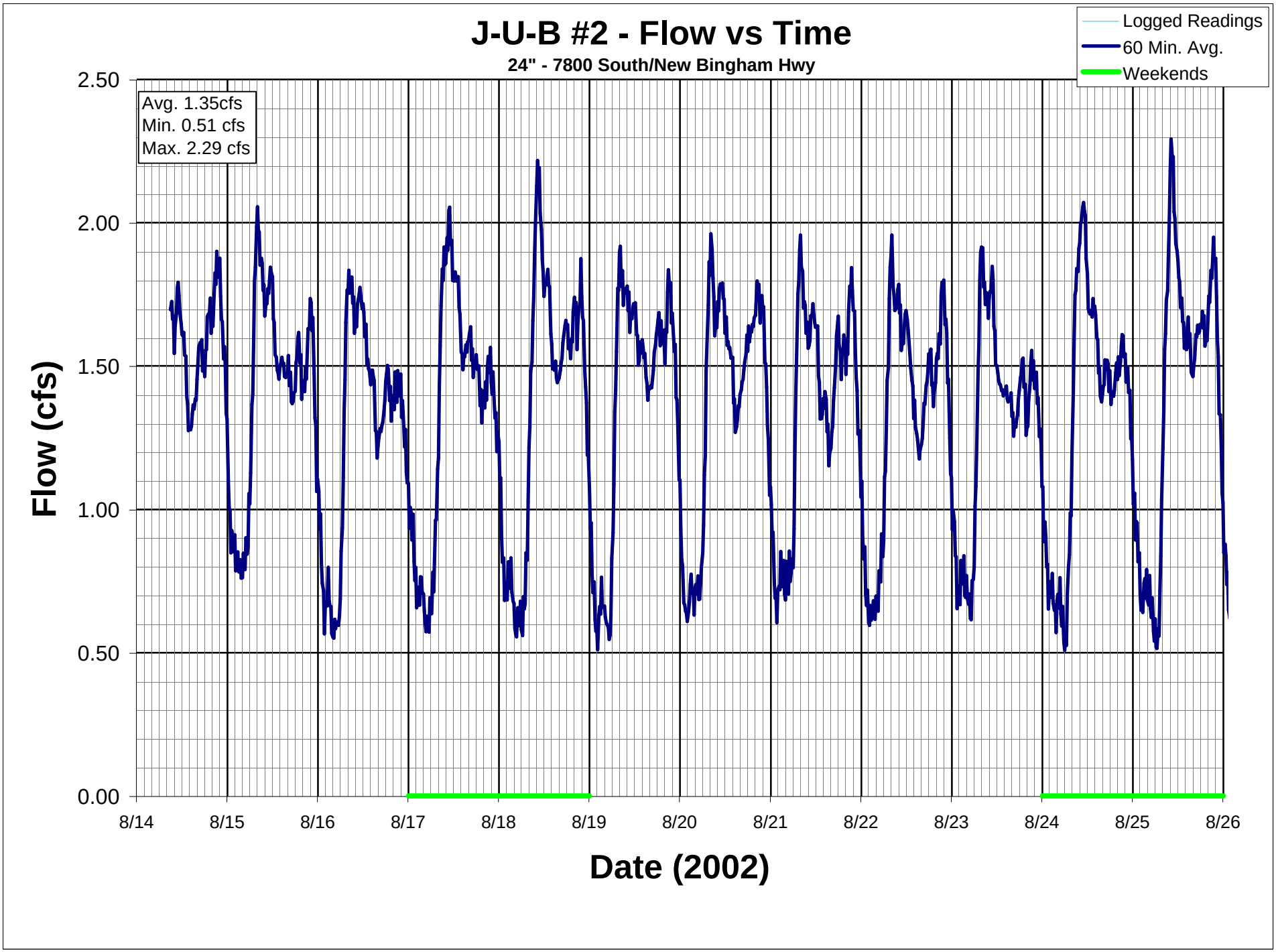
FLOW MONITOR RESULTS

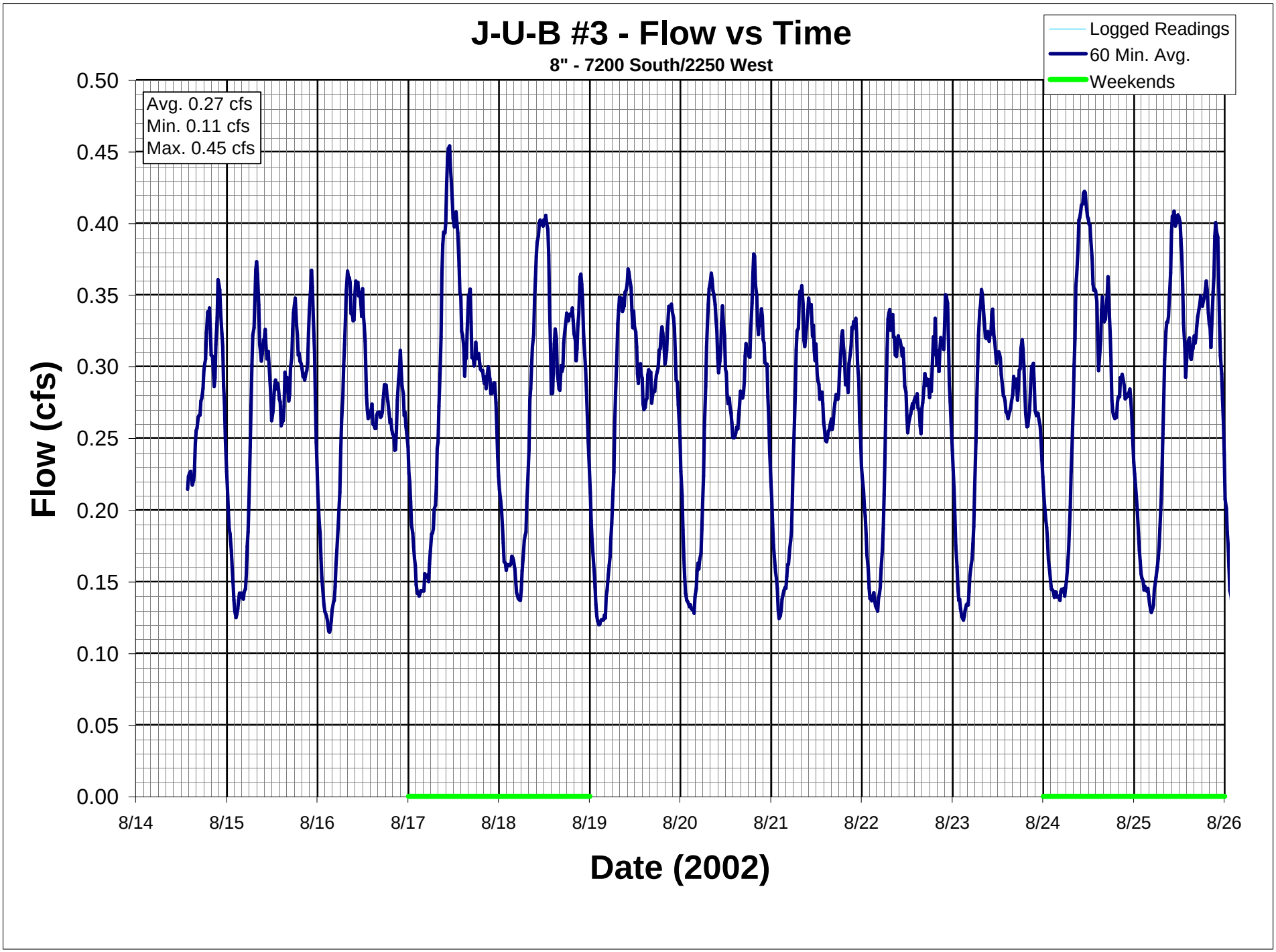
Monitor Periods

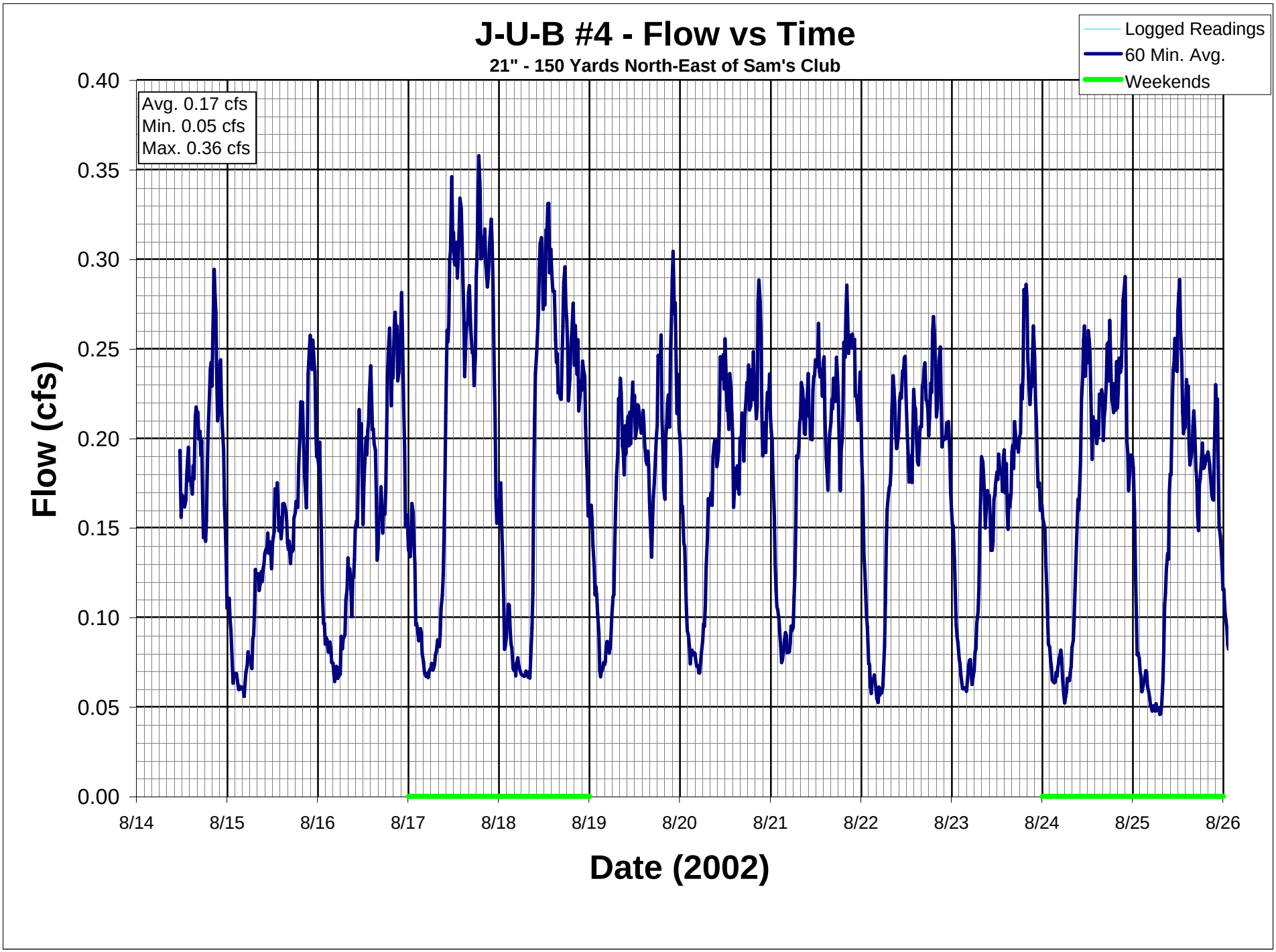
MODEL LOCATIONS

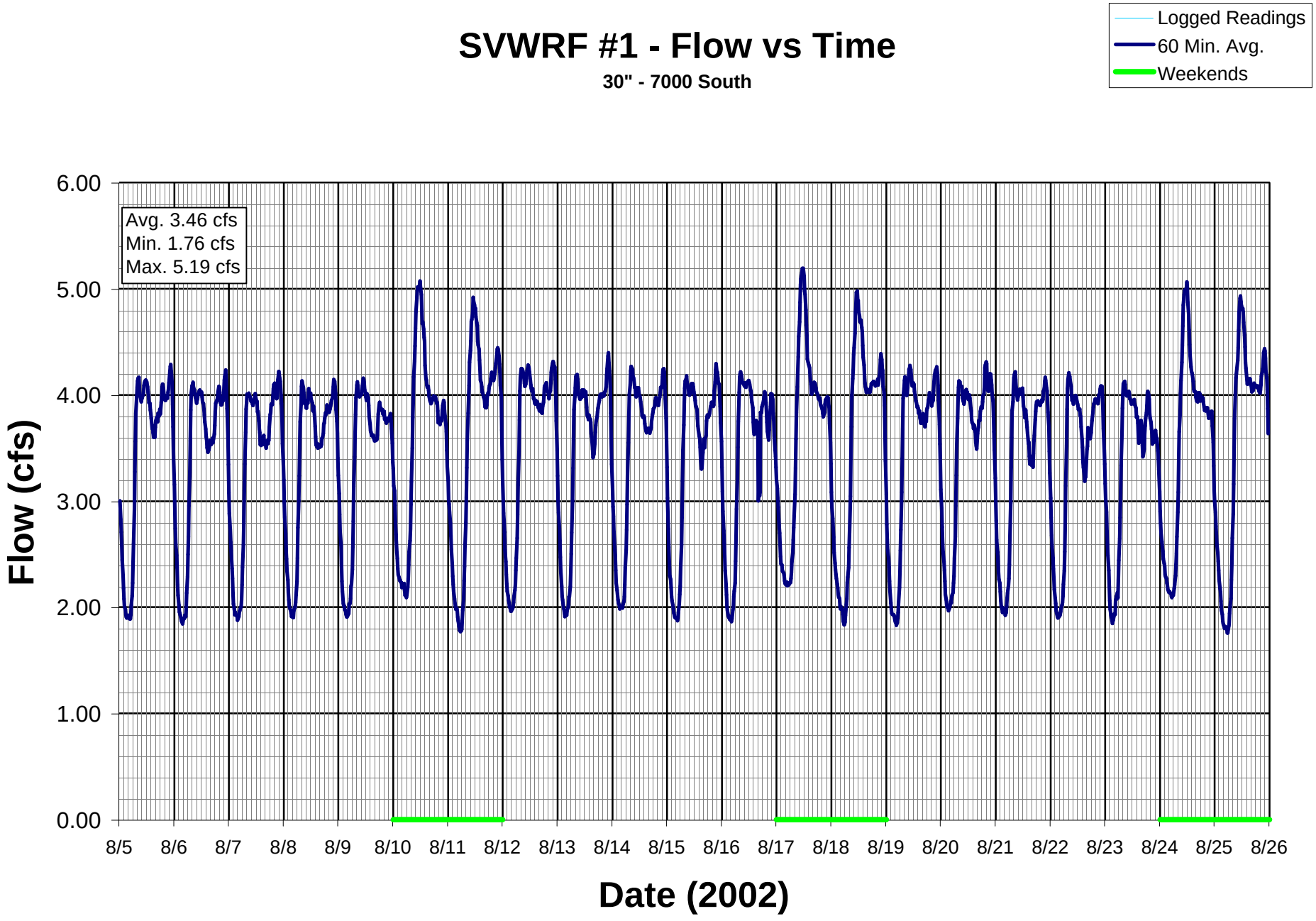
J-U-B #1	7800 South/4200 West
J-U-B #2	7800 South/New Bingham Hwy
J-U-B #3	7200 South/2250 West
J-U-B #4	150 Yards North-East of Sam's Club
SVWRF #1	7000 South
SVWRF #2	8000 South
SVWRF #3	9000 South
SVWRF #4	7800 South

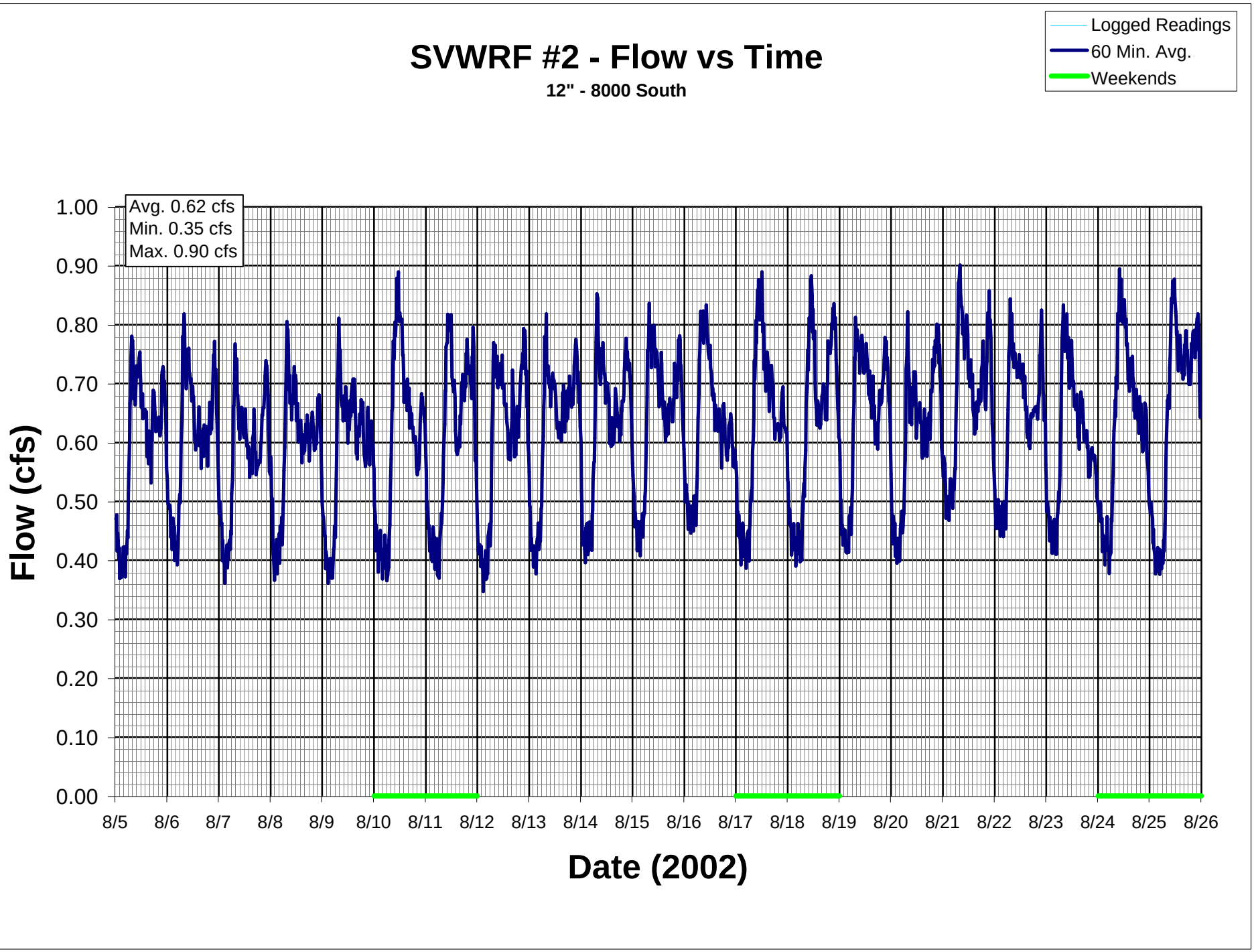

J-U-B #1 - Flow vs Time
24" - 7800 South/4200 West
Logged Readings
60 Min. Avg.
Weekends
Avg. 0.51 cfs
Min. 0.12 cfs
Max. 1.00 cfs
Flow (cfs)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
8/14
8/15
8/16
8/17
8/18
8/19
8/20
8/21
8/22
8/23
8/24
8/25
8/26
Date (2002)

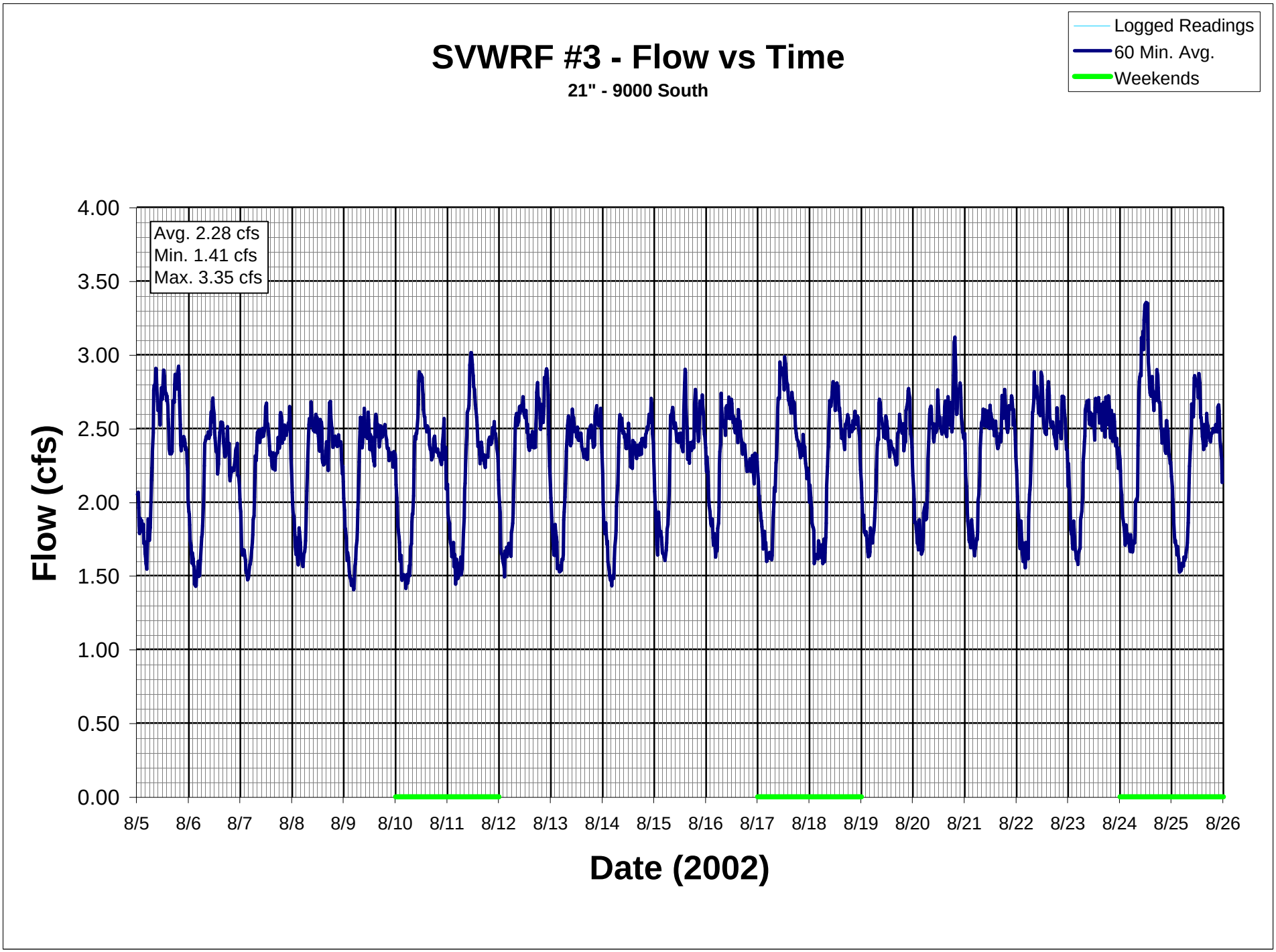

J-U-B #2 - Flow vs Time
24" - 7800 South/New Bingham Hwy
Logged Readings
60 Min. Avg.
Weekends
Avg. 1.35cfs
Min. 0.51 cfs
Max. 2.29 cfs
Flow (cfs)
2.50
2.00
1.50
1.00
0.50
0.00
8/14
8/15
8/16
8/17
8/18
8/19
8/20
8/21
8/22
8/23
8/24
8/25
8/26
Date (2002)

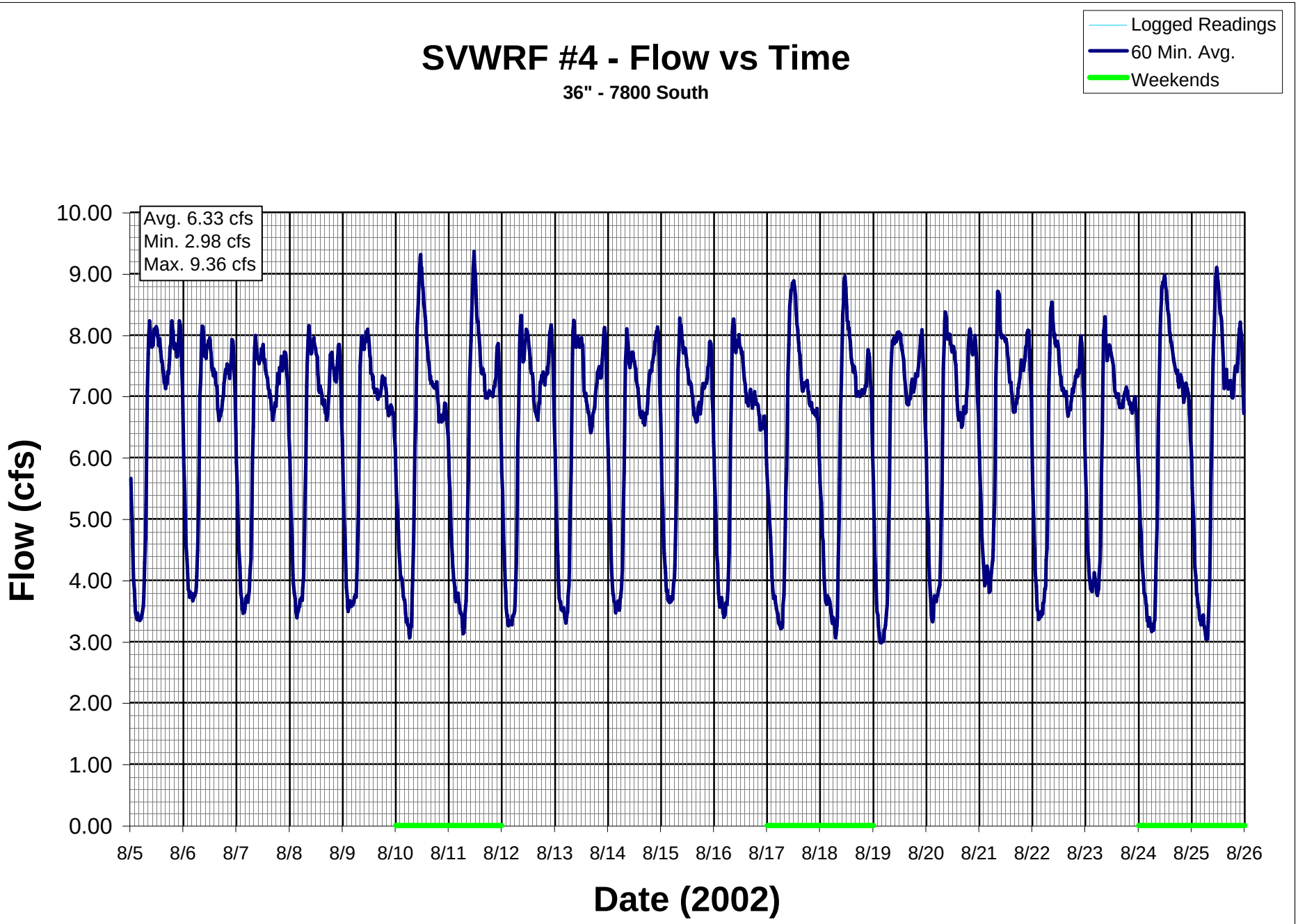

J-U-B #3 - Flow vs Time
8" - 7200 South/2250 West
Logged Readings
60 Min. Avg.
Weekends
Avg. 0.27 cfs
Min. 0.11 cfs
Max. 0.45 cfs
Flow (cfs)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
8/14
8/15
8/16
8/17
8/18
8/19
8/20
8/21
8/22
8/23
8/24
8/25
8/26
Date (2002)


J-U-B #4 - Flow vs Time
21" - 150 Yards North-East of Sam's Club
Logged Readings
60 Min. Avg.
Weekends
Avg. 0.17 cfs
Min. 0.05 cfs
Max. 0.36 cfs
Flow (cfs)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
8/14
8/15
8/16
8/17
8/18
8/19
8/20
8/21
8/22
8/23
8/24
8/25
8/26
Date (2002)


SVWRF #1 - Flow vs Time
30" - 7000 South
Logged Readings
60 Min. Avg.
Weekends
Avg. 3.46 cfs
Min. 1.76 cfs
Max. 5.19 cfs
Flow (cfs)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
8/5
8/6
8/7
8/8
8/9
8/10
8/11
8/12
8/13
8/14
8/15
8/16
8/17
8/18
8/19
8/20
8/21
8/22
8/23
8/24
8/25
8/26
Date (2002)


SVWRF #2 - Flow vs Time
12" - 8000 South
Logged Readings
60 Min. Avg.
Weekends
Avg. 0.62 cfs
Min. 0.35 cfs
Max. 0.90 cfs
Flow (cfs)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
8/5
8/6
8/7
8/8
8/9
8/10
8/11
8/12
8/13
8/14
8/15
8/16
8/17
8/18
8/19
8/20
8/21
8/22
8/23
8/24
8/25
8/26
Date (2002)


SVWRF #3 - Flow vs Time
21" - 9000 South
Logged Readings
60 Min. Avg.
Weekends
Avg. 2.28 cfs
Min. 1.41 cfs
Max. 3.35 cfs
Flow (cfs)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
8/5
8/6
8/7
8/8
8/9
8/10
8/11
8/12
8/13
8/14
8/15
8/16
8/17
8/18
8/19
8/20
8/21
8/22
8/23
8/24
8/25
8/26
Date (2002)


SVWRF #4 - Flow vs Time
36" - 7800 South
Logged Readings
60 Min. Avg.
Weekends
Avg. 6.33 cfs
Min. 2.98 cfs
Max. 9.36 cfs
Flow (cfs)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
8/5
8/6
8/7
8/8
8/9
8/10
8/11
8/12
8/13
8/14
8/15
8/16
8/17
8/18
8/19
8/20
8/21
8/22
8/23
8/24
8/25
8/26
Date (2002)

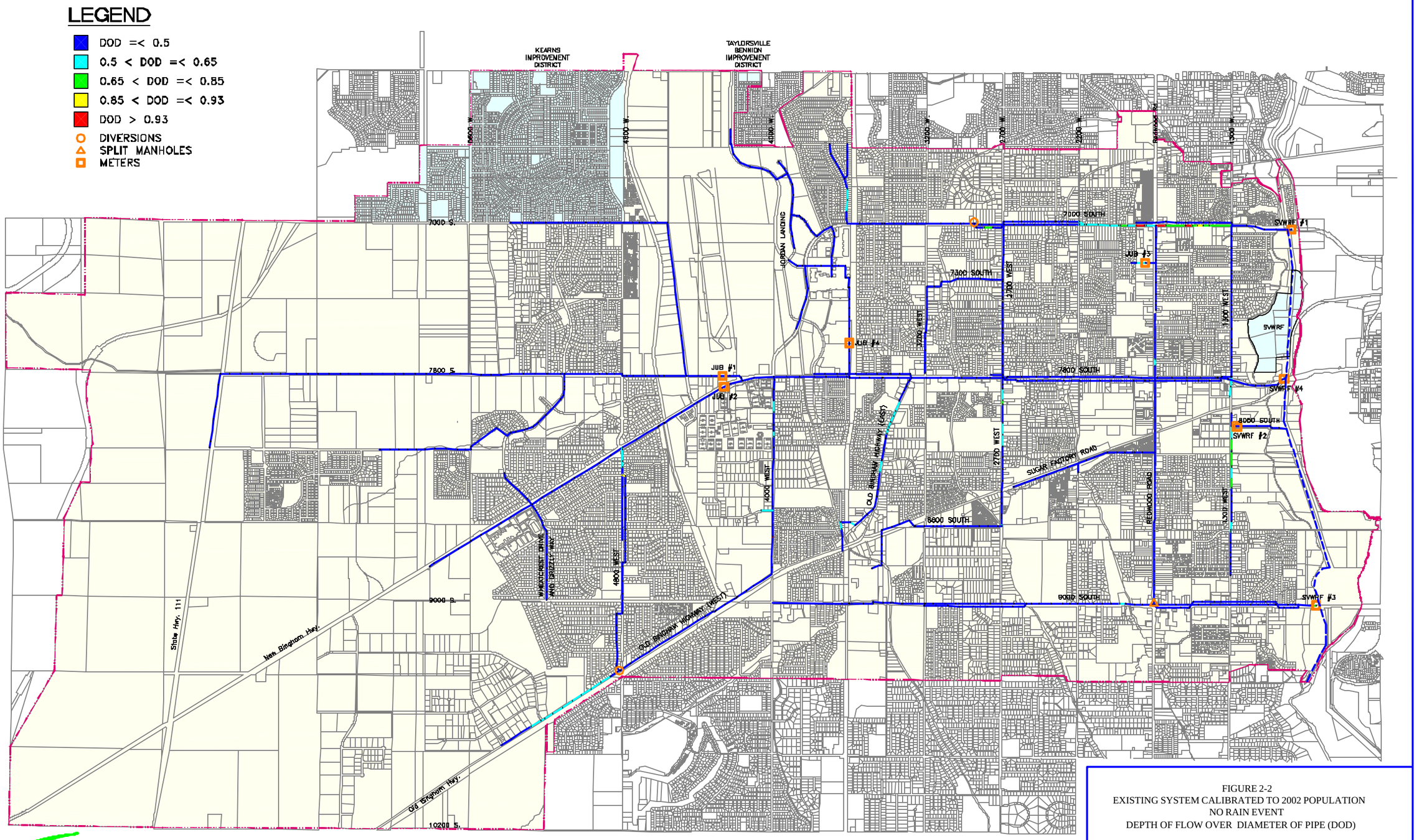


FIGURE 2-2
EXISTING SYSTEM CALIBRATED TO 2002 POPULATION
NO RAIN EVENT
DEPTH OF FLOW OVER DIAMETER OF PIPE (DOD)

West Jordan City

J-U-B
ENGINEERS • SURVEYORS • PLANNERS

West Jordan City Corporation
Public Works Department

Sanitary Sewer Model & Capital Facilities Plan

Appendix B

March 2003
J-U-B Engineers, Inc.

