SECTION 2
WATER AND WASTEWATER DESIGN CRITERIA

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SECTION 2 - WATER AND WASTEWATER DESIGN CRITERIA

2.1.0 GENERAL

The following information is intended to assist engineers and the general public in the design and construction of water and wastewater facilities. Information herein is to provide minimum New Braunfels Utilities (NBU) requirements only. Sound engineering judgment shall be utilized to determine if these minimum requirements are suitable for each engineering design.

2.2.0 SERVICE EXTENSION PROCEDURE

2.2.1 General Information

This section is intended to provide information needed to obtain water and wastewater service extension approvals for future development.

The service extension is not to be interpreted as a vehicle solely for the purpose of securing a utility commitment, but rather a procurement of rights to install utility mains, associated facilities, and off-site improvements within NBU's Adopted Water and Wastewater Service Area. These water and wastewater facilities are not extended through capital improvement programs or other NBU initiated projects.

The NBU Service Area is the Impact Fee Boundary for the NBU water and wastewater utility. It is a set of geographic boundaries within which water or wastewater service may be provided. Properties must be completely within the service area before a service extension application can be submitted.

2.2.2 Service Extension Application Requirements

The forms listed below are utilized when requesting a service extension. Other forms may apply. Examples of the forms are provided in Appendix A.

A. Administrative Application

B. NBU Board Application

C. Service Extension Policy General Provisions

D. LUE Calculation Sheet

E. Annexation Request

2.2.3. Service Extension Guidelines for Processing

A. All properties not within city limits of New Braunfels must request annexation or give the city the future right of annexation without protest. An annexation request or consent for annexation shall be submitted with the service extension application.

B. All extension requests not requiring NBU cost participation or reimbursement may be approved by the Chief Engineer of Water Services.

C. All service extensions requesting NBU cost participation or reimbursement must be submitted to the Chief Engineer of Water Services for consideration and approval by NBU Chief Executive Officer.

D. Approved applications are not a reservation of capacity in the system, but are an acknowledgment of the intent to serve.

2.2.4. System Capacity Determination Procedure for Reviewing Service Extensions by NBU

A. NBU will determine what existing facilities are in place and any remaining capacity after considering all existing services connected and capacities committed to the system.

B. NBU will determine the length of time, after all funded projects have been constructed, from present conditions until additional system improvements are needed.

C. A service extension may or may not be approved depending on the time frame of approval, funding, and construction of additional system improvements and related agreements and conditions.

2.2.5. Expiration of Service Extension Approvals

A. Expired service extensions may be refiled upon expiration date, not prior.

B. A new application packet will be required upon refiling.

C. A new number will be assigned and new fees required.

D. In cases where approvals are contingent upon developer contracts and/or Capital Improvement Projects (CIP), the timing for expiration begins upon completion and NBU acceptance of those projects, not the approval date of application.

Note: See Service Extension Policy General Provision in Appendix A for complete guide lines and policy concerning service extensions.

2.3.0. PRIVATE PLUMBING

2.3.1. Plumbing Inspections Inside and Outside the City's Zoning Jurisdiction

Within the zoning jurisdiction of the City of New Braunfels and within the boundaries of other jurisdictions as specified by contract, private plumbing installations shall be inspected by the Building Inspection Department to ensure compliance with the requirements of the Uniform Plumbing Code as codified by the City of New Braunfels or other jurisdictions. New private plumbing installations on properties located outside of the zoning jurisdiction of the City for which NBU provides direct retail water or wastewater service (outside-city installations) shall be inspected in accordance with the following rules:

A. Service Inspection Verification Form

Work on outside-city installations shall not commence until a Service Inspection Verification Form (SIV) has been obtained from the NBU Business Development Division located at 355 FM 306 and any applicable fee has been paid. For new installations the SIV must be obtained at the time a water and/or wastewater tap is purchased. A valid SIV must be posted at the site of every outside-city installation. Each address shall be posted and visible from two hundred (200) feet.

B. Inspections

Outside-city installations must be inspected for compliance with the Plumbing Code by a third-party inspector (i.e., not employed by the City or NBU) who is registered with NBU. Registration requirements are set forth below in Section 2.3.1.D. It shall be the responsibility of the property owner or a representative of the property owner to retain the services of a registered inspector. A list of registered inspectors may be obtained from NBU New Services Division.

The inspector must complete and deliver a Service Inspection Certification Form (see Appendix C) to the NBU New Services Division, certifying that the plumbing installation is in compliance with the Plumbing Code before final connection to the NBU water and/or wastewater systems may be made.

Upon the request of NBU, access to plumbing installations must be provided to NBU quality control inspectors.

C. Exceptions

Repairs, replacement, or alteration of any existing residential plumbing system outside of the zoning jurisdiction of NBU on properties for which NBU provides direct retail water or wastewater service are exempt from the requirements of this section if the work is performed in accordance with the requirements of the Plumbing Code. Not withstanding the above, verification of compliance with the Plumbing Code and cross connection control shall be at the option of NBU.

D. Inspector Registration Requirements

Applicants for registration must meet the following qualifications:

1. Applicants must be plumbing inspectors licensed by the Texas State Board of Plumbing Examiners.
2. Provide verification of at least one of the following:
   a. Plumbing inspector certification from the International Conference of Building Officials.
   b. Master plumbers license from the State of Texas.
   c. Texas Real Estate Inspector's License from the State of Texas Real Estate Commission.
   d. Plumbing engineering certification from the American Society of Plumbing Engineers.
3. Attend the inspection workshop administered by NBU.
4. Third-party inspectors conducting inspections within the NBU service area shall not have any financial or advisory interest in any plumbing company or plumbing materials or apparatus supply company.

2.3.2. Adherence to State Rules and Regulations Relating to Backflow and Cross Connection Control

Backflow prevention assemblies installed in private plumbing systems, fire protection systems, process water systems, and/or other private water distribution systems that are directly or indirectly connected to NBU's potable water distribution system shall obtain laboratory and field testing approval and listing as backflow prevention devices and assemblies from the University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USC FCCC&HR) or other approved agency with field and

laboratory testing to American Water Works Association (AWWA) standards and shall be installed in accordance with American Water Works Association manual M-14. It shall be the responsibility of the property owner or the representative of the property owner to provide verification of the required approvals upon request. The installation, maintenance, repair, replacement and operational testing shall strictly conform to the requirements of AWWA's of the AWWA's Cross Connection Control guidelines.

2.4.0 STANDARD PRODUCTS LIST PROCEDURES

2.4.1 Introduction

Through previous investigation, testing and usage by NBU, certain types, brands and models of some products and materials have established a satisfactory record for certain services. These products have been tabulated by manufacturer's names and identifying numbers on Standard Products Lists (SPL). Construction-related SPL has been assembled into the NBU "Standard Products List". The Standard Products List should not be interpreted as being pre-approved lists of products necessarily meeting the requirements for a given construction project and products included in the lists shall not be substituted unless they are approved by the Engineer and NBU. Contractors electing to use products from the SPL shall submit a list of products and the corresponding SPL number, together with the approvals for their use.