APPENDIX B

Existing System Land Use Database (2002)

FIELD NAME DESCRIPTIONS

FIELD	DESCRIPTION
G_ID	Land Use Identification Number number assigned by Hydra
R_LU_AREA	Total Land Use Area (acres)
R_DENSITY	Residential Density (dwelling units per acre)
R_BO_UNITS	Total Undeveloped residential area (acres)
R_CURRENT_UNITS	Total number of residential active connections
R_PPDU	Number of people per dwelling unit
RES_POP	Total ultimate population in land use
RES_ACTIVE (%)	Percent of the total pop. contributing flow. Used to adjust ultimate pop. to existing pop.
ACTIVE_POP	Population at Model Year
RES_CPC	Flow contribution (gallons per person per day)
C_IMP_AREA (AC)	Total developed Commercial Area (acres)
C_GPAD	Commercial contribution (gallons per acre per day)
COM_VOL	Total ultimate commercial flow (gallons)
COM_ACTIVE (%)	Percent of the total ultimate flow injected. Used to adjust ultimate flow to existing flow

G_ID	R_LU_AREA (ACRES)	R_DENSITY	R_BO_ UNITS	R_CURRENT _UNITS	R_PPDU	RES_POP	RES_ ACTIVE(%)	ACTIVE POP	RES_CPC	C_IMP_AREA (AC)	C_GPAD	COM_VOL	COM_ ACTIVE (%)
1	29.50	18.5	547	453	2.80	1531	83	1268	85	0.00	800	0	0
2	48.55	2.0	99	72	3.30	326	73	238	85	0.00	800	0	0
3	38.53	2.5	94	26	3.30	312	28	86	85	0.00	800	0	0
4	6.86	18.5	127	45	2.80	356	35	126	85	0.00	800	0	0
5	39.36	20.0	787	190	2.80	2204	24	532	85	0.00	800	0	0
6	7.57	2.5	19	2	3.30	62	11	7	85	0.00	800	0	0
7	0.00	0.0	0	0	3.30	1	100	1	85	8.75	850	14825	50
8	0.00	0.0	0	0	3.30	1	100	1	85	3.07	850	2612	100
9	20.17	7.1	143	143	3.30	472	100	472	85	0.00	800	0	0
10	10.05	5.9	59	0	3.30	195	0	0	85	0.00	800	0	0
11	0.00	0.0	0	0	3.30	1	100	1	85	1.21	850	2061	50
12	19.47	18.5	360	338	2.80	1009	94	946	85	0.00	800	0	0
13	0.00	0.0	0	0	3.30	1	100	1	85	45.60	850	48451	80
14	0.00	0.0	0	0	3.30	1	100	1	85	1.97	850	8374	20
15	55.97	3.7	204	172	3.30	674	84	568	85	0.00	800	0	0
16	0.00	0.0	0	0	3.30	1	100	1	85	2.88	850	2450	100
17	41.56	3.1	130	130	3.30	429	100	429	85	0.00	800	0	0
18	3.02	12.0	36	1	3.30	119	3	3	85	0.00	800	0	0
19	0.00	0.0	0	0	3.30	1	100	1	85	10.02	0	0	100
20	110.07	2.5	275	77	3.30	908	28	254	85	0.00	800	0	0
21	0.00	0.0	0	0	3.30	1	100	1	85	7.90	800	43989	14
22	0.00	0.0	0	0	3.30	1	100	1	85	1.83	800	1465	100
23	0.00	0.0	0	0	3.30	1	100	1	85	3.50	800	48276	6
24	18.77	2.5	47	42	3.30	155	90	139	85	0.00	800	0	0
25	22.62	5.9	133	132	3.30	440	99	436	85	0.00	800	0	0
26	31.53	4.6	146	146	3.30	482	100	482	85	0.00	800	0	0
27	1.53	12.0	18	1	3.30	61	5	3	85	0.00	800	0	0
28	0.00	0.0	0	0	3.30	1	100	1	85	2.48	0	0	100
29	3.51	8.0	28	0	3.30	93	0	0	85	0.00	800	0	0
30	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	827	0
31	13.28	5.9	79	62	3.30	260	79	205	85	0.00	800	0	0
32	7.38	4.7	35	0	3.30	115	0	0	85	0.00	800	0	0
33	28.59	2.8	80	34	3.30	264	42	112	85	0.00	800	0	0
34	0.00	0.0	0	0	3.30	1	100	1	85	4.36	800	5366	65
35	7.87	2.0	16	7	3.30	52	44	23	85	0.00	800	0	0
36	21.74	5.4	118	118	3.30	389	100	389	85	0.00	800	0	0
37	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	2102	0
38	9.48	12.0	114	114	3.30	375	100	376	85	0.00	800	0	0
39	0.00	0.0	0	0	3.30	1	100	1	85	10.68	0	0	100
40	26.20	3.0	78	78	3.30	257	100	257	85	0.00	800	0	0
41	3.99	12.0	48	48	3.30	158	100	158	85	0.00	800	0	0
42	7.30	10.3	75	75	3.30	248	100	248	85	0.00	800	0	0
43	0.00	0.0	0	0	3.30	1	100	1	85	2.00	800	4341	37
44	50.27	3.9	195	195	3.30	644	100	644	85	0.00	800	0	0
45	0.00	0.0	0	0	3.30	1	100	1	85	16.46	800	13171	100
46	20.14	21.9	440	440	2.80	1232	100	1232	85	0.00	800	0	0
47	0.00	0.0	0	0	3.30	1	100	1	85	7.03	800	5625	100
48	9.75	12.0	117	4	3.50	409	3	14	85	0.00	800	0	0
49	32.60	3.3	108	108	3.30	356	100	356	85	0.00	800	0	0
50	13.98	4.9	69	63	3.30	226	92	208	85	0.00	800	0	0
51	2.36	12.0	28	2	3.30	94	7	7	85	0.00	800	0	0
52	0.00	0.0	0	0	3.30	1	100	1	85	0.00	500	3916	0
53	183.41	3.1	576	576	3.30	1901	100	1901	85	0.00	800	0	0
54	0.00	0.0	0	0	3.30	1	100	1	85	9.60	0	0	100
55	110.09	2.2	242	218	3.30	799	90	719	85	0.00	800	0	0
56	0.00	0.0	0	0	3.30	1	100	1	85	1.00	800	8148	10
57	0.00	0.0	0	0	3.30	1	100	1	85	49.76	800	44632	89
58	27.96	2.6	73	59	3.30	240	81	195	85	0.00	800	0	0
59	76.66	2.6	199	184	3.30	658	92	607	85	0.00	800	0	0
60	160.16	1.9	304	291	3.30	1004	96	960	85	0.00	800	0	0
61	20.39	12.0	245	96	3.30	807	39	317	85	0.00	800	0	0
62	0.00	0.0	0	0	3.30	1	100	1	85	0.00	0	0	0
63	69.88	2.8	196	179	3.30	646	91	591	85	0.00	800	0	0
64	41.41	3.2	134	134	3.30	442	100	442	85	0.00	800	0	0
65	0.00	0.0	0	0	3.30	1	100	1	85	38.86	800	31087	100
66	11.19	6.1	68	68	3.30	224	100	224	85	0.00	800	0	0
67	56.99	3.2	183	183	3.30	604	100	604	85	0.00	800	0	0
68	3.66	2.8	10	3	3.30	34	29	10	85	0.00	800	0	0
69	0.00	0.0	0	0	3.30	1	100	1	85	6.82	800	5454	100
70	10.72	15.4	165	160	3.30	545	97	528	85	0.00	800	0	0
71	0.00	0.0	0	0	3.30	1	100	1	85	6.62	400	2649	100
72	0.00	0.0	0	0	3.30	1	100	1	85	32.44	0	0	100
73	119.95	3.1	367	367	3.30	1211	100	1211	85	0.00	800	0	0
74	0.00	0.0	0	0	3.30	1	100	1	85	4.62	800	3698	100
75	4.58	1.7	8	8	3.30	26	100	26	85	0.00	800	0	0
76	0.00	0.0	0	0	3.30	1	100	1	85	2.70	800	2159	100
77	32.60	3.8	124	124	3.30	409	100	409	85	0.00	800	0	0
78	0.00	0.0	0	0	3.30	1	100	1	85	8.03	800	6427	100

G_ID	R_LU_AREA (ACRES)	R_DENSITY	R_BO_ UNITS	R_CURRENT _UNITS	R_PPDU	RES_POP	RES_ ACTIVE(%)	ACTIVE POP	RES_CPC	C_IMP_AREA (AC)	C_GPAD	COM_VOL	COM_ ACTIVE (%)
79	0.00	0.0	0	0	3.30	1	100	1	85	15.79	800	12631	100
80	0.00	0.0	0	0	3.30	1	100	1	85	92.18	800	73744	100
81	27.54	5.7	158	158	3.30	522	100	521	85	0.00	800	0	0
82	0.00	0.0	0	0	3.30	1	100	1	85	2.31	800	3083	60
83	17.29	4.7	82	82	3.30	271	100	271	85	0.00	800	0	0
84	0.00	0.0	0	0	3.30	1	100	1	85	35.00	800	28001	100
85	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	5648	0
86	25.01	3.1	78	78	3.30	257	100	257	85	0.00	800	0	0
87	85.76	2.8	242	215	3.30	798	89	710	85	0.00	800	0	0
88	0.00	0.0	0	0	3.30	1	100	1	85	1.50	800	2801	43
89	0.00	0.0	0	0	3.30	1	100	1	85	0.50	800	1795	22
90	70.67	2.5	177	167	3.30	583	95	551	85	0.00	800	0	0
91	18.33	6.3	115	64	3.30	381	55	211	85	0.00	800	0	0
92	6.85	3.6	25	25	3.30	83	100	83	85	0.00	800	0	0
93	17.32	7.4	128	128	3.30	422	100	422	85	0.00	800	0	0
94	11.58	12.0	139	10	3.30	459	7	33	85	0.00	800	0	0
95	0.00	0.0	0	0	3.30	1	100	1	85	46.39	850	43810	90
96	4.94	2.4	12	1	3.30	40	8	3	85	0.00	800	0	0
97	18.55	12.0	223	0	3.30	735	0	0	85	0.00	800	0	0
98	0.00	0.0	0	0	3.30	1	100	1	85	19.64	850	16692	100
99	4.99	25.2	126	126	3.30	415	100	416	85	0.00	800	0	0
100	52.45	2.0	105	51	3.30	346	49	168	85	0.00	800	0	0
101	0.00	0.0	0	0	3.30	1	100	1	85	8.50	850	8419	86
102	26.39	1.2	32	23	3.30	105	73	76	85	0.00	800	0	0
103	0.00	0.0	0	0	3.30	1	100	1	85	2.18	850	1856	100
104	0.00	0.0	0	0	3.30	1	100	1	85	27.46	800	21970	100
105	11.45	12.0	137	0	3.30	454	0	0	85	0.00	800	0	0
106	34.97	2.7	93	60	3.30	306	65	198	85	0.00	800	0	0
107	9.25	12.0	111	1	3.30	366	1	3	85	0.00	800	0	0
108	16.37	1.4	23	23	3.30	76	100	76	85	0.00	800	0	0
109	10.79	1.4	15	15	3.30	50	100	50	85	0.00	800	0	0
110	19.70	12.0	236	0	3.30	780	0	0	85	0.00	800	0	0
111	0.00	0.0	0	0	3.30	1	100	1	85	3.10	850	9844	27
112	85.19	1.9	162	162	3.30	534	100	535	85	0.00	800	0	0
113	7.81	1.5	12	12	3.30	40	100	40	85	0.00	800	0	0
114	26.22	1.5	38	38	3.30	125	100	125	85	0.00	800	0	0
115	39.77	1.6	63	63	3.30	207	100	208	85	0.00	800	0	0
116	0.00	0.0	0	0	3.30	1	100	1	85	7.65	850	6504	100
117	72.31	3.2	228	228	3.30	752	100	752	85	0.00	800	0	0
118	0.00	0.0	0	0	3.30	1	100	1	85	0.00	400	3453	0
119	31.52	2.3	74	45	3.30	243	61	149	85	0.00	800	0	0
120	65.47	2.5	164	117	3.30	540	71	386	85	0.00	800	0	0
121	0.00	0.0	0	0	3.30	1	100	1	85	6.48	850	5507	100
122	0.00	0.0	0	0	3.30	1	100	1	85	3.01	800	2409	100
123	9.56	6.0	57	57	3.30	189	99	188	85	0.00	800	0	0
124	0.00	0.0	0	0	3.30	1	100	1	85	3.50	800	2799	100
125	60.82	2.5	152	45	3.30	502	30	149	85	0.00	800	0	0
126	97.55	2.5	244	70	3.30	805	29	231	85	0.00	800	0	0
127	28.73	2.7	78	75	3.30	256	97	248	85	0.00	800	0	0
128	7.93	12.5	99	60	3.30	327	61	198	85	0.00	800	0	0
129	4.63	12.0	56	0	3.30	183	0	0	85	0.00	800	0	0
130	0.00	0.0	0	0	3.30	1	100	1	85	19.00	800	30956	49
131	15.46	1.7	26	26	3.30	86	100	86	85	0.00	800	0	0
132	0.00	0.0	0	0	3.30	1	100	1	85	1.77	800	1415	100
133	8.74	3.3	29	29	3.30	96	100	96	85	0.00	800	0	0
134	2.90	6.0	17	6	3.30	57	35	20	85	0.00	800	0	0
135	16.80	12.0	202	70	3.30	665	35	231	85	0.00	800	0	0
136	103.01	3.4	350	203	3.30	1156	58	670	85	0.00	800	0	0
137	0.00	0.0	0	0	3.30	1	100	1	85	1.00	800	3655	22
138	5.40	18.0	97	0	3.30	321	0	0	85	0.00	800	0	0
139	0.00	0.0	0	0	3.30	1	100	1	85	22.00	800	24846	71
140	4.38	12.0	53	53	3.30	173	100	173	85	0.00	800	0	0
141	0.00	0.0	0	0	3.30	1	100	1	85	1.11	800	886	100
142	20.08	1.0	20	13	3.30	66	65	43	85	0.00	800	0	0
143	0.00	0.0	0	0	3.30	1	100	1	85	0.85	800	677	100
144	15.90	2.5	40	35	3.30	131	88	116	85	0.00	800	0	0
145	37.33	5.4	202	192	3.30	665	95	634	85	0.00	800	0	0
146	0.00	0.0	0	0	3.30	1	100	1	85	15.28	0	0	100
147	26.18	6.9	180	180	3.30	594	100	594	85	0.00	800	0	0
148	36.74	2.3	86	43	3.30	282	50	142	85	0.00	800	0	0
149	24.58	4.6	113	113	3.30	373	100	373	85	0.00	800	0	0
150	97.13	2.2	214	203	3.30	705	95	670	85	0.00	800	0	0
151	27.88	0.6	15	15	3.30	51	98	50	85	0.00	800	0	0
152	10.67	18.0	192	42	3.30	634	22	139	85	0.00	800	0	0
153	0.00	0.0	0	0	3.30	1	100	1	85	3.25	800	5246	50
154	0.00	0.0	0	0	3.30	1	100	1	85	62.89	9304	585112	100
155	0.00	0.0	0	0	3.30	1	100	1	85	20.00	800	22361	72
156	34.50	6.1	211	211	3.30	696	100	696	85	0.00	800	0	0

G_ID	R_LU_AREA (ACRES)	R_DENSITY	R_BO_ UNITS	R_CURRENT _UNITS	R_PPDU	RES_POP	RES_ ACTIVE(%)	ACTIVE POP	RES_CPC	C_IMP_AREA (AC)	C_GPAD	COM_VOL	COM_ ACTIVE (%)
157	187.88	2.7	498	419	3.30	1643	84	1383	85	0.00	800	0	0
158	0.00	0.0	0	0	3.30	1	100	1	85	72.06	0	0	100
159	61.60	4.8	296	281	3.30	976	95	927	85	0.00	800	0	0
160	0.00	0.0	0	0	3.30	1	100	1	85	3.79	800	3032	100
161	0.00	0.0	0	0	3.30	1	100	1	85	35.00	800	44774	63
162	20.61	2.5	51	51	3.30	168	100	168	85	0.00	800	0	0
163	0.00	0.0	0	0	3.30	1	100	1	85	5.00	800	5655	71
164	5.96	7.6	45	45	3.30	149	100	149	85	0.00	800	0	0
165	0.00	0.0	0	0	3.30	1	100	1	85	13.38	400	5354	100
166	0.00	0.0	0	0	3.30	1	100	1	85	2.03	800	1620	100
167	124.73	3.1	386	386	3.30	1273	100	1274	85	0.00	800	0	0
168	120.53	2.6	307	308	3.30	1014	100	1016	85	0.00	800	0	0
169	73.35	1.5	110	110	3.30	363	100	363	85	0.00	800	0	0
170	52.25	2.2	115	112	3.30	379	97	370	85	0.00	800	0	0
171	0.00	0.0	0	0	3.30	1	100	1	85	10.38	0	0	100
172	112.12	2.3	258	258	3.30	851	100	851	85	0.00	800	0	0
173	0.00	0.0	0	0	3.30	1	100	1	85	10.44	0	0	100
174	30.35	1.8	54	54	3.30	178	100	178	85	0.00	800	0	0
175	71.63	1.4	100	96	3.30	331	96	317	85	0.00	800	0	0
176	143.03	1.9	266	266	3.30	878	100	878	85	0.00	800	0	0
177	14.12	0.8	11	9	3.30	37	80	30	85	0.00	800	0	0
178	0.00	0.0	0	0	3.30	1	100	1	85	50.00	850	72898	58
179	24.57	6.5	160	0	3.30	527	0	0	85	0.00	800	0	0
180	95.30	2.4	231	231	3.30	761	100	762	85	0.00	800	0	0
181	20.81	6.5	135	0	3.30	446	0	0	85	0.00	800	0	0
182	0.00	0.0	0	0	3.30	1	100	1	85	0.00	850	2129	0
183	0.00	0.0	0	0	3.30	1	100	1	85	11.00	850	13688	68
184	0.00	0.0	0	0	3.30	1	100	1	85	30.00	2090	102973	61
185	6.39	12.0	77	0	3.30	253	0	0	85	0.00	800	0	0
186	0.00	0.0	0	0	3.30	1	100	1	85	12.00	800	14967	64
187	0.00	0.0	0	0	3.30	1	100	1	85	8.50	800	16538	41
188	53.27	3.0	160	160	3.30	527	100	528	85	0.00	800	0	0
189	0.00	0.0	0	0	3.30	1	100	1	85	24.00	800	32310	59
190	56.38	3.6	200	200	3.30	660	100	660	85	0.00	800	0	0
191	0.00	0.0	0	0	3.30	1	100	1	85	12.00	800	23865	40
192	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	2173	0
193	9.73	6.1	59	59	3.30	195	100	195	85	0.00	800	0	0
194	33.69	4.2	143	143	3.30	471	100	472	85	0.00	800	0	0
195	0.00	0.0	0	0	3.30	1	100	1	85	2.02	800	1613	100
196	0.00	0.0	0	0	3.30	1	100	1	85	13.50	800	12691	85
197	0.00	0.0	0	0	3.30	1	100	1	85	0.00	0	0	0
198	44.71	5.4	239	239	3.30	789	100	789	85	0.00	800	0	0
199	117.49	1.1	130	128	3.30	430	98	422	85	0.00	800	0	0
200	50.82	2.8	143	143	3.30	471	100	472	85	0.00	800	0	0
201	11.85	3.0	36	36	3.30	119	100	119	85	0.00	800	0	0
202	21.86	16.5	360	360	2.50	899	100	900	85	0.00	800	0	0
203	20.75	3.9	80	80	3.30	264	100	264	85	0.00	800	0	0
204	0.00	0.0	0	0	3.30	1	100	1	85	0.00	0	0	0
205	38.33	4.4	167	167	3.30	551	100	551	85	0.00	800	0	0
206	2.97	2.5	7	4	3.30	24	54	13	85	0.00	800	0	0
207	17.83	1.6	29	29	3.30	96	100	96	85	0.00	800	0	0
208	62.89	2.5	157	157	3.30	519	100	518	85	0.00	800	0	0
209	0.00	0.0	0	0	3.30	1	100	1	85	11.92	800	9535	100
210	28.67	18.0	516	0	3.30	1703	0	0	85	0.00	800	0	0
211	0.00	0.0	0	0	3.30	1	100	1	85	40.00	800	63647	50
212	0.00	0.0	0	0	3.30	1	100	1	85	16.00	800	15967	80
213	51.32	2.2	111	111	3.30	366	100	366	85	0.00	800	0	0
214	103.08	3.4	350	350	3.30	1157	100	1155	85	0.00	800	0	0
215	108.64	4.0	429	429	3.30	1416	100	1416	85	0.00	800	0	0
216	3.36	5.7	19	19	3.30	63	100	63	85	0.00	800	0	0
217	63.35	3.7	234	235	3.30	773	100	776	85	0.00	800	0	0
218	0.00	0.0	0	0	3.30	1	100	1	85	19.60	800	19603	80
219	8.16	12.0	98	98	3.30	323	100	323	85	0.00	800	0	0
220	13.58	1.6	22	22	3.30	73	100	73	85	0.00	800	0	0
221	78.71	2.5	196	196	3.30	647	100	647	85	0.00	800	0	0
222	99.63	2.7	268	268	3.30	884	100	884	85	0.00	800	0	0
223	0.00	0.0	0	0	3.30	1	100	1	85	0.00	0	0	0
224	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	19558	0
225	0.00	0.0	0	0	3.30	1	100	1	85	14.80	800	73078	16
226	12.18	1.5	18	18	3.30	60	100	59	85	0.00	800	0	0
227	2.68	4.5	12	0	3.30	40	0	0	85	0.00	800	0	0
228	15.23	7.0	106	106	3.30	350	100	350	85	0.00	800	0	0
229	82.70	2.3	190	170	3.30	628	89	561	85	0.00	800	0	0
230	162.81	2.5	402	112	3.30	1327	28	370	85	0.00	800	0	0
231	10.66	3.0	32	0	3.30	106	0	0	85	0.00	800	0	0
232	0.00	0.0	0	0	3.30	1	100	1	85	61.09	1230	75146	100
233	0.00	0.0	0	0	3.30	1	100	1	85	204.16	800	163328	100
234	0.00	0.0	0	0	3.30	1	100	1	85	0.00	700	106846	0

G_ID	R_LU_AREA (ACRES)	R_DENSITY	R_BO_ UNITS	R_CURRENT _UNITS	R_PPDU	RES_POP	RES_ ACTIVE(%)	ACTIVE POP	RES_CPC	C_IMP_AREA (AC)	C_GPAD	COM_VOL	COM_ ACTIVE (%)
235	0.00	0.0	0	0	3.30	1	100	1	85	417.00	800	677977	49
236	0.00	0.0	0	0	3.30	1	100	1	85	73.45	400	29380	100
237	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	7240	0
238	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	14464	0
239	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	85178	0
240	17.91	12.0	215	0	3.30	709	0	0	85	0.00	800	0	0
241	19.25	3.1	60	0	3.30	197	0	0	85	0.00	800	0	0
242	0.00	0.0	0	0	3.30	1	100	1	85	0.00	0	0	0
243	60.19	2.8	171	171	3.30	564	100	564	85	0.00	800	0	0
244	0.00	0.0	0	0	3.30	1	100	1	85	16.85	0	0	100
245	33.92	2.5	83	83	3.30	274	100	274	85	0.00	800	0	0
246	92.50	3.0	276	276	3.30	910	100	911	85	0.00	800	0	0
247	139.27	2.7	377	378	3.30	1245	100	1247	85	0.00	800	0	0
248	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	10823	0
249	183.44	2.5	462	418	3.30	1525	90	1379	85	0.00	800	0	0
250	0.00	0.0	0	0	3.30	1	100	1	85	43.00	800	53788	64
251	0.00	0.0	0	0	3.30	1	100	1	85	82.00	800	78466	84
252	0.00	0.0	0	0	3.30	1	100	1	85	36.00	800	43947	66
253	95.35	2.7	253	253	3.30	834	100	835	85	0.00	800	0	0
254	25.78	3.0	76	76	3.30	251	100	251	85	0.00	800	0	0
255	0.00	0.0	0	0	3.30	1	100	1	85	10.29	800	8232	100
256	0.00	0.0	0	0	3.30	1	100	1	85	4.80	800	5635	68
257	0.00	0.0	0	0	3.30	1	100	1	85	1.75	200	350	100
258	0.00	0.0	0	0	3.30	1	100	1	85	3.00	800	57181	4
259	25.96	12.0	312	0	3.30	1028	0	0	85	0.00	800	0	0
260	54.50	12.0	654	430	2.00	1308	66	860	85	0.00	800	0	0
261	0.00	0.0	0	0	3.30	1	100	1	85	34.00	800	304762	9
262	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	202459	0
263	0.00	0.0	0	0	3.30	1	100	1	85	3.70	800	28720	10
264	0.00	0.0	0	0	3.30	1	100	1	85	20.00	400	16311	49
265	0.00	0.0	0	0	3.30	1	100	1	85	16.00	400	18720	34
266	63.60	1.9	118	98	3.30	388	83	323	85	0.00	800	0	0
267	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	6036	0
268	76.30	1.9	147	81	3.30	486	55	267	85	0.00	800	0	0
269	0.00	0.0	0	0	3.30	1	100	1	85	3.07	0	0	100
270	21.85	2.2	47	47	3.10	146	100	146	85	0.00	800	0	0
271	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	16351	0
272	17.96	2.5	45	0	3.10	139	0	0	85	0.00	800	0	0
273	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	12707	0
274	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	7773	0
275	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	10461	0
276	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	18430	0
277	30.65	7.2	219	177	3.10	679	81	549	85	0.00	800	0	0
278	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	3568	0
279	23.49	5.3	123	123	3.10	382	100	381	85	0.00	800	0	0
280	0.00	0.0	0	0	3.30	1	100	1	85	1.96	800	1567	100
281	84.09	2.9	241	241	3.10	748	100	747	85	0.00	800	0	0
282	101.61	2.8	286	272	3.10	885	95	843	85	0.00	800	0	0
283	21.99	2.0	44	41	3.10	136	93	127	85	0.00	800	0	0
284	27.56	2.7	73	73	3.10	226	100	226	85	0.00	800	0	0
285	89.59	1.8	157	145	3.10	486	92	450	85	0.00	800	0	0
286	0.00	0.0	0	0	3.30	1	100	1	85	10.53	0	0	100
287	11.66	1.5	17	17	3.10	53	100	53	85	0.00	800	0	0
288	119.82	3.1	365	290	3.10	1133	79	899	85	0.00	800	0	0
289	0.00	0.0	0	0	3.30	1	100	1	85	9.70	0	0	100
290	58.79	3.0	176	0	3.10	547	0	0	85	0.00	800	0	0
291	32.25	6.5	210	0	3.10	650	0	0	85	0.00	800	0	0
292	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	14179	0
293	67.63	2.5	169	169	3.30	558	100	558	85	0.00	800	0	0
294	34.54	2.5	87	87	3.30	287	100	287	85	0.00	800	0	0
295	28.90	2.5	72	72	3.30	237	100	238	85	0.00	800	0	0
296	0.00	0.0	0	0	3.30	1	100	1	85	21.26	0	0	100
297	0.00	0.0	0	0	3.30	1	100	1	85	57.17	0	0	100
298	14.08	12.0	169	0	3.30	557	0	0	85	0.00	800	0	0
299	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	49676	0
300	0.00	0.0	0	0	3.30	1	100	1	85	13.12	2510	32938	100
301	0.00	0.0	0	0	3.30	1	100	1	85	5.14	0	0	100
302	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	5290	0
303	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	2816	0
304	45.66	3.8	172	0	3.30	568	0	0	85	0.00	800	0	0
305	10.97	4.0	44	0	3.30	145	0	0	85	0.00	800	0	0
306	9.50	4.0	38	0	3.30	125	0	0	85	0.00	800	0	0
307	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	43167	0
308	214.17	3.8	803	0	3.30	2650	0	0	85	0.00	800	0	0
309	32.20	12.0	386	0	3.30	1275	0	0	85	0.00	800	0	0
310	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	4667	0
311	62.50	6.5	406	0	3.30	1341	0	0	85	0.00	800	0	0
312	221.03	3.0	663	0	3.30	2188	0	0	85	0.00	800	0	0

G_ID	R_LU_AREA (ACRES)	R_DENSITY	R_BO_ UNITS	R_CURRENT _UNITS	R_PPDU	RES_POP	RES_ ACTIVE(%)	ACTIVE POP	RES_CPC	C_IMP_AREA (AC)	C_GPAD	COM_VOL	COM_ ACTIVE (%)
313	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	5443	0
314	21.37	6.5	139	0	3.30	458	0	0	85	0.00	800	0	0
315	67.19	12.0	806	0	3.30	2661	0	0	85	0.00	800	0	0
316	10.90	10.0	109	5	3.30	360	5	17	85	0.00	800	0	0
317	1.83	1.1	2	2	3.30	7	100	7	85	0.00	800	0	0
318	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	7412	0
319	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	94811	0
320	39.28	2.1	82	0	3.10	256	0	0	85	0.00	800	0	0
321	26.16	12.0	314	0	3.10	973	0	0	85	0.00	800	0	0
322	63.26	3.0	190	0	3.10	588	0	0	85	0.00	800	0	0
323	16.00	1.0	16	7	3.30	53	44	23	85	0.00	800	0	0
324	0.00	0.0	0	0	3.30	1	100	1	85	56.00	800	55313	81
325	20.2	2.3	46	3	3.30	153	6	10	85	0.00	800	0	0
326	17.1	4.9	84	84	3.30	277	100	277	85	0.00	800	0	0
327	0.0	0.0	0	0	3.30	1	100	1	85	1.50	800	2326	52
328	0.0	0.0	0	0	3.30	1	100	1	85	109.88	40	4395	100
329	0.0	0.0	0	0	3.30	1	100	1	85	6.00	800	18657	26
330	237.79	3.5	832	0	3.30	2746	0	0	85	0.00	800	0	0
331	48.61	6.5	316	0	3.30	1043	0	0	85	0.00	800	0	0
332	37.55	6.5	244	0	3.30	805	0	0	85	0.00	800	0	0
333	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	11237	0
334	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	13835	0
335	43.05	6.5	280	0	3.30	924	0	0	85	0.00	800	0	0
336	136.53	3.5	478	0	3.30	1577	0	0	85	0.00	800	0	0
337	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	15919	0
338	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	11404	0
339	49.50	6.5	322	0	3.30	1062	0	0	85	0.00	800	0	0
340	133.40	3.5	467	0	3.30	1541	0	0	85	0.00	800	0	0
341	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	8310	0
342	204.68	3.5	716	0	3.30	2364	0	0	85	0.00	800	0	0
343	298.25	3.5	1044	0	3.30	3445	0	0	85	0.00	800	0	0
344	354.70	3.5	1241	0	3.30	4097	0	0	85	0.00	800	0	0
345	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	11221	0
346	23.01	6.5	150	0	3.30	494	0	0	85	0.00	800	0	0
347	65.85	3.5	230	0	3.30	761	0	0	85	0.00	800	0	0
348	31.62	6.5	206	0	3.30	678	0	0	85	0.00	800	0	0
349	18.78	6.5	122	0	3.30	403	0	0	85	0.00	800	0	0
350	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	21775	0
351	188.32	3.5	659	0	3.30	2175	0	0	85	0.00	800	0	0
352	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	17428	0
353	140.00	3.5	490	0	3.30	1617	0	0	85	0.00	800	0	0
354	112.41	3.5	393	0	3.30	1298	0	0	85	0.00	800	0	0
355	49.38	6.5	321	0	3.30	1059	0	0	85	0.00	800	0	0
356	68.82	3.5	241	0	3.30	795	0	0	85	0.00	800	0	0
357	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	19967	0
358	38.43	6.5	250	0	3.30	824	0	0	85	0.00	800	0	0
359	192.41	3.5	673	0	3.30	2222	0	0	85	0.00	800	0	0
360	257.61	3.5	902	0	3.30	2975	0	0	85	0.00	800	0	0
361	273.08	3.5	956	0	3.30	3154	0	0	85	0.00	800	0	0
362	49.21	6.5	320	0	3.30	1056	0	0	85	0.00	800	0	0
363	102.47	3.5	359	0	3.30	1184	0	0	85	0.00	800	0	0
364	101.24	6.5	658	0	3.30	2172	0	0	85	0.00	800	0	0
365	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	37246	0
366	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	93249	0
367	90.60	3.5	317	0	3.30	1046	0	0	85	0.00	800	0	0
368	269.09	3.5	942	0	3.30	3108	0	0	85	0.00	800	0	0
369	404.14	3.5	1414	0	3.30	4668	0	0	85	0.00	800	0	0
370	265.28	3.5	928	0	3.30	3064	0	0	85	0.00	800	0	0
371	228.88	3.5	801	0	3.30	2644	0	0	85	0.00	800	0	0
372	40.62	3.5	142	0	3.30	469	0	0	85	0.00	800	0	0
373	21.87	3.5	77	0	3.30	253	0	0	85	0.00	800	0	0
374	7.37	6.5	48	0	3.30	158	0	0	85	0.00	800	0	0
375	45.78	3.5	160	0	3.30	529	0	0	85	0.00	800	0	0
376	0.00	0.0	0	0	3.30	1	100	1	85	0.00	800	71300	0
377	90.16	3.5	316	0	3.30	1041	0	0	85	0.00	800	0	0
378	27.60	12.0	331	0	3.30	1093	0	0	85	0.00	800	0	0

APPENDIX B

Ultimate System Land Use Database (2030)

FIELD NAME DESCRIPTIONS

FIELD	DESCRIPTION
G_ID	Land Use Identification Number number assigned by Hydra
R_LU_AREA	Total Land Use Area (acres)
R_DENSITY	Residential Density (dwelling units per acre)
R_BO_UNITS	Total Undeveloped residential area (acres)
R_CURRENT_UNITS	Total number of residential active connections
R_PPDU	Number of people per dwelling unit
RES_POP	Total ultimate population in land use
RES_ACTIVE (%)	Percent of the total pop. contributing flow. Used to adjust ultimate pop. to existing pop.
ACTIVE_POP	Population at Model Year
RES_CPC	Flow contribution (gallons per person per day)
C_IMP_AREA (AC)	Total developed Commercial Area (acres)
C_GPAD	Commercial contribution (gallons per acre per day)
COM_VOL	Total ultimate commercial flow (gallons)
COM_ACTIVE (%)	Percent of the total ultimate flow injected. Used to adjust ultimate flow to existing flow

G_ID	R_LU_AREA (ACRES)	R_DENSITY	R_BO_ UNITS	R_CURRENT _UNITS	R_PPDU	RES_POP	RES_ ACTIVE(%)	ACTIVE POP	RES_CPC	C_IMP_AREA (AC)	C_GPAD	COM_VOL	COM_ ACTIVE(%)
1	29.50	18.5	547	547	2.80	1531	100	1531	85	0.00	800	0	0
2	48.55	2.0	99	99	3.30	326	100	326	85	0.00	800	0	0
3	38.53	2.5	94	94	3.30	312	100	312	85	0.00	800	0	0
4	6.86	18.5	127	127	2.80	356	100	356	85	0.00	800	0	0
5	39.36	20.0	787	787	2.80	2204	100	2204	85	0.00	800	0	0
6	7.57	2.5	19	19	3.30	62	100	62	85	0.00	800	0	0
7	0.00	0.0	0	0	3.30	1	100	1	85	17.44	850	14825	100
8	0.00	0.0	0	0	3.30	1	100	1	85	3.07	850	2612	100
9	20.17	7.1	143	143	3.30	472	100	472	85	0.00	800	0	0
10	10.05	5.9	59	59	3.30	195	100	195	85	0.00	800	0	0
11	0.00	0.0	0	0	3.30	1	100	1	85	2.42	850	2061	100
12	19.47	18.5	360	360	2.80	1009	100	1009	85	0.00	800	0	0
13	0.00	0.0	0	0	3.30	1	100	1	85	57.00	850	48451	100
14	0.00	0.0	0	0	3.30	1	100	1	85	9.85	850	8374	100
15	55.97	3.7	204	204	3.30	674	100	674	85	0.00	800	0	0
16	0.00	0.0	0	0	3.30	1	100	1	85	2.88	850	2450	100
17	41.56	3.1	130	130	3.30	429	100	429	85	0.00	800	0	0
18	3.02	12.0	36	36	3.30	119	100	119	85	0.00	800	0	0
19	0.00	0.0	0	0	3.30	1	100	1	85	10.02	0	0	100
20	110.07	2.5	275	275	3.30	908	100	908	85	0.00	800	0	0
21	0.00	0.0	0	0	3.30	1	100	1	85	54.99	800	43989	100
22	0.00	0.0	0	0	3.30	1	100	1	85	1.83	800	1465	100
23	0.00	0.0	0	0	3.30	1	100	1	85	60.34	800	48276	100
24	18.77	2.5	47	47	3.30	155	100	155	85	0.00	800	0	0
25	22.62	5.9	133	133	3.30	440	100	440	85	0.00	800	0	0
26	31.53	4.6	146	146	3.30	482	100	482	85	0.00	800	0	0
27	1.53	12.0	18	18	3.30	61	100	61	85	0.00	800	0	0
28	0.00	0.0	0	0	3.30	1	100	1	85	2.48	0	0	100
29	3.51	8.0	28	28	3.30	93	100	93	85	0.00	800	0	0
30	0.00	0.0	0	0	3.30	1	100	1	85	1.03	800	827	100
31	13.28	5.9	79	79	3.30	260	100	260	85	0.00	800	0	0
32	7.38	4.7	35	35	3.30	115	100	115	85	0.00	800	0	0
33	28.59	2.8	80	80	3.30	264	100	264	85	0.00	800	0	0
34	0.00	0.0	0	0	3.30	1	100	1	85	6.71	800	5366	100
35	7.87	2.0	16	16	3.30	52	100	52	85	0.00	800	0	0
36	21.74	5.4	118	118	3.30	389	100	389	85	0.00	800	0	0
37	0.00	0.0	0	0	3.30	1	100	1	85	2.63	800	2102	100
38	9.48	12.0	114	114	3.30	375	100	375	85	0.00	800	0	0
39	0.00	0.0	0	0	3.30	1	100	1	85	10.68	0	0	100
40	26.20	3.0	78	78	3.30	257	100	257	85	0.00	800	0	0
41	3.99	12.0	48	48	3.30	158	100	158	85	0.00	800	0	0
42	7.30	10.3	75	75	3.30	248	100	248	85	0.00	800	0	0
43	0.00	0.0	0	0	3.30	1	100	1	85	5.43	800	4341	100
44	50.27	3.9	195	195	3.30	644	100	644	85	0.00	800	0	0
45	0.00	0.0	0	0	3.30	1	100	1	85	16.46	800	13171	100
46	20.14	21.9	440	440	2.80	1232	100	1232	85	0.00	800	0	0
47	0.00	0.0	0	0	3.30	1	100	1	85	7.03	800	5625	100
48	9.75	12.0	117	117	3.50	409	100	409	85	0.00	800	0	0
49	32.60	3.3	108	108	3.30	356	100	356	85	0.00	800	0	0
50	13.98	4.9	69	69	3.30	226	100	226	85	0.00	800	0	0
51	2.36	12.0	28	28	3.30	94	100	94	85	0.00	800	0	0
52	0.00	0.0	0	0	3.30	1	100	1	85	7.83	500	3916	100
53	183.41	3.1	576	576	3.30	1901	100	1901	85	0.00	800	0	0
54	0.00	0.0	0	0	3.30	1	100	1	85	9.60	0	0	100
55	110.09	2.2	242	242	3.30	799	100	799	85	0.00	800	0	0
56	0.00	0.0	0	0	3.30	1	100	1	85	10.18	800	8148	100
57	0.00	0.0	0	0	3.30	1	100	1	85	55.79	800	44632	100
58	27.96	2.6	73	73	3.30	240	100	240	85	0.00	800	0	0
59	76.66	2.6	199	199	3.30	658	100	658	85	0.00	800	0	0
60	160.16	1.9	304	304	3.30	1004	100	1004	85	0.00	800	0	0
61	20.39	12.0	245	245	3.30	807	100	807	85	0.00	800	0	0
62	0.00	0.0	0	0	3.30	1	100	1	85	0.45	0	0	100
63	69.88	2.8	196	196	3.30	646	100	646	85	0.00	800	0	0
64	41.41	3.2	134	134	3.30	442	100	442	85	0.00	800	0	0
65	0.00	0.0	0	0	3.30	1	100	1	85	38.86	800	31087	100
66	11.19	6.1	68	68	3.30	224	100	224	85	0.00	800	0	0
67	56.99	3.2	183	183	3.30	604	100	604	85	0.00	800	0	0
68	3.66	2.8	10	10	3.30	34	100	34	85	0.00	800	0	0
69	0.00	0.0	0	0	3.30	1	100	1	85	6.82	800	5454	100
70	10.72	15.4	165	165	3.30	545	100	545	85	0.00	800	0	0
71	0.00	0.0	0	0	3.30	1	100	1	85	6.62	400	2649	100
72	0.00	0.0	0	0	3.30	1	100	1	85	32.44	0	0	100
73	119.95	3.1	367	367	3.30	1211	100	1211	85	0.00	800	0	0
74	0.00	0.0	0	0	3.30	1	100	1	85	4.62	800	3698	100
75	4.58	1.7	8	8	3.30	26	100	26	85	0.00	800	0	0
76	0.00	0.0	0	0	3.30	1	100	1	85	2.70	800	2159	100

G_ID	R_LU_AREA (ACRES)	R_DENSITY	R_BO_ UNITS	R_CURRENT _UNITS	R_PPDU	RES_POP	RES_ ACTIVE(%)	ACTIVE POP	RES_CPC	C_IMP_AREA (AC)	C_GPAD	COM_VOL	COM_ ACTIVE(%)
77	32.60	3.8	124	124	3.30	409	100	409	85	0.00	800	0	0
78	0.00	0.0	0	0	3.30	1	100	1	85	8.03	800	6427	100
79	0.00	0.0	0	0	3.30	1	100	1	85	15.79	800	12631	100
80	0.00	0.0	0	0	3.30	1	100	1	85	92.18	800	73744	100
81	27.54	5.7	158	158	3.30	522	100	522	85	0.00	800	0	0
82	0.00	0.0	0	0	3.30	1	100	1	85	3.85	800	3083	100
83	17.29	4.7	82	82	3.30	271	100	271	85	0.00	800	0	0
84	0.00	0.0	0	0	3.30	1	100	1	85	35.00	800	28001	100
85	0.00	0.0	0	0	3.30	1	100	1	85	7.06	800	5648	100
86	25.01	3.1	78	78	3.30	257	100	257	85	0.00	800	0	0
87	85.76	2.8	242	242	3.30	798	100	798	85	0.00	800	0	0
88	0.00	0.0	0	0	3.30	1	100	1	85	3.50	800	2801	100
89	0.00	0.0	0	0	3.30	1	100	1	85	2.24	800	1795	100
90	70.67	2.5	177	177	3.30	583	100	583	85	0.00	800	0	0
91	18.33	6.3	115	115	3.30	381	100	381	85	0.00	800	0	0
92	6.85	3.6	25	25	3.30	83	100	83	85	0.00	800	0	0
93	17.32	7.4	128	128	3.30	422	100	422	85	0.00	800	0	0
94	11.58	12.0	139	139	3.30	459	100	459	85	0.00	800	0	0
95	0.00	0.0	0	0	3.30	1	100	1	85	51.54	850	43810	100
96	4.94	2.4	12	12	3.30	40	100	40	85	0.00	800	0	0
97	18.55	12.0	223	223	3.30	735	100	735	85	0.00	800	0	0
98	0.00	0.0	0	0	3.30	1	100	1	85	19.64	850	16692	100
99	4.99	25.2	126	126	3.30	415	100	415	85	0.00	800	0	0
100	52.45	2.0	105	105	3.30	346	100	346	85	0.00	800	0	0
101	0.00	0.0	0	0	3.30	1	100	1	85	9.90	850	8419	100
102	26.39	1.2	32	32	3.30	105	100	105	85	0.00	800	0	0
103	0.00	0.0	0	0	3.30	1	100	1	85	2.18	850	1856	100
104	0.00	0.0	0	0	3.30	1	100	1	85	27.46	800	21970	100
105	11.45	12.0	137	137	3.30	454	100	454	85	0.00	800	0	0
106	34.97	2.7	93	93	3.30	306	100	306	85	0.00	800	0	0
107	9.25	12.0	111	111	3.30	366	100	366	85	0.00	800	0	0
108	16.37	1.4	23	23	3.30	76	100	76	85	0.00	800	0	0
109	10.79	1.4	15	15	3.30	50	100	50	85	0.00	800	0	0
110	19.70	12.0	236	236	3.30	780	100	780	85	0.00	800	0	0
111	0.00	0.0	0	0	3.30	1	100	1	85	11.58	850	9844	100
112	85.19	1.9	162	162	3.30	534	100	534	85	0.00	800	0	0
113	7.81	1.5	12	12	3.30	40	100	40	85	0.00	800	0	0
114	26.22	1.5	38	38	3.30	125	100	125	85	0.00	800	0	0
115	39.77	1.6	63	63	3.30	207	100	207	85	0.00	800	0	0
116	0.00	0.0	0	0	3.30	1	100	1	85	7.65	850	6504	100
117	72.31	3.2	228	228	3.30	752	100	752	85	0.00	800	0	0
118	0.00	0.0	0	0	3.30	1	100	1	85	8.63	400	3453	100
119	31.52	2.3	74	74	3.30	243	100	243	85	0.00	800	0	0
120	65.47	2.5	164	164	3.30	540	100	540	85	0.00	800	0	0
121	0.00	0.0	0	0	3.30	1	100	1	85	6.48	850	5507	100
122	0.00	0.0	0	0	3.30	1	100	1	85	3.01	800	2409	100
123	9.56	6.0	57	57	3.30	189	100	189	85	0.00	800	0	0
124	0.00	0.0	0	0	3.30	1	100	1	85	3.50	800	2799	100
125	60.82	2.5	152	152	3.30	502	100	502	85	0.00	800	0	0
126	97.55	2.5	244	244	3.30	805	100	805	85	0.00	800	0	0
127	28.73	2.7	78	78	3.30	256	100	256	85	0.00	800	0	0
128	7.93	12.5	99	99	3.30	327	100	327	85	0.00	800	0	0
129	4.63	12.0	56	56	3.30	183	100	183	85	0.00	800	0	0
130	0.00	0.0	0	0	3.30	1	100	1	85	38.69	800	30956	100
131	15.46	1.7	26	26	3.30	86	100	86	85	0.00	800	0	0
132	0.00	0.0	0	0	3.30	1	100	1	85	1.77	800	1415	100
133	8.74	3.3	29	29	3.30	96	100	96	85	0.00	800	0	0
134	2.90	6.0	17	17	3.30	57	100	57	85	0.00	800	0	0
135	16.80	12.0	202	202	3.30	665	100	665	85	0.00	800	0	0
136	103.01	3.4	350	350	3.30	1156	100	1156	85	0.00	800	0	0
137	0.00	0.0	0	0	3.30	1	100	1	85	4.57	800	3655	100
138	5.40	18.0	97	97	3.30	321	100	321	85	0.00	800	0	0
139	0.00	0.0	0	0	3.30	1	100	1	85	31.06	800	24846	100
140	4.38	12.0	53	53	3.30	173	100	173	85	0.00	800	0	0
141	0.00	0.0	0	0	3.30	1	100	1	85	1.11	800	886	100
142	20.08	1.0	20	20	3.30	66	100	66	85	0.00	800	0	0
143	0.00	0.0	0	0	3.30	1	100	1	85	0.85	800	677	100
144	15.90	2.5	40	40	3.30	131	100	131	85	0.00	800	0	0
145	37.33	5.4	202	202	3.30	665	100	665	85	0.00	800	0	0
146	0.00	0.0	0	0	3.30	1	100	1	85	15.28	0	0	100
147	26.18	6.9	180	180	3.30	594	100	594	85	0.00	800	0	0
148	36.74	2.3	86	86	3.30	282	100	282	85	0.00	800	0	0
149	24.58	4.6	113	113	3.30	373	100	373	85	0.00	800	0	0
150	97.13	2.2	214	214	3.30	705	100	705	85	0.00	800	0	0
151	27.88	0.6	15	15	3.30	51	100	51	85	0.00	800	0	0
152	10.67	18.0	192	192	3.30	634	100	634	85	0.00	800	0	0

G_ID	R_LU_AREA (ACRES)	R_DENSITY	R_BO_ UNITS	R_CURRENT _UNITS	R_PPDU	RES_POP	RES_ ACTIVE(%)	ACTIVE POP	RES_CPC	C_IMP_AREA (AC)	C_GPAD	COM_VOL	COM_ ACTIVE(%)
153	0.00	0.0	0	0	3.30	1	100	1	85	6.56	800	5246	100
154	0.00	0.0	0	0	3.30	1	100	1	85	62.89	9704	610267	100
155	0.00	0.0	0	0	3.30	1	100	1	85	27.95	800	22361	100
156	34.50	6.1	211	211	3.30	696	100	696	85	0.00	800	0	0
157	187.88	2.7	498	498	3.30	1643	100	1643	85	0.00	800	0	0
158	0.00	0.0	0	0	3.30	1	100	1	85	72.06	0	0	100
159	61.60	4.8	296	296	3.30	976	100	976	85	0.00	800	0	0
160	0.00	0.0	0	0	3.30	1	100	1	85	3.79	800	3032	100
161	0.00	0.0	0	0	3.30	1	100	1	85	55.97	800	44774	100
162	20.61	2.5	51	51	3.30	168	100	168	85	0.00	800	0	0
163	0.00	0.0	0	0	3.30	1	100	1	85	7.07	800	5655	100
164	5.96	7.6	45	45	3.30	149	100	149	85	0.00	800	0	0
165	0.00	0.0	0	0	3.30	1	100	1	85	13.38	400	5354	100
166	0.00	0.0	0	0	3.30	1	100	1	85	2.03	800	1620	100
167	124.73	3.1	386	386	3.30	1273	100	1273	85	0.00	800	0	0
168	120.53	2.6	307	307	3.30	1014	100	1014	85	0.00	800	0	0
169	73.35	1.5	110	110	3.30	363	100	363	85	0.00	800	0	0
170	52.25	2.2	115	115	3.30	379	100	379	85	0.00	800	0	0
171	0.00	0.0	0	0	3.30	1	100	1	85	10.38	0	0	100
172	112.12	2.3	258	258	3.30	851	100	851	85	0.00	800	0	0
173	0.00	0.0	0	0	3.30	1	100	1	85	10.44	0	0	100
174	30.35	1.8	54	54	3.30	178	100	178	85	0.00	800	0	0
175	71.63	1.4	100	100	3.30	331	100	331	85	0.00	800	0	0
176	143.03	1.9	266	266	3.30	878	100	878	85	0.00	800	0	0
177	14.12	0.8	11	11	3.30	37	100	37	85	0.00	800	0	0
178	0.00	0.0	0	0	3.30	1	100	1	85	85.76	850	72898	100
179	24.57	6.5	160	160	3.30	527	100	527	85	0.00	800	0	0
180	95.30	2.4	231	231	3.30	761	100	761	85	0.00	800	0	0
181	20.81	6.5	135	135	3.30	446	100	446	85	0.00	800	0	0
182	0.00	0.0	0	0	3.30	1	100	1	85	2.50	850	2129	100
183	0.00	0.0	0	0	3.30	1	100	1	85	16.10	850	13688	100
184	0.00	0.0	0	0	3.30	1	100	1	85	49.27	2090	102973	100
185	6.39	12.0	77	77	3.30	253	100	253	85	0.00	800	0	0
186	0.00	0.0	0	0	3.30	1	100	1	85	18.71	800	14967	100
187	0.00	0.0	0	0	3.30	1	100	1	85	20.67	800	16538	100
188	53.27	3.0	160	160	3.30	527	100	527	85	0.00	800	0	0
189	0.00	0.0	0	0	3.30	1	100	1	85	40.39	800	32310	100
190	56.38	3.6	200	200	3.30	660	100	660	85	0.00	800	0	0
191	0.00	0.0	0	0	3.30	1	100	1	85	29.83	800	23865	100
192	0.00	0.0	0	0	3.30	1	100	1	85	2.72	800	2173	100
193	9.73	6.1	59	59	3.30	195	100	195	85	0.00	800	0	0
194	33.69	4.2	143	143	3.30	471	100	471	85	0.00	800	0	0
195	0.00	0.0	0	0	3.30	1	100	1	85	2.02	800	1613	100
196	0.00	0.0	0	0	3.30	1	100	1	85	15.86	800	12691	100
197	0.00	0.0	0	0	3.30	1	100	1	85	13.74	0	0	100
198	44.71	5.4	239	239	3.30	789	100	789	85	0.00	800	0	0
199	117.49	1.1	130	130	3.30	430	100	430	85	0.00	800	0	0
200	50.82	2.8	143	143	3.30	471	100	471	85	0.00	800	0	0
201	11.85	3.0	36	36	3.30	119	100	119	85	0.00	800	0	0
202	21.86	16.5	360	360	2.50	899	100	899	85	0.00	800	0	0
203	20.75	3.9	80	80	3.30	264	100	264	85	0.00	800	0	0
204	0.00	0.0	0	0	3.30	1	100	1	85	9.03	0	0	100
205	38.33	4.4	167	167	3.30	551	100	551	85	0.00	800	0	0
206	2.97	2.5	7	7	3.30	24	100	24	85	0.00	800	0	0
207	17.83	1.6	29	29	3.30	96	100	96	85	0.00	800	0	0
208	62.89	2.5	157	157	3.30	519	100	519	85	0.00	800	0	0
209	0.00	0.0	0	0	3.30	1	100	1	85	11.92	800	9535	100
210	28.67	18.0	516	516	3.30	1703	100	1703	85	0.00	800	0	0
211	0.00	0.0	0	0	3.30	1	100	1	85	79.56	800	63647	100
212	0.00	0.0	0	0	3.30	1	100	1	85	19.96	800	15967	100
213	51.32	2.2	111	111	3.30	366	100	366	85	0.00	800	0	0
214	103.08	3.4	350	350	3.30	1157	100	1157	85	0.00	800	0	0
215	108.64	4.0	429	429	3.30	1416	100	1416	85	0.00	800	0	0
216	3.36	5.7	19	19	3.30	63	100	63	85	0.00	800	0	0
217	63.35	3.7	234	234	3.30	773	100	773	85	0.00	800	0	0
218	0.00	0.0	0	0	3.30	1	100	1	85	24.50	800	19603	100
219	8.16	12.0	98	98	3.30	323	100	323	85	0.00	800	0	0
220	13.58	1.6	22	22	3.30	73	100	73	85	0.00	800	0	0
221	78.71	2.5	196	196	3.30	647	100	647	85	0.00	800	0	0
222	99.63	2.7	268	268	3.30	884	100	884	85	0.00	800	0	0
223	0.00	0.0	0	0	3.30	1	100	1	85	13.54	0	0	100
224	0.00	0.0	0	0	3.30	1	100	1	85	24.45	800	19558	100
225	0.00	0.0	0	0	3.30	1	100	1	85	91.35	800	73078	100
226	12.18	1.5	18	18	3.30	60	100	60	85	0.00	800	0	0
227	2.68	4.5	12	12	3.30	40	100	40	85	0.00	800	0	0
228	15.23	7.0	106	106	3.30	350	100	350	85	0.00	800	0	0

G_ID	R_LU_AREA (ACRES)	R_DENSITY	R_BO_ UNITS	R_CURRENT _UNITS	R_PPDU	RES_POP	RES_ ACTIVE(%)	ACTIVE POP	RES_CPC	C_IMP_AREA (AC)	C_GPAD	COM_VOL	COM_ ACTIVE(%)
229	82.70	2.3	190	190	3.30	628	100	628	85	0.00	800	0	0
230	162.81	2.5	402	402	3.30	1327	100	1327	85	0.00	800	0	0
231	10.66	3.0	32	32	3.30	106	100	106	85	0.00	800	0	0
232	0.00	0.0	0	0	3.30	1	100	1	85	61.09	1820	111192	100
233	0.00	0.0	0	0	3.30	1	100	1	85	204.16	800	163328	100
234	0.00	0.0	0	0	3.30	1	100	1	85	152.64	700	106846	100
235	0.00	0.0	0	0	3.30	1	100	1	85	847.47	800	677977	100
236	0.00	0.0	0	0	3.30	1	100	1	85	73.45	400	29380	100
237	0.00	0.0	0	0	3.30	1	100	1	85	9.05	800	7240	100
238	0.00	0.0	0	0	3.30	1	100	1	85	18.08	800	14464	100
239	0.00	0.0	0	0	3.30	1	100	1	85	106.47	800	85178	100
240	17.91	12.0	215	215	3.30	709	100	709	85	0.00	800	0	0
241	19.25	3.1	60	60	3.30	197	100	197	85	0.00	800	0	0
242	0.00	0.0	0	0	3.30	1	100	1	85	11.39	0	0	100
243	60.19	2.8	171	171	3.30	564	100	564	85	0.00	800	0	0
244	0.00	0.0	0	0	3.30	1	100	1	85	16.85	0	0	100
245	33.92	2.5	83	83	3.30	274	100	274	85	0.00	800	0	0
246	92.50	3.0	276	276	3.30	910	100	910	85	0.00	800	0	0
247	139.27	2.7	377	377	3.30	1245	100	1245	85	0.00	800	0	0
248	0.00	0.0	0	0	3.30	1	100	1	85	13.53	800	10823	100
249	183.44	2.5	462	462	3.30	1525	100	1525	85	0.00	800	0	0
250	0.00	0.0	0	0	3.30	1	100	1	85	67.24	800	53788	100
251	0.00	0.0	0	0	3.30	1	100	1	85	98.08	800	78466	100
252	0.00	0.0	0	0	3.30	1	100	1	85	54.93	800	43947	100
253	95.35	2.7	253	253	3.30	834	100	834	85	0.00	800	0	0
254	25.78	3.0	76	76	3.30	251	100	251	85	0.00	800	0	0
255	0.00	0.0	0	0	3.30	1	100	1	85	10.29	800	8232	100
256	0.00	0.0	0	0	3.30	1	100	1	85	7.04	800	5635	100
257	0.00	0.0	0	0	3.30	1	100	1	85	1.75	200	350	100
258	0.00	0.0	0	0	3.30	1	100	1	85	71.48	800	57181	100
259	25.96	12.0	312	312	3.30	1028	100	1028	85	0.00	800	0	0
260	54.50	12.0	654	654	2.00	1308	100	1308	85	0.00	800	0	0
261	0.00	0.0	0	0	3.30	1	100	1	85	380.95	800	304762	9
262	0.00	0.0	0	0	3.30	1	100	1	85	253.07	800	202459	0
263	0.00	0.0	0	0	3.30	1	100	1	85	35.90	800	28720	100
264	0.00	0.0	0	0	3.30	1	100	1	85	40.78	400	16311	100
265	0.00	0.0	0	0	3.30	1	100	1	85	46.80	400	18720	100
266	63.60	1.9	118	118	3.30	388	100	388	85	0.00	800	0	0
267	0.00	0.0	0	0	3.30	1	100	1	85	7.55	800	6036	100
268	76.30	1.9	147	147	3.30	486	100	486	85	0.00	800	0	0
269	0.00	0.0	0	0	3.30	1	100	1	85	3.07	0	0	100
270	21.85	2.2	47	47	3.10	146	100	146	85	0.00	800	0	0
271	0.00	0.0	0	0	3.30	1	100	1	85	20.44	800	16351	100
272	17.96	2.5	45	45	3.10	139	100	139	85	0.00	800	0	0
273	0.00	0.0	0	0	3.30	1	100	1	85	15.88	800	12707	100
274	0.00	0.0	0	0	3.30	1	100	1	85	9.72	800	7773	100
275	0.00	0.0	0	0	3.30	1	100	1	85	13.08	800	10461	100
276	0.00	0.0	0	0	3.30	1	100	1	85	23.04	800	18430	100
277	30.65	7.2	219	219	3.10	679	100	679	85	0.00	800	0	0
278	0.00	0.0	0	0	3.30	1	100	1	85	4.46	800	3568	100
279	23.49	5.3	123	123	3.10	382	100	382	85	0.00	800	0	0
280	0.00	0.0	0	0	3.30	1	100	1	85	1.96	800	1567	100
281	84.09	2.9	241	241	3.10	748	100	748	85	0.00	800	0	0
282	101.61	2.8	286	286	3.10	885	100	885	85	0.00	800	0	0
283	21.99	2.0	44	44	3.10	136	100	136	85	0.00	800	0	0
284	27.56	2.7	73	73	3.10	226	100	226	85	0.00	800	0	0
285	89.59	1.8	157	157	3.10	486	100	486	85	0.00	800	0	0
286	0.00	0.0	0	0	3.30	1	100	1	85	10.53	0	0	100
287	11.66	1.5	17	17	3.10	53	100	53	85	0.00	800	0	0
288	119.82	3.1	365	365	3.10	1133	100	1133	85	0.00	800	0	0
289	0.00	0.0	0	0	3.30	1	100	1	85	9.70	0	0	100
290	58.79	3.0	176	176	3.10	547	100	547	85	0.00	800	0	0
291	32.25	6.5	210	210	3.10	650	100	650	85	0.00	800	0	0
292	0.00	0.0	0	0	3.30	1	100	1	85	17.72	800	14179	100
293	67.63	2.5	169	169	3.30	558	100	558	85	0.00	800	0	0
294	34.54	2.5	87	87	3.30	287	100	287	85	0.00	800	0	0
295	28.90	2.5	72	72	3.30	237	100	237	85	0.00	800	0	0
296	0.00	0.0	0	0	3.30	1	100	1	85	21.26	0	0	100
297	0.00	0.0	0	0	3.30	1	100	1	85	57.17	0	0	100
298	14.08	12.0	169	169	3.30	557	100	557	85	0.00	800	0	0
299	0.00	0.0	0	0	3.30	1	100	1	85	62.09	800	49676	100
300	0.00	0.0	0	0	3.30	1	100	1	85	13.12	2510	32938	100
301	0.00	0.0	0	0	3.30	1	100	1	85	5.14	0	0	100
302	0.00	0.0	0	0	3.30	1	100	1	85	6.61	800	5290	100
303	0.00	0.0	0	0	3.30	1	100	1	85	3.52	800	2816	100
304	45.66	3.8	172	172	3.30	568	100	568	85	0.00	800	0	0

G_ID	R_LU_AREA (ACRES)	R_DENSITY	R_BO_ UNITS	R_CURRENT _UNITS	R_PPDU	RES_POP	RES_ ACTIVE(%)	ACTIVE POP	RES_CPC	C_IMP_AREA (AC)	C_GPAD	COM_VOL	COM_ ACTIVE(%)
305	10.97	4.0	44	44	3.30	145	100	145	85	0.00	800	0	0
306	9.50	4.0	38	38	3.30	125	100	125	85	0.00	800	0	0
307	0.00	0.0	0	0	3.30	1	100	1	85	53.96	800	43167	100
308	214.17	3.8	803	803	3.30	2650	100	2650	85	0.00	800	0	0
309	32.20	12.0	386	386	3.30	1275	100	1275	85	0.00	800	0	0
310	0.00	0.0	0	0	3.30	1	100	1	85	5.83	800	4667	100
311	62.50	6.5	406	406	3.30	1341	100	1341	85	0.00	800	0	0
312	221.03	3.0	663	663	3.30	2188	100	2188	85	0.00	800	0	0
313	0.00	0.0	0	0	3.30	1	100	1	85	6.80	800	5443	100
314	21.37	6.5	139	139	3.30	458	100	458	85	0.00	800	0	0
315	67.19	12.0	806	806	3.30	2661	100	2661	85	0.00	800	0	0
316	10.90	10.0	109	109	3.30	360	100	360	85	0.00	800	0	0
317	1.83	1.1	2	2	3.30	7	100	7	85	0.00	800	0	0
318	0.00	0.0	0	0	3.30	1	100	1	85	9.27	800	7412	100
319	0.00	0.0	0	0	3.30	1	100	1	85	118.51	800	94811	100
320	39.28	2.1	82	82	3.10	256	100	256	85	0.00	800	0	0
321	26.16	12.0	314	314	3.10	973	100	973	85	0.00	800	0	0
322	63.26	3.0	190	190	3.10	588	100	588	85	0.00	800	0	0
323	16.00	1.0	16	16	3.30	53	100	53	85	0.00	800	0	0
324	0.00	0.0	0	0	3.30	1	100	1	85	69.14	800	55313	100
325	20.16	2.3	46	46	3.30	153	100	153	85	0.00	800	0	0
326	17.10	4.9	84	84	3.30	277	100	277	85	0.00	800	0	0
327	0.00	0.0	0	0	3.30	1	100	1	85	2.91	800	2326	100
328	0.00	0.0	0	0	3.30	1	100	1	85	109.88	40	4395	100
329	0.00	0.0	0	0	3.30	1	100	1	85	23.32	800	18657	100
330	237.79	3.5	832	832	3.30	2746	100	2746	85	0.00	800	0	0
331	48.61	6.5	316	316	3.30	1043	100	1043	85	0.00	800	0	0
332	37.55	6.5	244	244	3.30	805	100	805	85	0.00	800	0	0
333	0.00	0.0	0	0	3.30	1	100	1	85	14.05	800	11237	100
334	0.00	0.0	0	0	3.30	1	100	1	85	17.29	800	13835	100
335	43.05	6.5	280	280	3.30	924	100	924	85	0.00	800	0	0
336	136.53	3.5	478	478	3.30	1577	100	1577	85	0.00	800	0	0
337	0.00	0.0	0	0	3.30	1	100	1	85	19.90	800	15919	100
338	0.00	0.0	0	0	3.30	1	100	1	85	14.26	800	11404	100
339	49.50	6.5	322	322	3.30	1062	100	1062	85	0.00	800	0	0
340	133.40	3.5	467	467	3.30	1541	100	1541	85	0.00	800	0	0
341	0.00	0.0	0	0	3.30	1	100	1	85	10.39	800	8310	100
342	204.68	3.5	716	716	3.30	2364	100	2364	85	0.00	800	0	0
343	298.25	3.5	1044	1044	3.30	3445	100	3445	85	0.00	800	0	0
344	354.70	3.5	1241	1241	3.30	4097	100	4097	85	0.00	800	0	0
345	0.00	0.0	0	0	3.30	1	100	1	85	14.03	800	11221	100
346	23.01	6.5	150	150	3.30	494	100	494	85	0.00	800	0	0
347	65.85	3.5	230	230	3.30	761	100	761	85	0.00	800	0	0
348	31.62	6.5	206	206	3.30	678	100	678	85	0.00	800	0	0
349	18.78	6.5	122	122	3.30	403	100	403	85	0.00	800	0	0
350	0.00	0.0	0	0	3.30	1	100	1	85	27.22	800	21775	100
351	188.32	3.5	659	659	3.30	2175	100	2175	85	0.00	800	0	0
352	0.00	0.0	0	0	3.30	1	100	1	85	21.79	800	17428	100
353	140.00	3.5	490	490	3.30	1617	100	1617	85	0.00	800	0	0
354	112.41	3.5	393	393	3.30	1298	100	1298	85	0.00	800	0	0
355	49.38	6.5	321	321	3.30	1059	100	1059	85	0.00	800	0	0
356	68.82	3.5	241	241	3.30	795	100	795	85	0.00	800	0	0
357	0.00	0.0	0	0	3.30	1	100	1	85	24.96	800	19967	100
358	38.43	6.5	250	250	3.30	824	100	824	85	0.00	800	0	0
359	192.41	3.5	673	673	3.30	2222	100	2222	85	0.00	800	0	0
360	257.61	3.5	902	902	3.30	2975	100	2975	85	0.00	800	0	0
361	273.08	3.5	956	956	3.30	3154	100	3154	85	0.00	800	0	0
362	49.21	6.5	320	320	3.30	1056	100	1056	85	0.00	800	0	0
363	102.47	3.5	359	359	3.30	1184	100	1184	85	0.00	800	0	0
364	101.24	6.5	658	658	3.30	2172	100	2172	85	0.00	800	0	0
365	0.00	0.0	0	0	3.30	1	100	1	85	46.56	800	37246	100
366	0.00	0.0	0	0	3.30	1	100	1	85	116.56	800	93249	100
367	90.60	3.5	317	317	3.30	1046	100	1046	85	0.00	800	0	0
368	269.09	3.5	942	942	3.30	3108	100	3108	85	0.00	800	0	0
369	404.14	3.5	1414	1414	3.30	4668	100	4668	85	0.00	800	0	0
370	265.28	3.5	928	928	3.30	3064	100	3064	85	0.00	800	0	0
371	228.88	3.5	801	801	3.30	2644	100	2644	85	0.00	800	0	0
372	40.62	3.5	142	142	3.30	469	100	469	85	0.00	800	0	0
373	21.87	3.5	77	77	3.30	253	100	253	85	0.00	800	0	0
374	7.37	6.5	48	48	3.30	158	100	158	85	0.00	800	0	0
375	45.78	3.5	160	160	3.30	529	100	529	85	0.00	800	0	0
376	0.00	0.0	0	0	3.30	1	100	1	85	89.12	800	71300	100
377	90.16	3.5	316	316	3.30	1041	100	1041	85	0.00	800	0	0
378	27.60	12.0	331	331	3.30	1093	100	1093	85	0.00	800	0	0

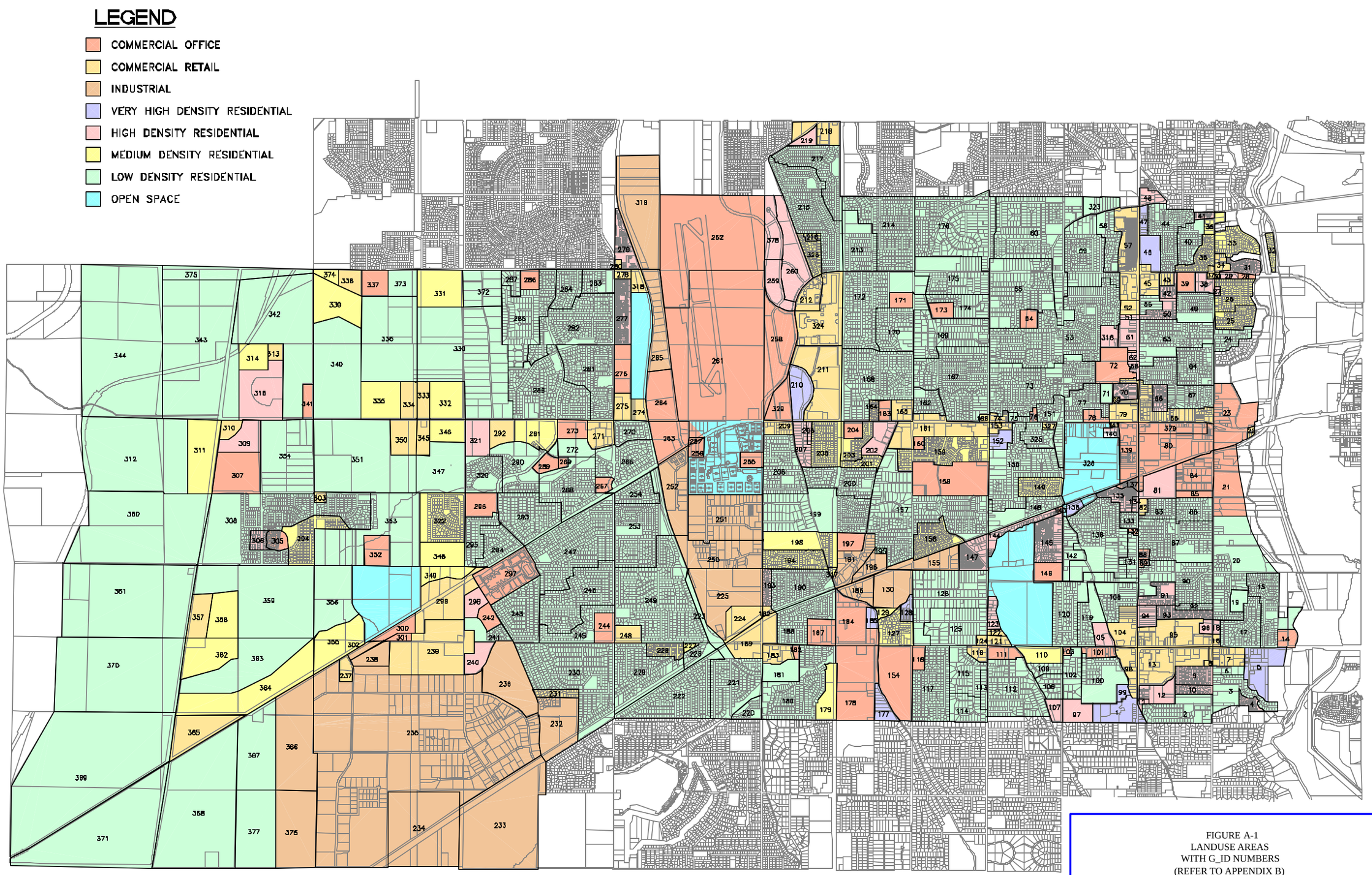


FIGURE A-1
LANDUSE AREAS
WITH G_ID NUMBERS
(REFER TO APPENDIX B)

West Jordan City

J-U-B
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LEGEND

- COMMERCIAL OFFICE
- COMMERCIAL RETAIL
- INDUSTRIAL
- VERY HIGH DENSITY RESIDENTIAL
- HIGH DENSITY RESIDENTIAL
- MEDIUM DENSITY RESIDENTIAL
- LOW DENSITY RESIDENTIAL
- OPEN SPACE
- SERVICE AREA
- 123 SERVICE AREA IDENTIFICATION

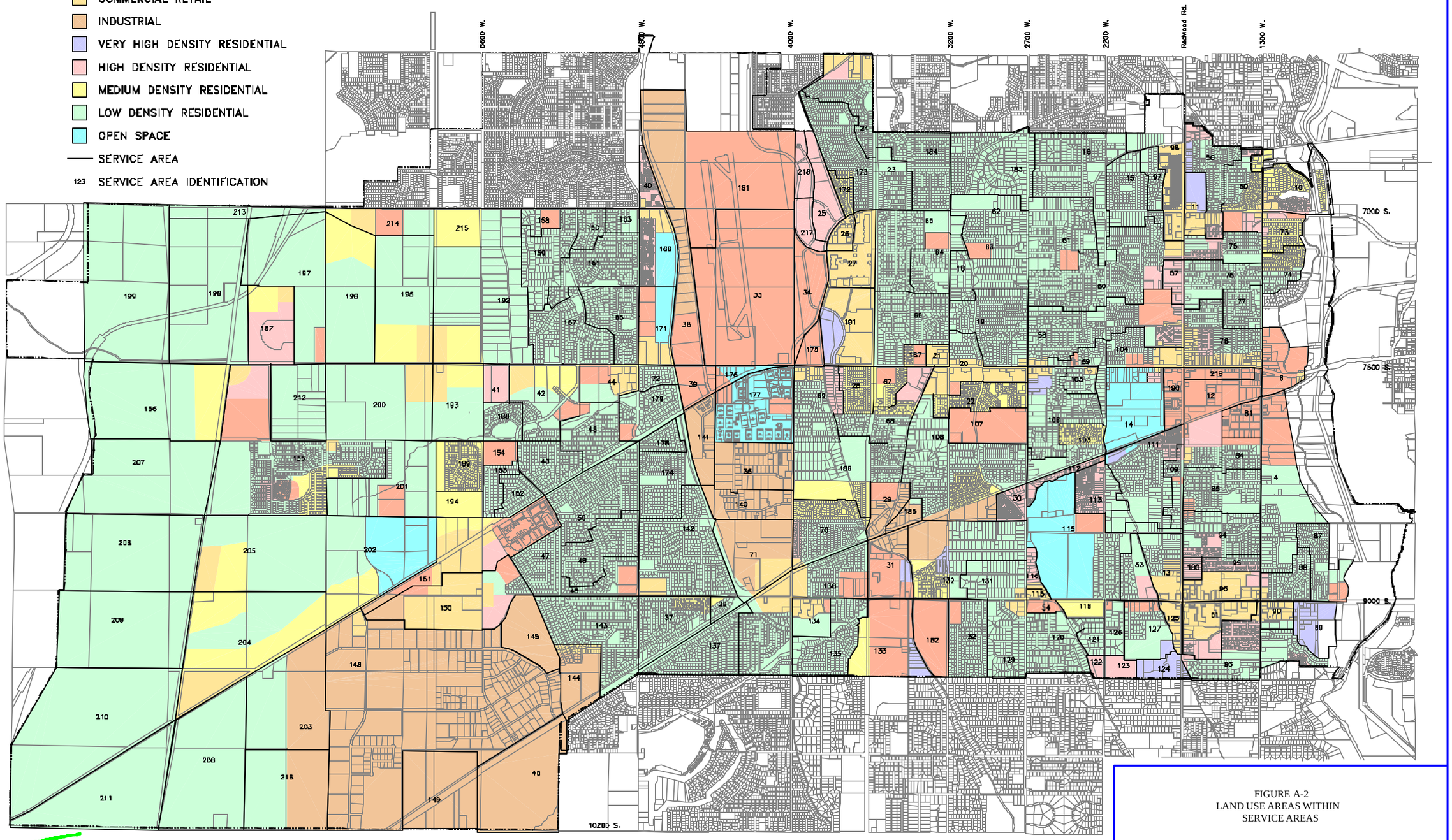

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FIGURE A-2
LAND USE AREAS WITHIN
SERVICE AREAS

West Jordan City

APPENDIX D

State of Utah, Rule317-3. Design Requirements for Wastewater Collection, Treatment and Disposal Systems.

Rule R317-3. Design Requirements for Wastewater Collection, Treatment and Disposal Systems.

As in effect on November 1, 2007

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- R317-3-12. Effluent Filtration.
- KEY
- Date of Enactment or Last Substantive Amendment
- Notice of Continuation
- Authorizing, Implemented, or Interpreted Law

R317-3-1. Technical and Procedural Requirements.

1.1. Scope of This Rule

A. General. This rule is intended to aid the logical development, from feasibility study to startup, of a wastewater collection, treatment and disposal project.

B. Authority. Construction permits and approvals are issued pursuant to the provisions of Sections 19-5-107 and 19-5-108. Violation of construction permit or approval including compliance with the conditions thereof, or beginning of construction, or modification without the executive secretary's approval, is subject to the penalties provided in Section 19-5-115.

C. Applicability

1. This rule applies to:

a. communities, sewerage agencies, industries, and federal or state agencies (hereinafter referred to as the applicant), and

b. i. construction, installation, modification or operation of any treatment works or part thereof or any extension or addition thereto, or

ii. construction, installation, modification or operation of any establishment or any extension or modification or addition to it, the operation of which would probably result in a discharge.

2. The applicant must not advertise the project for bids and must not begin construction without receiving a construction permit.

D. Requirements

1. The design requirements in this rule are for collection, treatment and disposal of wastewater largely originating from domestic sources. These criteria are intended to be limiting values for items upon which an evaluation of such plans and specifications will be made and to establish, as far as practicable, uniformity of practice. This rule also provides for a mechanism to apply water pollution control research and recommendations for further evaluation by the design engineer.

2. Communities, and the engineering profession should discuss with the staff of the executive secretary possible combinations of wastewater treatment and disposal processes or situations not covered in detail by this rule.

E. Construction Permit and Approvals

1. When a Permit or an Approval is Issued. A construction permit or an approval is issued when the applicant has met all requirements of this rule, including any additional requirements of funding programs administered by the executive secretary. The applicant or the designee or the consultant should meet with the staff of the executive secretary to discuss the plan of study

before undertaking extensive engineering studies for construction of treatment works. A permit for construction of a new treatment works or a sewerage system, or modifications to an existing treatment works or sewerage system for multiple units under separate ownership will be issued only if the treatment works or sewerage system are under the sponsorship of a body politic as defined in R317-1-1.

2. Variance. The executive secretary may grant a variance from the minimum requirements stated in this rule, subject to site-specific consideration and justification, but not overriding safeguarding of public health or protection of water quality or engineering practice. The applicant must submit pertinent and relevant material in support of a variance from the minimum requirements.

3. Limitations

a. The issuance of a construction permit does not relieve in any way the applicant of the obligation to obtain other approvals and permits, i.e., ground water discharge permit, clearances etc., from other agencies which may have jurisdiction over the project.

b. The permit will expire at the end of one year from the date of issuance if the approved project is not under substantial construction. Plans and specifications must be resubmitted for review and reissuance of the expired permit.

F. Definitions

1. The annual average daily rate of flow is defined as:

a. an average of daily rates of flow over a period of not less than one year; or

b. the rate of flow equal to or greater than 50 percent of the daily flow rate data.

2. The average design rate of flow or the average peak-monthly rate of flow is defined as:

a. a moving average of daily rates of flow over a thirty consecutive days; or over a period of month whichever produces a higher rate of flow; or

b. the rate of flow equal to or greater than 92 percent of the daily flow rate data.

3. The maximum design rate of flow or peak-daily rate of flow is defined as:

a. the maximum rates of flow over a 24 hour period; or

b. the rate of flow equal to or greater than 99.7 percent of the daily flow data.

4. The peak design rate of flow or peak-hourly rate of flow is defined as:

a. the maximum rate of flow over a 60-minute period; or

b. the rate of flow equal to or greater than 99.9 percent of the daily flow data.

5. The minimum daily rate of flow is defined as the minimum rate of flow over a twenty-four hour period.

6. Industrial waste flow is defined as the maximum rate of flow for each of industries tributary to the sewer system.

7. Other Definitions. Other definition of terms and their use in this rule is intended to be in accordance with:

a. R317-1 (Definitions and General Requirements), and

b. Glossary - Water and Wastewater Control Engineering, jointly prepared by American Public Health Association (APHA), American Society of Civil Engineers (ASCE), American Water Works Association (AWWA), and Water Pollution Control Federation (WPCF).