Products in use by NBU are subject to ongoing consideration and evaluation by staff. When changes, deletions, or additions become necessary and are approved, the product list will be revised and included in updates to the Standard Products List.

Questions concerning NBU's Standard Products List may be addressed to the Material Management Division.

2.4.2 NBU Water and Wastewater Utility Standard Product Approval Process

A. Product and equipment manufacturers shall submit a written request for consideration to the Material Management Division. This request shall comprise a complete submittal, in a single package, and include the following:

1. Product description, technical specifications, and catalog information.
2. All applicable product standards (AWWA, ASTM, ANSI, NFPA and others) and related manufacturer's certifications.
3. Test results showing compliance with applicable standards, including independent laboratory test results, if necessary.
4. Manufacturer's installation procedures for the particular product.
5. Product availability, delivery time, and manufacturer's location.
6. Maintenance requirements, special equipment and procedures, and recommended maintenance schedules.
7. Product references (municipal or public users) shall include users name, address and telephone number, product application and number of years in use, and name and telephone number of a contact person having knowledge of the particular usage.
8. Material safety data sheet (MSDS), if applicable.
9. Recent product revisions or improvements.

10. Explanation of how the product benefits NBU in terms of prolonged service life, reduced maintenance, reduced life-cycle cost and other relevant aspects.

B. If the submittal is acceptable, the Material Management Division shall submit it to NBU staff for consideration. Products may be requested for testing or field evaluation.

C. Following review of the submittals NBU staff may request a presentation by the manufacturer at a regularly-scheduled staff meeting to demonstrate the product or provide additional information.

D. Procedures for testing or evaluation shall be as agreed upon between the supplier and NBU. Results will become a part of the product file and will be made available to the supplier upon request.

E. When products are evaluated in a construction or CIP project, the location and installation details shall be recorded in the inspection record and filed with NBU. In addition, the installation shall be cross-referenced on all as-built plans, profiles, quad maps, and other NBU maintained maps.

F. A database listing all testing locations, time of test and results shall be compiled and periodically updated. From this information, the NBU staff will recommend approval or disapproval of the products.

G. Material Management Division will advise the applicant of NBU's decision regarding the product.

H. The newly accepted product will be added to the appropriate Standard Products List (SPL).

I. Problems regarding accepted products shall be submitted to Material Management Division for review. Such review may lead to a recommendation to rescind approval. NBU shall inform the product manufacturer of the reasons for removal from the SPL.

2.4.3 Product and Purchase Specification Review

All purchase specifications and each SPL will be reviewed at least every five (5) years. Products will be under constant evaluation as they are used in the water and wastewater systems.

2.5.0 CONSTRUCTION PLAN INFORMATION AND SUBMITTAL REQUIREMENTS

2.5.1 General

A. One (1) complete set of Civil Construction plans shall be submitted to the Water Systems Engineering Division for verification of conformance to the NBU Standards and Specifications. Refer to the NBU Development Guide for the submittal checklist.

B. Plans submitted to NBU must show approved easements and/or permits on highway and/or railroad crossings.

C. A Development Permit must be obtained from the regulatory agencies prior to final plan approval.

D. Plans that include fire lines must have approval by the City of New Braunfels Fire Department and other related agencies.

E. All water and/or wastewater plans will include the following items:

1. Engineer's dated signature and seal of a Professional Engineer licensed in the State of Texas on each plan sheet.
2. Engineering firm name and registered number (format F-xxxxx) on each plan sheet.
3. Date of plans and revisions.
4. North arrow and scale must be shown. The standard horizontal scale for plan and profile sheets shall be 1" = 50', 40' or 20' for the plan view. The vertical scale shall be 1" = 5', 4' or 2'. The same scale shall be used on all plan and profile sheets. For sheets other than plan and profile, horizontal scales of 1" = 50', 40' or 20' may be used as appropriate.
5. A general location map.
6. Standard NBU Water and Wastewater construction notes.
7. Indicate on cover sheet, subdivision file number and/or service extension number and all required permit numbers such as development permit, Texas Department of Transportation permit, railroad crossing permit, etc.
8. Volume and page number of recorded easement and of any temporary working space.
9. Size, pipe material and location of main with respect to the easements and rights-of-way.
10. Property lines and dimensions, legal description, lot and block numbers, rights-of-way dimensions, and curb and sidewalk locations and street names.
11. Location, size, and material of all existing water and wastewater mains, lines, and services. The direction of flow in the wastewater mains shall be indicated.
12. Location, size, and description of other utilities where they may conflict with water or wastewater mains or other service lines.
13. Curve data for roads, property lines, and water and wastewater lines.
14. Curves are not permitted on wastewater mains unless given written approval by the NBU Engineer.
15. Final plat recording or land status report.
16. Street address for all existing structures shall be shown on the lot(s) where the structures are located.
17. Pressure zone designation for subject tract and zone boundaries where applicable.

C. Final plan approval may require additional authorizations.

1. Texas Department of Transportation permit
2. Railroad permit
3. Gas Company permit
4. Easement acquisition (Volume and Page listed on plans)
5. County approval
6. Texas Department of Health approval
7. Texas Commission on Environmental Quality approval
8. Non-occupancy letter
9. Service Extension approval

2.5.2 Water System Plan

A. All plan view drawings shall include all applicable items listed in the General Requirements above plus the following items.

1. Stations of all proposed connections to existing or proposed water mains.
2. For proposed connections to water mains or facilities to be constructed by others: identify the project by name, the design engineer, and service extension number.
3. Station numbers for mains shall be identified for beginning points, ending points, points of curvature, points of tangent, points of reverse curve, points of intersection, valves, fire hydrants, other appurtenances and grade breaks.
4. Station numbers shall be identified for the water mains where they cross any other utility.
5. Details of appurtenances shall be shown.
6. The location of all existing and proposed water services, water mains, valves and fire hydrants shall be identified.
7. One hundred year flood plain limits shall be shown.
8. A reference noting the field book notes for the original survey.
9. Design velocity at maximum day plus fire flow.
10. Calculated design pressure at highest and lowest lot served.
11. Thrust restraint when required shall be shown on the plan view.
12. Retaining walls, including geogrid, straps, tie-backs and all other components.
13. Culverts, bridges, and other drainage structures.

B. A profile view shall be provided for all water mains 12 inches in diameter and larger. It shall show all applicable items listed in the General Requirements plus the following items:

1. The existing ground profile and proposed street finish grade or subgrade.
2. Station numbers and elevations of all utility crossings.
3. Station numbers and soil geology information at stream crossings to evaluate the need for special surface restoration.
4. Identify pipe size, percent grade, and pipe material to be used including ASTM and/or AWWA designation. If an alternate material is to be allowed, both should be listed (example “D.I. or DR14 PVC”).
5. Station numbers and elevations for starting points, ending points, point of intersection, grade breaks, valves, fire hydrants, air release valves, pressure/flow regulating valves and at intermediate points every 100 feet.
6. Retaining walls, including geogrid, straps, tie-backs and all other components.
7. Culverts, bridges, and other drainage structures.