8. Units of Expression The units of expression used are in accordance with those recommended in WPCF Manual of Practice Number 6, Units of Expression for Wastewater Treatment.

9. Terms

a. The term shall is used where practice is standardized to permit specific delineation of requirements or where safeguarding of the public health or protection of water quality justifies such definite action.

b. Other terms, such as should, recommended, preferred, indicate desirable procedures or methods, with deviations subject to individual consideration and justification, but not overriding safeguarding of public health or protection of water quality or engineering practice.

c. Desirable procedures or methods may be mandatory requirements for projects using state or federal funds.

1.2. Engineering Report

A. The Scope of the Report

1. The applicant or the applicant's consulting engineer should submit an engineering report to the executive secretary at least 60 days before the date when action by the executive secretary is desired. The report shall be prepared under the direction of a registered professional engineer licensed to practice in the State of Utah. The report must establish the need, scope, basis and viability for:

a. all projects involving innovative treatment and disposal processes, and

b. collection and pumping systems handling flows in excess of 1 million gallons per day (3,785 cubic meters per day).

2. The documents submitted for formal approval should include all pertinent and relevant material to aid in the review of the submitted reports.

B. What is Required in the Report

1. The magnitude and complexity of the project will determine the scope of the report.

2. The report must provide basic information; criteria and assumptions; evaluation of alternate projects, with preliminary layouts and cost estimates; assessment of environmental factors; financing methods, anticipated charges for users; organizational and staffing requirements; conclusions or recommendations with a proposed project for consideration; and an outline of official actions and procedures required to implement the project.

3. The report should detail various concepts (including process description and sizing), factual data, and controlling assumptions and considerations for the functional planning of sewerage facilities. These data form the continuing technical basis for the detailed design and preparation of construction plans and specifications.

4. The report should include preliminary architectural, structural, mechanical, and electrical designs, sketches and outline specifications of process units, special equipment, etc.

5. The applicant or the consultant must address specific program and funding requirements in the report.

6. A detailed topical outline is available from the division.

C. Supplemental Requirements for Lagoons and Land Application. The engineer's report shall contain pertinent information on location, geology, hydrology, hydrogeology, soil conditions, area for expansion and any other factors that will affect the feasibility and acceptability of the proposed lagoon and land application projects.

1. Project Location. The engineer's report shall include on a 7.5-minute US Geological Survey topographic map showing the following within two mile (3.22 kilometers) radius of the proposed project site:

a. the location and direction of all residences, commercial developments, parks, recreational areas, land requirements for future additional treatment units and increased waste loadings, and land use zoning of area;

b. elevations and contours of the site and adjacent area;

c. watercourses and water supplies (including a log of each well, unless waived by the executive secretary);

d. location, depth, and discharge point of any field tile in the immediate area of the proposed site;

e. buffer zones;

f. limits of all flood plains, public drinking water supply watersheds and inland wetlands; and

g. natural site drainage zones.

2. Soil Borings and Geology. The applicant must determine representative subsurface soil characteristics and geology of the project site using a number of soil borings logged by an independent soil testing laboratory. At least one boring shall be a minimum of 25 feet (7.6 meters) in depth or into bedrock, whichever is shallower. The borings shall be filled and sealed. The report must address the following items as a minimum:

a. depth, type and texture of soil, all confirmed field data by the Soil Conservation Service (US Department of Agriculture);

b. hydraulic conductivity of the project site or the lagoon bottom as determined in the field, and lagoon bottom materials;

c. soil chemical properties such as, pH, nutrient levels, cation exchange capacity, etc.;

d. depth to bedrock;

e. bedrock type;

f. geologic discontinuities - faults, fractures, sinkholes;

g. jointing and permeability of rock.

3. Ground Water Issues

a. ground water depth confirmed by field investigations, for various seasons, including data from the period between March and May;

b. location of perched water tables;

c. ground water contours;

d. direction of ground water movement and flow;

e. ground water points of discharge;

f. available analyses of site ground water quality and drinking water wells in the vicinity, including but not limited to: coliform bacteria, pH, nitrates, total nitrogen, chlorides, sulfates, and total hardness;

g. a description of the depth and type of all water supply wells within two-mile (3.22 kilometers) radius of the proposed project site;

h. ground water monitoring needs using a system of wells or lysimeters around the perimeter of the project site; and

i. compliance with the requirements of R317-6 (Ground Water Quality Protection Rules) including securing a ground water discharge permit.

4. Climate Data

a. total precipitation for each month;

b. mean number of days per year with temperatures less than or equal to 32 degrees Fahrenheit (0 degree Centigrade);

c. wind velocities and direction;

d. evapotranspiration data.

D. Reports on Supplementary Investigations. Reports on soils, foundation, geological and hydrogeological investigations must be submitted by the applicant or the consultant, to the executive secretary. These reports are supplementary to a proposal, predesign or design report, plans and specifications for all projects. The reports must focus on any existing site conditions which may affect feasibility or constructibility of the project. If such problems do exist, mitigative and remedial measures thereto must be recommended by the applicant's consultant. The basis of conclusions reached should be supported with relevant and detailed information, graphically and narratively. The recommendations must be incorporated in the design.

1.3. Predesign Report

A. A predesign report must be prepared for the projects designed to:

1. treat domestic sewage flow in excess of 5 million gallons per day (18,900 cubic meters per day); or

2. incorporate emerging, innovative and alternative technologies.

B. The report must be submitted for review and approval by the division. The report shall include a summary of process design criteria, the basis of design, process and hydraulic profiles, outline of all appurtenant facilities, and supporting information.

C. Approval of a predesign report represents an agreement-in-principle subject to receipt, review and approval of satisfactory engineering plans and specifications. Such agreement-in-principle will be modified or revised in light of new information that may become available later. Also, an approval of prefinal documents is not an authorization to advertise the project for bids or to begin construction; but allows the applicant to proceed with preparing final engineering drawings and specifications.

1.4. Construction Plans

A. General. A complete set of construction drawings covering all disciplines shall be submitted for review in fulfillment of the requirements of this rule. The size, complexity and nature of the project will determine the extent of involvement of various disciplines. Such disciplines are, but not necessarily limited to, Civil, Structural, Mechanical, Architectural, Mechanical, Electrical, Geotechnical, Instrumentation, Heating, Ventilating and Air Conditioning etc. All designs shall be in accordance with the requirements of applicable local, state and federal rules or regulations, the latest recognized practice standards including the Uniform Building Code, the National Electrical Code, the Uniform Mechanical Code, the Uniform Plumbing Code and other industry standards. The plans shall be clear, legible and suitable for microfilming or image processing.

1. Standard Information

a. Plans shall show a suitable project title, the name of municipality, sewer district, sewerage agency, sponsoring institution or industry, current revision date, and the name of engineer in charge of the project, engineer's registration number, an imprint of registration seal and signature.

b. Plans shall be drawn to a scale which will permit all necessary information to be plainly shown. Numerical and graphical scales in foot-pound-second (FPS or English) system shall be shown. The use of the international system (metric or MKS or meter-kilogram-second) of units is encouraged.

c. All plan views shall indicate a north point, preferably in a standardized direction. A suitable geographical reference for the project shall also be shown. Topographical and elevation data should be presented on a recognized standard datum. Such datum should be clearly indicated.

2. Vicinity and Location Plans. A large scale vicinity map should be provided for a suitable geographical reference to the project. It should also indicate vehicular access to the project.

3. General Site Work Plans.

a. A site plan showing the project lay out should be included to establish a reference to the existing features. Similarly, a reduced-scale site or key plan should be drawn on all drawings to provide the context of work shown on the drawing to the site.

b. For the entire project site, information shall be provided on topography, survey data, location of test borings, limits of work, staging area for contractors, areas of project related site work, and other work that may overlap the areas of concentrated work activities. Information shall be compiled to the extent practicable on utility locations, above and below ground utilities which might interfere with the proposed construction, particularly water mains, gas mains, storm drains, and telephone and power conduits, outside piping, all known existing structures, security improvements, roads, signage, lighting, and other site improvements. Compiled information should be shown on plans.

4. Detailed Plans. Construction to be performed in areas of concentrated work such as individual installations, buildings, rooms or assemblies shall be shown on the detailed plans. Such plans shall show plan views, elevations, sections and supplementary views which, together with the specifications and general layouts, provide the working information for the contract and construction of the works. They shall also include detailed design data in all applicable disciplines, dimensions and relative elevations of structures, the location and outline form of equipment, location size of piping, water levels, water surface and hydraulic profiles, and ground elevations.

B. Plans for Sewers. Construction plans are required to be submitted for projects involving new sewer systems. Projects for substantial additions to the existing systems are required to be submitted only in fulfillment of the requirements of the funding agency. These plans must detail the following information:

1. Geographical Features

a. Topography and elevations. Existing or proposed improvements, streets, the boundaries of all streams and water impoundments, and water surfaces shall be clearly shown. Contour lines at suitable intervals should be included.

b. Streams. The direction of flow in all natural or artificial streams, and high and low water elevations of all water surfaces at sewer outlets shall be shown.

2. Boundaries. The boundary lines of the municipality or the sewer district, and the area to be sewered, shall be shown.

3. Sewers. The plan shall show the location, size and direction of flow of all existing and proposed sanitary sewers draining to the treatment works concerned.

4. Plans and Profiles. Detailed plans and profiles shall be submitted. Profiles should have a horizontal scale of not more than 100 feet to the inch and vertical scale of not more than 10 feet to the inch. Plan views should be drawn to a corresponding horizontal scale and preferably be shown on the same sheet. Plans and profiles shall show:

a. Location of streets and sewers;

b. ground surface; size of pipe; length between manholes; manhole identifiers, such as numbers etc.; invert and surface elevation at each manhole; and grade of sewer between each two adjacent manholes;

c. the elevation and location of the basement floor on the profile of the sewer, showing feasibility to serve adjacent basements except where otherwise noted on the plans; and

d. Locations of all special features such as inverted siphons, concrete encasements, elevated sewers, special construction to implement proper separation from water mains etc.

5. Detailed drawings, made to a scale to clearly show the nature of the design, shall be furnished to show the following particulars:

a. all stream crossings and sewer outlets, with elevations of the stream bed and of normal and extreme high and low water levels;

b. details of all special sewer joints, pipeline construction or installation, and cross-sections; and

c. details of all sewer appurtenances such as manholes, inspection chambers, inverted siphons, regulators, flow measurement or control stations and elevated sewers.

C. Plans for Pumping Stations. Construction plans shall be submitted for construction or modifications of pumping stations having the installed capacity in excess of 1 million gallons per day (3,785 cubic meters per day). These plans must detail the following information besides vicinity, site and location, and engineering information required:

1. Vicinity, Site and General Site Work Plans

a. the location and extent of the tributary area;

b. any municipal boundaries within the tributary area;

c. the location of the pumping station and force main, and pertinent elevations; and

d. availability of power sources, including alternative sources.

2. Detailed Plans. Detailed plans shall be submitted showing the following:

a. topography of the site with all pertinent elevations;

b. soils or foundation report;

c. existing pumping station with all adjacent improvements;

d. proposed pumping station, including provisions for installation of future pumps or ejectors, emergency power generation, and other reliability features;

e. maximum hydraulic gradient including calculations in downstream gravity sewers when all installed pumps are in operation; and

f. elevation of high water at the site, and maximum elevation of sewage in the collection system upon occasion of power failure.

D. Plans for Treatment Plants. Construction plans shall be submitted for construction or modifications of treatment plants. These plans must detail the following information besides vicinity, site and location, and engineering information required:

1. Location Plan. A plan shall be submitted showing the treatment plant in relation to the remainder of the system.

2. General Layout. Layouts of the proposed treatment plant shall be submitted, showing:

a. topography of the site;

b. size and location of plant structures, and adjacent improvements;

c. schematic flow diagram(s), including mass balance, showing the flow through various plant units, and showing utility systems serving the plant processes;

d. outside or yard piping, including any arrangements for bypassing individual units (Materials handled and direction of flow through pipes shall be shown.); and

e. hydraulic profiles, including calculations, showing the flow of the major liquid or solid process streams including raw or treated sewage, supernatant liquor, scum and sludge.

3. Detailed Plans. Detailed plans shall show the following:

a. location, dimensions, and elevations of all existing and proposed plant facilities;

b. elevations of a 100-year water level of the body of water to which the plant effluent is to be discharged;

c. type, size, pertinent features, and operating capacity of all pumps, blowers, motors, and other mechanical devices;

d. schematics, sectional or isometric views of all process and utility piping not shown on the General Site Work Plans;

e. hydraulic profile at the minimum, average, and maximum rate of flow; and

f. description of any features not otherwise covered by other drawings or specifications or engineer's report.

1.5. Technical Specifications. Complete technical specifications for the construction of sewers, pumping stations, treatment plants, and all other appurtenances, shall accompany the plans. The specifications accompanying construction drawings shall include all construction information not shown on the drawings which is necessary to inform the builder in detail of the design requirements for the quality of materials, workmanship and fabrication of the project. They shall also include: the type, size

strength, operating characteristics, and rating of equipment; allowable infiltration; the complete requirements for all mechanical and electrical equipment, including machinery, valves, piping, and jointing of pipe; electrical apparatus, wiring, instrumentation, and meters; laboratory fixtures and equipment; operating tools, construction materials; special filter materials, such as, stone, sand, gravel, or slag; miscellaneous appurtenances; chemicals when used; instructions for testing materials and equipment as necessary to meet design standards; and performance tests for the completed work and component units. Performance tests must be conducted at design load conditions wherever practical.

1.6. Revisions to the Approved Plans and Specifications. Any changes, such as addenda, change orders, field change etc., to the approved plans or specifications affecting capacity, flow, operation of units, or point or quality of discharge shall be submitted for review and approval before any such change is made in either contract documents or construction. Plans or specifications proposed to be so revised must, therefore, be submitted at least 30 days in advance of any construction work which will be affected by such changes to permit sufficient time for review and approval. Changes under emergency conditions may be communicated verbally, and then submitted in writing. Structural revisions or other minor changes not affecting capacities, flows, or operation are to be permitted during construction without approval.

1.7. Construction Supervision. The applicant must demonstrate that adequate and competent inspection will be provided during construction. It is the responsibility of the applicant to provide frequent and comprehensive inspection of the project.

1.8. Plan of Operation

A. Submittal. A plan of operation must be prepared at the mid-point of construction, but no later than at the time of 80 percent completion of construction, unless waived by the executive secretary on the basis of funding program requirements, and the scope and the complexity of the project.

B. Contents of the Plan. The plan of operation must provide a concise, sequential description of and implementation schedule for the following activities:

1. hiring and training of operators;

2. start-up schedules and services;

3. safety programs, plans and procedures;

4. emergency operations procedures and plan;

5. process monitoring program;

6. laboratory and testing services;

7. user charge and pretreatment program, necessary to assure cost-effective, efficient and reliable startup and operation of the facility, future expansion and upgrade; and

8. maintenance of water quality and public health.

1.9. Operation and Maintenance Manual

A. Submittal. A draft of the manual must be submitted at the mid-point of construction, unless waived by the executive secretary on the basis of funding program requirements, and the scope and the complexity of the project. Final draft must be submitted for review and approval, no later than at the 90 percent stage of construction in the final form or 30 days prior to startup, whichever occurs first.

B. Contents of the Manual

1. The manual presents procedures to facilitate operation and maintenance of the plant under all conditions, technical guidance for troubleshooting, and requirements for compliance with the permits and approvals issued. The manual must address the needs of the system being employed and must be directed toward the level of training required of the operating staff.

2. The manual must include all information pertinent for the facilities besides information from manufacturers' catalogs or brochures.

1.10. Start-up

A. Certificate of Completion. The engineer in charge of construction management or inspection of the approved project or facilities shall submit a certificate, bearing the seal of the professional engineer, to the effect that the facilities were constructed in accordance with approved plans, specifications, addenda and change orders to the owner with a copy thereof to the division.

B. Authorization to Operate. The applicant will request a final inspection the division upon receipt of the certificate of completion. No facilities may be placed in service before the final inspection by the division, and authorization to operate the facility is issued in writing by the executive secretary.

C. As-built or Record Drawings.

1. Within 30 days of acceptance by the owner of wastewater or industrial waste facilities from the contractor, a copy of such acceptance must be submitted to the division for record.

2. As-built or record drawings clearly showing the as-built project shall be submitted to the executive secretary within 120 days after the completion of the construction of the approved project or facilities.

1.11. Operation During Construction

A. Construction-related Bypass. Operation of all existing sewers, pump stations, and treatment plants must continue without interruption during the construction of new facilities or modification of existing facilities. Therefore, bypassing will not be allowed except under extenuating circumstances. If this is not possible and construction will result in the discharge of partially treated and untreated sewage into the surface waters of the state, an approval for such a discharge shall be required from the executive secretary before such discharge occurs.

B. Request for a Construction-related Bypass. A formal request for the consideration of a construction-related bypass shall be submitted to the executive secretary by the permittee not less than 90 days prior to the date of proposed bypass initiation. Such request shall contain at least the following information:

1. a detailed description of the construction work to be performed which the owner has deemed warrants a bypass;

2. an analysis of all known alternatives which would eliminate or reduce the need for plant bypassing;

3. cost-benefit and effective analysis of alternatives, including an assessment of resource damages;

4. the minimum and maximum duration of bypassing under each alternative;

5. the applicant's preferred alternative for conducting the bypass;

6. the projected date of initiation of bypass.

C. Approval or Denial of a Construction-related Bypass

1. The request for a construction-related bypass will be approved or denied following a thorough review with due consideration of compliance with the discharge permit(s); water quality standards; and all known available and reasonable methods to abate water pollution.

2. An approval issued to permit bypass will contain all restrictions necessary to minimize the duration of bypassing. A denial determination will state the reasons for the denial and will direct the permittee to initiate a plan of action to implement an alternative to bypassing.

1.12. Innovative Processes Evaluation

A. Basic requirements. The executive secretary will consider the evaluation of innovative approaches to wastewater treatment in the interest of encouraging advances in technology, processes, equipment and material not covered by this rule, provided that:

1. a favorable recommendation has been made by a professional engineer licensed to practice in Utah, following his own evaluation of developmental processes or equipment or material, for a specific project;

2. the applicant has capital and technical resources to replace or modify developmental processes, equipment and material with conventional processes, equipment and material;

3. the risk incurred with the experimentation rests solely with the proponent of processes, equipment and material as evidenced by the written acknowledgement to the executive secretary; and

4. the applicant will replace the failed processes, equipment and material with a proven conventional processes, equipment and material as evidenced by the written acknowledgement to the executive secretary.

B. Approval Limitations

1. The executive secretary may approve developmental processes, equipment and material may be approved in the form of terms and conditions to a construction permit, when reliable operating data from full scale installations are not available. The term and conditions may include such as, but not necessarily limited to, demonstration period for a successful application, requirements to submit reports on the operation of the system during the experimental period.

2. The executive secretary may limit the number of approvals for the same developmental processes, equipment and material until reliable and valid operational experience is gained.

C. Evaluation Criteria. The evaluation of innovative processes will include the following factors:

1. anticipated performance of the system in full scale field conditions,

2. ability to consistently meet required effluent and water quality standards,

3. any evidence of equivalence to conventional technology,

4. the owner's ability to finance, and to operate and maintain the system with the level of expertise necessary, and

5. submission of process descriptions, schematics, reports, monitoring and performance data, costs, specific studies, bench scale test data and pilot plant test data, and any other information appropriate and necessary for the evaluation.

R317-3-2. Sewers.

2.1. General. Construction of a new sewer system project may not begin unless the applicant has submitted an engineering report detailing the design, and construction plans to the executive secretary for review and approval evidenced by a construction permit. The executive secretary will not normally review construction plans for extensions of the existing sewer systems to new areas or replacement of sanitary sewers in the existing sewer systems unless requested or required by state or federal funding programs. Rain water from roofs, streets, and other areas, and ground water from foundation drains must not be allowed to enter the sewer system through planning, design and construction quality assurance and control measures.

2.2. Basis of Design

A. Planning Period. Sewers should be designed for the estimated ultimate tributary population or the 50-year planning period, whichever requires a larger capacity. The executive secretary may approve the design for reduced capacities provided the capacity of the system can be readily increased when required. The maximum anticipated capacity required by institutions, industrial parks, etc. must be considered in the design.

B. Sewer Capacity. The required sewer capacity shall be determined on the basis of maximum hourly domestic sewage flow; additional maximum flow from industrial plants; inflow; ground water infiltration; potential for sulfide generation; topography of area; location of sewage treatment plant; depth of excavation; and pumping requirements.

1. Per Capita Flow. New sewer systems shall be designed on the basis of an annual average daily rate of flow of 100 gallons per capita per day (0.38 cubic meter per capita per day) unless there are data to indicate otherwise. The per capita rate of flow includes an allowance for infiltration/inflow. The per capita rate of flow may be higher than 100 gallons per day (0.38 cubic meter per day) if there is a probability of large amounts of infiltration/inflow entering the system.

2. Design Flow

a. Laterals and collector sewers shall be designed for 400 gallons per capita per day (1.51 cubic meters per capita per day).

b. Interceptors and outfall sewers shall be designed for 250 gallons per capita per day (0.95 cubic meter per capita per day), or rates of flow established from an approved infiltration/inflow study.

c. The executive secretary will consider other rates of flow for the design if such basis is justified on the basis of supporting documentation.

C. Design Calculations. Detailed computations, such as the basis of design and hydraulic calculations showing depth of flow, velocity, water surface profiles, and gradients shall be submitted with plans.

2.3. Design and Construction Details

A. Minimum Size

1. No gravity sewer shall be of less than eight inches (20 centimeters) in diameter.

2. A 6-inch (15 centimeters) diameter pipe may be permitted when the sewer is serving only one connection, or if the applicant justifies the need for such diameter on the basis of supporting documentation.

B. Depth. Sewers should be sufficiently deep to receive sewage from basements and to prevent freezing. Insulation shall be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

C. Odor and Sulfide Generation. The design shall incorporate features to control and mitigate odor and sulfide generation in sewers. Such features may include steeper slope to achieve higher velocity, reaeration through induced turbulence, etc.

D. Slope

1. The pipe diameter and slope shall be selected to obtain velocities to minimize settling problems.

2. All sewers shall be designed and constructed to give mean velocities of not less than 2 feet per second (0.61 meter per second), when flowing full, based on Manning's formula using an n value of 0.013.

3. Sewers shall be laid with uniform slope between manholes.

4. Table R317-3-2.3(D)(4) shows the minimum slopes which shall be provided; however, slopes greater than these are desirable.

E. Flatter Slopes. Slopes flatter than those required for the 2-feet-per-second (0.61 meter per second)-velocity criterion when flowing full, may be permitted by the executive secretary provided that:

1. there is no other practical alternative;

2. the depth of flow is not less than 30 percent of the diameter at the average design rate of flow;

3. the design engineer has furnished with the report the computations showing velocity and depth of flow corresponding to the minimum, average and peak rates of flow for the present and design conditions in support of the request for variance; and

4. the operating authority of the sewer system submits a written acknowledgement of the ability to provide any additional sewer maintenance required by flatter slopes.

F. Steep Slopes

1. Where velocities greater than 15 feet per second (4.6 meters per second) are attained, special provision shall be made to protect against displacement by erosion and shock.

2. Sewers on 20 percent slopes or greater shall be anchored securely against lateral and axial displacement with suitable thrust blocks, concrete anchors or other equivalent restraints, spaced as follows:

a. Not over 36 feet (11 meters) center to center on grades 20 percent and up to 35 percent;

b. Not over 24 feet (7.3 meters) center to center on grades 35 percent and up to 50 percent;

c. Not over 16 feet (4.9 meters) center to center on grades 50 percent and over.

G. Alignment. Sewers 24 inches (61 centimeters) in diameter or less shall be laid with a straight alignment between manholes. The alignment shall be checked by either using a laser beam or lamping.

H. Changes in Pipe Size. When a smaller sewer joins a large one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.

I. Materials

1. The material of pipe selected should be suitable for local conditions. The material of sewer pipe should be compatible with factors such as industrial wastewater characteristics, putrecibility, physical and chemical properties of adjacent soil, heavy external loading, etc.

2. The material of pipe must withstand superimposed loads without any damage. The design of trench widths and depths should allow for loads. Special bedding, concrete cradle or encasement, or other special construction may be used to withstand extraordinary superimposed loading.

2.4. Curved Sewers. Curved sewers are permitted only under circumstances where conventional sewer construction is not feasible. A conceptual approval must be obtained before beginning the design.

A. Design

1. The minimum radius of curvature shall be greater than 200 feet or one-half of the maximum deflection angle for the material of pipe allowed by the manufacturer.

2. The design n value for the sewer pipe shall be 0.018.

3. Only one horizontal curve in the sewer alignment will be allowed between manholes. No vertical curves shall be permitted.

4. Manhole spacing shall not exceed 400 feet (122 meters).

5. Manholes must be provided at the beginning and the end of a curved alignment (i.e. change in radius of curvature).

6. The design should consider increased erosion potential due to high velocities.

B. Other Requirements

1. Maintenance equipment shall be available at all times for inspection and cleaning.

2. Horizontal and vertical alignment of the sewer after the construction must be verified and certified by a registered professional engineer.

a. Accurate record or as-built drawings must be prepared showing the physical location of the pipe in the ground, and submitted to the division in accordance with the requirements of R317-3-1.

2.5. Installation Requirements

A. Standards

1. The technical specifications shall require that installation be in accordance with the requirements based on the criteria, standards and procedures established by:

a. this rule;

b. recognized industry standards and practices as published in their technical publications;

c. the product manufacturer's recommendations and guidance;

d. Uniform Building Code, Uniform Plumbing Code, Uniform Mechanical Code and National Electrical Code;

e. American Society of Testing Materials;

f. American National Standards Institute; and

g. Occupational Safety and Health Administration (OSHA), US Department of Labor or its succeeding agencies.

2. Requirements shall be set forth in the specifications for the pipe and methods of bedding and backfilling thereof so as not to damage the pipe or its joints, impede cleaning operations and future tapping, nor create excessive side fill pressures or ovalation of the pipe, nor seriously impair flow capacity.

B. Identification of Sewer Lines. A clearly labelled tracer location tape shall be placed two feet above the top of sewer lines less than or equal to 24 inch (61 centimeters) in diameter, along its entire length.

C. Deflection Test

1. Deflection test shall be performed on all flexible pipes. The test shall be conducted after the final backfill has been in place at least 30 days.

2. No pipe shall show a deflection in excess of 5 percent.

3. If the deflection test is run using a rigid ball or mandrel, it shall have a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.

D. Joints and Infiltration

1. Joints. The installation procedures of joints and the materials to be used shall be included in the specifications. Sewer joints shall be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.

2. Leakage Tests. Procedures for leakage tests shall be specified. This may include appropriate water or low pressure air testing. The leakage outward or inward (exfiltration or infiltration) shall not exceed 200 gallons per inch of pipe diameter per mile per day (0.19 cubic meter per centimeter of pipe diameter per kilometer per day) for any section of the system. An exfiltration or infiltration test shall be performed with a minimum positive head of 2 feet (0.61 meter). The air test, if used, shall, as a minimum, conform to the test procedure described in the American Society of Testing Materials standards. The testing methods selected should take into consideration the range in ground water elevations projected during the test.

E. Inspection

1. The specifications shall include requirements for inspection of manholes for water-tightness prior to placing in service, including television inspection.

2. Records of television inspection shall be retained for future reference.

2.6. Manholes

A. Location. Manholes shall be installed at:

1. the end of each line exceeding 150 feet (46 meters) in length;

2. all changes in grade, size, or alignment;

3. all intersections; and

4. distances not greater than:

a. 400 feet (120 meters) for sewers 15 inches (38 centimeters) or less; and

b. 500 feet (150 meters) for sewers 18 inches (46 centimeters) to 30 inches (76 centimeters).

5. Distances up to 600 feet (180 meters) may be approved in cases where adequate cleaning equipment for such spacing is provided.

6. Greater spacing may be permitted in larger sewers.

7. Cleanouts shall not be substituted for manholes nor installed at the end of lines greater than 150 feet (46 meters) in length.

B. Drop Type Manholes

1. A drop pipe should be provided for a sewer entering a manhole at an elevation of 24 inches (61 centimeters) or more above the manhole invert. Where the difference in elevation between the incoming sewer and manhole invert is less than 24 inches (61 centimeters), the invert should be filleted to prevent solids deposition.

2. Drop manholes should be constructed with an outside drop connection. If an inside drop connections is necessary, it shall be secured to the interior wall of the manhole and provide access for cleaning.

3. Due to the unequal earth pressures that would result from the backfilling operation in the vicinity of the manhole, the entire outside drop connection shall be encased in concrete.

C. Diameter. The minimum diameter of manholes shall be 48 inches (1.22 meters); larger diameter manholes are preferable for large diameter sewers. A minimum diameter of 22 inches (56 centimeters) shall be provided for safe access.

D. Flow Channel. The flow channel through manholes should be made to conform in shape and slope to that of the sewers. The depth of flow channels should be up to one-half to three-quarters of the diameter of the sewer. Adjacent floor area should drain to the channel with the minimum slope of 1 inch per foot (8.3 centimeters per meter).

E. Watertightness

1. Manholes shall be of the pre-cast concrete or poured-in-place concrete type. Manholes shall be waterproofed on the exterior.

2. Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.

3. Watertight manhole covers shall be used wherever the manhole tops may be flooded by street runoff or high water. Locked manhole covers may be desirable in isolated easement locations or where vandalism may be a problem.

F. Electrical. Electrical equipment installed or used in manholes shall conform to appropriate National Electrical Code requirements.

2.7. Inverted Siphons. Inverted siphons shall consist of at least two barrels, with a minimum pipe size of 6 inches (15 centimeters) with an arrangement to exclude debris and solids. The siphon shall be provided with necessary appurtenances for convenient flushing and maintenance. The manholes shall have adequate clearances for rodding; and in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least 3.0 feet per second (0.92 meter per second) for average flows. The inlet and outlet details shall be so arranged that the normal flow is diverted to 1 barrel, and that either barrel may be cut out of service for cleaning. The vertical alignment should permit cleaning and maintenance.

2.8. Sewers In Relation To Streams

A. Location of Sewers on Streams

1. The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. In general, the following cover requirements must be met:

a. one foot (30 centimeters) of cover is required where the sewer is located in bedrock;

b. three feet (90 centimeters) of cover is required in other material;

c. cover in excess of 3 feet (90 centimeters) may be required in streams having a high erosion potential; and

d. in paved stream channels, the top of the sewer must be placed below the bottom of the channel pavement.

2. If the proposed sewer crossing will not interfere with the future improvements to the stream channel, then reduced cover may be permitted.

B. Horizontal Location. Sewers shall be located along streams outside of the stream bed and sufficiently removed therefrom to provide for future possible stream widening and to prevent pollution by siltation during construction.

C. Structures. The sewer outfalls, headwalls, manholes, gate boxes, or other structures shall be located so they do not interfere with the free discharge of flood flows of the stream.

D. Alignment

1. Sewers crossing streams should be designed to cross the stream as nearly at right angles to the stream flow as possible, and shall be free from change in grade.

2. Sewer systems shall be designed to minimize the number of stream crossings.

E. Construction

1. Materials. Sewers entering or crossing streams shall be constructed of cast or ductile iron pipe with mechanical joints; otherwise they shall be constructed so they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials which will not cause siltation.

2. Siltation and Erosion. Construction methods that will minimize siltation and erosion shall be employed. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams to provide adequate control of siltation and erosion. Specifications shall require that cleanup, grading, seeding, and planting or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected for more than seven days.

F. Aerial Crossings

1. A carrier pipe shall be provided for all aerial sewer crossings. Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent frost heave, overturning and settlement.

2. Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between above-ground and below-ground sewers.

3. The design engineer shall consider the impact of flood waters and debris for aerial stream crossings. The bottom of the pipe should be placed below the elevation of twenty-five (25) year flood. Crossings, in no case, shall block the channel.

2.9. Protection of Water Supplies. The applicant must review the requirements stated in R309-112-2 - Distribution System Rules, Drinking Water and Sanitation Rules, to assure compliance with the said rule.

A. Water Supply Interconnections. There shall be no physical connections 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 supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

B. Relation to Water Mains

1. Horizontal Separation

a. Sewers shall be laid at least 10 feet (3.0 meters) horizontally from any existing water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten foot separation, a deviation may be allowed based on the supportive data from the design engineer. Such deviation may allow installation of the sewer closer to a water main, provided that the sewer is laid:

(1) in a separate trench, or

(2) on an undisturbed earth shelf located on one side of the sewer trench, or

(3) in the sewer trench which has been backfilled and compacted to not less than 95 percent of the optimum density as determined by the ASTM Standard D-690, as amended, and

b. In each of the above cases, the bottom of the water main shall be at least 18 inches (46 centimeters) above the top of the sewer.

2. Crossings. Sewers crossing above water mains shall be laid to provide a minimum vertical distance of 18 inches (46 centimeters) between the outside of the water main and the outside of the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.

3. Special Conditions. When it is impossible to obtain proper horizontal and vertical separation as stated above, the sewer shall be designed and constructed of cast iron, ductile iron, galvanized steel or protected steel pipe with mechanical joints for the minimum distance of 10 feet on either side of the point of crossing. The design engineer may use other types of joints if equivalent joint integrity is demonstrated. The lines shall be pressure tested to assure watertightness before backfilling.

R317-3-3. Sewage Pumping Stations.

3.1. General. Sewage pumping station structures, and electrical and mechanical equipment shall be protected from physical damage that would be caused by a 100-year flood. Sewage pumping stations must remain fully operational and accessible during a 25-year flood.

3.2. Design

A. Pumping Rates. The pumps and controls of main pumping stations, and especially pumping stations pumping to the treatment works or operated as part of the treatment works, should be selected to operate at varying delivery rates to permit discharging sewage at approximately its rate of delivery to the pump station.

B. System - Head Calculation

1. The design engineer shall submit system-head calculations and curves. System-head curves for C values of 100, 120 and 140 in the Hazen William's equation for calculating head loss corresponding to minimum, median and maximum water levels shall be developed.

2. A system-head curve for C value of 120 corresponding to median (normal operating) water level shall be used to make preliminary selection of motor and pump. The pump and motor must operate satisfactorily over the entire range of system-head curves for C values of 100 and 140 corresponding to minimum and maximum water levels intersected by the head-discharge relationship of a given pump.

3. Pumps and motors shall be sized for the 10-year peak flows; preferably the 20-year sewage flow requirements. These operating points shall be shown on the system-head curves.

C. Accessibility. The pumping station shall be readily accessible by maintenance vehicles during all weather conditions. The facility should be located off the traffic way of streets and alleys.

D. Grit. Where it is necessary to pump sewage before grit removal, the design of the wet well and pump station piping shall be such that operational problems from the accumulation of grit are avoided.

E. Odor and Corrosion Control. The pumping station design should incorporate measures for:

1. mitigating the effects of sulfide corrosion to structure and equipment; and

2. effective odor control when a populated area is within close proximity.

F. Structures

1. Dry wells, including their superstructure, shall be completely separated from the wet well.

2. Provision shall be made to facilitate maintenance and removal of pumps, motors, and other mechanical and electrical equipment.

3. Safe means of access and proper ventilation shall be provided to dry wells and to wet wells containing either bar screens or mechanical equipment requiring inspection or maintenance.

a. For built-in-place pump stations, a stairway with rest landings shall be provided at vertical intervals not to exceed 12 feet (3.7 meters). For factory-built pump stations over 15 feet (4.6 meters) deep, a rigidly fixed landing shall be provided at vertical intervals not to exceed 10 feet (3.0 meters). Where a landing is used, a suitable and rigidly fixed barrier shall be provided to prevent an individual from falling past the intermediate landing to a lower level.

b. Where space requirements are insufficient, the design may provide for a manlift or elevator in lieu of landings in a factory-built station if the design includes an emergency access or exit.

c. Local, state and federal safety requirements, including those in applicable fire code, the Uniform Building Code, etc., must be reviewed and complied with. Those requirements, if more stringent than the ones stated above, shall be incorporated in the design.

4. Construction Materials. The materials selected in construction and installation must be safe and able to withstand adverse operating environmental conditions caused by presence of hydrogen sulfide and other corrosive gases, greases, oils, and other constituents frequently present in sewage.

3.3. Pumps and Pneumatic Ejectors

A. Multiple Units

1. At least two pumps or pneumatic ejectors shall be provided. A minimum of three pumps shall be provided for stations handling flows greater than 1 million gallons per day (3,785 cubic meters per day).

2. If only two units are provided, they should have the same capacity. Each shall be capable of handling flows in excess of the expected maximum flow. Where three or more units are provided, they should be designed to fit actual flow conditions and must be of such capacity that with any one of the largest units out of service, the remaining units shall have capacity to handle maximum sewage flows.

B. Protection Against Clogging

1. Pumps handling sewage from 30 inch (76 centimeters) or larger diameter sewers shall be protected by readily accessible bar racks from clogging or damage.

2. Bar racks should have clear openings not exceeding 1-1/2 inches (6.4 centimeters). The design shall provide for a mechanical hoist.

3. The design engineer shall consider installation of mechanically cleaned and duplicate bar racks in the pumping stations handling larger than five million gallons per day (18,900 cubic meters per day) rate of flow.

4. Small pumping stations pumping less than one million gallons per day (3,785 cubic meters per day) shall be equipped with bar racks or inline grinding devices, etc., to prevent clogging.

C. Pump Openings. Except where grinder pumps are used, pumps shall be capable of passing spheres of at least 3 inches (7.6 centimeters) in diameter, and pump suction and discharge piping shall be at least 4 inches (10.2 centimeters) in diameter.

D. Priming. The pump shall be so placed that it will operate under a positive suction head under normal operating conditions, except for submersible pumping stations.

E. Electrical Equipment. Electrical systems and components (e.g., motors, lights, cables, conduits, switchboxes, and control circuits) in raw sewage wet wells, or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, shall comply with the National Electrical Code requirements for Class 1 Group D, Division 1 locations. In addition, equipment located in the wet well shall be suitable for use under corrosive conditions. Each flexible cable shall be provided with watertight seal and separate strain relief. A fused disconnect switch located above ground shall be provided for all pumping stations. When such equipment is exposed to weather, it shall as a minimum, meet the requirements of weatherproof equipment (NEMA 3R).

F. Intake. Each pump should have an individual intake. Turbulence should be avoided near the intake in wet wells. Intake piping should be as straight and short as possible.

G. Dry Well Dewatering. A separate sump pump equipped with dual check valves shall be provided in dry wells to remove leakage or drainage. Discharge shall be located as high as possible. A connection to the pump suction is also recommended as an auxiliary feature. Water ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces should have an adequate slope to a point of drainage. Pump seal water shall be piped to the sump.