(NOTE: Plan Approval shall expire one year from the date of current approval. If construction has not begun on the facility within one year of the approval date, plans must be resubmitted for approval and must include all criteria in effect at the time resubmitted.)

2.5.3 Wastewater System Plans

A. All plan view drawings shall include all applicable items listed in the General Requirements mentioned above plus the following items.

1. Station numbers at all proposed connections to existing or proposed wastewater mains.

2. For proposed connections to wastewater mains or facilities to be constructed by others, identify the project name, the design engineer, and the service extension number.
3. The location, alignment, and structural features of the wastewater main, including manholes and concrete retards, if applicable.
4. Station numbers for beginning points, ending points, manholes, clean-outs and other appurtenances.
5. Details of all required appurtenances.
6. Location of all existing and proposed wastewater services, mains and manholes.
7. One hundred year flood plain limits.
8. A reference noting the field book notes for the original survey.
9. Retaining walls, including geogrid, straps, tie-backs and all other components.
10. Culverts, bridges, and other drainage structures.

B. A profile view shall be provided for all wastewater mains and shall include all applicable items listed in the general requirements above plus the following items:

1. The existing ground profile and proposed street finish grade or subgrade or finished grade if not under pavement.
2. Station numbers and elevations of all utility crossings.
3. Station numbers and soil geology information at stream crossings to evaluate the need for special surface restoration.
4. Identify the pipe size, percent grade, and pipe material to be used including ASTM and/or AWWA designation. If an alternate material is to be allowed, both should be listed (example “DI or PVC”).
5. Station numbers and elevations for starting points, ending points, manholes, wastewater service lines, clean-outs, and at intermediate points every 100 feet.
6. Elevations shall be indicated on the profile showing the finish floor elevations of all existing structures. If the structure has an active septic tank or other disposal system, the flow line elevation of the plumbing where it exits from the structure is to be indicated. If a lot or tract is vacant, side shots may be required from the middle of each lot to ensure gravity service is possible from the lot to the main.
7. Design flows, minimum and maximum, and flow velocities at minimum and maximum dry weather flows.
8. Retaining walls, including geogrid, straps, tie-backs and all other components.
9. Culverts, bridges, and other drainage structures.

(NOTE: Plan Approval shall expire one year from the date of current approval. If construction has not begun on the facility within one year of the approval date, plans must be resubmitted for approval and must include all criteria in effect at the time resubmitted.)

2.6.0 CONSTRUCTION INSPECTION AND ACCEPTANCE

2.6.1 Construction Inspection Procedure

To have a NBU inspector assigned to a project, the following items must be submitted to the Water Systems Engineering Division. The appropriate contact person will be able to answer any questions regarding the following

information:

A. Two (2) sets of signed plans are required. Also required are two (2) copies of signed contracts (lump sum contracts should include water and wastewater quantities on a developer's or consulting engineer's letterhead), two (2) sets of cut sheets with one (1) copy of field notes and two (2) copies of any permits listed on the front of the plans.

B. One (1) copy of the bid tabulation (if the project is bid out) will be required with the above listed items for all service extensions submitted for construction. All of these required items must be submitted at the same time. For reviews occurring during the construction phase, two (2) copies of the revised plans are required.

C. To set up a Pre-Construction Meeting, contact the Water Systems Engineering Division.

D. One (1) copy of the approved plans and contracts must be submitted to the Water Systems Engineering Division at least three (3) working days before the Pre-Construction Meeting.

E. The contractor shall call the One Call System for information on existing buried utilities.

2.6.2 NBU Acceptance

To obtain final NBU acceptance of a project, one (1) paper and digital copy of Record Drawings showing all field changes, final quantities and cost information, along with the consulting engineer's concurrence for acceptance form, must be submitted. Refer to CAD Deliverables in the Appendix for acceptable drawing formats. Any outstanding fees, based on final cost figures, must be paid prior to final acceptance.

If landscaping and vegetation items are outstanding, a conditional acceptance letter may be issued. This allows for the release of letter of credit requirement for the majority of the water and wastewater related work that has been satisfactorily completed. When all work is completed and all necessary information is provided, a final acceptance letter will be issued.

If the project includes a lift station, the lift station will be considered separately for operation and maintenance acceptance. (Refer to Section 2.7.3)

2.7.0 LIFT STATION REVIEW, APPROVAL AND ACCEPTANCE

2.7.1 Engineering Report, Plans and Specifications Review and Approval

(NOTE: Plan Approval shall expire one year from the date of approval. If construction has not begun on the facility within one year of the approval date, plans must be resubmitted for approval and must include all criteria in effect at the time resubmitted.)

A. Prior to design two (2) copies of a detailed engineering report shall be submitted to the Water Systems Engineering Division for review and approval of the lift station and all related line work. The engineering report shall include the following:

1. Justification for the proposed lift station. The report must clearly show that gravity lines are not available and are not economically feasible and that the number of lift stations has been minimized. This justification must include a cost benefit analysis of gravity versus lift station project including 30 years of operation and maintenance of the

proposed system.

2. A master development plan for the service area of the proposed lift station shall be prepared. This plan shall include a map showing the location of the lift station, the service area, the boundaries of the drainage basin it is in and the location of the nearest existing wastewater interceptor within or outside of that basin.
3. Engineering calculations and data described in Sections 2.9.3.A and 2.9.3.H shall be contained in the engineering report.
4. The Engineering Report shall be approved by NBU prior to beginning preparation of the plans and specifications.

B. Prior to construction two (2) complete sets of the Civil Construction plans and specifications shall be submitted to the Water Systems Engineering Division for review and approval. These plans and specifications shall be prepared, sealed, signed, and dated by a Professional Engineer licensed to practice in Texas and shall be in compliance with the approved Engineering Report. The plans and specifications for the lift station shall also include all related line work and a comprehensive site plan including any required access road(s) and easement(s).

C. All plans and specifications for lift stations within the NBU Service Area, submitted for review and approval, must demonstrate compliance with current NBU Design Criteria and standard lift station specifications. Approval of the lift station plans and specification does not imply NBU will accept the lift station for operation and maintenance (Refer to 2.7.3).

1. Within the NBU Service Area the following type of Lift Stations may be submitted for review and approval:
   a. Self priming pump facilities with rated horsepower no greater than 25 BHP for the largest pump.
   b. For installation with a required rated horsepower motor greater than 25 BHP the Utility prefers wet/dry well type installation. However, self priming pump facilities with a rated horsepower of between 25 BHP and 50 BHP may be considered on a case-by-case basis. The Engineer must submit cost comparisons for self priming versus wet/dry well installations. The cost comparison should include initial station costs, pump replacement costs, installation costs, and all operational and maintenance cost including energy costs over the life of the station. The comparison should assume a typical service life for pumps.