H. Controls

1. Type. Control systems for liquid level monitoring shall be of the air bubbler type, the capacitance type, the encapsulated float type, or the non-contact type. The selection of type of controls must be based on wastewater characteristics and other site related conditions. The executive secretary may approve the existing float- tube control systems on pumping stations being upgraded. The electrical equipment shall comply with the National Electrical Code requirements for Class I, Group D, Division 1 locations.

2. Location. The level control system shall be located away from the turbulence of incoming flow and pump suction.

3. Alternation. The design engineer must consider automatic alternation of the sequencing of pumps in use.

I. Valves

1. Suction Line. An isolation valve shall be placed on the suction line of each pump except on submersible pumps.

2. Discharge Line

a. Isolation and check valves shall be placed on the discharge line of each pump. The check valve shall be located between the isolation valve and the pump.

b. Check valves shall not be placed in the vertical run of discharge piping unless the valve is designed for that specific application.

c. Ball valves may be permitted in the vertical runs.

d. All valves shall be suitable for the material being handled, and capable of withstanding normal operating pressure and water hammer.

e. Where limited pump backspin will not damage the pump and low discharge head conditions exist, a short individual force main for each pump, may be approved by the executive secretary in lieu of a discharge manifold.

3. Location. Valves shall not be located in wet well. They shall be located in a dry well adjacent to the pumps or in an adjacent isolated pit appropriately protected from physical, weather or freezing damage, with proper access for operation and maintenance.

J. Wet Wells

1. Divided Wells. Wet well should be divided into multiple sections, properly interconnected, to facilitate repairs and cleaning, and non-turbulent hydraulic operating condition to each pump inlet.

2. Size. The wet well size and level control settings shall be appropriate to avoid heat buildup in the pump motor due to frequent starting (short cycling), and septic conditions due to excessive detention time.

3. Floor Slope. The wet well floor shall have a minimum slope of one to one to the hopper bottom. The horizontal area of the hopper bottom shall be not greater than necessary for proper installation and function of the pump inlet.

K. Ventilation. All pump stations must be ventilated to maintain safe operating environment. Where the pump pit is below the ground surface, mechanical ventilation is required, so arranged as to independently ventilate the dry well and the wet well if screens or mechanical equipment requiring maintenance or inspection are located in the wet well. There shall be no interconnection between the wet well and dry well ventilation systems. In pits over 15 feet (4.6 meters) deep, multiple inlets and outlets are recommended. Dampers should not be used on exhaust or fresh air ducts. Fine screens or other obstructions in air ducts should be avoided to prevent clogging. Switches for operation of ventilation equipment should be marked and located for convenient operation from outside of the enclosed environment. All intermittently operated ventilating equipment shall be interconnected with the respective pit lighting system. Automatic controls are recommended for intermittently ventilated pump stations. Fan parts should be of non-corrosive material. All parts adjacent to moving ones should be of non-sparking materials. Consideration should be given to installation of automatic heating and dehumidification equipment.

1. Wet Wells. Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 12 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Ventilating equipment should force air into wet well rather than exhaust it from wet well.

2. Dry Wells. Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 6 complete air changes per hour; if intermittent, at least 30 complete air changes per hour.

L. Flow Measurement. Continuous measuring and recording of sewage flow shall be provided at all pumping stations with a design pumping capacity greater than one million gallons per day (3,785 cubic meters per day).

M. Water Supply. There shall be no physical connection between any potable water supply and a sewage pumping station which under any condition might cause contamination of the potable water supply. The potable water supply to a pumping station shall be protected against cross connection or backflow.

3.4. Self-Priming Pumps. Self-priming pumps shall be capable of rapid priming and repriming at the lead pump on elevation. Such self-priming and repriming shall be accomplished automatically under design operating conditions. Suction piping should not exceed the size of the pump suction and shall not exceed 25 feet (7.6 meters) in total length. Priming lift at the lead pump on elevation shall include a safety factor of at least 4 feet (1.2 meters) from the maximum allowable priming lift for the specific equipment at design operating conditions. The combined total of dynamic suction lift at the pump off elevation and required net positive suction head at design operating conditions shall not exceed 22 feet (6.7 meters).

3.5. Submersible Pump Stations. Submersible pump stations may be used for flows less than 0.25 million gallons per day (946 cubic meters per day). The executive secretary may approve submersible pump stations for flows greater than 0.25 million gallons per day (946 cubic meters per day), based on operational, reliability and maintenance considerations. The submersible pumps stations shall meet the design requirements stated above, except as modified in this section.

A. Construction. Submersible pumps and motors shall be designed specifically for raw sewage use, including totally submerged operation during a portion of each pumping cycle. An effective method to detect shaft seal failure or potential seal failure shall be provided, and the motor shall be of squirrel-cage type design without brushes or other arc-producing mechanisms.

B. Pump Removal. Submersible pumps shall be readily removable and replaceable without dewatering the wet well or disconnecting any piping in the wet well.

C. Electrical

1. Power Supply and Control. Electrical supply, control and alarm circuits shall be designed to allow for disconnection of the equipment from outside and inside of pumping station. Terminals and connectors shall be protected from corrosion by location outside of wet well or through use of watertight seals. If located outside of the pumping station, weatherproof equipment shall be used.

2. Controls. The motor control center shall be located outside of the wet well and be protected by a conduit seal or other appropriate measures meeting the requirements of the National Electrical Code, to prevent the atmosphere of the wet well from gaining access to the control center. The seal shall be so located that the motor may be removed and electrically disconnected without disturbing the seal.

3. Power Cord. Pump motor power cords shall be designed for flexibility and serviceability under severe service conditions and shall meet the requirements of the Mine Safety and Health Administration for trailing cables. Ground fault interruption protection shall be used to deenergize the circuit in the event of any failure in the electrical integrity of the cable. Power cord terminal fittings shall be corrosion-resistant and constructed in a manner to prevent the entry of moisture into the cable, shall be provided with strain relief appurtenances, and shall be designed to facilitate field connecting.

3.6. Valves. Valves shall be located in a separate valve pit. Accumulated water shall be drained to the wet well or the soil. If the valve pit is drained to the wet well, an effective method shall be provided to prevent sewage gases and liquid from entering the pit during surcharged wet well conditions.

3.7. Alarm Systems.

A. Alarm systems shall be provided for pumping stations. The alarm shall be activated in cases of power failure, high water level in dry or wet well, pump failure, use of the lag pump, air compressor failure, or any other pump malfunction.

B. Pumping station alarms shall be telemetered, including identification of the alarm condition, to the operating agency's facility that is manned 24 hours a day. If such a facility is not available and 24-hour holding capacity is not provided, the alarm shall be telemetered to the operating agency's facility during normal working hours and to the home of the person(s) responsible for the lift station during off-duty hours.

C. The executive secretary may approve audio-visual alarm systems with a self-contained power supply in lieu of the telemetering system outlined above, depending upon location, station holding capacity and inspection frequency.

3.8. Emergency Operation

A. Pumping stations and collection systems shall be designed to prevent bypassing of raw sewage and backup into the sewer system. For use during possible periods of extensive power outages, mandatory power reductions, or uncontrolled storm events, a controlled high-level wet well overflow or emergency power generator shall be provided. Where a high level overflow is utilized, storage or retention tanks, or basins, shall be provided having at least a 2-hour retention capacity at the anticipated overflow rate.

B. The applicant must review the requirements of R317-6 (Ground Water Quality Protection Rule) for compliance with the said rule for earthen retention basins.

C. The operating agency shall provide:

1. an in-place or portable pump, driven by an internal combustion engine or an emergency generator capable of pumping from the wet well to the discharge side of the station for pump stations with a capacity in excess of one million gallons per day (3,785 cubic meters per day), and

2. an engine-driven generating equipment or an independent source of electrical power or emergency generators capable of pumping from the wet well to the discharge side of the station for pump stations with a capacity in excess of five million gallons per day (18,925 cubic meters per day).

3.9. Auxiliary and Emergency Equipment Requirements

A. General. The following general requirements shall apply to all internal combustion engines used to drive auxiliary pumps, service pumps through special drives, or electrical generating equipment.

1. Engine Protection. The engine must be protected from damaging operating conditions. Protective equipment shall shut down the engine and activating an alarm on site unless continuous manual supervision is planned. Protective equipment shall monitor for conditions of low oil pressure and overheating, Oil pressure monitoring is not required for engines with splash lubrication.

2. Size. The engine shall have adequate rated power to start and continuously operate all connected loads.

3. Fuel Type. The type of fuel must be carefully selected for maintaining reliability and ease of starting, especially during cold weather conditions. Unused fuel from the fuel storage tank should be removed annually, and the tank refilled with fresh fuel.

4. Engine Ventilation. The engine shall be located above grade with adequate ventilation of fuel vapors and exhaust gases.

5. Routine Start-up. All emergency equipment shall be provided with instructions indicating the need for regular starting and running of such units at full loads.

6. Protection of Equipment. Emergency equipment shall be protected from damage at the restoration of regular electrical power.

B. Engine-Driven Pumping Equipment. Where permanently installed or portable engine-driven pumps are used, the following requirements in addition to general requirements apply:

1. Pumping Capacity. Engine-driven pump(s) shall be capable of pumping at the design pumping rates unless storage capacity is available for flows in excess of pump capacity. Pumps shall be designed for anticipated operating conditions, including suction lift if applicable.

2. Operation. Provisions shall be made for automatic and manual start-up and load transfer. The pump must be protected against damage from adverse operating conditions. Provisions should be considered to allow the engine to start and stabilize at operating speed before assuming the load. Where manual start-up and transfer is justified, storage capacity and alarm system must meet the requirements stated hereinabove.

3. Portable Generating Equipment. Where portable generating equipment or manual transfer of power to the pumping equipment is provided, sufficient storage capacity shall be provided in the design of pumping station, to allow time for detection

of pump station failure and transportation and connection of generating equipment. The use of special electrical connections and double throw switches are recommended for connecting portable generating equipment.

3.10. Instructions and Equipment

A. Sewage pumping stations and their operators must be supplied with a complete set of operational instructions, including emergency procedures, maintenance schedules, special tools, and necessary spare parts.

B. Local, state and federal safety requirements, including those in applicable fire code, the Uniform Building Code etc., must be reviewed and complied with. Those requirements take precedence over the foregoing requirements, if more stringent, and should be incorporated in the design.

3.11. Force Mains

A. Velocity. A velocity of not less than 2 feet per second (0.61 meter per second) shall be maintained at the average design flow, to avoid septic sewage and resulting odors.

B. Air Relief Valve. An automatic air relief valve shall be placed at high points in the force main to prevent air locking.

C. Termination. Force mains should enter the gravity sewer system at a point not more than 2 feet (30 centimeters) above the flow line of the receiving manhole.

D. Design Pressure. The force main and fittings, including reaction blocking, shall be designed to withstand normal pressure and pressure surges (water hammer).

E. Special Construction. Force main construction near streams or used for aerial crossings shall meet the requirements stated in Sewers.

F. Design Friction Losses

1. Friction losses through force mains shall be based on the Hazen and Williams formula or other hydraulic analysis to determine friction losses. When the Hazen and Williams formula is used, the design shall be based on the value of C equal to 120; for unlined iron or steel pipe the value of C equal to 100 shall be used.

2. When initially installed, force mains will have a significantly higher C factor. The higher C factor should be considered only in calculating maximum power requirements.

G. Separation from Water Main. The applicant or the design engineer must review the requirements stated in R309-112.2 - Distribution System rules, Drinking Water and Sanitation Rules, to assure compliance with the said rule.

H. Identification. A clearly labelled tracer location tape shall be placed two feet above the top of force mains less than or equal to 24 inch (61 centimeters) in diameter, along its entire length.

R317-3-4. Treatment Works.

4.1. Plant Location

A. The treatment plant structures and all related equipment shall be protected from physical damage by the 100-year flood. Treatment works must remain fully operational and accessible during the 25-year flood.

B. These conditions shall apply to all new facilities under construction as well as the existing facilities being expanded, upgraded or modified.

4.2. Quality of Effluent. The effluent requirements and water quality standards established in the discharge permit, R317-1 (Definitions and General Requirements), R317-2 (Standards of Quality for Waters of the State) shall be used to determine the required degree of wastewater treatment, and unit processes and operations.

4.3. Design

A. Basis of Design. The plant design shall be based on the higher value of:

1. a moving average of daily rates of flow and wastewater strength as measured by five-day biochemical oxygen demand (BOD_5) and suspended solids determination tests over a period of 30 consecutive days; or

2. an average of values rate of flow and wastewater strength as measured by five-day biochemical oxygen demand (BOD_5) and suspended solids determination tests, over a period of month; or

3. the rate of flow and wastewater strength as measured by five-day biochemical oxygen demand (BOD_5) and suspended solids determination tests, equal to or greater than 92 percent of the daily flow rate and wastewater strength data.

B. Hydraulic Design. The hydraulic capacities of all units and conveyance structures shall be computed and checked for the maximum and average design rates of flow with one largest unit out of service. No overtopping of any structure under any condition shall be permitted.

1. New Systems. The design for sewage treatment plants shall be based upon an average daily per capita flow of 100 gallons (0.38 cubic meter) unless the applicant provides and justifies a better estimate of flow based on water use data. An allowance shall be made in the design for industrial wastewaters and rates of infiltration/inflow.

2. Existing Systems. For an existing system, the applicant may use the data based on both dry- weather and wet-weather conditions. The data over a minimum period of one year shall be taken as the basis for the design.

C. Organic Design

1. New System Design

a. Domestic waste treatment design shall be on the basis of at least 0.17 pounds (0.08 kilogram) or 200 milligrams per liter of BOD_5 per capita per day and 0.20 pounds (0.09 kilogram) or 250 milligrams per liter of suspended solids per capita per day, unless information is submitted to justify alternate designs.

b. When garbage grinders are used in areas tributary to a domestic treatment plant, the design basis may be increased to 0.22 pounds (0.10 kilogram) or 260 milligram per liter of BOD_5 per capita per day and 0.25 pounds (0.11 kilogram) or 300 milligram per liter of suspended solids per capita per day.

c. An allowance shall be made in the design for industrial wastewaters and rates of infiltration/inflow.

d. Other approved methods for measurement of organic strength of wastewater published in Standard Methods for Examination of Water and Wastewater, jointly prepared by American Public Health Association (APHA), American Society of Civil Engineers (ASCE), American Water Works Association (AWWA), and Water Pollution Control Federation (WPCF), will be accepted in lieu of the five-day biochemical oxygen demand (BOD_5) test.

2. Existing Systems

a. For an existing system, the applicant may use the data based on the actual strength of the wastewater as determined by analysis of composite samples for five-day biochemical oxygen demand (BOD_5) and suspended solids. An appropriate increment for growth shall be included in the basis of design.

b. The data over a minimum period of one year shall be taken as the basis for the design.

D. Shock Loadings. The applicant shall consider the shock loadings of high concentrations and diurnal peaks for short periods of time on the treatment process, particularly for small treatment plants.

E. Design by Analogy. The applicant may utilize the data from similar municipalities in the case of new systems, provided that the reliability and applicability of such data is established through thorough investigations and documentation.

F. Flow Conduits. All piping and channels shall be designed to carry the maximum rates of flows. The incoming sewer shall be designed for unrestricted flow. Bottom corners of the channels must be filleted. Conduits shall be designed to avoid creation of pockets and corners where solids can accumulate. Suitable gates shall be placed in channels to seal off unused sections which might accumulate solids. The use of shear gates or stop planks is permitted where they can be used in place of gate valves or sluice gates. Corrosion resistant materials shall be used for these control gates.

G. Arrangement of Process Units. The design should provide for an arrangement of component parts of the plant, for greatest operating and maintenance convenience, reliability flexibility, economy, continuity of maximum effluent quality, and ease of installation of future units.

H. Flow Division Control. The design shall provide for flow division control facilities to insure organic and hydraulic loading control to various process units. Convenient, easy and safe access, change, observation, and maintenance shall be considered in the design of such facilities. Flow division shall be measured using flow measurement devices to assure uniform loading of all unit processes and operations.

4.4. Plant Design Details

A. Mechanical Equipment. The specifications should provide for:

1. services of a representative of the manufacturer to supervise the installation and initial operation of major items of mechanical equipment; and

2. performance tests of the installed equipment before acceptance by the applicant.

B. Unit Bypasses

1. A minimum of two units in the liquid treatment process train shall be provided for all unit processes and operations in all plants rated at over 1 million gallons per day (3,785 cubic meters per day).

2. The executive secretary will approve any exceptions based on reliability and operability of the components.

3. The design shall provide for properly located and arranged bypass structures and piping so that each unit of the plant can be removed from service independently. The bypass design shall facilitate plant operation during unit maintenance and emergency repair so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode.

C. Unit Bypass During Construction. Any bypass during construction or operation must be approved by the executive secretary before such bypass occurs, as provided in this rule.

D. Drains. The design shall incorporate means to completely drain each unit with a discharge to a point within the process or the plant.

E. Protection of Structures. The design shall incorporate hydrostatic pressure relief devices to prevent flotation of structures.

F. Pipe Cleaning and Maintenance. Fittings, valves, and other appurtenances shall be provided for pipes subject to clogging, to facilitate proper cleaning through mechanical cleaning or flushing. Pipes subject to clogging, such as pipes carrying sludge, shall be lined with a material which creates a smooth and nonadhering surface, thereby reducing clogging and resistance to flow.

G. Construction Materials. The materials of construction and equipment shall be resistant to hydrogen sulfide and other corrosive gases, greases, oils, chemicals, and similar constituents frequently present in sewage. This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided to minimize galvanic action, and consequent corrosion.

H. Painting

1. Piping within the plant shall be color coded to facilitate identification of piping, particularly in the plants rated over 5 million gallons per day (18,925 cubic meters per day). Table R317-3-4.4(H)(1) shows color and identification scheme recommended by the American National Standards Institute (ANSI 253.1 and 13.1) shall be used for the purposes of standardization.

2. The labels shall be stenciled in conformance with the ANSI standard A13.1.

3. The executive secretary may approve painting of piping with one color with a labelling scheme in conformance with the ANSI standard A13.1 provided that:

a. labels are color coded as directed above;

b. piping contents and direction of flow are legibly stenciled on the label; and

c. labels are securely on the piping at interval and all locations required in the above referenced standard.

I. Operating Equipment. A complete outfit of tools, accessories, and spare parts necessary for the plant operator's use should be provided. Readily-accessible storage space and workbench facilities should be provided, and consideration be given to provision of a garage for large equipment storage, maintenance, and repair.

J. Erosion Control During Construction. Effective site erosion control shall be provided during construction.

K. Grading and Landscaping. The site should be graded and landscaped upon completion of the plant. Concrete or gravel walkways should be provided for access to all units. Steep slopes should be avoided to prevent erosion. Surface water shall not be permitted to drain into any unit. Particular care shall be taken to protect all treatment plant components from storm water runoff.

4.5. Plant Outfall Lines

A. Discharge Impact Control. The outfall sewer shall be designed to discharge to the receiving stream in a manner not to impair the beneficial uses of the receiving stream and acceptable to the executive secretary. The outfall design should provide for:

1. Free fall or submerged discharge at the site selected;

2. Cascading of effluent to increase dissolved oxygen concentration in the effluent; and

3. Limited or complete dispersion of discharge across stream to minimize impact on aquatic life movement, and growth in the immediate reaches of the receiving stream; and

B. Protection and Maintenance. The outfall sewer shall be so constructed and protected against the effects of floodwater, ice, or other hazards as to reasonably insure its structural stability and freedom from stoppage.

C. Sampling Provisions. All outfall lines shall be designed with a safe and convenient access, preferably using a manhole, so that a sample of the effluent can be obtained at a point after the final treatment process, and before discharge to or mixing with the receiving waters.

4.6. Essential Facilities

A. Emergency Power Facilities

1. General. All plants shall have an alternate source of electric or mechanical power to allow continuity of operation during power failures. Methods of providing alternate sources include:

a. provision of at least two independent sources of power, such as feeders, grid, etc., to the plant;

b. portable or in-place internal combustion engine equipment which will generate electrical or mechanical energy; or

c. portable pumping equipment when only emergency pumping is required.

2. Power for Aeration. Standby power generating capacity normally is not required for aeration equipment used in the activated sludge type processes or aerated lagoons. In cases where a history of long-term (4 hours or more) power outages have occurred, auxiliary power for minimum aeration of the activated sludge type processes or aerated lagoon will be required. Full power generating capacity may be required when discharge is to critical stream segments to protect downstream uses identified in R317-2 (Standards for Quality for Waters of the State).

3. Power for Disinfection. Standby power generating capacity shall include the capacity needed for continuous disinfection of wastewater during power outages.

B. Plant Water Supply

1. General. An adequate supply of potable water under pressure should be provided for use in the laboratory and for general cleanliness around the plant. No piping or other connections shall exist in any part of the treatment works which, under any conditions, might cause the contamination of a potable water supply. The chemical quality of the water should be checked for suitability for its intended uses such as in heat exchangers, chlorinators, etc.

2. Direct Connections

a. Potable water from a municipal or separate supply may be used directly at points above grade for hot and cold supplies in lavatory, water closet, laboratory sink (with vacuum breaker), shower, drinking fountain, eye wash fountain, and safety shower; unless local authorities require a positive break at the property line.

b. The applicant must review the requirements stated in R309-112.2 - Distribution System Rules, Drinking Water and Sanitation Rules, to assure compliance with the said rule.

c. Hot water for any of the above units shall not be taken directly from a boiler or piping used for supplying hot water to a sludge heat exchanger or digester heating unit.

3. Indirect Connections

a. Where a potable water supply is used for any purpose in a plant, a break tank, pressure pump, and pressure tank shall be provided. Water shall be discharged to the break tank through an air gap at least 6 inches (15.2 centimeters) above the maximum flood line or the spill line of the tank, whichever is higher.

b. A sign shall be permanently posted at every hose bib, faucet, hydrant, or sill cock located on the water system beyond the break tank to indicate that the water is not safe for drinking.

4. Separate Potable Water Supply. Where it is not possible to provide potable water from a public water supply, a separate well may be provided. Location and construction of the well shall be in accordance with the requirements of R309, Drinking Water and Sanitation Rules.

5. Separate Non-Potable Water Supply. Where a separate non-potable water supply or plant effluent is to be provided, a break tank will not be necessary, but all system outlets shall be posted with a permanent sign indicating the water is not safe for drinking.

C. Sanitary Facilities. Toilet, shower, lavatory, and locker facilities shall be provided in convenient locations to serve the expected staffing level at the plant.

D. Floor Slope. All floor surfaces shall be sloped adequately to a collection floor drain system.

E. Stairways

1. Stairways shall be installed wherever possible in lieu of ladders. Spiral or winding stairs are permitted only for secondary access where dual means of egress are provided. Stairways shall have slopes between 50 degrees and 30 degrees (preferably nearer the latter) from the horizontal to facilitate carrying samples, tools, etc. Each tread and riser shall be of uniform dimension in each flight. Minimum tread run shall not be less than 8 inches (20.3 centimeters). The sum of the tread run and riser shall not be less than 17 inches (43 centimeters) nor more than 18 inches (46 centimeters). A flight of stairs shall consist of not more than a 12-foot (3.7 meters) continuous rise without a platform.

2. Local, state and federal safety requirements, including those in applicable fire code, the Uniform Building Code, etc., must be reviewed and complied with. Those requirements take precedence over the foregoing requirements, if more stringent, and should be incorporated in the design.

4.7. Flow Measurement. Flow measurement devices, preferably of the primary type (devices which create a hydrodynamic condition that is sensed by the secondary element), shall be provided at the plant to continuously indicate, totalize and record volume of wastewater entering the plant in a unit time.

A. Flumes. Installation of flumes shall be as follows:

1. Flumes with throat widths of less than 6 inches (15 centimeters) shall not be installed. Throat width shall be selected to measure the entire range of anticipated flow rates at all measurement locations.

2. Locations close to turbulent, surging or unbalanced flow, or a poorly distributed velocity pattern shall be avoided. For super-critical upstream flow, a hydraulic jump should be forced to occur in a section upstream of the flume at a distance of at least 30 times maximum upstream operating depth of flume followed by a straight approach section of a length specified in this rule.

3. For flumes with throat width less than half the width of the approach channel, the length of approach channel - straight upstream section - shall be the greater of 20 times the throat width or ten times maximum upstream operating depth in flume.

4. For flumes with throat width greater than half the width of the approach channel, the length of approach channel - straight upstream section - shall be not less than ten times the maximum upstream operating depth in flume.

5. Parshall flumes shall be permitted only in locations where free discharge conditions exists on the downstream side at the average design flow. Submergence must not exceed 60 percent at the maximum design flow.

6. The stilling well, if used, and secondary measuring elements, such as floats, sensors, or gages, shall be protected against extreme weather conditions.

B. Other Flow Measurement Devices. Effluent discharged to receiving waters should be measured using flow measurement devices, such as weirs, sonic or capacitance type, etc.

C. Flow Recorders

1. Clock-wound mechanisms for recording of flow are not permitted.

2. Battery powered flow measurement devices may be permitted at locations where electrical power is not available, and continuous operability of flow measurement devices is demonstrated.

4.8. Safety and Hazardous Chemical Handling. Adequate provision shall be made to effectively protect the operator and visitors from hazards. Local, state and federal safety requirements must be reviewed and complied with. Typical items for consideration are fence, splash guards, hand and guard rails, labeling of containers and process piping, warning signs, protective clothing, first aid equipment, containments, eye-wash fountains and safety showers, dust collection, portable emergency lighting, etc.

4.9. Laboratory.

A. Treatment plants rated in excess of 1 million gallons per day (3,785 cubic meters per day) shall include a laboratory for making the necessary analytical determinations and operating control tests. Otherwise, the applicant shall show availability of services of state-certified laboratories on a continuous contract basis.

B. The laboratory size, bench space, equipment and supplies shall be such that it can perform analytical work for:

1. All self-monitoring parameters required by discharge permits;

2. The process control necessary for good management of each treatment process included in the design; and

3. Industrial waste control or pretreatment programs.

R317-3-5. Screening and Grit Removal.

5.1. Screening Devices. Coarse bar racks or screens shall be used to protect pumps, comminutors, flow measurement devices and other equipment.

5.2. Bar Racks and Screens

A. Location

1. Indoor. Screening devices, installed in a building where other equipment or offices are located, shall be accessible only through a separate outside entrance to protect the operating personnel and the equipment from damage and nuisance caused by gases, odors and potential flooding.

2. Outdoors. Screening devices not installed in enclosures or buildings shall be protected from freezing or other adverse environmental conditions.

B. Access. Screening areas shall be provided with proper work and safe access and egress, proper and emergency lighting, ventilation, and a convenient and safe means for removing the screenings.

C. Design and Installation

1. Bar Spacing. Clear openings between bars should be:

a. not more than 1 inch (2.54 centimeters) for manually cleaned screens; and

b. less than 5/8 of an inch (1.59 centimeters) for mechanically cleaned screens.

2. Bar Slope. Manually cleaned screens, except those for emergency use, should be placed on a slope of 30 to 45 degrees from the horizontal.

3. Approach Velocities. At average design flow conditions, approach velocities should be no less than 1.25 feet per second (38 centimeters per second), to prevent settling; and no greater than three (3) feet per second (91 centimeters per second) to prevent forcing material through the openings.

4. Channels. Dual channels shall be provided and equipped with the necessary gates to isolate flow from any screening unit. Provisions shall also be made to facilitate dewatering each unit. The channel preceding and following the screen shall be shaped to eliminate stranding and settling of solids. Entrance channels should be designed to provide equal and uniform distribution of flow to the screens.

5. Reliability. A minimum of two screens shall be provided. Each screen shall be designed to handle the peak design rate of flow. Where more than two screens are provided, the peak design rate of flow shall be handled with one of the largest units out of service. Where a single mechanical screen handles the peak design rate of flow, then other unit can be a manually cleaned screen.

6. Flow Measurement. The types and locations of flow measurement devices should be selected for reliability and accuracy. The effect of changes in backwater elevations, due to intermittent blinding and cleaning of screens, should be considered in the selection of the locations for flow measurement equipment.

7. Invert. The screen channel invert should be 3.0 to 6.0 inches (7.6-15.2 centimeters) below the invert of the incoming sewer.

D. Safety

1. Railings and Gratings.

a. All screening installations shall be equipped with guard rails and deck grating to insure operator safety.

b. The manually cleaned bar rack shall be accessible for cleaning insuring operator safety.

c. Proper guard rails and enclosures shall be used to protect the operator from moving parts of mechanically operated and cleaned screens. These guard rails and enclosures shall be removable for safe access to maintain and repair mechanically operated and cleaned screens. Catchments shall be provided to prevent dripping of liquids in multi- level installations.

2. Equipment Deactivation and Lockout. Each piece of electrical power mechanical equipment shall be equipped with a positive means of deactivating or locking out or isolating from its power source. Such device shall be located in close proximity to the equipment.

3. Removal of Screenings. The design shall provide for mechanical conveying or lifting systems for safe transport of screenings from a subgrade installation to a collection point on grade.

E. Power Control Systems

1. Timing Devices. All mechanical units which are operated by timing devices shall be provided with auxiliary override controls which will set the cleaning mechanism in operation at a preset high water elevation or water differential across the screen.

2. Electrical Fixtures and Controls. Electrical fixtures and controls in screening areas where hazardous gases may accumulate shall meet the requirements of the National Electrical Code for Class I, Group D, Division 1 locations.

3. Manual Override. Automatic controls shall be supplemented with a manual override.

F. Disposal of Screenings

1. Facilities shall be provided for removal, handling, storage, and disposal of screenings in a sanitary manner. Separate grinding of screenings and return to the sewage flow is unacceptable. Manually cleaned screening facilities should include an

accessible platform from which the operator may rake screenings easily and safely. Suitable drainage facilities shall be provided for both the platform and the storage areas.

2. Screenings may be landfilled. The ultimate disposal of screenings shall conform to and comply with the requirements for the ultimate disposal of residues or sludge management plan.

5.3. Comminutors

A. General. Comminutors may be used in plants, excepting aerated or facultative or total containment lagoons, where mechanically cleaned bar screens are not used.

B. Design Considerations

1. Location. Comminutors should be located downstream of bar screen and any grit removal equipment.

2. Size. Comminutor capacity shall be adequate to handle the peak design rate of flow.

3. Installation.

a. A comminutor bypass channel, with manually cleaned bar screen, shall be provided. The use of the bypass channel should be automatic at depths of flow exceeding the design capacity of the comminutor. The bypass channel should be able to pass the peak design rate of flow when the comminutor channel is out of service.

b. Each comminutor that is not preceded by grit removal equipment should be protected by a 6-inch (15.2 centimeters) deep easily cleaned gravel trap.

PC Maintenance. Gates shall be provided for isolation of comminutor, comminutor channel including bypass channel for draining, repairs and maintenance. Provisions shall be made to facilitate servicing of units in place and removing units from their location for servicing.

5. Electrical Power Controls and Motors. Electrical equipment in comminutor chambers where hazardous gases may accumulate shall meet the requirements of the National Electrical Code for Class 1, Group D, Division 1 locations. Motors in areas not governed by this requirement may need protection against accidental submergence.

5.4. Grit Removal Facilities

A. General. Grit removal facilities shall be provided for all mechanical treatment plants. Pumps, comminutors, and other mechanical equipment preceding grit removal, shall be protected from the damaging effects of grit. Storage capacity shall be provided in treatment units where grit is likely to accumulate.

B. Location. Grit removal facilities should be located ahead of pumps and comminuting devices. Coarse bar racks should be placed ahead of grit removal facilities.

C. Enclosed Facilities

1. Ventilation. Uncontaminated air shall be introduced continuously at a minimum rate of 12 air changes per hour, or intermittently at a minimum rate of 30 air changes per hour. Odor control facilities are recommended.

2. Access. Grit removal facilities shall be provided with proper and safe access, and egress from equipment and facilities.

3. Electrical Work. All electrical work in enclosed grit removal areas where hazardous gases may accumulate shall meet the requirements of the National Electrical Code for Class 1, Group D, Division 1 locations.

D. Outdoor Facilities. Grit removal facilities located outside the buildings shall be protected from freezing, and other adverse environmental conditions.

E. Type and Number of Units

1. Number of Units. For plants treating:

a. more than 1 million gallons per day rate of flow (3,785 cubic meters per day), two mechanically cleaned grit removal units shall be installed in a parallel configuration. Each grit channel shall be designed to handle the peak design rate of flow.

b. less than 1 million gallons per day rate of flow (3,785 cubic meters per day), a single manually cleaned or mechanically cleaned grit chamber with a bypass channel shall be provided.

2. Other types. When arrangements other than channel-type of grit removal is considered, equipment for agitation, air supply, grit collection, grit removal, and grit washing shall be provided with controls for handling variations in rates of flow, and providing operating flexibility.

F. Design Factors

1. General. The designed effectiveness of a grit removal system shall be commensurate with the requirements of the subsequent process units.

2. Inlet Configuration. Inlet turbulence shall be minimized. The inlet flow direction must be parallel to the induced roll direction within aerated grit chambers.

3. Velocity and Detention Time.

a. Horizontal Channel-type Grit Chambers.

(1) Velocity of flow through a channel-type chamber shall be controlled such that it is not less than one foot per second (30 centimeters per second) during normal variations in flow.

(2) The detention time shall be based on the size of particle to be removed but not less than 20 seconds at the maximum design flow. Velocity and detention time in the channel shall be regulated by installation of control devices such as proportional flow, Sutro weirs, etc.

b. Aerated grit chambers.

(1) The velocity of flow through an aerated grit chamber shall not be less than 1 foot per second (30 centimeters per second) during normal variations in flow, in the direction of induced roll.

(2) A minimum detention time of two to five minutes at the maximum design flow shall be provided. Rate of aeration shall not be less than 4 cubic feet per minute per lineal foot (1.5 liters per second per meter). Outlet weir shall be provided parallel to the direction of induced roll.

c. Square grit chambers. Detention time and overflow rate for square grit chambers shall be based on the size of particles intended to be removed. Overflow rate should not exceed 40,000 gallons per day per square foot of the chamber area (1,600 cubic meters per day per square meter).

4. Grit Washing. Grit should be washed before the disposal.

5. Drains. Provision shall be made for to adequately bypass, isolate and dewater each grit removal unit for maintenance.

6. Water. An adequate supply of service or non-potable plant water under pressure shall be provided for cleanup.

G. Grit Handling.

1. Mechanical equipment for hoisting or transporting grit to ground level shall be provided in grit removal facilities located in deep pits. Impervious, non-slip, working surfaces with adequate drainage shall be provided for grit handling areas. Grit transporting facilities shall be provided with protection against freezing and loss of material.

2. Grit may be landfilled. The ultimate disposal of grit shall conform to and comply with the requirements for the ultimate disposal of residues or sludge management plan.

R317-3-6. Settling.

6.1. General Considerations

A. Number of Units. Multiple units capable of independent operation shall be provided in all plants where the design rate of flow exceed 1 million gallons per day (3,785 cubic meters per day). Plants where the design rate of flow is less than one (1) million gallons per day (3,785 cubic meters per day), shall include other provisions to assure continuity of treatment.

B. Arrangement. Settling tanks shall be arranged for optimum site utilization, and shall be consistent with the hydraulic head requirements for other ancillary units.

C. Flow Distribution. Effective flow measurement devices and control appurtenances (e.g. valves, gates, splitter, boxes, etc.) should be provided to permit proper proportioning of flow to each unit.

D. Tank Configuration. The selection of tank size and shape, and inlet and outlet type and location shall be based on the site and flow patterns.

6.2. Design Considerations

A. Dimensions.

1. The minimum length of flow from inlet to outlet should not be less than be 10 feet (3 meters) unless special provisions are made to prevent short circuiting. The sidewater depth for primary clarifiers shall be not less than 8 feet (2.4 meters).

2. Clarifiers following an activated sludge process shall have sidewater depths of at least 12 feet (3.7 meters) to provide adequate separation zone between the sludge blanket and the overflow weirs.

3. Clarifiers following fixed film reactors shall have sidewater depth of at least 8 feet (2.4 meters).

B. Surface Loading (Overflow) Rates

1. Primary Settling Tanks

a. Surface loading or overflow rates at the average design rate of flow for primary tanks shall not exceed:

(1) 600 gallons per day per square foot (24 cubic meters per square meter per day) for plants treating at the rate of flow less than 1 million gallons per day (3,785 cubic meter per day), or

(2) 1,000 gallons per day per square foot (41 cubic meters per square meter per day) for plants treating at the rate of flow more than 1 million gallons per day (3,785 cubic meter per day).

b. For primary settling, expected influent BOD_5 removal and surface loading is as shown by the relationship: E = (41.5 - (0.01 x Surface loading at average design Q)) where, E = efficiency, percent, and surface loading less than or equal to 2,000 gallons per day per square foot (82 cubic meters per square meter per day). However, anticipated higher BOD_5 removal than the one predicted using above relationship for sewage or sewage containing appreciable quantities of industrial wastes (or chemical additions to be used), shall be validated by plant performance data.

2. Intermediate Settling Tanks. Surface loading or overflow rates for intermediate settling tanks following fixed film reactor processes shall not exceed 1,000 gallons per day per square foot (41 cubic meters per square meter per day) at the average design rate of flow.

3. Final Settling Tanks

a. Settling tests should be conducted wherever a pilot study of biological treatment is warranted by unusual waste characteristics or treatment requirements.

b. The applicant will conduct pilot testing where proposed loadings go beyond the limits set forth in this section.

c. Surface loading or overflow rates for settling tanks following fixed film processes shall not exceed 800 gallons per day per square foot (33 cubic meters per square meter per day) at the average design rate of flow.

d. Settling tanks following activated sludge processes must be designed to meet thickening as well as solids separation requirements. Surface loading or overflow, and weir overflow rates must be adjusted for the various processes to minimize the problems with sludge loadings, density currents, inlet hydraulic turbulence, and occasional poor sludge settleability. The high rate of recirculation of return sludge from the final settling tanks to the aeration or reaeration tanks requires careful consideration of above factors. The hydraulic design of intermediate and final settling tanks following the activated sludge process shall be based upon the average design rate of flow excluding activated sludge return flow as shown in Table R317-3-6.2(B)(3)(d).

C. Inlet Structures. Inlets should be designed to dissipate the inlet velocity and to distribute the flow equally both horizontally and vertically and to prevent short circuiting. Channels should be designed to maintain a velocity of at least one foot per second (0.3 meter per second) at the minimum design flow. Corner pockets and dead ends should be eliminated and corner fillets or channeling used where necessary. Provisions shall be made for elimination or removal of floating materials in inlet structures.

D. Effluent Overflow Weirs

1. General. Effluent overflow weirs shall be adjustable for leveling.

2. Location. Effluent overflow weirs shall be located to optimize actual hydraulic detention time, and minimize short circuiting.

3. Design Rates. Weir loadings shall not exceed 10,000 gallons per day per lineal foot (124 cubic meters per meter per day) for plants treating the average design rate of flow of one (1) million gallons per day (3,785 cubic meters per day) or less. Higher weir loadings may be used for plants designed for larger average flows, but shall not exceed 15,000 gallons per day per lineal foot (186 cubic meters per meter per day). If pumping is required, weir loadings must be related to pump delivery rates to avoid short circuiting.

4. Weir Troughs. Weir troughs shall be designed to prevent submergence at the maximum design rate of flow (peak daily flow), and to maintain a velocity of at least one foot per second (0.3 meter per second) at one-half of the average design rate of flow. Submergence may be permitted at the maximum design rate of flow (peak daily flow) with one unit out of service.

E. Submerged Surfaces. The tops of troughs, beams, and similar submerged construction elements shall have a minimum slope of 1.4 vertical to 1 horizontal; the underside of such elements should have a slope of 1 to 1 to prevent the accumulation of scum and solids.

F. Unit Dewatering. The bypass design shall provide for redistribution of the plant flow to the remaining units in operation.

G. Freeboard. Walls of settling tanks shall extend at least 6 inches (15 centimeters) above the surrounding ground surface and shall provide not less than 12 inches (30 centimeters) freeboard. Additional freeboard or the use of wind screens should be provided where larger settling tanks are subject to high velocity wind currents that would cause tank surface waves and inhibit effective scum removal.

6.3. Sludge and Scum Removal

A. Scum Removal. Effective scum collection and removal facilities, including baffling, shall be provided for primary, intermediate and secondary settling tanks. The unusual characteristics of scum which may adversely affect pumping, piping, sludge handling and disposal, should be recognized in design. Provisions may be made for the discharge of scum with the sludge; however, other special provisions for disposal may be necessary.

B. Sludge Removal. Sludge collection and withdrawal facilities shall be designed to assure rapid removal of the sludge. Suction withdrawal of sludge from the tank floor should be provided for activated sludge plants designed for reduction of the nitrogenous oxygen demand.

1. Sludge Hopper. When scrapers are used to move sludge into a discharge hopper, the minimum slope of the side walls shall be 1.7 vertical to 1 horizontal. Hopper wall surfaces should be made smooth with rounded corners to aid in sludge removal. Hopper bottoms shall have a maximum dimension of two feet (0.6 meter). Deep sludge hoppers for sludge thickening are not acceptable.

2. Sludge Removal Piping. Each hopper shall have an individually valved sludge withdrawal line at least six inches (15 centimeters) in diameter. The static head available for withdrawal of sludge shall be 30 inches (76 centimeters) or greater, as necessary to maintain a three foot per second (0.91 meter per second) velocity in the withdrawal pipe. Clearance between the end of the withdrawal line and the hopper walls shall be sufficient to prevent bridging of the sludge. Adequate provisions shall be made for rodding or back-flushing individual pipe runs for activated sludge secondary clarifiers except for oxidation ditch clarifiers. Piping shall also be provided to return waste sludge to primary clarifiers.

3. Sludge Removal Control. Sludge wells shall be provided with telescoping valves or other equipment for viewing, sampling and controlling the rate of sludge withdrawal. The use of sight glass and sampling valves may be appropriate. A means of measuring the sludge removal rate shall be provided. Air lift type of sludge removal must not be used for removal of primary sludges. Sludge pump motor control systems shall include time clocks and valve controls for regulating the duration and sequencing of sludge removal.

6.4. Protective and Service Facilities

A. Operator Protection. All settling tanks shall be equipped to provide safe working conditions for operators. Such features shall include machinery covers, life lines, stairways, walkways, handrails and slip resistant surfaces.

B. Mechanical Maintenance Access. The design shall provide for convenient and safe access to routine maintenance items such as gear boxes, scum removal mechanisms, baffles, weirs, inlet stilling baffle area, sludge and scum pumps, and effluent channels.

C. Electrical Fixtures and Controls. Electrical fixtures and controls in enclosed settling basins shall meet the requirements of the National Electrical Code for Class 1, Group D, Division 1 locations. The fixtures and controls shall be located so as to provide convenient and safe access for operation and maintenance. Walkways, bridge area and area around settling tanks shall be illuminated with area lighting for operating personnel safety.

R317-3-7. Biological Treatment.

7.1. Trickling Filters

A. General. Trickling filters shall be preceded by effective settling tanks equipped with scum and grease collecting devices, or other suitable pretreatment facilities.

B. Hydraulics

1. Distribution. The sewage may be distributed over the filter by rotary distributors or other suitable devices which will ensure uniform wastewater distribution to the surface area. Uniform hydraulic distribution of sewage on the filters is required.

2. For reaction type distributors, a minimum head of 24 inches (61 centimeters) between low water level in the siphon chamber and center of the arms is required. Similar allowance in design shall be provided for added pumping head requirements where pumping to the reaction type distributor is used. The applicant should evaluate other types of drivers and drives.

3. A minimum clearance of 6 inches (15 centimeters) between media and distributor arms shall be provided. Larger clearance than 6 inches (15 centimeters) must be provided where ice buildup may occur.

C. Wastewater Application. Application of the sewage shall be continuous. The piping system shall be designed for recirculation. The design must provide for routine flushing of filters by heavy dosing at intermittent intervals.

D. Piping System. The piping system, including dosing equipment and distributor, shall be designed to provide capacity for the peak design rate of flow, including recirculation.

E. Media

1. Quality

a. The media may be crushed rock, slag, or specially manufactured material. The media shall be durable, resistant to spalling or flaking and insoluble in sewage. The top 18 inches (46 centimeters) shall have a loss by the 20-cycle, sodium sulfate soundness test of not more than 10 percent. The balance is to pass a ten-cycle test using the same criteria. Slag media shall be free from iron.

b. Manufactured media shall be resistant to ultraviolet degradation, disintegration, erosion, aging, all common acids and alkalies, organic compounds, and fungus and biological attack. Such media shall be structurally capable of supporting a man's weight or a suitable access walkway shall be provided to allow for distributor maintenance.

2. Depth. The filter design shall provide for a depth of:

a. not less than 5 feet (1.5 meters) above the underdrains, but not more than 10 feet (3 meters) when rock or slag media is used in the filters.

b. not less than 10 feet (3 meters) above the underdrains to provide adequate contact time with the wastewater, but not more than 30 feet (9 meters) unless additional structural construction and aeration are provided, when manufactured media is used in the filters.

3. Size and Grading of Media

a. Rock, Slag and Similar Media

(1) Rock, slag, and similar media shall not contain more than 5 percent by weight of pieces whose longest dimension is three times the least dimension.

(2) Media shall be free from thin, elongated and flat pieces, dust, clay, sand or fine material and shall conform to the size and grading when mechanically graded over vibrating screens with square openings, as shown in Table R317-3-7.1(E)(3(a)(2).

b. Manufactured Media. The applicant must evaluate suitability of manufactured media on the basis of experience with installations handling similar wastes and loadings.

c. Handling and Placing of Media. Material delivered to the filter site shall be stored on wood- planked or other approved clean, hard-surfaced areas. All material shall be rehandled at the filter site and no material shall be dumped directly into the filter. Crushed rock, slag and similar media shall be washed and rescreened or forked at the filter site to remove all fines. Such material shall be placed by hand to a depth of 12 inches (30 centimeters) above the tile underdrains. The remainder of material may be placed by means of belt conveyors or equally effective methods approved by the design engineer. All material shall be carefully placed so as not to damage the underdrains. Manufactured media shall be handled and placed as approved by the engineer. Trucks, tractors, and other heavy equipment shall not be driven over the filter during or after construction.

F. Underdrain System

1. Arrangement. Underdrains with semicircular inverts or equivalent should be provided and the underdrainage system shall cover the entire floor of the filter. Inlet openings into the underdrains shall have an unsubmerged gross combined area equal to at least 15 percent of the surface area of the filter.

2. Hydraulic Capacity and Ventilation.

a. The underdrains shall have a minimum slope of 1 percent. Effluent channels shall be designed to produce a minimum velocity of two (2) feet per second (0.61 meters per second) at average daily rates of application to the filter.

b. The underdrainage system, effluent channels, and effluent pipe shall be designed to permit a free passage of air preventing septicity within the filter. The size of drains, channels, and pipe should be such that not more than 50 percent of their cross-sectional area will be submerged under the design peak hydraulic loading, including proposed or possible future recirculated flows. Forced air ventilation must be provided for deep or covered filters using manufactured media. The design of filters should be compatible for the installation of odor control equipment such as covers, forced air ventilation, scrubber, etc., as a retrofit.

3. Flushing. The design should include means for flushing of the underdrains. In small filters, use of a peripheral head channel with vertical vents is acceptable for flushing purposes. Means or facilities of inspection of underdrainage should be provided.

G. Special Features

1. Flooding. Appropriate valves, sluice gates, or other structures shall be provided to enable flooding of filters comprised of rock or slag media.

2. Freeboard. A freeboard of not less than 4 feet (1.2 meters) should be provided for tall filters using manufactured media, to maximize the containment of windblown spray.

3. Maintenance. All distribution devices, underdrains, channels, and pipes shall be installed so that they may be properly maintained, flushed or drained.

4. Freeze Protection. When climatic conditions are expected to result in operational problems due to cold temperatures, the filters may be covered for protection against freezing; maintaining operation and treatment efficiencies.

5. Recirculation. The piping and pumping systems shall be designed for recirculation rates as required to achieve sufficient wetting of biofilm and the design efficiency.

6. Recirculation Measurement. Recirculation rate to the filters shall be measured using flow measurement and recording devices. Time lapse meters and pump head recording devices are acceptable for facilities treating less than 1 million gallons per day (3,785 cubic meters per day).

H. Rotary Distributor Seals. Mercury seals are not permitted. The design of the distributor support septum shall provide for convenient and easy seal replacement to assure continuity of operation.

I. Multi-Stage Filters. The foregoing standards in this rule also apply to all multi-stage filters.

J. Unit Sizing

1. Required volumes of rock or slag media filters shall be based upon the following equations: For Single or First stage of Trickling Filter: $E = 100 - ((100 / (3 + 2 (R/I))) + (0.4 x (W / V) - 10))$. For Second stage of Trickling Filter: $E = 100 x ((1 + (R_2 / I)) / (2 + (R_2 / I)))$ where, E = Efficiency, percent R = recirculated flow through trickling filter, mgd I = raw sewage flow, mgd W = pounds of BOD_5 per day in raw sewage V = volume of filter media in 1000 cubic feet R_2 = recirculated flow through second-stage trickling filter, mgd.

2. The required volume of media may be determined by pilot testing or use of any of the various empirical design equations that have been verified through actual full scale experience. Such calculations must be submitted if pilot testing is not utilized. Pilot testing is recommended to verify performance predictions based upon the various design equations, particularly when significant amounts of industrial wastes are present.

3. Expected performance of filters packed with manufactured media shall be determined from documented full scale experience on similar installations or through actual use of a pilot plant on site.

K. Nitrification

1. Trickling filters may be used for nitrification. The design should be based as shown in Table R317-3-7.1(K)(1).

2. Nitrification is affected by variations in flow, loadings and temperature, and other factors. Therefore, the applicant must conduct pilot studies before developing the design criteria.

L. Design Safety Factors. Trickling filters are affected by diurnal load conditions. The volume of media determined from either pilot plant studies or use of acceptable design equations shall be based upon organic loading at the maximum design rate of flow rather than the average design rate of flow.

7.2. Activated Sludge

A. General. The activated sludge process and its several modifications may be used to accomplish varied degrees of removal of suspended solids, and reduction of carbonaceous and nitrogenous oxygen demand. The degree and consistency of treatment required, type of waste to be treated, proposed plant size, anticipated degree of operation and maintenance, and operating and capital costs determine the choice of the process to be used. The design shall provide for flexibility in operation. Plants over 1 million gallons per day (3,785 cubic meters per day) shall be designed to facilitate easy conversion to various operational modes. In severe climates, protection against freezing shall be provided to ensure continuity of operation and performance.

B. Aeration

1. Capacities and Permissible Loadings

a. The design of the aeration tank for any particular adaptation of the process shall be based on full scale experience at the plants receiving wastewater of similar characteristics under similar climatic conditions, pilot plant studies, or calculations based on process kinetics parameters reported in technical literature. The size of treatment plant, diurnal load variations, degree of treatment required, temperature, pH, and reactor dissolved oxygen when designing for nitrification, influence the design. Calculations using values differing substantially from those in the table shown below must reference actual operational data.

b. The applicant must substantiate capability of the aeration and clarification systems in the processes using mixed liquor suspended solids levels greater than 5,000 milligrams per liter.

c. The applicant shall use the values shown in Table R317-3-7.2(B)(1)(c) to determine the aeration tank capacities and permissible loadings for the several adaptations of the processes, when process design calculations are not submitted. These

values are based on the average design rate of flow, and apply to plants receiving peak to average diurnal load ratios ranging from about 2:1 to 4:1.

2. Arrangement of Aeration Tanks

a. Dimensions. Effective mixing and utilization of air must be the basis of dimensions of each independent mixed liquor aeration tank or return sludge reaeration tank. Liquid depths should not be less than 10 feet (3 meters) or more than 30 feet (9 meters) unless the applicant justifies the need for shallower or deeper tanks.

b. Short-circuiting. The shape of the tank and the installation of aeration equipment should provide for positive control of short-circuiting through the aeration tank.

c. Number of Units. Total aeration tank volume shall be divided among two or more units, capable of independent operation, to meet applicable effluent limitations and reliability guidelines.

d. Inlets and Outlets. Inlets and outlets for each aeration tank unit shall be suitably equipped with valves, gates, stop plates, weirs, or other devices to permit controlling the flow to any unit and to maintain reasonable constant liquid level. The hydraulic properties of the system shall permit the maximum instantaneous hydraulic load to be carried with any single aeration tank unit out of service.

e. Conduits. Channels and pipes carrying liquids with solids in suspension shall be designed to maintain self-cleaning velocities or shall be agitated to keep such solids in suspension at all rates of flow within the design limits. Drains shall be installed in the aeration tank to drain segments or channels which are not being used due to alternate flow patterns.

f. Freeboard. All aeration tanks should have a freeboard of not less than 18 inches (46 centimeters). Additional freeboard or windbreak may be necessary to protect against freezing or windblown spray.

3. Aeration Requirements

a. Oxygen requirements must be calculated based on factors such as, maximum organic loading, degree of treatment, level of suspended solids concentration (mixed liquor) to be maintained, and uniformly maintaining a minimum dissolved oxygen concentration in the aeration tank, at all times, of two milligrams per liter.

b. When pilot plant or experimental data on oxygenation requirements are not available, the design oxygen requirements shall be calculated on the basis of:

(1) 1.2 pounds 0_2 per pound of maximum BOD_5 applied to the aeration tanks (1.2 kilograms 0_2 per kilogram of maximum BOD_5), for carbonaceous BOD_5 removal in all activated sludge processes with the exception of the extended aeration process,

(2) 2 pounds 0_2 per pound of maximum BOD_5 applied to the aeration tanks (two kilograms 0_2 per kilogram of maximum BOD_5) for carbonaceous BOD_5 removal in the extended aeration process,

(3) 4.6 pounds 0_2 per pound of maximum total kjeldahl nitrogen (TKN) applied to the aeration tanks (1.2 kilograms 0_2 per kilogram of maximum TKN), for oxidizing ammonia in the case of nitrification, and

(4) oxygen demand due to the high concentrations of BOD_5 and TKN associated with recycle flows such as, digester supernatant, heat treatment supernatant, belt filter pressate, vacuum filtrate, elutriates, etc.

c. Oxygen utilization should be maximized per unit power input. The aeration system should be designed to match the diurnal organic load variation while economizing on power input.

4. Diffused Air Systems

a. The design of the diffused air system to provide the oxygen requirements shall be done using data derived from pilot testing or an empirical approach.

b. Air requirements for a diffused air system may be determined by use of any of the recognized equations incorporating such factors as:

(1) tank depth;

(2) alpha factor of waste;

(3) beta factor of waste;

(4) certified aeration device transfer efficiency;

(5) minimum aeration tank dissolved oxygen concentrations;

(6) critical wastewater temperature; and

(7) altitude of plant.

c. In the absence of experimentally determined alpha and beta factors by an independent laboratory for the manufacturer or at the site, wastewater transfer efficiency shall be assumed to be 50 percent of clean water efficiency for plants treating primarily (90 percent or greater) domestic sewage. Treatment plants where the waste contains higher percentages of industrial wastes shall use a correspondingly lower percentage of clean water efficiency and shall submit calculations to justify such a percentage.

d. The design air requirements shall be calculated on the basis of:

(1) 1,500 cubic feet per pound of maximum BOD_5 applied to the aeration tanks (94 cubic meters per kilogram of maximum BOD_5), for carbonaceous BOD_5 removal in all activated sludge processes with the exception of the extended aeration process,

(2) 2,000 cubic feet per pound of maximum BOD_5 applied to the aeration tanks (125 cubic meters per kilogram of maximum BOD_5) for carbonaceous BOD_5 removal in the extended aeration process,

(3) 5800 cubic feet per pound of maximum total kjeldahl nitrogen (TKN) applied to the aeration tanks (360 cubic meters per kilogram of maximum TKN), for oxidizing ammonia in the case of nitrification,

(4) corresponding air quantities for satisfaction of oxygen demand due to the high concentrations of BOD_5 and TKN associated with recycle flows such as, digester supernatant, heat treatment supernatant, belt filter pressate, vacuum filtrate, elutriates, etc., and

(5) air required for channels, pumps, aerobic digesters, or other uses.

e. The capacity of blowers or air compressors, particularly centrifugal blowers, must be calculated on the basis of air intake temperature of 40 degrees Centigrade (104 degrees Fahrenheit) or higher and the less than normal operating pressure. The capacity of drive motor must be calculated on the basis of air intake temperature of -30 degrees Centigrade (-22 degrees Fahrenheit) or less. The design must include means of controlling the rate of air delivery to prevent overheating or damage to the motor.

f. The blowers shall be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service. The design shall also provide for varying the volume of air delivered in proportion to the load demand of the plant. Aeration equipment shall be easily adjustable in increments and shall maintain solids suspension within these limits.

g. Diffuser systems shall be capable of providing for the maximum design oxygen demand or 200 percent of the average design oxygen demand, whichever is larger. The air diffusion piping and diffuser system shall be capable of delivering normal air requirements with minimal friction losses.

h. Air piping systems should be designed such that total head loss from blower outlet (or silencer outlet where used) to the diffuser inlet does not exceed 0.5 pounds per square inch (0.04 kilogram per square centimeter) at average operating conditions.

i. The spacing of diffusers should be in accordance with the oxygen requirements through the length of the channel or tank, and should be designed to facilitate adjustment of their spacing without major revision to air header piping. Removable diffuser assemblies are recommended to minimize downtime of aeration tanks.

j. Individual assembly units of diffusers shall be equipped with control valves, preferably with indicator markings for throttling, or for complete shutoff. Diffusers in any single assembly shall have substantially uniform pressure loss.

k. Air filters shall be provided in numbers, arrangements, and capacities to furnish, at all times, an air supply sufficiently free from dust to prevent damage to blowers and clogging of the diffuser system used.

5. Mechanical Aeration Systems

a. Oxygen Transfer Performance. The mechanism and drive unit shall be designed for the expected conditions in the aeration tank in terms of the power performance. The mechanical aerator performance shall be verified by certified testing.

b. Design Requirements. The design requirements of a mechanical aeration system shall accomplish the following:

(1) Maintain a minimum of 2.0 milligrams per liter of dissolved oxygen in the mixed liquor at all times throughout the tank or basin;

(2) Maintain all biological solids in suspension;

(3) Meet maximum oxygen demand and maintain process performance with the largest unit out of service; and

(4) Provide for varying the amount of oxygen transferred in proportion to the load demand on the plant.

c. Winter Protection. Due to high heat loss and the nature of spray-induced agitation, the mechanism, as well as subsequent treatment units, shall be protected from freezing where extended cold weather conditions occur.

6. Return Sludge Equipment

a. Return Sludge Rate

(1) The minimum permissible return sludge rate of withdrawal from the final settling tank is a function of the concentration of suspended solids in the mixed liquor entering it, the sludge volume index of these solids, and the length of time these solids are retained in the settling tank. Since undue retention of solids in the final settling tanks may be deleterious to both the aeration and sedimentation phases of the activated sludge process, the rate of sludge return expressed as a percentage of the average design flow of sewage should be between the limits set forth in Table R317-3-7.2(B)(6)(a)(1).

(2) The rate of sludge return shall be varied by means of variable speed motors, drives, or timers (in plants designed for less than one million gallons per day - 3,785 cubic meters per day) to pump sludge at the above rates.

b. Return Sludge Pumps

(1) If motor driven return sludge pumps are used, the maximum return sludge capacity shall be with the largest pump out of service. A positive head should be provided on pump suctions. Pumps should have at least 3 inch (7.6 centimeters) suction and discharge openings.

(2) If air lifts are used for returning sludge from each settling tank hopper, no standby unit is required provided the design of the air lifts are such to facilitate their rapid and easy cleaning and provided standby air lifts are provided. Air lifts should be at least 3 inches (7.6 centimeters) in diameter.

c. Return Sludge Piping. Discharge piping shall not be less than 4 inches (10 centimeters) in diameter, and should be designed to maintain a velocity of not less than two (2) feet per second (0.61 meters per second) when return sludge facilities are operating at normal return sludge rates. Sight glasses, sampling ports and rate of flow controllers for return activated sludge flow from each settling tank hopper shall be provided.

7. Waste Sludge Facilities

a. The design of waste sludge control facilities should be based on a logically developed solids mass balance at the maximum design flow. Otherwise, a maximum capacity of not less than 25 percent of the average design flow shall be provided, and function satisfactorily at rates of 0.5 percent of average sewage flow or a minimum of 10 gallons per minute (0.63 liters per second), whichever is larger.

b. Sight glasses, sampling ports and rate of flow controllers for waste activated sludge flow shall be provided.

c. Waste sludge may be discharged to the concentration or thickening tank, primary settling tank, sludge digestion tank, vacuum filters, other thickening equipment, or any practical combination of these units.

7.3. Flow Measurement. Instrumentation should be provided in all plants for indicating flow rates of raw sewage or primary effluent, return sludge, and air to each tank unit. For plants designed for the average design rate of flow of 1 million gallons per day (3,785 cubic meters per day) or more, these devices should total, record, and indicate the rate of flow. Where the design provides for all return sludge to be mixed with the raw sewage (or primary effluent) at one location, then the mixed liquor flow rate to each aeration unit should be measured.

7.4. Other Biological Systems. The executive secretary may consider and approve new biological treatment processes with promising applicability in wastewater treatment. The approval will be based on the required engineering data for new process evaluation as provided in this rule.

7.5. Packaged Plants. The executive secretary may consider and approve packaged biological treatment plants only when there are no other and appropriate alternatives for waste treatment. These type of plants shall be designed for handling large flow variations and to meet all requirements contained in this rule. The applicant must consider the need for close attention and competent operating supervision, including routine laboratory control, when proposing a packaged plant.

R317-3-8. Disinfection.

8.1. General

A. All wastewaters containing pathogens or coliform bacteria must be disinfected before discharge to a water course. The disinfection procedures must consider any effect on the natural aquatic habitat and biota of the receiving water course. Effectiveness of disinfection also varies with BOD_5 and suspended solids in the effluent. If chlorination is utilized, it may be necessary to dechlorinate if the residual chlorine level would otherwise impair the receiving water course. The applicant must submit justification to the executive secretary for the determination of the acceptability of any disinfection system other than chlorination or ultraviolet irradiation.

B. If effluent to be discharged meets applicable bacteriologic standards before disinfection, the executive secretary may waive the disinfection process. However, all plants must have an ability to introduce a disinfectant in the effluent with proper reaction time before discharge. An example could be multi-celled (more than three cells) lagoon discharge following extended storage in excess of 150 days.

C. The disinfection method should be selected after due consideration of wastewater flow rates, application rates, demand rates and effects, pH of the wastewater, cost of equipment, availability, maintenance, reliability and safety problems.

D. Chlorine is the most commonly used chemical for wastewater disinfection. The forms most often used are liquid-gaseous chlorine and sodium and calcium hypochlorite. The executive secretary may review and accept other disinfection methods based on the information submitted.

8.2. Design

A. Capacity of System

1. Required disinfection capacity will vary, depending on the uses and points of application of the disinfectant, e.g., prechlorination, post chlorination, odor and process control uses, etc.

2. For disinfection of the wastewater before its discharge to a water course, the disinfection system capacity shall be sufficient to produce an effluent that will meet the coliform bacteria limits specified for that installation at all times. This condition must be attainable when maximum flow rates occur and during emergency conditions. For non-chemical disinfecting systems, an equivalent installed capacity shall be provided. Normal dosage requirements for disinfection will vary with the quality of effluent to be treated.

3. Duplicate disinfection systems shall be provided. Where only two units are installed, each shall be capable of feeding the expected maximum dosage rate.

4. Disinfection system equipment should be provided with necessary changeable parts to permit operation of system at initial anticipated flows at mid-scale on flow meters and other devices. Spare parts shall be provided for all disinfection equipment to replace parts which are subject to wear and breakage. Operation and maintenance data for all equipment shall be furnished.

5. Dosage control based on effluent flow rate should be provided because of the diurnal variations in the disinfectant demand of the wastewater. A residual disinfectant concentration must be maintained to insure the pathogen destruction, and subsequent reactivation, if any.

B. Contact Period

1. For a chlorination system, a minimum contact period is required after a thorough mixing of disinfectant with the effluent. The minimum contact period shall be greater of:

a. 30 minutes at the maximum design rate of flow (peak daily rate of flow) or the maximum pumping rate, or

b. 60 minutes at the average design rate of flow.

2. This contact period shall normally be provided in the contact tank. Contact period in pipeline or outfalls before discharge into a water course, may be credited towards the contact time if the effluent discharge point can be sampled.

C. Contact Chambers

1. The contact chambers must be designed such that:

a. effectiveness of disinfection is maximized;

b. accumulation of solids is minimized;

c. maintenance and cleaning is facilitated; and

d. short circuiting of flow is reduced to a practical minimum by installation of baffles.

2. Two tanks are required for all plants treating more than 1 million gallons per day (3,785 cubic meters per day). Means of removal of solids from the tank bottom shall be provided. Solids and drainage water must be returned to the head end of the plant. Skimming devices should be provided in all contact tanks. Covered tanks must have means of access for maintenance and cleaning.

3. Pipelines and outfall sewers may be acceptable as effective plug-flow contact chambers.

4. The applicant must incorporate all of the above process and design features in devices using other disinfecting methods.

D. Point of Application

1. The design shall provide for application of chlorine or other disinfectants to all fully treated, partially treated, or untreated wastewater discharged from the treatment plant. Other points of application shall be incorporated in the design for process considerations such as prechlorination, odor control, control of sludge bulking, etc. All application points shall be submerged below the wastewater surface.

2. Chlorine shall be positively mixed as rapidly as possible, with a complete mix being effected in three seconds. This may be accomplished by either the use of turbulent flow regime or a mechanical flash mixer.

8.3. Disinfection Methods

A. Chlorination (Liquid or Gaseous Chlorine)

1. Equipment

a. The installed capacity of a chlorine feed system shall be sufficient to provide a dosage of 25 milligrams per liter at the maximum design rate of flow. Procedures recommended by the Chlorine Institute and the Occupational Safety and Health Administration, the US Department of Labor, and succeeding organizations should be carefully followed in handling, installation, operation and maintenance of chlorination equipment. The requirements, procedures and recommendations from these organizations take precedence over the requirements stated herein, if more stringent.

b. Liquid chlorine lines from tank cars to evaporators shall be buried and installed in a conduit and shall not be exposed in below grade spaces. Systems shall be designed for the shortest possible pipe transportation of liquid chlorine. When chlorine cylinders are used, two scales, indicating and recording type, should be used for weighing the cylinders in use. Each scale should be sized to accommodate the maximum number of cylinders required to deliver chlorine at the maximum chlorine feeding rate. Adequate means for supporting cylinders on the scales should be provided. Scales shall be of corrosion-resistant material.

c. Separate manifolds shall be provided for the bank of cylinders on each scale. The manifolds shall be properly valved so that one bank of cylinders may be replaced while chlorine is being withdrawn from the other bank of cylinders. Provision should be made for automatically changing the withdrawal of chlorine from one bank of cylinders to the second when the chlorine in the first bank of cylinders has been exhausted.

d. Gas chlorinators shall be of the solution feed type. The design capacity of evaporators must correspond to gaseous chlorine demand, where several cylinders or ton containers are manifolded to evaporate sufficient chlorine. Chlorine gas systems and piping should be of vacuum type.

2. Housing and Storage

a. Local, state and federal safety requirements, including fire code, shall be carefully followed in storing and handling of chlorine containers, cylinders or tank cars.

b. Gaseous chlorine and chlorination equipment rooms shall be isolated from other sections of the building by gas-tight partitions. Separation of the chlorine storage room and the chlorination equipment room is required for safety. All doors and rooms containing gas chlorination equipment and rooms used for chlorine gas storage should open only to the outside of the building, and all doors should be equipped with panic hardware and a viewing window. Multiple exits to the outside should be provided for each room in which chlorine gas is stored or used. Rooms housing chlorination equipment should be heated to 70 degrees Fahrenheit (21 degrees Centigrade), but never in excess of normal summer temperatures. Rooms containing chlorine cylinders from which chlorine is being withdrawn should be heated to above 60 degrees Fahrenheit (16 degrees Centigrade), but never above the temperature of the equipment room. Where chlorine containers are stored out of doors, the storage area shall be provided with a canopy. Similar precautions should be taken for tank cars. Also, if containers are stored out of doors, cylinders and containers must be allowed to reach room temperature before being placed in use. Floor drains from chlorine rooms must not be connected to floor drains from other rooms.

c. Chlorine rooms shall be at ground level, and should permit easy access to all equipment. The storage area should be separated from the feed area. Chlorination equipment should be situated as close to the application point as reasonably possible.

3. Ventilation and Heating

a. With chlorination systems, forced, mechanical ventilation shall be installed which will provide one complete air change per minute when the room is occupied.

b. When unoccupied, facilities in the ventilation system may be provided with means to reduce the number of air changes to twenty per hour to conserve energy. Whenever such a two-speed ventilation system is used, adequate provisions shall be made to insure that one complete air change per minute is provided when the room is occupied.

c. The entrance to the air exhaust duct from the room shall be near the floor and the point of discharge shall be so located as not to contaminate the air inlet to any buildings or inhabited areas.

d. Air inlets shall be so located as to provide cross ventilation with air and at such temperature that will not adversely affect the chlorination equipment. The vent hose from the chlorinator shall discharge to the outside atmosphere above grade or to the scrubbing system.

e. Switches for exhaust fans and cylinders shall be kept at essentially room temperature.

f. Chlorine scrubbing systems should be incorporated in the design of handling and storage areas where required by the state or local codes.

4. Ancillary Services

a. Water Supply. An ample supply of water meeting a minimum of secondary effluent quality, R317-1, Definitions and General Requirements, shall be available for operating the chlorinator. All in-plant use of effluent shall be taken from downstream of the sampling point for effluent quality monitoring and permit compliance. Where a booster pump is required, a standby booster pump shall be provided, and standby power shall be available.

b. Other Equipment. All electrical fixtures and drainage conduits in chlorination equipment rooms and chlorine storage rooms shall be gas-tight to prevent the spread of chlorine gas in the event of a leak.

5. Piping and Material. Piping systems should be as simple as possible, specifically selected and manufactured to be suitable for chlorine service, with a minimum number of joints. Piping should be well supported and protected against temperature extremes. Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, polyvinyl chloride (PVC), or Uscolite materials are satisfactory for wet chlorine or aqueous solutions of chlorine.

6. Reliability. The design of the system must include the necessary provisions that will either prevent failures or allow immediate corrective action to be taken. Standby power, duplicate equipment and water storage shall be incorporated in the design to prevent interruption of feed, water supply and backup to power and equipment failures.

7. Residual Monitoring

a. An indicating and recording type residual chlorine analyzer using accepted test procedures shall be installed to monitor residual chlorine as required in the discharge permit.

b. Where dechlorination is used, residual chlorine analyzers shall be equipped with audible and visual alarms to indicate discharge of chlorine in the effluent.

8. Safety

a. At least two complete sets of respiratory air-pac protection equipment, meeting the requirements of the Occupational Safety and Health Administration (OSHA), shall be available where chlorine gas is handled, and shall be stored at a convenient location, but not inside any room where chlorine is used or stored. Instructions for using the equipment shall be posted near the equipment. The equipment shall, using compressed air, have at least 30-minute capacity, and be compatible with the equipment used by the fire department responsible for the plant.

b. Where ton containers or tank cars are used, a leak repair kit approved by the Chlorine Institute shall be provided. Caustic soda solution reaction tanks for absorbing the contents of leaking ton containers must be provided where such containers are in use. The installation of automatic gas detection and related alarm equipment must be provided.

B. Ultraviolet Irradiation

1. The executive secretary will consider and approve the use of ultraviolet irradiation for disinfection of wastewater treatment plant effluent based on the information submitted. Effectiveness of this system depends upon shallowness of depth or contact volume at the point of application and relative absence of suspended solids.

a. The applicant must submit supporting data describing the proposed system and including such items as contact geometry between the ultraviolet light source and water, reliability, and suitability of the effluent for this process. Designs should be investigated for sound application of the fundamentals of UV disinfection theory.

b. The design shall be based on factors such as, plug-flow hydraulics, intimate contact with the UV light for a sufficient period, short-circuiting, illumination. Tracer test results are helpful in assessment of hydraulic characteristics.

c. Materials of construction should be consistent with the wastewater and environment.

2. The design of ultraviolet disinfection systems shall be based on on-site testing and the following considerations:

a. Wastewater characteristics. Concentration of total suspended solids (TSS), calcium, magnesium, iron, etc., should be such that UV disinfection is effective. The wastewater should contain low levels of total suspended solids, preferably 20 milligrams per liter or below, and must transmit at least 50 percent of UV light through a wastewater depth of one (1) centimeter.

b. Layout

(1) Adequate space around the UV units to accommodate maintenance activities is required.

(2) Easy removal and replacement of lamps without the use of special tools by one man should be a feature of the equipment design.

(3) The ballasts should be arranged for ready and unhindered access for removal or replacement of any ballast without having a need to remove others.

(4) The layout design must provide adequate floor space for any separate components of the UV system in addition to the UV reactor itself, including requirements for power supply cabinets or cleaning equipment.

(5) Modular design with multiple units to allow uninterrupted service when performing maintenance must be specified.

3. Electrical Requirements

a. power consumption of this process alone should be separately metered.

b. UV lamps and ballasts must be properly matched. The proper matching of lamp and ballast will improve the lamps output and extend its useful life.

c. arrangements for shutting off banks of lamps within a single unit must be provided for lamp replacement or maintenance.

d. power controls should be provided for matching output of lamps with the rate of flow, and system maintenance by the plant staff.

e. minimum electrical standards of construction shall conform to the National Electrical Code, and other applicable codes and standards, consistent with the location or environment surrounding the UV unit and associated equipment.

4. Ventilation. Adequate ventilation to the structure housing the electrical components of the system must be provided to prevent failures from overheating.

5. Cleaning

a. The various means of chemical cleaning available must be evaluated. The evaluation must cover methods required for the unit to be drained; volume of cleansing agent required per cleaning; disposition of spent cleaning solution; manpower requirements to accomplish a cleaning cycle; capital costs of the cleaning and equipment; cleaner cost availability; and special storage and handling needs.

b. The system design must provide for complete draining and easy cleaning.

c. Ultrasonic cleaning must be considered for prevention of biofilm growth on non-illuminated quartz sleeves.

6. Monitoring and Instrumentation

i. Adequate staffing and resources to conduct the data collection and monitoring required for assessing performance must be provided.

ii. Each individual lamp output shall be measured and recorded.

8.4. Dechlorination

A. Sulfur Dioxide (SO_2)

1. Sulfur dioxide is most readily available in liquid (gaseous) form in ton containers similar to chlorine. Approximately, 1 milligram per liter of sulfur dioxide is required to dechlorinate 1 milligram per liter of chlorine residual (free or combined).

2. The dechlorination reaction between sulfur dioxide and both free and combined chlorine is a rapid reaction and requires only a few seconds of contact. The design of sulfur dioxide system must be based on the following considerations:

a. Equipment. Generally sulfur dioxide shall be fed as a gas similar to chlorine gas, as described in R317-3-8. The sulfur dioxide header should be heated to prevent re-liquefaction.

b. Housing and Storage. These requirements are same as to those for chlorine, as described in R317- 3-8.

c. Ventilation. These requirements are same as to those for chlorine, as described in R317-3-8.

d. Ancillary Services. These requirements are same as to those for chlorine, as described in R317-3- 8.

e. Piping and Material. Pipe material (plastics) inside the sulfonator must be compatible with continuous exposure to sulfur dioxide gas.

f. Reliability. These requirements are same as to those for chlorine, as described in R317-3-8.

g. Residual Monitoring. Control is critical when sulfur dioxide is used as the dechlorinating agent because excess sulfur dioxide consumes excess dissolved oxygen in the wastewater or receiving waters. The dechlorination reaction between sulfur dioxide and both free and combined chlorine is rapid, a few seconds at the most, so sampling can be performed immediately downstream of good mixing. The system should be monitored with a residual chlorine analyzer.

h. The design shall incorporate reaeration of the effluent to be in compliance with the dissolved oxygen requirement, if any, of the discharge permit.

i. Safety

(1) Adequate precautions must be taken for storing sulfur dioxide as it is a potentially hazardous chemical to store.

(2) Provide the same amount of air changes per hour as would be required for chlorine, together with a sulfur dioxide sensing and alarm detector.

B. Other Dechlorinating Agents. The executive secretary may review and approve other methods and chemicals for dechlorination based on the information submitted.

R317-3-9. Sludge Processing and Disposal.

9.1. Design Considerations

A. Process Selection

1. The selection of sludge handling and disposal methods must be based on the following considerations:

a. Energy requirements;

b. Efficiency of equipment for sludge thickening;

c. Complexity and costs of equipment and operations;

d. Staffing requirements;

e. Toxic effects of heavy metals and other substances on sludge stabilization and disposal alternatives;

f. Treatment and disposal of side-stream flows, such as digester and thickener supernatant;

g. Process considerations and good house keeping procedures for minimum waste stream generation;

h. A back-up method of sludge handling and disposal; and

i. The long term effects and regulatory requirements on methods of ultimate sludge disposal.