2.7.2 Submittal and Shop Drawing Review

Once the engineering report, plans and specifications have been approved, at least two (2) complete sets of submittals and shop drawings shall be provided to the NBU Water Systems Engineering Division. These submittals shall contain complete detailed information and drawings for all lift station equipment and components.

2.7.3 NBU Operation and Maintenance Acceptance

NBU may accept a lift station with a firm pumping capacity greater than 120 gpm for operation and maintenance provided the following conditions are met:

A. The station is located within NBU's approved wastewater service area.

B. NBU has inspected the lift station and determined that it is constructed in conformance to NBU's requirements. Any lift station not conforming to

Utility standards shall be upgraded to NBU standards before NBU will accept the lift stations for operation and maintenance.

C. The owner or his representative has provided all information requested in Sections 2.7.1 and 2.7.2 above, five (5) complete sets of all Operations and Maintenance Manuals for all equipment installed, and has received NBU's approval.

D. The owner has granted NBU a wastewater easement for the lift station and access road. A copy of the recorded easement plat, legal description and any other legal documents granting the easement shall be delivered to NBU. The easement shall extend to at least five (5) feet outside the lift station fence and shall include access road with turn-around areas that extend back to paved public rights-of-way. This easement shall be separate and in addition to any necessary pipeline easement.

   If the lift station is to become a permanent installation, transfer of ownership and title to the land may be required by NBU prior to acceptance of the station for operation and maintenance.

E. A letter of assignment has been written to NBU from the owner transferring title of the lift station and related equipment to NBU. This letter shall be delivered to NBU before acceptance of the lift station for operation and maintenance. The original owner may regain title to a temporary lift station that was designed and constructed entirely at his expense and for which no refund was made by NBU. After written notification by NBU that the lift station has been abandoned, the original owner has one (1) month to notify NBU in writing of his intent to regain title to the temporary lift station site.

F. One (1) complete set of Record Drawings shall be provided to NBU in paper and digital format, as specified by the Cad Deliverables in the Appendix, prior to acceptance of the lift station for operation and maintenance.

2.8.0 ABANDONMENT OR REMOVAL OF FACILITIES

If a new project will abandon existing facilities, the plans shall provide for the appropriate abandonment or removal (if required by NBU) of these facilities.

2.8.1 Mains

Abandonment of wastewater mains in private easements shall consist of filling the main with a pumpable grout or slurry and meeting requirements of the current specifications. Plans should include method of abandoning or removing all other Mains.

2.8.2 Manholes

The abandoned manholes shall be removed to a level not less than four feet below grade, inlets and outlets securely plugged and the structure filled with stabilized sand in compliance with current specifications shall be required.

2.8.3 Lift Stations

Abandonment of lift stations shall consist of removing all pumps, motors, couplings, valves, and controls from the dry well and all appurtenances above finished grade. Both the wet well and dry well shall be cut down five feet below grade, filled with cement stabilized sand, and covered with top soil to grade. The associated force main shall be properly abandoned. This

includes cutting and plugging both ends and/or grouting main as appropriate. Area shall be re-vegetated. NBU shall be notified prior to abandonment.

2.8.4 Service Lines

All water service lines (including fire lines) that are being abandoned and not transferred to a new distribution line should be disconnected at the corporation stop and all other valves and appurtenances removed.

2.9.0 DESIGN REQUIREMENTS FOR WATER AND WASTEWATER SYSTEMS

2.9.1 INTRODUCTION

These guidelines are intended to establish the minimum basic design requirements for water and wastewater systems within NBU's service area, but do not address major facilities such as water and wastewater treatment plants. Generally, these systems will be operated and maintained by NBU.

All project manuals shall include the appropriate NBU Standard Specifications. All projects are required to be built in accordance with these NBU Standard Specifications, which may include other requirements not addressed here. All variations are subject to the approval of NBU. Additional requirements for specific projects may be established where the conditions of service to the tract and related system operation and maintenance needs warrant.

The following information is provided to assist engineers and the general public in the design and construction of water and wastewater facilities within the NBU service area. All plans for such facilities shall be prepared by or under the supervision of a Professional Engineer, licensed in the State of Texas. It will be the responsibility of the engineer to ensure that the plans are in compliance with the latest versions of all applicable federal, state, and local ordinances, rules, and regulations.

These include, but are not limited to, the following:

A. Design Criteria for Sewage Systems - Texas Commission on Environmental Quality (TCEQ).
B. Rules and Regulations for Public Water Systems - TCEQ.
C. The Code of the City of New Braunfels.
D. NBU Standard Specifications.
E. NBU Water and Wastewater Design Criteria.

2.9.2 WATER SYSTEMS

A. Size/Capacity Determination

1. General

a. Hazen Williams Friction Coefficient C = 100, higher C coefficient may be used for new mains only upon approval by NBU with sufficient documentation to show effects of long term use.
b. Average day demand = 350 gal / day
c. Peak day demand = 800 gal / day
d. Peak hour demand = 0.083 gal / min
e. Maximum system static pressure - 150 psi

f. If the maximum static pressure exceeds 90 psi, a PRV will be required on the property owner's side of the water meter and should be shown on the plan view.

g. Minimum operating pressure is 50 psi at the highest elevation meter location using average day demand.

2. Peak Hour Demand Requirements

   a. The maximum allowable velocity shall not exceed 5 feet per second (fps).

   b. The minimum pressure at any point in the affected pressure zone must not be less than 35 psi.

3. Emergency Demand (Fire Flow) Requirements

   a. The maximum allowable velocity shall not exceed 10 fps.

   b. Fire flow requirements will be determined in accordance with the City of New Braunfels Fire Code and associated rules. The City of New Braunfels Fire Department has adopted the 2006 International Fire Code. Also, refer to the City of New Braunfels Code of Ordinance for Fire Department amendments.

   c. The minimum residual pressure at any point in the affected pressure zone at peak day plus fire flow must not be less than 20 psi.

4. Sizing of Water Mains - Computer modeling is preferred for sizing water mains. However, for water mains less than 12 inches in diameter other engineering calculation methods may be accepted. The largest size, as determined by comparing the service area's peak hour demand and peak day plus fire flow demand, shall be used.

5. Storage Requirements - If it is determined by NBU that additional storage is required, the following criteria shall be used:

Effective Storage	=	100 gal/person
Emergency Storage	=	100 gal/person
TOTAL STORAGE	=	200 gal/person

   Effective Storage is defined as storage, which will provide a minimum of 35 psi of pressure at the highest service elevation in pressure zone.

   The Engineer may be required to provide computer simulations as determined on a case by case basis.

B. Mains

1. Minimum main size shall be 8 inches. The minimum size for any street type, however, will be governed by various factors which include fire protection requirements, high density land usage, and the designer's consideration of general system gridding, future transmission mains, neighboring developments and area configuration. Looped systems are required for service reliability. The maximum length for an 8 inch main is 1320 feet before it must be looped. Also, a fire line can not be more than 100 feet in length. Transmission line sizes will be determined on a case by case basis.

2. Water mains should be located, where maintenance can be accomplished with the least interference with traffic, structures, and other utilities.

   The separation between water and wastewater mains must comply with TCEQ rules or have a variance approved by TCEQ before

submittal to NBU. [Texas Administrative Code, Title 30, Part 1, Chapter 217, Rule 217.53, paragraph (d)]

Mains should usually be located as per standard details within the street unless approved otherwise.

In major collector and arterial roadways, mains should be located outside the pavement, curbs, etc., wherever feasible. When mains are located outside of the rights-of-way, they shall be within a dedicated utility easement. Main assignments in such city streets must be approved by NBU. Assignments for lines in county roads must also be approved by the county engineer.

1. Piping materials and appurtenances shall conform to NBU Standard Specifications and the NBU Standard Products List (SPL).
2. Minimum depth of cover over the uppermost projection of the pipe and all appurtenances shall be 42 inches. Add concrete cap or encasement if cover is less than 42 inches; maximum depth will be as approved by NBU for the specific materials, application, and conditions.
3. For mains of 16 inches and larger, drain valves shall be placed at low points.
4. All fire lines shall have a gate valve on the line at the connection to the main line and a backflow preventer inside the property line, but accessible for inspection by NBU and City personnel. All unmetered fire lines shall have a NBU approved backflow device.
5. On water mains 16 inches in diameter and larger, automatic air release valves will be placed at all high points and at the down-slope side of all valve locations. Air/vacuum and vacuum release valves shall be approved on a case-by-case basis.
6. Line Stoppers
   NBU will require contractors to use line stoppers to take an outage during construction if system valves are not available or existing valves do not function. Line stoppers will be required based on the following criteria.
   a. If the number of residential customers affected is greater than 20 and expected to last more than 4 hours.
   b. If any commercial customers are affected by the outage then the use of line stoppers will be determined on a case by case basis.
   c. If any critical care customers are affected by the outage then the use of line stoppers will be determined on a case by case basis.
   d. System conditions may require a line stopper and may not be known until construction commences.
7. No water line shall be deflected either vertically or horizontally, in excess of that recommended by the manufacturer of the pipe or coupling without the appropriate use of bends or offsets. Fittings may be required where more than two pipe lengths are deflected.
8. The determination of whether or not a given section of pipeline needs restrained joints or other means of anchorage shall be made by qualified professional engineer and approved by New Braunfels Utilities. All thrust anchorages shall be designed for a safety factor of not less than 1.50 under maximum pressure loading. Thrust blocks will not be allowed on the system without special approval. Joints will be restrained with restraining systems approved by NBU and restraint length shall be submitted to NBU at the time of plan submittal.

C. Valves

1. There shall be a valve in each fire hydrant lead restrained to the main. These, and all valves sixteen (16) inches and smaller, shall be resilient seated gate valves. In lines larger than sixteen (16) inches and larger, butterfly valves may be used.
2. Valves shall be located at the intersection of two or more mains and shall be spaced so that no more than 30 customers will be without water during a shutout. For lines smaller than 24 inches, typical spacing should be 500 feet in high-density areas and 1200 feet in residential area. Mains 24" and larger shall be valved at intervals not to exceed 2000 ft.
3. At dead ends, gate valves shall be located one (1) pipe length (10-ft. minimum) from the end points of the main. The Engineer shall provide (and show on drawings) complete restraint for all such valves, pipe extensions, and end caps.
4. Branch piping (both new and future branches) shall be separated from the main with gate valves. In branches larger than sixteen (16) inches these shall be butterfly valves.
5. Valves shall be located so that isolating any intersection of water main requires closing of no more than three (3) valves.
6. The operating nut or extension of any valve shall be between 18" and 24" below finished grade.
7. Valves with valve extensions and those at pressure zone boundaries shall be equipped with a locking type debris cap.
8. All horizontal gate valves larger than 16" shall have the operating bonnet located in a vault. All butterfly valves shall have actuators enclosed in a vault.
9. Valves having "push on" joints are not permitted for fire hydrant leads and laterals.
10. Where pressures are 90 psi or above then it will be required for customers to place pressure reducing valves on service lines on property side of meter. Pressure reducing valves shall be installed on water mains at NBU's discretion.

D. Fire Hydrants

1. Hydrants shall be installed at the intersection of two (2) streets and between intersections where necessary, at distances not in excess of 300 feet between hydrants in commercial or other high-density areas and not more than 600 feet in residential areas.
2. Hydrants shall be installed on both sides of all divided road/highways, unless otherwise approved by NBU and NBFD. Roads/highways where opposing lanes of traffic are separated by a vehicle obstruction shall be considered a divided road/highway.
3. Fire Hydrants located (off tee fittings) at the end of dead end mains and cul-de-sacs will be required in place of a permanent blow-off.
4. No private fire hydrants shall be allowed.
5. The entire fire hydrant assembly shall be restrained joints.

E. Services

1. Water services shall be in accordance with NBU Standard Details. More than two meters on a single service line will be considered on a case-by-case basis.
2. Individual meter services will not be taken from transmission lines. Transmission lines are generally considered to be 24 inches in

diameter or larger. Exceptions must be approved by Water System Engineering at time of plan submittal. The Engineer shall submit a letter with this request.

3. All multi-family and commercial customers shall install, at a minimum, a double-check valve assembly depending on the application. All backflow devices shall be tested upon installation by a recognized backflow prevention assembly tester and certified to be operating within specifications. The backflow must be tested annually by a recognized backflow prevention assembly tester and certified to be operating within specification. The annual tests need to be reported to NBU Water Systems Engineering Division.

F. Water Meters for Multi-Family and Large Commercial Customers

1. Each unit in a duplex, triplex, fourplex, or condominium shall be provided with an individual water meter.
2. Separate meters, with the proper backflow prevention device, shall be used for all irrigation, swimming pools, common laundry areas, and all other common areas of each multi-family facility.
3. All large commercial or multi-family building of any type that has a site plan area of over 10,000 square feet will purchase and install a separate meter or meters for all irrigation, fountain, swimming pool, and any other outdoor use of water. The separate meter or meters for outdoor water use shall be installed on a tap that is independent of the domestic tap serving the commercial or multi-family building.
4. All multi family, manufactured home rental community, or multiple use facility shall provide for the measurement of the quantity of water, if any, consumed by the occupants of each unit through the installation of:
   a. Submeters, owned by the property owner or manager, for each dwelling unit or rental unit.
   b. Individual meters for each dwelling unit or rental unit.

G. Small Commercial and Single Family Residential Irrigation Meters

1. All small commercial buildings with a site plan of 10,000 square feet or less and all single family residential dwellings are required to have separate irrigation meters if an irrigation system is installed.
2. Separate taps are not required for irrigation meters for the small commercial under 10,000 square feet and single family residential dwellings. Irrigation meters for these establishments can be teed off of a single domestic service tap.
3. All small commercial and single family residential irrigation meters shall have the proper backflow prevention device installed on the irrigation system.