2. The selected process shall be designed to result in stabilized sludge prior to disposal. Significant reduction of odors, volatile solids and reduction or deactivation of pathogenic organisms can be achieved by chemical, physical, thermal or biological treatment processes; thereby reducing public health hazards and nuisance conditions.

B. Sludge Quantities

1. The sludge treatment system shall be designed to accommodate the quantities of sludge generated through the design period. Individual process sizing shall consider the sludge generation peaking factors appropriate for the size and type of facility, with allowance for: seasonal variations, industrial loads, and type of collection system. Reserve capacity in the form of off-line storage, standby units or use of extended hours of operation should be considered to handle peak sludge loads.

2. In plants treating less than one million gallons per day (3,785 cubic meters per day), sludge dewatering equipment may operate for less than 35 hours per week. Sludge processing equipment must be designed to operate efficiently over the range of sludge characteristics expected from the preceding unit process. The design engineer shall submit to the executive secretary, copies of design sizing calculations and relevant information to include:

a. average and maximum sludge quantities;

b. number and size of units;

c. equipment characteristics, conditioning chemical requirements and basic sizing parameters;

d. hours of operation;

e. expected capture efficiency;

f. expected percent solids yield.

C. Recycle loads. The sludge system as well as the liquid handling system shall be designed to take into consideration the recycle BOD5, suspended solids, nitrogen and phosphorus from the solids processing units. The magnitude of such recycle loads and resulting additional sludge will normally range from 5 to 30 percent of the influent loads. Solids balances to account for the additional solids must be calculated.

D. Sludge Storage

1. Design Considerations

a. When the plant design, except for the lagoons, does not include aerobic or anaerobic digesters, or gravity thickeners, etc., a minimum sludge storage for the entire sludge production over a two week period must be provided.

b. In-line storage by increasing mixed liquor solids concentration in aeration tanks or increasing retention in settling tanks is not permitted.

c. Aerated off-line sludge storage of not less than seven days shall be provided for oxidation ditch type activated sludge plants without a sludge digestion process.

2. Equipment Design. The sludge storage system should be equipped with mixing devices to prevent separation of solids and provide a more uniform feed to dewatering devices. Provision for adding lime, chlorine or air to prevent septicity and resulting odors is desirable. Decanting systems to provide thicker solids and flushing water to clean out tankage are necessary. Covering and odor control devices should be provided to minimize nuisance conditions.

9.2. Sludge Pumps and Piping

A. Design Basis

1. Pump Capacity. Capacity shall be adequate to cover the full range of solid concentrations and sludge production. Variable speed or other rate control systems should be provided for all sludge pumps. Maximum operating pressure should be calculated to account for the high friction factor when pumping thixotropic sludges in low velocity laminar ranges.

2. Duplicate Units. Duplicate units shall be provided where failure of one unit would seriously hamper plant operation. Pump suction and discharge manifolds should be interconnected so that one pump discharge can be used to backflush other suction piping.

3. Minimum Head. A minimum positive static head of 24 inches (61 cm) shall be provided at the suction side of centrifugal type pumps and is desirable for all types of sludge pumps. Maximum suction lift should not exceed 10 feet (3 meters) for plunger or diaphragm pumps.

4. Piping

a. Size. Sludge withdrawal piping shall have a minimum diameter of 8 inches (20 cm) for gravity withdrawal and 6 inches (15 cm) for pump suction and discharge lines. Where withdrawal is by gravity, available head shall be adequate to provide sufficient velocity in pipe; thereby preventing solids deposition in pipe.

b. Slope. Gravity flow piping should be laid on a uniform grade and alignment. The slope of gravity discharge lines should not be less than 3 percent.

c. Lining. Scum and primary sludge conveying piping should be lined with a low roughness material such as, glass lining, to reduce friction and to aid in cleaning and maintenance.

B. Equipment Features

1. Plunger type, screw feed type, rotary lobe type, recessed-impeller centrifugal type, progressive cavity type or other types of pumps with demonstrated solids handling capability shall be provided for handling raw sludge. Plunger pump backup for centrifugal pumps is recommended. The abrasive nature of sludges, especially those containing grit, must be considered in the selection of pump type and materials of construction.

2. Sludge grinders should be used where downstream process equipment, such as frame and plate presses, centrifuges, heat exchangers, sludge mixing devices or progressive cavity pumps, is susceptible to rag or trash build-up.

3. Valves. The piping system shall be equipped with isolation valves to allow for repairs and replacement of equipment or metering devices.

4. Piping Layout. Provisions should be made for cleaning, draining and flushing sludge piping. Flanges tees and crosses and cleanouts to allow rodding of suction line are desirable. Provision for back flushing with positive displacement pump discharge is desirable. Provision for cleaning by hot water, steam injection, in-line pigging or chemical degreasing should be considered in long lines containing raw sludge or scum.

C. Control Devices

1. Flow meters should be provided on all process and ancillary lines such as feed, withdrawal, gas, transfer, recirculation, hot water etc. Provision should be made for equipment isolation, cleaning and calibrating.

2. Sludge pumps used on intermittent withdrawal service should be equipped with variable timer equipment.

3. Quick-closing sampling valves shall be installed at the sludge pump, unless sludge sampling is provided separately elsewhere. The size of the valve and piping shall be at least 1 1/2 inches in diameter (3.8 centimeters).

9.3. Sludge Thickeners

1. The design of thickeners (gravity, dissolved-air flotation, centrifuge, and others) should consider the type and concentration of sludge, the sludge stabilization processes, the method of ultimate sludge disposal, chemical needs, and the cost of operation. The pumping rate and piping of the concentrated sludge should be selected such that anaerobic conditions are prevented.

2. No credit towards sludge storage or digestion, if any, in thickeners shall be permitted.

A. Gravity Thickening

1. Design Basis

a. Typical loading rates and resulting solids concentration for gravity thickening are as shown in Table R317-3-9.3(A)(1)(a).

b. Equipment and piping must be designed to deliver sufficient dilution water to gravity thickeners. Flow rate of dilution water shall be measured and recorded. Hydraulic loading to produce overflow rates of 400 to 800 gallons per day per square foot (16-33 cubic meter per day per square meter) shall be maintained to prevent septicity.

2. Equipment Features

a. Heavy duty scrapers capable of withstanding extra heavy torque loads should be provided.

b. Sidewater depths of 10-14 feet (3-4.2 meters) are recommended.

c. Ability to add chlorine solution should be provided to prevent septicity.

d. Tank covers and odor control systems should be considered depending on adjacent land use.

B. Co-Settling. Trickling filter or activated sludge may be returned to primary clarifiers for co- settling. If this method is utilized:

1. Peak design overflow rates for the primary clarifier shall not exceed 1,500 gallons per day per square foot (61 cubic meters per day per square meter), including recirculated sludge flow, and

2. Minimum sidewater depth in the primary clarifier must not be less than 12 feet (3.7 meters).

9.4. Anaerobic Digestion

A. Design Basis

1. The anaerobic digestion system shall provide for active digestion, supernatant separation, sludge concentration and storage. Heating and gas collection systems are required. Mixing systems for primary digesters shall be provided, and are recommended for secondary digesters.

2. Multiple digestion units shall be provided in all plants designed for more than 1 million gallons per day (3,7854 cubic meter per day) rate of flow. For plants designed for less than one million gallons per day (3,785 cubic meters per day), alternative methods of sludge stabilization and emergency storage must be available if only one unit is available.

3. The total digestion tank capacity should be determined by rational calculations based upon the following factors:

a. sludge characteristics - volume and percent solids,

b. the temperature to be maintained in the digesters,

c. the degree and extent of mixing in the digesters, and

d. the degree of volatile solids reduction desired.

4. Calculations shall be submitted to justify the basis of design. Otherwise, the following assumptions shall be used:

a. sludge characteristics - domestic wastewater sludge volume generated as shown in Table R317-3- 9.4(A)(4)(a).

b. the temperature to be maintained in the digesters: 90 to 100 degrees Fahrenheit (32-38 degrees Centigrade).

c. the degree and extent of mixing in the digesters: 40 horsepower per million gallons (8 watts per cubic meter).

d. volatile solids in digested sludge: 50 percent.

5. Completely-mixed systems, mixed at an intensity such that digester contents are completely turned over every 30 minutes, may be loaded at a rate up to 120 pounds of volatile solids per 1,000 cubic feet of volume per day (1.92 kilograms per cubic meter per day) in the active digestion units. When grit removal facilities are not provided, the digester volume must be increased to accommodate grit accumulation.

6. Moderately mixed digestion systems, mixed by circulating sludge through an external heat exchanger, may be loaded at a rate up to 40 pounds of volatile solids per 1,000 cubic feet of volume per day (0.64 kilograms per cubic meter per day) in the active digestion units. This loading may be modified upward or downward depending upon the degree of mixing provided.

7. For those units intended to serve as supernatant separation tanks, the depth should be sufficient to allow for the formation of a reasonable depth of supernatant liquor. A minimum sidewater depth of 20 feet (6.1 meters) is recommended.

B. Tank Covers

1. All anaerobic digestion tanks shall be covered. Primary tanks may be equipped with gas-tight, fixed steel or concrete covers or floating steel covers made gas-tight by extended rims. Secondary tank covers may be of the fixed type or floating steel type, including gas storage type units.

2. Floating covers shall be equipped with a guide rail system to prevent tipping and lower-landing ridges, and cover restraints.

C. Sludge Inlets and Outlets

1. Multiple recirculation, withdrawal and return points, should be provided, to enhance flexible operation and effective mixing, unless mixing facilities are incorporated within the digester. The returns, in order to assist in scum breakup, should discharge above the liquid level and be located near the center of the tank.

2. Raw sludge feed to the digester should be through the sludge heater and recirculation return piping, or directly to the tank if internal mixing facilities are provided.

3. Sludge withdrawal to disposal should be from the bottom of the tank. This pipe should be interconnected with the recirculation piping, if such piping is provided, to increase versatility in mixing the tank contents. Additional alternative withdrawal lines should be provided.

D. Supernatant Withdrawal

1. Supernatant piping should not be less than 6 inches (15 centimeters) in diameter. Piping should be arranged so that withdrawal can be made from three or more levels in the digester. A positive, unvalved, vented overflow shall be provided with a drop leg for a liquid seal and downstream vent.

2. If a supernatant selector is provided, provisions shall be made for at least one other draw-off level, located in the supernatant zone of the tank, in addition to the unvalved emergency supernatant draw-off pipe. High pressure back-wash facilities shall be provided.

3. Multiple supernatant draw-offs should be provided for sampling at different levels. Sampling pipes must be at least 1 1/2 inches (3.8 centimeters) in diameter, and should terminate at a suitably-sized sampling sink or basin.

E. Sampling. Sampling hatches shall be provided in all tank covers with water seal tubes extending to beneath the liquid surface.

F. Gas Collection, Piping and Appurtenances

1. General. All portions of the gas system, including the space above the tank liquor, storage facilities and piping, shall be so designed that under normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure. All enclosed areas where any gas leakage might occur shall be adequately ventilated.

2. Safety Equipment. All safety equipment shall be provided where gas is produced. Pressure and vacuum relief valves, flame traps, gas detectors, and automatic safety shut off valves, shall be provided.

3. Gas Piping and Condensate. Gas piping shall be of adequate diameter for gas flow rate and shall slope to condensate traps at low points. The use of float-controlled condensate traps is not permitted.

4. Gas Utilization Equipment.

a. Gas-fired boilers for heating digesters shall be located in a separate room not directly connected to the digester gallery. Gas lines to these units shall be provided with flame traps.

b. Dual fuel engines on major pumps or blowers, should be installed with possible recovery of exhaust and jacket cooling heat for use in heating digester or building spaces. An alternate system would consist of direct electric power generation. Gas cleaning and storage may be desirable.

5. Electrical Fixtures. Electrical fixtures and controls in enclosed places where hazardous gases may accumulate shall comply with the National Electrical Code for Class I, Division I Group D locations. Digester galleries must be isolated from normal operating areas to avoid an extension of the hazardous location.

6. Waste Gas.

a. Waste gas burners shall be readily accessible and should be located at least 25 feet (7.6 meters) away from any plant structure if placed at ground level, or they may be located on the roof of the control building at a height of not less than three feet (0.9 meter) from the top of the roof.

b. All waste gas burners shall be equipped with automatic ignition, such as a pilot light or a device using a photoelectric cell sensor. Consideration should be given to the use of natural or propane gas to insure reliability of the pilot light.

c. Necessary approvals from the Utah Air Conservation Committee and its succeeding authorities, shall be obtained for burning any waste gas and any other emissions from the treatment plant.

7. Ventilation. Any underground enclosures connecting with digesters or containing sludge or gas piping or equipment shall be forced ventilated. The piping gallery for digesters should not be connected to other passages.

8. Metering. Gas meters, with by-pass, shall be provided to meter total and waste gas production.

G. Digester Heating

1. Insulation. Wherever possible, digesters should be constructed above ground water level and should be suitably insulated to minimize heat loss.

2. Heating Facilities

a. External Heating. Sludge may be heated by circulating the sludge through external heaters. Piping should be designed to provide for the preheating of feed sludge before introduction to the digesters, especially if sludge thickeners are not used, or if feed is a batch feed resulting in high intermittent feed rates. Provisions shall be made in the lay-out of the piping and valving to facilitate cleaning of these lines. Heat exchanger sludge piping should be sized for heat transfer requirements.

b. Other Heating Methods. The executive secretary may approve review other types of heating facilities based on the information submitted by the applicant.

3. Heating Capacity. Heating capacity sufficient to consistently maintain the design sludge temperature shall be provided. Where digester tank gas is used for sludge heating, an auxiliary fuel supply is required.

4. Hot Water Internal Heating Controls

a. A suitable automatic mixing valve shall be provided to temper the boiler water with return water so that the inlet water to the heat jacket can be held below a temperature at which caking will be accentuated. Manual control should also be provided by suitable by-pass valves.

b. The boiler should be provided with suitable automatic controls to maintain the boiler temperature at approximately 180 degrees Fahrenheit (82.2 degrees Centigrade), to minimize corrosion, and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, or excessive temperatures.

c. Thermometers shall be provided to show temperatures of the sludge, hot water feed, hot water return, and boiler water.

H. Mixing Systems. Sludge mixing systems shall be gas recirculation, draft tube mixing, mechanical mixer or pump recirculation types. The mixing system should be designed such that routine maintenance can be performed without taking the digester out of service.

I. Operational Considerations

1. Piping Flexibility. Where two stage digestion is practiced, provision shall be made to feed and heat the secondary digester. Mixing systems should be installed in secondary digestion units.

2. Provision to pump secondary sludge to primary units for reseeding and extending sludge detention time is recommended.

3. When digested sludge is pumped to the dewatering unit, piping shall be laid out so as to prevent uncontrolled gravity flow.

4. Provisions to adjust pH and alkalinity by addition of chemicals shall be made.

J. Maintenance Features for draining, cleaning, and maintenance must be considered in the design of the digesters.

1. Slope. The tank bottom should slope to drain toward the withdrawal pipe. For tanks equipped with a suction mechanism for withdrawal of sludge, a bottom slope of 1:12 or greater is recommended. Where the sludge is to be removed by gravity alone, 1:4 slope is recommended.

2. Access Manholes. At least two 36 inch (91 centimeters) diameter access manholes should be provided in the top of the tank in addition to the gas dome. There should be stairways to reach the access manholes. A separate sidewall manhole shall be provided. The opening should be large enough to permit the use of mechanical equipment to remove grit and sand.

3. Safety. Local, state and federal safety requirements, including those in applicable fire code, the Uniform Building Code etc., must be reviewed and complied with. Those requirements take precedence over the requirements stated herein, if more stringent, and should be incorporated in the design. Nonsparking tools, safety lights, rubber-soled shoes, safety harness, gas detectors for inflammable and toxic gases, and at least two self-contained breathing units shall be provided for emergency use.

9.5. Aerobic Digestion

A. General. Aerobic digestion may be used for stabilization of primary sludge, and activated or trickling filter sludge. Digestion may take place in single or multiple tanks designed to provide effective air mixing, reduction of the organic matter, supernatant separation, and sludge concentration under controlled conditions.

B. Tank Capacity. The digestion tank capacity shall be based on such factors as, quantity of sludge produced, sludge concentration and related characteristics, time of aeration, sludge temperature, etc.

1. Volatile Solids Loading. Volatile suspended solids loading shall not exceed 100 pounds per 1,000 cubic feet of volume per day (1.60 kilograms per cubic meter per day) in the digestion units.

2. Detention Time. The minimum detention time of 15 days shall be provided for aerobic digestion. The detention time may vary with sludge characteristics. Where sludge temperature is lower than 50 degrees Fahrenheit (10 degrees Centigrade) additional detention time should be considered. Covering of the aerobic digesters may be considered to prevent heat losses to atmosphere.

3. Multiple Units. Multiple tanks are required for plants designed to treat more than 1 million gallons per day (3,785 cubic meters per day). Adequate provision must be made for sludge handling and storage for the plants treating less than 1 million gallons per day (3,785 cubic meters per day). When multiple units are provided, ability to utilize them in serial operation is recommended.

4. Mixing and Air Requirements

a. Aerobic sludge digestion tanks shall be designed for effective mixing. Sufficient air shall be provided to keep the solids in suspension and maintain dissolved oxygen between 1 to 2 milligrams per liter.

b. A minimum air volume of 30 cubic feet per minute per 1,000 cubic feet of tank volume (0.51 liters per cubic meter per second) shall be provided with the largest blower out of service for the mixing and aeration requirements. For the diffused aeration systems, the nonclog type air diffusers are recommended, and shall be designed to permit continuity of service.

c. A minimum of 75 horsepower per million gallon of tank volume (15 watts per cubic meter) shall be provided for mechanical aeration systems. Mechanical aerators must be protected where freezing temperatures are expected. Submerged turbine units or floating surface aerators may be considered to allow for liquid level variation.

5. Supernatant Separation. Facilities shall be provided for effective separation and withdrawal of supernatant and for effective collection and removal of scum and grease. Multiple level decant withdrawal lines should be provided.

6. Foam Spray. Foam suppression spray water piping and nozzles should be provided.

9.6. Sludge Dewatering

A. Belt Filter Press

1. Design Basis

a. Hydraulic and solids loading rates, conditioning requirements, and performance shall be based on pilot unit performance or operational results on similar sludges.

b. Multiple units are required unless storage capacity or alternate dewatering methods are available to handle sludge during prolonged power outage.

c. In plants designed for 1 million gallons per day (3,785 cubic meters per day), the operational period should not usually exceed 35 hours per week which allows one shift operation with time for chemical makeup, cleanup and delays. In plants designed for over 1 million gallons per day (3,785 cubic meters per day), the operational period may approach 20 hours per day.

2. Equipment Features

a. The facility should provide for chemical storage, feed equipment, belt wash water, and filtrate return and for conveying and loading sludge cake onto transport vehicles.

b. Belt alignment and tensioning should be regulated automatically.

c. If a single unit is provided, standby equipment should be provided for the sludge feed pump, belt wash, and chemical feed.

d. Facilities or piping for filtrate and wash water sampling should be provided.

3. Operational Considerations. Good house keeping and maintenance features should include press housing, ventilation, safe and convenient access for cleanup and maintenance, floor drains, minimum splashing of filtrate or wash water, etc.

9.7. Sludge Drying Beds

A. Design Basis

1. The area of sludge drying beds is determined by factors such as, climatic conditions, the character and volume of the sludge to be dewatered, the method and schedule of sludge removal, and other methods of sludge disposal.

2. The applicant or the design engineer must submit the basis of design including calculations for review. When the basis of design is not submitted, the drying bed area shall be determined on the basis of 4 square feet per population equivalent (0.38 square meter per population equivalent) when the drying bed is the primary method of dewatering, and 2.0 square feet per population equivalent (0.19 square meter per population equivalent) if it is to be used as a backup dewatering unit. An increase of bed area by 25 percent is required for paved beds. Sludge storage or alternate dewatering methods should be considered for winter weather.

3. A ground water discharge permit may be required for beds without an impervious base. Hydraulic conductivity shall not be greater than 1 x 10-6 centimeters per second or as required for compliance with the provisions of R317-6 (Ground Water Quality Protection Regulations).

B. Design Features

1. Gravel. The lower course of gravel around the underdrains should be properly graded and not less than 12 inches (30.5 centimeters) in depth, extending at least 6 inches (15.2 centimeters) above the top of the underdrains. It is desirable to place this in two or more layers. The top layer of at least 3 inches (7.6 centimeters) must consist of gravel 1/8 inch to 1/4 inch (3.18 to 6.35 millimeters) in size. The remaining layer of gravel below the top 3-inch (7.6 centimeters) layer may be 3/4 to 1 inch (1.9 to 2.5 centimeters) in size.

2. Sand. The top course placed above the gravel should consist of at least 6 to 9 inches (15.2 to 22.9 centimeters) of clean coarse sand. The finished sand surface should be level.

3. Underdrains. Underdrains should be clay pipe or concrete drain tile at least 4 inches (10.2 centimeters) in diameter laid with open joints. Underdrains should be spaced not more than 20 feet (6.1 meters) apart. Underdrainage should be returned to the process with raw or settled sewage.

4. Partially Paved Type. The partially paved drying bed should be designed with consideration for the space requirement to operate mechanical equipment for removing the dried sludge. Paving must positively slope to the underdrains.

5. Containment Walls. Walls should be water-tight and extend 15 to 18 inches (38 to 46 centimeters) above and at least 6 inches (15 centimeters) below the surface of the drying bed. Outer walls should be curbed to prevent soil from washing onto the beds.

6. Sludge Removal. Not less than two beds should be provided and they should be arranged to facilitate sludge removal. Paved truck tracks should be provided for all percolation-type sludge beds.

7. Sludge Feed Line. The sludge pipe to the drying beds should terminate at least 12 inches (30.5 centimeters) above the floor surface and be so arranged that it will drain into the bed. Concrete splash blocks should be provided at sludge discharge points.

9.8. Other Sludge Treatment Methods. Other methods for sludge dewatering, treatment, and stabilization will be considered by the executive secretary based on such factors as the need, suitability of application and process, reliability and flexibility, etc.

R317-3-10. Lagoons.

10.1. Lagoon Siting

A. Distance from Habitation. A lagoon should be sited as far as practicable, with a minimum of 1/4 mile (0.4 kilometer), from areas developed for residential or commercial or institutional purposes or may be developed for such purposes within a foreseeable future. Site characteristics such as topography, prevailing wind direction, forests, etc., must be considered in siting the lagoon.

B. Prevailing Winds. The lagoon should be sited where the direction of local prevailing winds is towards uninhabited areas.

C. Surface Runoff. The lagoon should not be sited in watersheds receiving significant amounts of storm-water runoff. Storm-water runoff should be diverted around the lagoon and protect lagoon embankments from erosion.

D. Hydrology and hydrogeology. Close proximity to water supplies and other facilities subject to wastewater contamination should be avoided in siting the lagoon. A minimum separation of four (4) feet (1.2 meters) between the bottom of the lagoon and the maximum ground water elevation should be maintained.

E. Geology

1. The lagoon shall not be located in areas which may be subjected to karstification, i.e., sink holes or underground streams generally occurring in area underlain by porous limestone or dolomite or volcanic soil.

2. A minimum separation of 10 feet (3.0 meters) between the lagoon bottom and any bedrock formation is recommended.

10.2. Small Facilities. The executive secretary will review and approve the construction of a lagoon for a design rate of flow less than 25,000 gallons per day (95 cubic meters per day) only if:

A. there are no other alternatives for wastewater treatment and disposal available to the applicant;

B. there is no other appropriate technology for wastewater treatment and disposal except lagoon; and

C. the applicant has resources to satisfactorily operate and maintain the lagoon.

10.3. Basis of Design. Design variables such as lagoon depth, number of units, detention time, and additional treatment units must be based on effluent standards for BOD_5, total suspended solids (TSS), E. coli, dissolved oxygen (DO), and pH.

A. Design for Discharging and Total Containment Lagoons

1. The design shall be based on BOD_5 loading ranging from 15 to 35 pounds per acre per day (16.8-39.2 kilograms per hectare per day).

2. The design for total containment lagoons shall be based on conservative estimates of precipitation, evaporation, seepage or percolation and inflow relevant to the site. A mass diagram showing each of the foregoing factors on a month-by-month basis, shall be prepared and submitted with the design and plans for review.

B. Design Depth. The minimum operating depth should be such that growth of aquatic plants is suppressed to prevent damage to the dikes, bottom, control structures, aeration equipment and other appurtenances.

1. Discharging or Total Containment Lagoons. The maximum water depth shall be 6 feet (1.8 meters) in primary cells. Greater depth in subsequent cells may be deeper than 6 feet provided that supplemental aeration or mixing is incorporated in the design. Minimum operating depth shall be three feet.

2. Aerated Lagoons. The design water depth should range from 10 to 15 feet (three to 4.5 meters). The type of the aeration equipment, waste strength and climatic conditions affect the selection of the design water depth.

3. Sludge Accumulation. The minimum depth of 18 inches (45 centimeters) for sludge accumulation shall be provided in primary cells of facultative lagoons.

C. Freeboard. The minimum freeboard shall be three (3) feet (1.0 meter). For small systems - less than 50,000 gallons per day (190 cubic meters per day), the minimum freeboard can be reduced to two (2) feet (0.6 meter).

D. Slope

1. Maximum Dike Slope. The inner and outer dike slopes shall not be steeper than 3 horizontal to 1 vertical (3:1).

2. Minimum Dike Slope. Inner dike slope shall not be flatter than 4 horizontal to 1 vertical (4:1). A flatter slope can be specified for larger installations because of wave action, but have the disadvantages of added shallow areas, that are conducive to emergent vegetation.

E. Seepage

1. The bottom of lagoons treating domestic sewage shall be no less than 12-inch (30 centimeters) in thickness, constructed in two six-inch (15 centimeters) lifts. The selection of the type of seals using soils, bentonite, or synthetic liners for the lagoon bottom shall be based on the design hydraulic conductivity, durability, and integrity of the proposed material.

2. Hydraulic conductivity of the lagoon bottom as constructed or installed, shall be such that it meets the requirements of ground water discharge permit issued under R317-6, (Ground Water Quality Protection rules). It shall not exceed 1.0×10^{-6} centimeters per second.

3. The seepage loss may vary with the thickness of the bottom seal and hydraulic head thereon. Detailed calculations on the determination of seepage loss shall be submitted with the design. It shall not exceed 6,500 gallons per acre per day (60.8 cubic meters per hectare per day).

4. Results of field and laboratory hydraulic conductivity tests, including a correlation between them, shall meet the design and ground water discharge permitting requirements, before the use of lagoon can be authorized.

5. Hydraulic conductivity for the lagoon where industrial waste is a significant component of sewage, shall be based on ground water protection criteria contained in R317-6 (Ground Water Quality Protection rules).

F. Detention time

1. Discharging Lagoons. Detention time in the lagoon shall be the greater, and exclusive of the capacity provided for sludge build-up, of:

a. 120 days based on winter flow and the maximum operating depth of the entire system; or

b. 60 days based on summer flow and peak monthly infiltration/inflow.

c. The detention time shall not be less than 150 days at the mean operating depth for effluent discharge without chlorination. In order to meet bacteriologic standards in such a case, at least 5 cells shall be provided. The detention time and organic loading rate shall depend on climatic or stream conditions.

2. Aerated Lagoons

a. The detention time shall be the greater of:

(1) 30 days minimum; or

(2) the value determined using the following formula: $E = (1/(1 + (2.3 \times K_1 \times t)))$ where: t = detention time, days; E = fraction of BOD_5 remaining in an aerated lagoon; K_1 = reaction coefficient, aerated lagoon, base 10. For normal domestic sewage, the K_1 value may be assumed to be 0.12 day^{-1} at 20 degrees Centigrade, and 0.06 day^{-1} at one degree Centigrade.

b. The reaction rate coefficient for domestic sewage which includes some industrial wastes must be determined experimentally for various conditions which might be encountered in the aerated lagoons. The reaction rate coefficient based on temperature used in the experimental data, shall be adjusted for the minimum sewage temperature.

G. Aeration Requirements for Aerated Lagoons

1. The design parameters for the aerated lagoon should be based on pilot testing or validated experimental data.

2. When pilot testing is not conducted, the design should be based on two pounds of oxygen input per pound of BOD_5 applied (two kilograms of oxygen input per kilogram of BOD_5 applied). However, it may vary with the degree of treatment, and the concentration of suspended solids to be maintained. A tapered mode of aeration is permitted based on applied BOD_5 to each cell.

3. Aeration equipment shall be capable of maintaining a minimum dissolved oxygen level of 2 milligrams per liter in the lagoon at all times such that their circles of influence meet.

a. Circle of Influence. It is that area in which return velocity is greater than 0.15 feet per second as indicated by the manufacturer's certified data. Table R317-3-10.3(G)(3)(a) may be used when the manufacturer's certified data is not available.

b. Freezing. Suitable protection from weather shall be provided for aerators and electrical controls.

H. Industrial Wastes. For industrial waste treatment using lagoon, the design parameters shall be based on the type and treatability of industrial wastes using biological processes. In some cases it may be necessary to pretreat industrial waste or combine with domestic sewage.

10.4. Lagoon Construction Details

A. Cell Shape. The shape of all cells should be such that there are no narrow or elongated portions. Round, square or rectangular lagoons with a length not exceeding three times the width are most desirable. No islands, peninsulas or coves are permitted. Dikes should be rounded at corners to minimize accumulations of floating materials. Common-wall dike construction, wherever possible, is strongly encouraged.

B. Multiple Units

1. At a minimum, the lagoon system shall consist of three cells of approximately equal capacity designed to facilitate both series and parallel operations.

2. The executive secretary may approve less than three cells on the basis of review of factors such as, the rate of flow, the need, treatment reliability, etc.

3. All systems shall be designed with piping:

a. to permit isolation of any cell without affecting the transfer and discharge capabilities of the total system, and

b. to split the influent waste load to a minimum of two cells or all primary cells in the system.

C. Embankments and Dikes

1. Material. Dikes shall be constructed of relatively impervious material and compacted to no less than 90 percent Standard Proctor Density at 3 percent above the optimum moisture density to form a stable structure. The area where the embankment is to be placed shall be from vegetation and unstable organic material.

2. Top Width. The minimum dike width shall be 8 feet (2.4 meters) and shall permit access by maintenance vehicles.

D. Lagoon Bottom

1. Soil. Soil used in constructing the lagoon bottom (not including seal) and dike cores shall be incompressible and tight and compacted at a moisture content of 3 percent above the optimum water content to at least 90 percent Standard Proctor Density.

2. Uniformity. The lagoon bottom should be as level as possible at all points. Finished elevations shall not be more than three (3) inches (7.5 centimeters) from the average elevation of the bottom.

3. Prefilling. The lagoon should be prefilled to a level which protects the liner, prevents weed growth, reduces odor, and maintains moisture content of the seal. However, the dikes must be completely prepared before the introduction of any water.

E. Construction Quality Control and Assurance. A construction quality control and assurance plan showing frequency and type of testing for materials used in construction shall be submitted with the design for review and approval. Results of such testing, gradation, compaction, field permeability, etc., shall be submitted to the executive secretary.

F. Erosion Control

1. The site shall be protected from erosion. The design of control measures shall be based on factors, such as lagoon location and size, seal material, topography, prevailing winds, cost breakdown, application procedures, etc.

2. For aerated lagoons, the slopes and bottom shall be protected from erosion resulting from turbulence.

3. Exterior face of the dike slope shall be protected from erosion due to severe flooding of a water course.

4. Seeding. The outside surface of dikes shall have a cover layer of at least 4 inches (10 centimeters), of fertile topsoil to promote establishment of an adequate vegetative cover wherever riprap is not utilized. Prior to prefilling, adequate vegetation shall be established on dikes from the outside toe to 2 feet (0.6 meter) above the lagoon bottom on the interior as measured on the slope. Perennial-type, low-growing, native, spreading grasses that minimize erosion and can be mowed are most satisfactory for seeding on dikes. Alfalfa and other deep-rooted crops must not be used for seeding since the roots of this type are apt to impair the water holding efficiency of the dikes.

5. Riprap or equivalent material shall be placed from 1 foot (0.3 meter) above the high water mark to two feet (0.6 meter) below the low water mark (measured on the vertical) for protection from severe wave action.

a. Riprap. The interior face of dikes must be protected from erosion by riprap or other equivalent methods of erosion control.

(1) Riprap layer shall be of durable, angular, sound and hard, field or quarry stones, and shall be free from seams, cracks and structural defects.

(2) The thickness of riprap layer shall be at least 8 inches (20 centimeters).

(3) Stones to be used in the riprap layer shall meet the following requirements:

(a) A minimum of 50 percent of stones by weight, shall be of sizes between two-thirds and one and one-half of the layer thickness;

(b) No more than ten percent of stones by weight, shall be of a size less than one-tenth of the layer thickness;

(c) The specific weight of stones must range between 2.5 and 2.82;

(d) Durability shall be tested in accordance with ASTM Standard C-535, as amended, and stones wearing in excess of 40 percent shall not be used.

(e) Stones shall be graded and manipulated in size so as to produce a regular surface of dense and stable mass. A stable foundation for the placed riprap shall be provided at the toe of the dike.

10.5. Influent Piping

A. Influent and Effluent Structures

1. All influent and effluent structures shall be located to minimize short-circuiting within lagoons, and to avoid blocking of lagoon circulation. Such structures must have protection against freezing or ice damage under winter conditions.

2. Inlets to the primary cells shall meet the following criteria:

a. Surcharging of upstream sewer from the inlet manhole is not permitted.

b. Multiple influent discharge points for primary cells of 20 acres (8 hectares) or larger should be provided to enhance the distribution of waste load in the cell.

c. Discharge shall be in the center of a round or a square cell, or at the third point farthest from the outlet structure in a rectangular cell, or at least 100 feet (30 meters) from the toe of the dike.

d. All aerated cells shall have an influent line which distributes the load within the mixing zone of the aeration equipment. Multiple inlets may be considered for a diffused aeration system.

e. Force mains shall be valved at the lagoon, and may terminate in a vertically or horizontally discharging section. The discharge end of the vertical pipe must be located no more than one foot above the lagoon bottom. Flow velocities in the discharge section entering the lagoon must not be in excess of two feet per second.

B. Influent Discharge Apron

1. The influent line shall discharge horizontally into a shallow, saucer-shaped, depression extending below the lagoon bottom not more than the diameter of the influent pipe plus 1 foot.

2. The end of the discharge line shall rest on a suitable concrete apron large enough to prevent the terminal influent velocity at the end of the apron from causing soil erosion. A 2-foot (0.6 meter) square apron shall be provided at the minimum.

C. Flow Measurement. Influent flow to the lagoon shall be continuously indicated and recorded. Flow measurement and recording equipment shall be weatherproof.

D. Level Gauges. Level gauges with clear markings shall be provided in:

1. each cell to measure and manually record the depth; and

2. the primary flow measurement device structure to indicate the depth or the rate of flow.

E. Manhole

1. A manhole or vented cleanout wye shall be installed prior to entrance of the influent line into the primary cell and shall be located close to the dike as topography permits. Its invert shall be at least 6 inches (15 centimeters) above the maximum operating level of the lagoon and provide sufficient hydraulic head without surcharging the manhole.

2. A manhole is required for small systems to house flow measurement device. For larger systems, flow measurement device and related instrumentation must be housed in a headworks type structure.

F. Flow Distribution. Flow distribution structures shall be designed to effectively split hydraulic and organic loads equally to primary cells.

G. Material. The material for influent line to the lagoon should meet the requirements of material for underground sewer construction described in this rule. Unlined corrugated metal pipe is not permitted due to corrosion problems. The material selection shall be based on factors such as, wastewater characteristics, heavy external loadings, abrasion, soft foundations, etc.

10.6. Control Structures and Interconnecting Piping

A. Structure

1. As a minimum, control structures shall:

a. be accessible for maintenance and adjustment of controls;

b. be adequately ventilated for safety and to minimize corrosion;

c. be locked to discourage vandalism;

d. contain controls to permit water level and flow rate control, and complete shutoff;

e. be constructed of non-corrodible materials (metal-on-metal); and

f. be located to minimize short-circuiting within the cell and avoid freezing and ice damage.

2. Recommended devices to regulate water level are valves, slide tubes or dual slide gates. Regulators should be designed so that they can be preset to stop flows at any lagoon elevation.

B. Piping. All piping shall be of cast iron or other material for installation of underground piping. The piping shall be located along the bottom of the lagoon with the top of the pipe just below average elevation of the lagoon bottom. Pipes should be anchored and protected from erosion.

10.7. Effluent Discharge Piping

A. Submerged Takeoffs. For lagoons designed for shallow or variable depth operations, submerged takeoffs are required. Intakes shall be located a minimum of 10 feet (3.0 meters) from the toe of the dike and 2 feet (0.6 meter) from the seal, and shall employ vertical withdrawal.

B. Multi-level Takeoffs. For lagoons that are designed deeper than 10 feet (3 meters), enough to permit stratification of lagoon content, multiple takeoffs are required. There shall be a minimum of three withdrawal pipes at different elevations. Adequate structural support for takeoffs shall be provided.

C. Emergency Overflow. An emergency overflow should be provided to prevent overtopping of dikes. The hydraulic capacity for continuous discharge structures and piping shall allow for a minimum of 250 percent of the design flow of the system. The hydraulic capacity for controlled-discharge systems shall permit transfer of water at a minimum rate of six (6) inches (15 centimeters) of lagoon water depth per day at the available head.

10.8. Miscellaneous

A. Fencing. The lagoon area shall be enclosed with not less than 6 feet high chain link fence to prevent entering of livestock and to discourage trespassing. Fencing must not obstruct vehicle traffic on top of the dikes. A vehicle access gate of sufficient width to accommodate all maintenance equipment shall be provided. All access gates shall be provided with locks.

B. Access. An all-weather access road shall be provided to the lagoon site to allow year-round maintenance of the facility.

C. Warning Signs. Permanent signs shall be provided along the fence around the lagoon to designate the nature of the facility and advise against trespassing. At least one sign shall be provided on each side of the site and one for every 500 feet (150 meters) of its perimeter.

D. Service Building A service building for laboratory and maintenance equipment should be considered.

10.9. Industrial Waste Lagoons. The executive secretary will review the design of lagoons for treatment of industrial wastes on the basis of such factors as treatability, operability, reliability, ground water protection levels, water quality objectives, etc.

R317-3-11. Land Application of Wastewater Effluents.

11.1. Effluent Criteria. Land application of effluents is permitted following treatment if standards are met as defined in R317-1, Definitions and General Requirements. The proposal for land application must include detailed site information, effluent characteristics, meteorological data, type of crop to be grown, ground water data, and a site management plan and practices.

11.2. Site Operation and Management

A. Piping System

1. All distribution pipes and sprinklers must have the capability to be completely drained.

2. Main distribution headers must have flow measurement devices and pressure gages. All land applied flow must be totalized.