2.9.3 WASTEWATER SYSTEMS

A. Determination of Wastewater Flow

1. Residential single family units shall be assumed to produce an average wastewater flow of 210 gallons/day. When designing lift stations, assume 300 gallons/day.
2. Industrial wastewater flows will be evaluated on a case by case basis.
3. Inflow/Infiltration.

   In sizing wastewater lines, external contributions are accounted for by

including 750 gallons per acre per day served for inflow and infiltration. For wastewater lines in the Edwards Aquifer Zone refer to the Texas Commission on Environmental Quality requirements. Strict attention shall be given to minimizing inflow and infiltration.

4. Peak Dry Weather Flow.

The peak dry weather flow is derived from the formula:

$$Q_{pd} = \frac{[18+(0.0206 \times F)^{0.5}]}{[4+(0.0206 \times F)^{0.5}]} \times F$$

where:

$$F = \frac{210(\text{gal/LUE/day}) \times (\#\ \text{LUE})}{1440}$$

F = average dry-weather flow in gpm

5. Peak Wet Weather Flow.

The peak wet weather flow is obtained by adding inflow and infiltration to the peak dry weather flow. In designing for an existing facility, flow measurement shall be used in lieu of calculations for the pre-existing developed area.

6. Minimum Flow.

The minimum flow is derived from the formula:

$$Q_{min} = [0.2 \times (0.0144 \times F)^{0.198}] \times F$$

B. Determination of Pipe Size

1. Minimum Size.

The minimum diameter of all gravity wastewater mains shall be eight (8) inches. For service line sizes, refer to the NBU Standard Details.

2. Design Requirements.

For wastewater mains, fifteen (15) inches in diameter or smaller, use the larger size as determined below:

a. The main shall be designed such that the Peak Dry Weather Flow shall not exceed 65% of the capacity of the pipe flowing full.

b. The main shall be designed such that the Peak Wet Weather Flow shall not exceed 85% of the capacity of the pipe flowing full.

For wastewater mains, eighteen (18) inches in diameter or larger, the main shall be designed such that the Peak Wet Weather Flow shall not exceed 80% of the capacity of the pipe flowing full.

3. Design Velocities.

The minimum design velocity calculated using the Peak Dry Weather Flow shall not be less than two (2) feet per second (fps). The maximum design velocity calculated using the Peak Wet Weather Flow should not exceed ten (10) fps. Velocities in excess of 10 fps may be considered under special conditions where no other options are available. In such cases, proper consideration shall be given to pipe material, abrasive characteristics of the wastewater flows, turbulence and displacement by erosion or shock.

4. Minimum Slope.

   Minimum allowable slope for mains in the New Braunfels Utilities service area shall conform with the Texas Commission on Environmental Quality standards. (see table below)

Sizes of Pipe In Inches I.D.	Minimum Slope In Percent	Maximum Slope In Percent
6	0.50	12.35
8	0.33	8.40
10	0.25	6.23
12	0.20	4.88
15	0.15	3.62
18	0.11	2.83
21	0.09	2.30
24	0.08	1.93
27	0.06	1.65
30	0.055	1.43
33	0.05	1.26
36	0.045	1.12
39	0.04	1.01
>39	Calculate	Calculate

C. Design Considerations

1. Materials and Standards.

   All materials and appurtenances shall conform to the NBU Standard Products List.

2. Protecting Public Water Supply.

   No physical connection shall be made between a drinking water supply and a wastewater pipe or any appurtenance thereof. An air gap of a minimum of two inlet pipe diameters between the potable water supply and the overflow level connected to the wastewater pipe shall be provided.

3. Location.

   The location of the wastewater main shall be in conformance with the NBU Standard Details (location shall be center of street). Alternative assignments must be approved by Water Systems Engineering.

4. Separation Distance.

   The separation between wastewater mains and other utilities shall be in accordance with the Rules adopted by the Texas Commission on Environmental Quality.

5. Steep grades.

   Where the pipe grade exceeds 12 percent and the construction is outside of any pavement, concrete retards conforming to the NBU standards will be required at intervals of no more than 25 feet (preferably at joint locations).

6. Depth of Cover.

   The minimum depth of cover over the upper-most projection of the main shall be 36 inches. Add concrete cap or encasement if cover is less than 36 inches; the maximum depth shall be as approved by NBU for the specific material, application, and conditions.

7. Turbulence.

Wastewater lines shall be designed to minimize turbulence to prevent release of sulfide gases and subsequent corrosion.

D. Manholes

All manhole ring and covers shall have ring covers locked into place by a one (1) foot wide concrete collar per Standard Detail Drawing No. 329. All manholes shall be constructed so that the top of the ring is two inches (2”) above surrounding ground except when located in paved area. In paved areas, the manhole ring shall be flush with pavement.

1. Location.

   Manholes shall be located and spaced so as to facilitate inspection and maintenance of the wastewater main. Manholes shall be placed at the following locations:

   a. Intersections of mains.
   b. Horizontal alignment changes.
   c. Vertical grade changes.
   d. Change of pipe size.
   e. Change of pipe material.
   f. The point of discharge of a force main into a gravity wastewater main.
   g. Intersection of service lines to main lines 24 inches and larger.
   h. A manhole is required at the point of connection of a building service line to the public wastewater service stub for multi-family projects exceeding fifteen (15) dwelling units and for commercial developments {containing more than 4,000 square feet} requiring a water meter greater than 2".
   i. At other locations as required by the City of New Braunfels Industrial Waste Ordinance.

2. Spacing.

   Manhole spacing for lines smaller than 24 inches should not exceed 500 ft.; for larger mains, spacing may be increased, subject to approval by NBU in writing.

3. Covers.

   All manholes not located in paved areas, or those residing in drainage ways shall have bolted, watertight covers. Where watertight manhole covers are used, every third manhole will be vented and equipped with manhole rain infiltration inserts.

4. Corrosion Prevention.

   Manholes shall be constructed of or lined with a corrosion resistant material. Where new construction ties into an existing manhole, the existing manholes must be lined, coated, or replaced with a corrosion resistant material.

5. All lines into manholes, including drop connections, shall match crown-to-crown where feasible. Any deviation must be approved in advance by NBU in writing.

6. Drop manholes will have a maximum of 8’ of drop and are not allowed where main size exceeds 15”. The minimum distance before requiring a drop pipe is 2’ of drop.

7. Manholes shall have the following minimum sizing:

   a. 48” for mains up to 18” in diameter
   b. 60” for 24” mains

c. 72” for 30” and 36” mains
d. 84” diameter for mains 48” and larger.

E. Ventilation

Ventilation shall be provided as required by TCEQ Rules and Regulations.

F. Inverted Siphons

When justified and approved by NBU in writing, siphons shall have a minimum of two barrels. The minimum pipe size shall be eight (8) inches with a minimum flow velocity of 3.0 fps at peak dry weather flow. The minimum dry weather flow shall be used to size the smallest barrel. Three-barrel siphons shall be designed to carry the capacity of the incoming gravity wastewater mains(s) with one barrel out of service.

An additional corrosion resistant pipe shall be designed to allow for the free flow of air between the inlet and outlet siphon boxes. The diameter of this air jumper shall not be smaller than one-half the diameter of the upstream wastewater pipe. Air jumper pipe design shall provide for removal of condensate water that will collect in the pipe.

Siphon inlet and outlet structures shall be manufactured with approved corrosion resistant material and shall provide for siphon cleaning and maintenance requirements.

G. Service Lines

Wastewater service lines, between the main and property line, shall have an inside diameter not less than six (6) inches. The minimum grade allowed for service lines is two (2) percent. In all new systems, grade breaks exceeding allowable joint deflection must be made with approved fittings and shall not exceed a cumulative total of 45 degrees. No service connections shall be made to mains larger than 15” in diameter.

Usually wastewater services are placed at the center of a lot. Services to lots will terminate at the property line with a cleanout or will extend four (4) feet past the underground electric conduit if electric is installed in the front easement. Services should have a minimum of thirty-six (36) inches of cover. Cleanout shall be installed at the property line. Service to lots having a five (5) foot by five (5) foot water/wastewater easement will terminate within the easement. For details, see the NBU Standard Details.

H. Lift Stations (Excluding low pressure systems)

Lift stations are discouraged and will be allowed only where conventional gravity service is not feasible (Lift Station installation cost plus 30 years O&M expense is less than installation cost for gravity system). This subsection details the specific design criteria for wastewater lift stations. Additional requirements for individual lift stations may be imposed by NBU as conditions warrant.

In addition to these criteria, all lift stations must meet the Texas Commission on Environmental Quality Chapter 217 rules and the NBU Lift Station Specifications.

1. Flow Development

Calculation of wastewater flow shall be done in accordance with Section 2.9.3.A. The following calculations shall be included.

a. Maximum Wet Weather Flow (Design Flow)

This flow is used to determine the lift station design capacity. All lift stations shall be designed to handle the maximum wet weather flow for its service area.

Equation:

(Population of service area × 100 gallons per capita per day (gpcd) × maximum flow peaking factor) + (750 gallons per day) × (number of acres).

b. Maximum Wet Weather Flow

This flow is used to determine pipe size in the collection system.

Equation:

(Population of service area) × (100 gpcd) × (maximum flow peaking factor)

c. Average Dry Weather Flow

This is the flow developed without the maximum flow peaking factor. This flow is used to determine the average detention time in the wet well.

Equation

(Population of service area) × (100 gpcd)

d. Minimum Dry Weather Flow

This is used to determine the maximum detention time in the wet well.

Equation

(Population of service area) × (100 gpcd) × (minimum flow peaking factor)

e. A minimum of two (2) pumps shall be required for all lift stations. The capacity of the pumps shall be such that the maximum wet weather flow can be handled with the largest pump out of service.

2. Wet Well Design

a. The bottom of the wet well shall have a minimum slope to the intake of two (2) vertical to one (1) horizontal. There shall be no projections in the wet well, which would allow deposition of solids.

b. The wet well volume shall be sized to provide adequate storage volume at peak design flows and a pump cycle time of sufficient duration to prevent pump short cycling and consequential motor damage. Pump cycle time, defined as the sum of “pump off” time plus “pump on” time, shall be as follows:

Motor H.P.	Minimum Cycle Time in Minutes (t_c)
2 to 50	10
51 to 75	15
76 to 250	30
251 to 1500	45

Volume between “pump on” and “pump off” elevation (of the pump cycle) shall be determined by the following criteria:

$V = (t_c/4) \times q$ where q = pump capacity in gpm

c. All "pump on" levels shall have a minimum separation of one (1) foot between levels. All "pump off" levels shall be at least six (6) inches above the top of the pump casing. For more than two (2) pumps, the "pump off" levels shall be staged with a minimum separation of one (1) foot between levels.

d. An example of a two (2) pump staging sequence follows:

High level alarm
Lag pump on
Lead pump on
Lag pump off
Lead pump off
Low level alarm

The high level alarm shall be at least one foot above the last (highest) "pump on" level in the wet well and also at least one (1) foot below the flowline of the lowest influent line into the wet well.

3. Wet Well Detention Time

a. Calculate the detention time (Td) in the wet well for the maximum wet weather flow, maximum dry weather flow and average dry weather flow using the following equation:

$$T_d = t_f + t_e$$

Where:

t_f = (v) ÷ (i) = time to fill the wet well in minutes

t_e = (v) ÷ (q - i) = time to empty the wet well in minutes

V = volume of wet well between "pump on" and "pump off" elevations in gallons

q = Pump capacity in gpm

i = flow into the station corresponding to the maximum wet weather flow, maximum dry weather flow or average dry weather flow in gpm.

b. Maximum detention time shall be calculated with i = minimum dry weather flow.

c. Odor control shall be provided for the wet well if the total detention time in the wet well and force main system exceeds 180 minutes.

4. Static Head

The static head shall be calculated for "pump on" and "pump off" elevations in the wet well.

5. Net Positive Suction Head

The net positive suction head (NPSH) required by the pump selected shall be compared with the NPSH available in the system at the eye of the impeller. The engineer shall consult the pump manufacturer for the NPSH required values for that pump and compare them with calculated values for the NPSH available. The NPSH available should be greater than the NPSH required for selected pump. The following equation may be used for calculating the NPSH available:

$$NPSH_A = P_B + H_s - P_v - H_{fs}$$

Where: P_B = barometric pressure in feet absolute,

H_s = minimum static suction head in feet,

P_v = vapor pressure of liquid in feet absolute,

H_{fs} = friction loss in suction in feet.

For lift stations in NBU's service area a barometric pressure of 33.4 feet may be used and a vapor pressure of one and four-tenths (1.4) feet may be used. These value are based on the following assumptions: an altitude of 500 feet above sea level, a water temperature of 85ºF and a specific gravity of water of 0.996 at 85ºF.

6. Suction Piping Design
   a. All suction piping shall be flanged ductile iron and have a minimum diameter of four (4) inches. Each pump shall have a separate suction pipe.
   b. Suction piping shall have a velocity of three (3) to five (5) fps.
   c. All suction pipes inside the wet well shall be equipped with a flare type, down-turned intake. The distance between the bottom of the flare and the floor of the wet well shall be between D/3 and D/2 where D is the diameter of the flare inlet.
7. Force Main Design
   a. All force mains shall be ductile iron with non-corrosive lining, PVC class 160 or an approved HDPE with a minimum diameter of four (4) inches. Force main pipe within the station shall be flanged. Flexible fittings shall be provided at the exit wall.
   b. Force mains shall be sized so that the flow velocity is between three (3.0) and six (6.0) feet per second at ultimate development. During initial development phases, flow velocities may be as low as two and one-half (2.5) feet per second.
   c. The maximum time required to flush the force main shall be calculated on the basis of average dry weather flow. Flush time shall be calculated for average dry weather flow using the following equations:

$$T_{flush} = (t_f + t_e) \times \frac{\text{(Force Main Length)}}{(t_{c/2}) \times (V_{fm}) \times (60 \text{ sec/min})}$$

Where:

t_e = Time to empty wet well in minutes

t_f = Time to fill wet well in minutes

V_{fm} = Flow velocity in the force main in feet per second

t_c = Pump cycle time in minutes

$$*t_e = \frac{V}{q - i}$$

$$*t_f = \frac{V}{i}$$

i = average dry weather flow in gpm

*See Section 2.9.3.H.3.a, "Wet Well Detention Time", for an explanation of V and q.

   d. Odor and corrosion control shall be provided for the force main if the force main detention time exceeds 30 minutes if dual force mains are not feasible.
   e. Location and size of all air release valves shall be evaluated for odor or nuisance potential to adjacent property by the design

engineer.