B. Warning Signs. Signs warning of the nature of the facility shall be provided at the boundaries of the site.

R317-3-12. Effluent Filtration.

12.1. Granular Media Filters. Granular media filters may be used as a tertiary treatment device for the removal of residual suspended solids from secondary effluents. A pretreatment process such as chemical coagulation and sedimentation or other acceptable process must precede the filter units, where effluent suspended solids requirements are less than 10 milligrams per liter, or where secondary effluent quality can be expected to fluctuate significantly, or where filters follow a treatment process and where significant amounts of algae will be present.

12.2. Design Considerations. The plant design should incorporate flow-equalization facilities to moderate filter influent quality and quantity. The selection of pumping equipment ahead of filter units should be designed to minimize shearing of floc particles.

A. Filter Types. Filters may be of the gravity or pressure type. Pressure filters shall be provided with ready and convenient access to the media for treatment or cleaning. Where greases or similar solids which result in filter plugging are expected, filters should be of the gravity type.

B. Filtration Rates. Filtration rates shall not exceed 5 gallons per minute per square foot. (3.4 liters per square meter per second) based on the maximum hydraulic flow rate applied to the filter units.

C. Number of Units. Total filter area shall be provided in two or more units, and the filtration rate shall be calculated on the total available filter area with one unit out of service.

D. Filter Backwash

1. Backwash Rate. The backwash rate shall be adequate to fluidize and expand each media layer a minimum of 20 percent based on the media selected. The backwash system shall be capable of providing a variable backwash rate having a maximum of at least 20 gallons per minute per square foot, (13.6 liters per square meter per second) and a minimum backwash period of 10 minutes.

2. Backwash Pumps. Pumps for backwashing filter units shall be sized and interconnected to provide the required rate to any filter with the largest pump out of service. Filtered water should be used as the source of backwash water. Waste filter backwash shall be returned to the treatment process or otherwise adequately treated.

E. Filter Media

1. Selection. Selection of proper media size will depend on the rate of filtration rate, the type of pretreatment, filter configuration, and effluent quality objectives. In dual or multi-media filters, media size selection must consider compatibility among media.

2. Media Specifications. Table R317-3-12.2(E)(2) provides minimum media depths and the normally acceptable range of media sizes. The applicant has the responsibility for selection of media to meet specific conditions and treatment requirements relative to the project under consideration.

12.3. Filter Appurtenances. The filters shall be equipped with wash water troughs, surface wash or air scouring equipment, means of measurement and positive control of the backwash rate, equipment for measuring filter head loss, positive means of

shutting off flow to a filter being backwashed, and filter influent and effluent sampling points. If automatic controls are provided, there shall be a manual override for operating equipment, including each individual valve essential to the filter operation. The underdrain system shall be designed for uniform distribution of backwash water (and air if provided) without danger of clogging from solids in the backwash water. Provision shall be made to allow periodic chlorination of the filter influent or backwash water to control slime growths.

12.4. Reliability. Each filter unit shall be designed and installed so that there is ready and convenient access to all components and the media surface for inspection and maintenance without taking other units out of service. The need for enclosing filter units shall depend on expected extreme climatic conditions at the treatment plant site. As a minimum, all controls shall be protected from adverse process and climatic conditions. The structure housing filter controls and equipment shall be provided with adequate heating and ventilation equipment to minimize problems with excess humidity.

12.5. Backwash Surge Control. The rate of waste filter backwash water return to treatment units shall be controlled such that the rate does not exceed 15 percent of the design average daily flow rate to the treatment units. The hydraulic and organic loads from waste backwash water shall be considered in the overall design of the treatment plant. Where waste backwash water is returned for treatment by pumping, adequate pumping capacity shall be provided with the largest unit out of service.

12.6. Backwash Water Storage. Total backwash water storage capacity provided in an effluent clearwell or surge tank or other unit shall equal or exceed the volume required for two complete backwash cycles. Additional storage capacity should be considered for operational flexibility.

12.7. Proprietary Equipment. Where proprietary filtration equipment, not conforming to the preceding requirements is proposed, data which supports the capacity of the equipment to meet effluent requirements under design conditions shall be submitted for review and approval by the executive secretary.

TABLE R317-3-2.3(D)(4).
Minimum Slopes

Sewer Size, inch (centimeter)	Minimum Slope, feet per feet or meter per meter
8 (20)	0.00334
9 (23)	0.00285
10 (25)	0.00248
12 (30)	0.00194
14 (36)	0.00158
15 (38)	0.00144
16 (41)	0.00132
18 (46)	0.00113
21 (53)	0.00092
24 (61)	0.00077
27 (69)	0.00066
30 (76)	0.00057
36 (91)	0.00045

TABLE R317-3-4.4(H)(1).
Painting

Service	Color
Sludge	Brown
Gas	Orange
Potable Water	Blue
Non-Potable Water	Blue with a 6-inch (15 centimeters) red band spaced 30 inches

	(76 centimeters) apart
Chlorine	Yellow
Compressed Air	Green
Sewage	Gray

TABLE R317-3-6.2(B)(3)(d).
Loadings for Final Settling Tanks
Following Activated Sludge Process

Process	Average Design Rate of Flow, million gallons per day (cubic meters per day)	Surface Loading, gallons per day per square foot (cubic meters per day per square meter)	Surface Loading, pounds per day per square foot (kilograms per day per square meter)
Contact Stabilization	0.5 (1,893) to 1.5 (5,678)	400 (16.3) to 600 (24.5)	
	Greater than or equal to 1.5 (5,678)	500 (20.4) to 700 (28.5)	
Extended Aeration	Less than or equal to 0.5 (1,893)	200 (8.2) to 400 (16.3)	
	0.5 (1,893) to 1.5 (5,678)	300 (12.3) to 500 (20.4)	25 (122.1)
	Greater than or equal to 1.5 (5,678)	400 (16.3) to 600 (24.5)	
Other than Contact Stabilization and Extended Aeration	Less than or equal to 0.5 (1,893)	400 (16.3) to 600 (24.5)	
	0.5 (1,893) to 1.5 (5,678)	500 (20.4) to 700 (28.5)	25 (122.1)

Greater than or equal to 1.5 (5,678)	600 (24.5) to 800 (32.6)

TABLE R317-3-7.1(E)(3)(a)(2).
Media Grading

	Percent by Weight
Passing 4-1/2 inch (11.4 centimeters) screen	100
Retained on 3 inch (7.6 centimeters) screen	95 - 100
Retained on 2 inch (5.1 centimeters) screen	98

TABLE R317-3-7.1(K)(1).
Hydraulic and Organic Loadings
for Nitrification in Trickling Filters

Trickling Filter Configuration	Loadings
Rock or Slag Media Filters	
Hydraulic Loading	Less than or equal to 4 million gallons per acre per day, or less than or equal to 4 cubic meters per square meter per day
Organic Loading	Less than or equal to 25 pounds BOD_5 per day per 1000 cubic feet, or less than or equal to 0.4 kilograms BOD_5 per day per cubic meter
Deep Manufactured Media Filters	
Hydraulic Loading	Less than or equal to 25 million gallons per acre per day, or less than or equal to 25 cubic meters per square

	meter per day
Organic Loading	Less than or equal to 100 pounds BOD_5 per day per 1000 cubic feet, or less than or equal to 1.6 kilograms BOD_5 per day per cubic meter

TABLE R317-3-7.2(B)(1)(c)
Permissible Aeration Tank Capacities and Loadings

Process	Hydraulic Retention Time (HRT), hours	Solids Retention Time (SRT), days	Aeration Tank Loading, pounds of BOD_5 per day per 1000 cubic feet	Food:Mass (F:M) Ratio, pounds of BOD_5 per day per pound of MLVSS (2)	Mixed Liquor Suspended Solids (1) (MLSS) milligrams per liter
Conventional	4-8	4-8	20-40	0.2-0.4	1,500-4,000
Step Aeration					
Complete Mix					
Contact Stabilization	1-3 (4) 3-6 (5)	3-10	50 (3)	0.2-0.6	2,000-4,000
Extended Aeration, or Oxidation Ditch	24	30	10-12	0.05-0.1	2,000-4,000

Notes:

(1) Mixed Liquor Suspended Solids (MLSS) values are dependent upon the surface area provided for sedimentation and the rate of sludge return as well as the aeration process.

(2) Mixed Liquor Volatile Suspended Solids (MLVSS)

(3) Total Aeration capacity, includes both contact and reaeration capacities. Normally, the contact zone equals 30 to 35 percent of the total aeration capacity.

(4) Contact zone

(5) Reaeration zone

TABLE R317-3-7.2(B)(6)(a)(1).
Return Sludge Rate

Process	Q_R / Q, Percent
Standard Rate	15-75
Carbonaceous stage of separate stage nitrification	15-75
Step Aeration	15-75
Contact stabilization	50-150
Extended aeration	50-150
Nitrification stage of separate stage nitrification	50-200

TABLE R317-3-9.3(A)(1)(a).
Gravity Thickening

Type	Solids Loading Rate, pounds per day per square foot (kilograms per square meter per day)	Percent solids in thickened sludge
Primary sludge	20-30 (98-146)	8-10
Trickling filter sludge	8-10 (39-49)	7-9
Activated sludge	4-8 (20-49)	2.5-3
Combined primary and trickling filter sludges	10-12 (49-59)	7-9
Combined primary and activated sludges	6-10 (29-49)	3-6

TABLE R317-3-9.4(A)(4)(a).
Sludge Volume Generated

Type of Plant	cubic feet per Population Equivalent (P.E.) or cubic meters per Population Equivalent (P.E.)
Trickling Filter	5 (0.14)

Activated Sludge	6 (0.17)

TABLE R317-3-10.3(G)(3)(a).
Circle of Influence

Nameplate Horsepower	Radius, Feet
5	35
10-25	50
40-60	50-100
75	60-100
100	100

TABLE R317-3-12.2(E)(2).
Media Depths and Size

Media Material	Single Media	Multi-Media	
		Two	Three
Anthracite:			
Minimum Depth, inches		20	20
Effective Size, millimeters		1-2	1-2
Sand:			
Minimum Depth, inches	48	12	10
Effective Size, millimeters	1-4	0.5-1	0.6-0.8
Garnet or Similar Material:			
Minimum Depth, inches			2
Effective Size, millimeters			0.3-0.6

Uniformity Coefficient shall be less than or equal to 1.7

APPENDIX E

Standard Template Forms for
Quit-Claim Deed,
Grant of Perpetual Easement,
Grant of Temporary Easement,
Easement, and
Special Warranty Deed

WHEN RECORDED, PLEASE RETURN TO:

West Jordan City Attorney
8000 South Redwood Road
West Jordan, Utah 84088

QUIT CLAIM DEED

[*Grantor's name*], of *[City name]*, [*County name*], *[State name]*, (hereinafter "Grantor"), hereby conveys and quit claims to the City of West Jordan, Utah, a municipal corporation and political subdivision of the State of Utah (hereinafter "Grantee"), for [*price* or *purpose, such as road dedication*] and other good and valuable consideration, the receipt of which is hereby acknowledged, the following described tract of land in Salt Lake County, State of Utah, to wit:

[See Exhibit A attached hereto and by this reference incorporated herein.]

The foregoing affects a portion of Salt Lake County Sidwell No. _____.

Signed and delivered this _____ day of _____, 2007.

CITY OF WEST JORDAN, UTAH

By: _____ Attest: _____
David B. Newton, Mayor Melanie Briggs, City Recorder

STATE OF UTAH)
:ss
COUNTY OF SALT LAKE)

On this _____ day of _____, 2007, personally appeared before me David B. Newton, who being by me duly sworn did say that he is the Mayor of the CITY OF WEST JORDAN, UTAH, and that the foregoing instrument was signed in behalf of said municipal corporation and political subdivision of the State of Utah, and he acknowledged to me that said corporation executed the same.

_____
NOTARY PUBLIC

Residing in _____ County, _____

My commission expires: _____

WHEN RECORDED, PLEASE RETURN TO:

West Jordan City Attorney
8000 South Redwood Road
West Jordan, Utah 84088

GRANT OF PERPETUAL EASEMENT

[INSERT GRANTORS NAME HERE], of **[INSERT WHAT CITY THEY RESIDE IN HERE]**, County of Salt Lake, State of Utah, "Grantor(s)," for good and valuable consideration, the receipt of which is hereby acknowledged, hereby grants, bargains and conveys unto THE CITY OF WEST JORDAN, UTAH, a municipal corporation and political subdivision of the State of Utah, "Grantee," its successors, assigns, lessees, licensees and agents, A PERPETUAL EASEMENT upon, over, under and across the following described land which the Grantor(s) own(s) or in which the Grantor(s) has/have an interest, in the County of Salt Lake, State of Utah, more particularly described as follows:

[INSERT LEGAL DESCRIPTION HERE]

The above described parcel of land contains _____ square feet, more or less.

The foregoing affects a portion of the following Salt Lake County Sidwell Number: _____.

The Easement herein granted is for the following purpose: underground storm water lines and appurtenant structures.

The Grantee shall have the right to construct, operate, maintain and remove the facility, together with appurtenant structures, from time to time as the Grantee may require. The Grantee shall have the right of ingress and egress over and across the immediately adjacent land of the Grantors to and from the above-described property. The Grantee shall have the right to clear and remove all trees and other obstructions within the Easement area that may interfere with the use of the Easement by the Grantee. The Grantor(s) reserves the right to occupy, use and cultivate said property for all purposes not inconsistent with the rights herein granted.

Signed and delivered this _____ day of _____, 2007.

[INSERT INDIVIDUAL OR CORPORATE NAME(S) HERE]

By: _____ By: _____

Its: _____ Its: _____

Individual Acknowledgment

STATE OF _____)
:ss.
COUNTY OF _____)

On the _____ day of _____, 2007, personally appeared before me _____, the signer(s) of the foregoing instrument who duly acknowledged to me that he/she/they executed the same.

_____
Notary Public

Residing at _____

My Commission Expires _____

Corporate Acknowledgment

STATE OF _____)
:ss.
COUNTY OF _____)

On this _____ day of _____, 2007, personally appeared before me _____, who being by me duly sworn did say that he/she/they is/are the _____ of _____, a _____ corporation, and that the foregoing instrument was signed in behalf of said corporation by authority of its Board of Directors, and he/she/they acknowledged to me that said corporation executed the same.

_____
Notary Public

Residing at _____

My Commission Expires _____

WHEN RECORDED, PLEASE RETURN TO:

West Jordan City Attorney
8000 South Redwood Road
West Jordan, Utah 84088

GRANT OF TEMPORARY EASEMENT

[INSERT GRANTORS NAME HERE], of **[INSERT WHAT CITY THEY RESIDE IN HERE]**, County of Salt Lake, State of Utah, "Grantor(s)," for good and valuable consideration, the receipt of which is hereby acknowledged, hereby grants, bargains and conveys unto THE CITY OF WEST JORDAN, UTAH, a municipal corporation and political subdivision of the State of Utah, "Grantee," its successors, assigns, lessees, licensees and agents, A TEMPORARY EASEMENT upon, over, under and across the following described land which the Grantor(s) own(s) or in which the Grantor(s) has/have an interest, in the County of Salt Lake, State of Utah, more particularly described as follows:

[INSERT LEGAL DESCRIPTION HERE]

The above described parcel of land contains _____ square feet, more or less.

The foregoing affects a portion of the following Salt Lake County Sidwell Number: _____.

The Easement herein granted is for the following purpose: **underground storm water lines and appurtenant structures**.

The Grantee shall have the right to construct, operate, maintain and remove the facility, together with appurtenant structures, from time to time as the Grantee may require. The Grantee shall have the right of ingress and egress over and across the immediately adjacent land of the Grantors to and from the above-described property. The Grantee shall have the right to clear and remove all trees and other obstructions within the Easement area that may interfere with the use of the Easement by the Grantee. The Grantor(s) reserves the right to occupy, use and cultivate said property for all purposes not inconsistent with the rights herein granted.

This temporary easement shall expire upon completion of construction.

Signed and delivered this _____ day of _____, 2007.

[INSERT INDIVIDUAL OR CORPORATE NAME(S) HERE]

By: _____ By: _____

Its: _____ Its: _____

Individual Acknowledgment

STATE OF _____)
:ss.
COUNTY OF _____)

On the _____ day of _____, 2007, personally appeared before me _____, the signer(s) of the foregoing instrument who duly acknowledged to me that he/she/they executed the same.

_____
Notary Public

Residing at _____

My Commission Expires _____

Corporate Acknowledgment

STATE OF _____)
:ss.
COUNTY OF _____)

On this _____ day of _____, 2007, personally appeared before me _____, who being by me duly sworn did say that he/she/they is/are the _____ of _____, a _____ corporation, and that the foregoing instrument was signed in behalf of said corporation by authority of its Board of Directors, and he/she/they acknowledged to me that said corporation executed the same.

_____
Notary Public

Residing at _____

My Commission Expires _____

EASEMENT

For the sum of One Dollar ($1.00) and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the undersigned GRANTORS hereby grant, convey, sell, and set over unto DRAPER CITY, a Utah municipal corporation, hereinafter referred to as GRANTEE, its successors and assigns, a perpetual right-of-way and easement to construct, install, operate, maintain, repair, inspect, protect, remove and replace
_____
_____
_____, hereinafter called the "Facilities", said right-of-way and easement being situate in Salt Lake County, State of Utah over and through a parcel of the GRANTORS' land, which easement is more particularly described as follows:

> See Exhibit "A" attached hereto and by this reference made a part hereof.

TO HAVE AND TO HOLD the same unto the said GRANTEE, its successors and assigns, so long as such Facilities shall be maintained, with the right of ingress and egress in said Grantee, its officers, employees, agents and assigns to enter upon the above-described property with such equipment as is necessary to construct, install, maintain, operate, repair, inspect, protect, remove and replace the Facilities. During construction periods, GRANTEE and its agents may use such portion of the property along and adjacent to said right-of-way as may be reasonably necessary in connection with the construction or repair of the Facilities. The contractor performing the work shall restore all property, through which the work traverses, to as near its original condition as is reasonably possible. GRANTORS shall have the right to use said premises except for the purpose for which this right-of-way and easement is granted to the GRANTEE, provided such use shall not interfere with the Facilities or operation of the Facilities, or any other rights granted to the GRANTEE hereunder.

GRANTORS shall not build or construct or permit to be built or constructed any building or other improvement over or across said right-of-way and easement nor change the contour thereof without the written consent of GRANTEE. This right-of-way and easement shall be binding upon and inure to the benefit of the successors and assigns of the GRANTORS and the successors and assigns of the GRANTEE, and may be assigned in whole or in part by GRANTEE.

IN WITNESS WHEREOF, the GRANTORS have executed this right-of-way and easement, this ____ day of _____, 19___.

GRANTORS

INDIVIDUAL ACKNOWLEDGMENT

STATE OF UTAH)
:ss.
COUNTY OF SALT LAKE)

On the ___ day of _____, 19_____, personally appeared before me _____, the signer(s) of the above instrument who duly acknowledged to me that he/she/they executed the same.

Notary Public

Residing In: My Commission Expires:

_____

CORPORATE ACKNOWLEDGMENT

STATE OF UTAH)
:ss.
COUNTY OF SALT LAKE)

On the ___ day of _____, 19_____, personally appeared before me _____, who being by me duly sworn, did say that he is the _____ of _____, a corporation, and that said instrument was signed in behalf of said corporation by authority of its bylaws (or by a resolution of its Board of Directors) and said _____ acknowledged to me that said corporation executed the same.

Notary Public

Residing In: My Commission Expires:

_____

WHEN RECORDED, PLEASE RETURN TO:
West Jordan City Attorney
8000 South Redwood Road
West Jordan, Utah 84088

SPECIAL WARRANTY DEED

This Special Warranty Deed is made on this _____ day of _____, 2007, by [*Grantor's name*], of *[City name]*, [*County name*], *[State name]*, (hereinafter "Grantor"), to the City of West Jordan, Utah, a municipal corporation and political subdivision of the State of Utah (hereinafter "Grantee"):

Grantor, in consideration of [*price* or *purpose, such as road dedication*] and other good and valuable consideration, the receipt of which is hereby acknowledged, grants, bargains, sells, and conveys to Grantee, and Grantee's successors and assigns, all that real property situated in Salt Lake County, Utah, more particularly described as follows:

[Insert legal description]

The foregoing affects a portion of Salt Lake County Sidwell No._____.

To have and to hold the described property, together with the tenements, hereditaments, and appurtenances belonging to the property to Grantee, Grantee's successors and assigns forever.

And Grantor, for Grantor and Grantor's heirs, successors and assigns, covenants with Grantee, Grantee's successors and assigns, that Grantor is lawfully seized in fee simple of the described property; Grantor has a good right to convey; the described property is free from all encumbrances; Grantor and Grantor's heirs, successors and assigns, and all persons acquiring any interest in the property granted, through or for Grantor, on demand of Grantee, or Grantee's successors and assigns, and at the expense of Grantee, Grantee's successors and assigns, will execute any instrument necessary for the further assurance of the title to the premises that may be reasonably required; and Grantor and Grantor's heirs, successors and assigns will forever warrant and defend all of the property so granted to Grantee, Grantee's successors and assigns, against every person lawfully claiming the property or any part of the property by, through, or under Grantor.

Continued on Page 2

Witness my hand on the date first above written.

Grantor's name here

By: _____

Its: _____

STATE OF _____)
:SS
COUNTY OF _____)

On this _____ day of _____, 2007, personally appeared before me _____, who being by me duly sworn did say that he/she/they is/are the _____ of [*Grantor's name here*], and that the foregoing instrument was duly authorized by the [*type of entity, such as L.L.C. or Corporation*] at a lawful meeting held or by authority of its bylaws and signed in behalf of said [*type of entity, such as L.L.C. or Corporation*].

_____
NOTARY PUBLIC

My Commission Expires:

Residing in [*City name*], [*State name*]

APPENDIX F

Sanitary Sewer Related Permits

Public Right-of-Way
Encroachment Permit Application and Agreement and
Encroachment Ordinance (Title 72, Chapter 3)

Water/Sanitary Sewer Service Abandonment Permit

Sanitary Sewer Service Connection Permit

CITY OF WEST JORDAN
ENGINEERING DEPARTMENT
8000 SOUTH REDWOOD ROAD
WEST JORDAN, UTAH 84088
(801) 569-5070

PUBLIC RIGHT-OF-WAY ENCROACHMENT PERMIT APPLICATION AND AGREEMENT

Company Name:	Permit No.:
License No.:	Date Issued:
Applicant Name:	Cost of Permit:
Title:	Check No.:
Address:	Receipt No.:
City, State, Zip:	Work No.:
Contractor Performing Work:	FAX No.:
Nature of Work: ☐ Telephone ☐ Electrical ☐ CATV ☐ Gas ☐ Water ☐ Stormdrain ☐ Wastewater ☐ Secondary Water ☐ Other:	Cell No.:

AGREEMENT

1. **Standards/Location of Work** - The above indicated applicant is hereby granted subject to Title 72, Chapter 3 of the City's Municipal code, the City's Policies and Design Criteria Manuals, the Construction Specifications Manual, Standard Drawings Manual, State Occupational Safely and Health Laws, Manual on Uniform Traffic Control Devices (MUTCD), Instructions to Flaggers, the approved plans, and any special limitations set herein, permission for the purpose of _____ _____, within the right-of-way limits in the following locations: _____ _____. Prior to Work being performed in the public right-of-way, the Permittee will make proper provisions for protecting the public's safety and property. This permit is a binding agreement between the Permittee and the City and shall be only for the location listed on this permit.
2. **Permit Fee** - City of West Jordan Encroachment Permit Fee shall apply. If for an excavation in public right-of-way, the excavation is _____ feet long, _____ feet wide, and _____ feet deep.
3. **Beginning and Ending of Work** - The work permitted herewith shall commence on _____ and shall be diligently prosecuted to completion. The work shall be completed and all disturbed surface or objects restored on or before _____. In the event work is commenced under this permit and the permittee fails or refuses to complete the work, the City of West Jordan may, at its election, fill in or otherwise correct any existing deficiencies at the expense of the and subject to immediate payment by the permittee.
4. **Performance Bond and Insurance** - The Permittee shall supply to the City a performance bond of $_____ per square foot of the Work or $1,000.00, which ever is greater, for a period of three (3) years after completion of work to Guarantee satisfactory performance. The bond shall be in the name of the Permittee. The Permittee shall provide to the City copies of workers compensation insurance and liability insurance that names the City, it's elected officials, appointed officials, employees, volunteers, and agents as additionally insured. The Permittee shall be responsible for any liability or personal injury involved through neglect. The Permit Holder agrees to indemnify the City against all claims, demands, costs, damages, attorney fees or other expenses of any kind by such neglect. *NOTE: The above underlined vergiage must be in your Liability Insurance under Special Items.
5. **Notice of Work to Begin** - Before work permitted herewith is commenced, the permittee shall call in on the inspection line (801) 569-5051 before 3:00 p.m., and commencement of said work is understood to indicate that the permittee will comply with all instruction and regulations of the City of West Jordan (as listed) with respect to performance of said work and that she/he will properly control and warn the public of said work to prevent accident. The Permittee shall inform all emergency services, school districts, UDOT and UTA two (2) working days in advance of any approved road closures or detours.
6. **Restoration of Right-of-Way** - This permit is issued with the understanding that the Permittee will restore the right-of-way to its original or better condition. Such restoration shall take place within two (2) working days from the time of completion of the Work. If the Permittee fails to meet this obligation within the time indicated herein, the City may make all the necessary restorations at the Permittee's expense.
7. **Limits of Work Area** - Permittee shall not perform any work on City of West Jordan right-of-way beyond those areas of operation stipulated on this permit. This permit in no way allows the Permittee access to private properties; the individual property owners must grant access.
8. **Suspension of Work** - If permittee fails to comply with City of West Jordan regulations, specifications or instructions pertinent to this permit, the City Engineer or his duly authorized representative, may by verbal order, suspend the work until the violation in corrected. If permittee fails or refuses to comply promptly, the City Engineer or his authorized representative may issue a written order stopping all or any part of the work. When satisfactory corrective action is taken, an order permitting resumption of work may be issued.
9. **Permit Period/Extensions** - This permit is valid forty-five days (45) from issue date. The City may grant an extension of time with a written request from the Permittee to the Engineering Department. Such request must be submitted five (5) working days before the expiration date of the permit.
10. **On-Site Permit Requirements** - A copy of the City's current trench detail, and approved plan of the Work, and approved traffic control plan, a signed copy of this Permit, and a copy of the City's Public Improvement Standards, Specifications, and Plans shall be on the work site at all times. The City shall be granted access to these papers at all times.
11. **Temporary Asphalt Patching** - Asphalt patching to roads between October 15 and March 1 will be considered temporary only and must be replaced after March 1 following APWA standards.

(SEE NEXT PAGE FOR ADDITIONAL INFORMATION)

12. **Failure to Perform** - Failure of the Permittee to follow the provisions of this permit shall result in the retraction of the permit by the City and loss of privileges to work within the City's right-of-way.

Special Limitations:

- Traffic Control Plans, signs and channelizing devices must conform to MUTCD Standards as a minimum, and all signs must be equipped with three orange flags. Traffic Control Plan to be approved by City's Traffic Engineer.
- Contact the inspection line at (801) 569-5051 at the time of lane or shoulder closure, with route, location and duration. Call again when the job is complete.
- This Agreement and/or permit is for City of West Jordan approval only. You are responsible to obtain clearances from UDOT, UTA, railroads, private property owners and other local jurisdictions that you are working with.
- Call for Blue Stakes and check for other utilities in the area prior to excavation.
- Traffic Control Supervisor required.
- Flowable fill is required under pavement. Saw cut and tack coat joints. Replace asphalt to the existing depth or 6-inch minimum.
- Plates must be secured to road if required and a "Bump" sign must be used.
- Untreated Base Course with 97-percent compaction for the full depth of the trench with 6-inch lifts.
- Within 6-feet of asphalt, with a vertical grade separation of 6-inch or greater requires approved barrier.
- Licensee is responsible for repairing and/or restoring any portion or the roadway damaged during construction.
- Licensee must restore shoulder of highway to its original or better condition to include reseeding, replacing sidewalk, fencing, pipe, culverts or signs removed or damaged during construction.
- Paint striping is to be replaced with the same material within 48-hours of completion of the permit. The paint materials must maintain City of West Jordan standard specifications for 6-months.
- No storage of backfill material or pipe will be allowed within the ASHTO Clear Zone. Excavations must be backfilled daily or barrier will be required.
- Within 350-feet of an intersection, must call City Traffic Engineer for requirements.
- Permittee will comply with all applicable environmental laws.

Additionally – For concrete paved roadways, the permittee is responsible for all panels that have 2-ich holes bored into the panel. If these panels fail in the future due to the bores, the Permittee will be required to replace the effected panels.

Accepted By:
My carrying out the activities allowed by this permit is conclusive evidence that I have accepted all provisions, limitations, and restrictions of the permit and attachments, understand and agree to all penalties for failing to comply with them and understand my ability to review a sample permit and applicable attachments at the City Engineer's office.

Permit Applicant:

Name	Title	Date

PERMIT PROCESSING AND APPROVAL

Processed and Approved By:
City of West Jordan, Engineering Department

☐ Fees paid ☐ Insurance Received
☐ Bond Received ☐ Traffic Control Plan
☐ Other

Name	Traffic Engineer	Date

Name	Title	Date

INSPECTIONS

Beginning of Work: Phone call received:	Inspection Completed By/Date:
Intermediate Work: Phone call received:	Inspection Completed By/Date:
Intermediate Work: Phone call received:	Inspection Completed By/Date:
Completion of Work: Phone call received:	Inspection Completed By/Date:

FINAL PROCESSING AND RELEASES

Inspector Approval:		**Administrative Approval to Release:**	
Signature	Date	Signature	Date

c:\CWJ Construction Inspection & Management Manuals\Forms\Encroachment Permit Appl. 11-29-2006

Refer to Title 72, Chapter 3 of the City's Municipal Code
www.wjordan.com/files/NEWsystem2006Title72PublicWorks.pdf

CITY OF WEST JORDAN
ENGINEERING DEPARTMENT
8000 SOUTH REDWOOD ROAD
WEST JORDAN, UTAH 84088
(801) 569-5070

WATER/SANITARY SEWER SERVICE ABANDONMENT PERMIT

Company Name:	Permit No.:
License No.:	Date Issued:
Applicant Name:	Cost of Permit:
Title:	Check No.:
Address:	Work No.:
City, State, Zip:	FAX No.:
Nature of Work: ☐ Water ☐ Stormdrain ☐ Wastewater ☐ Secondary Water ☐ Other:	Cell No.:

AGREEMENT

1. **Public Right-of-Way Encroachment Permit -** The above indicated Applicant is hereby granted, subject the Applicant obtaining an *'Encroachment Permit'* as indicated in Title 72, Chapter 3 of the City's Municipal code, and meeting all of the requirements specified for said permit. The *'Water & Wastewater Service Abandonment Permit'* is not valid without having first obtained an *'Encroachment Permit'* and this Permit is subject to all of the requirements and conditions specified in the *'Encroachment Permit'* for this project.
2. **Standards/Location of Work -** The above indicated Applicant is hereby granted subject to Titles 72, Chapter 3, and 90-1-104 of the City's Municipal code, the City's Policies and Design Criteria Manuals, the Construction Specifications Manual, Standard Drawings Manual, State Occupational Safely and Health Laws, the approved plans, and any special limitations set herein, permission for the purpose of abandoning a (water) and/or (wastewater) service, within the right-of-way limits, or associated with the City's public utilities in the following locations: _____. Prior to Work being performed in the public right-of-way, the Permittee will make proper provisions for protecting the public's safety and property and obtain an Encroachment Permit. This permit is a binding agreement between the Permittee and the City and shall be only for the location listed on this permit.
3. **Permit Fee** – Please see the most current version of the City of West Jordan, Fees and Charges Schedule.
4. **Permit Requirements** – As part of the submittal process for receiving approval of this permit, the Applicant shall provide the following:
   (1) Demolition plans – Show location of structure and location of all utilities, including electric, gas, water, and wastewater.
   (2) Termination details – provide detailed drawings indicating how and where the water and wastewater services will be terminated.
   (3) Payment of fee
5. **Proper Abandonment of Public Utility** – Permittee is responsible for knowing and understanding the City's standards and requirements for abandonment of its utilities. Check with the Engineering Inspector for the project prior to beginning work so these requirements can be provided.
6. **Suspension of Work -** If permittee fails to comply with City of West Jordan regulations, specifications or instructions pertinent to this permit, the City Engineer or his duly authorized representative, may by verbal order, suspend the work until the violation in corrected. If permittee fails or refuses to comply promptly, the City Engineer or his authorized representative may issue a written order stopping all or any part of the work. When satisfactory corrective action is taken, an order permitting resumption of work may be issued.
7. **Permit Period/Extensions -** This permit is valid forty-five days (45) from issue date. The City may grant an extension of time with a written request from the Permittee to the Engineering Department. Such request must be submitted five (5) working days before the expiration date of the permit.
8. **On-Site Permit Requirements -** A copy of the City's current trench detail, and approved plan of the Work, and approved traffic control plan, a signed copy of this Permit, and a copy of the City's Public Improvement Standards, Specifications, and Plans shall be on the work site at all times. The City shall be granted access to these papers at all times..
9. **Failure to Perform -** Failure of the Permittee to follow the provisions of this permit shall result n the retraction of the permit by the City and loss of privileges to work within the City's right-of-way.

Accepted By:
My carrying out the activities allowed by this permit is conclusive evidence that I have accepted all provisions, limitations, and restrictions of the permit and attachments, understand and agree to all penalties for failing to comply with them and understand my ability to review a sample permit and applicable attachments at the City Engineer's office.

Permit Applicant:

_____	_____	_____
Name	Title	Date

PERMIT PROCESSING AND APPROVAL

Processed and Approved By: ☐ Fees paid ☐ Plan of Work
City of West Jordan, Engineering Department

Name	Title	Date

INSPECTIONS

Beginning of Work: Phone call received:	Inspection Completed By/Date:
Intermediate Work: Phone call received:	Inspection Completed By/Date:
Intermediate Work: Phone call received:	Inspection Completed By/Date:
Completion of Work: Phone call received:	Inspection Completed By/Date:

FINAL PROCESSING AND RELEASES

Inspector Approval:		**Administrative Approval to Release:**	
Signature	Date	Signature	Date

c:\CWJ Construction Inspection & Management Manuals\Forms\Water-Wastewater Service Abandonment Permit Appl. 11-20-2005

CITY OF WEST JORDAN
ENGINEERING DEPARTMENT
8000 SOUTH REDWOOD ROAD
WEST JORDAN, UTAH 84088
(801) 569-5070

SANITARY SEWER SERVICE CONNECTION PERMIT

Company Name:	Permit No.:
License No.:	Date Issued:
Applicant Name:	Cost of Permit:
Title:	Check No.:
Address:	Work No.:
City, State, Zip:	FAX No.:
Nature of Work: ☐ Water ☐ Stormdrain ☐ Wastewater ☐ Secondary Water ☐ Other:	Cell No.:

AGREEMENT

1. **Public Right-of-Way Encroachment Permit -** The above indicated Applicant is hereby granted, subject the Applicant obtaining an *'Encroachment Permit'* as indicated in Title 72, Chapter 3 of the City's Municipal code, and meeting all of the requirements specified for said permit. The *'Wastewater Service Connection Permit'* is not valid without having first obtained an *'Encroachment Permit'* and this Permit is subject to all of the requirements and conditions specified in the *'Encroachment Permit'* for this project.
2. **Standards/Location of Work -** The above indicated Applicant is hereby granted subject to Titles 72, Chapter 3, and 90-1-104 of the City's Municipal code, the City's Policies and Design Criteria Manuals, the Construction Specifications Manual, Standard Drawings Manual, State Occupational Safely and Health Laws, the approved plans, and any special limitations set herein, permission for the purpose of abandoning a (water) and/or (wastewater) service, within the right-of-way limits, or associated with the City's public utilities in the following locations: _____. Prior to Work being performed in the public right-of-way, the Permittee will make proper provisions for protecting the public's safety and property and obtain an Encroachment Permit. This permit is a binding agreement between the Permittee and the City and shall be only for the location listed on this permit.
3. **Permit Fee –** Please see the most current version of the City of West Jordan, Fees and Charges Schedule.
4. **Proper Connection Wastewater Service –** Permittee is responsible for knowing and understanding the City's standards and requirements for connecting wastewater service laterals to the City's public wastewater system. Check with the Engineering Inspector for the project prior to beginning work so these requirements can be provided.
5. **Suspension of Work -** If permittee fails to comply with City of West Jordan regulations, specifications or instructions pertinent to this permit, the City Engineer or his duly authorized representative, may by verbal order, suspend the work until the violation in corrected. If permittee fails or refuses to comply promptly, the City Engineer or his authorized representative may issue a written order stopping all or any part of the work. When satisfactory corrective action is taken, an order permitting resumption of work may be issued.
6. **Permit Period/Extensions -** This permit is valid forty-five days (45) from issue date. The City may grant an extension of time with a written request from the Permittee to the Engineering Department. Such request must be submitted five (5) working days before the expiration date of the permit.
7. **On-Site Permit Requirements -** A copy of the City's current trench detail, and approved plan of the Work, and approved traffic control plan, a signed copy of this Permit, and a copy of the City's Public Improvement Standards, Specifications, and Plans shall be on the work site at all times. The City shall be granted access to these papers at all times..
8. **Failure to Perform -** Failure of the Permittee to follow the provisions of this permit shall result n the retraction of the permit by the City and loss of privileges to work within the City's right-of-way.

Accepted By:
My carrying out the activities allowed by this permit is conclusive evidence that I have accepted all provisions, limitations, and restrictions of the permit and attachments, understand and agree to all penalties for failing to comply with them and understand my ability to review a sample permit and applicable attachments at the City Engineer's office.

Permit Applicant:

_____	_____	_____
Name	Title	Date

PERMIT PROCESSING AND APPROVAL

Processed and Approved By: ☐ Fees paid ☐ Plan of Work
City of West Jordan, Engineering Department

_____	_____	_____
Name	Title	Date

INSPECTIONS

Beginning of Work: Phone call received:	Inspection Completed By/Date:
Intermediate Work: Phone call received:	Inspection Completed By/Date:
Intermediate Work: Phone call received:	Inspection Completed By/Date:
Completion of Work: Phone call received:	Inspection Completed By/Date:

FINAL PROCESSING AND RELEASES

Inspector Approval:		**Administrative Approval to Release:**	
Signature	Date	Signature	Date

c:\CWJ Construction Inspection & Management Manuals\Forms\Wastewater Service Connection Permit Appl. 11-20-2005

APPENDIX H

South Valley Water Reclamation Facility
Rules and Regulations
July 1, 1991

Reformatted March 1999

(Please see separate binder for this document)