The use of air release valves shall be restricted to installations where there are not possible alternatives.

f. Sulfide Generation Potential.

Lift station/force main systems shall be evaluated for their sulfide generation potential and their ability to achieve scouring velocities during average dry weather flow periods. If the evaluation indicates that sulfide concentration of greater than 2 ppm and solids deposition are likely, the design shall:

1) define a workable sulfide control technique that will minimize sulfide formation in the force main,
2) include "pig" launching stations and recovery points to allow cleaning of the force main, and
3) protect the gravity main and manholes downstream of the force main from corrosion. The length of pipe to be protected shall be determined on a case by case basis.

g. Thrust restraint when required shall be shown on the plan view.

8. Head Loss Curves

a. Data points for the system capacity curve shall be provided in tabular form and graphed with pump head capacity curve on the same graph. Two system capacity curves shall be plotted using the Hazen Williams coefficient values of C = 100 and C= 140.

b. Pump output in gpm at maximum and minimum head shall be clearly shown on the system curve for each pump and combination of pumps.

c. For stations with two (2) or more pumps operating in parallel, multiple and single operation points shall be plotted on the system curve.

d. Pumps with the highest efficiencies at all operating points shall be used.

e. If pumps are equipped with smaller impellers during start up to handle lower than design flows, impellers sized to handle the design flow shall also be provided.

9. Buoyancy Calculations

The lift station design shall include a complete analysis of buoyant forces on the entire lift station structure.

10. Water Hammer

a. Calculations for water hammer showing maximum pressures, which would occur upon total power failure while pumping, shall be provided using the following equations.

$$p = \frac{\mathrm{a} \times \mathrm{v}}{2.31 \times \mathrm{g}} + \text{operating pressure of pipe (psi)}$$

$$\mathrm{a} = \frac{12}{\{(\mathrm{w}/\mathrm{g}) \times [(1/\mathrm{k}) + (\mathrm{d}/(\mathrm{E} \times \mathrm{t}))]\}^{0.5}}$$

where:

p = water hammer pressure (psi)
a = pressure wave velocity (ft/s)
w = specific weight of water (62.4 lb./ft^3)
g = acceleration of gravity (32.2 ft/s^2)
k = bulk modulus of water (300,000 psi)
d = inside diameter of pipe (in)
E = Young's modulus of pipe (psi)
t = pipe wall thickness (in)
v = flow velocity in pipe (ft/s)
L = length of force main (ft)

Surge control measures shall be provided when pressures, including those due to water hammer, exceed the pressure rating of the pipe.

11. Suction Specific Speed

Suction specific speed of the pumps shall be calculated using the following formula:

$$SSS = R\ (Q)^{0.5} / (H)^{0.75}$$

where: SSS = suction specific speed (rpm)
Q = flow at the best efficiency point, gallons per minute (gpm)
H= net positive suction head required at maximum impeller speed (feet)
R= speed of pump and motor in rpm

Suction specific speed should be below 9,000 rpm to ensure that the pump will not cavitate because of internal recirculation.

12. Stiffness Ratio

In order to ensure that the pump shaft does not bend an excessive amount, the engineer shall calculate the stiffness ratio of the shaft using the following equation:

$$\text{Stiffness Ratio} = L^3 / D^4$$

where:

L = distance from impeller centerline to the centerline of the inboard bearing (inches)
D = diameter of shaft (inches)

The stiffness ratio shall not exceed 60.

13. Energy Calculations

For lift stations with flows exceeding 75 gpm but less than 1,000 gpm, and if the engineer is considering a submersible type lift station as an option then the engineer shall submit cost comparisons for submersible stations versus wet well/dry well stations. These cost comparisons should include the initial station costs, installation costs, and power costs for the life of the station.

Energy costs for each type station shall be calculated using the following equations:

a. Calculate the water horsepower required.

$$P = \frac{(Q)(h)(8.34\ \text{lb/gal})}{33{,}000\ \text{ft-lb min/hp}}$$

where:

P = water horsepower (hp)
Q = flow, gallons per minute (gpm)
h = head, feet (ft)

b. Calculate the brake horsepower required.

$$\text{Bhp} = \frac{P}{\text{pump efficiency*}}$$

where: Bhp = brake horsepower (hp)
P = water horsepower (hp)

* Use the most efficient pumps for the application.

c. Calculate the electrical horsepower required

$$\text{Ehp} = \frac{\text{Bhp}}{\text{motor efficiency}}$$

where: Ehp = electrical horsepower (hp)
Bhp = brake horsepower (hp)

Use the most efficient motors for the application

d. Calculate the power required in kilowatts.

$$\text{EkW} = (\text{Ehp})(0.746\ \text{Kw/hp})$$

e. Calculate daily power consumption in kilowatt-hours.

$$E = [(EKW_1)(t_1) + (EkW_2)(t_2) + (EkW_3)(t_3)...]$$

where: E = total power consumption, kilowatt hours (kWh) per day
EkW_n = power required, kilowatts for pumps 1,2,...,n
t_n = estimated pump run time in hours per day for pumps 1,2,...,n

f. Calculate the estimated cost for power consumption over the life of the station.

$$C = (E)(\$0.06/\text{kWh})(T)$$

where:

C = cost of power over the life of the station (dollars)
E = power consumption (kilowatt-hour per day – kWh/day)
T = time the station is expected to be in service (days)

g. Stress and thrust calculations for internal station piping and bends shall be provided for stations with flows over 1000 gpm.

14. Pump Installation

Installation of the pump and motor shall be in accordance with American National Standard for Centrifugal Pumps for Nomenclature, Definitions, Application, and Operational Hydraulics Institute ANSI/HI 1.1-1.5-1994 and manufacturer's printed instructions.

a. Alignment

1) The pump and driver initially received from the factory shall be mounted on a common base plate and coupled.

2) The pump and motor shall be placed on the foundation uncoupled.

3) The baseplate shall rest on metal leveling and support wedges or shims.

4) The metal leveling and support wedges shall be located directly beneath the portions of the baseplate carrying the greatest loads with spacing to provide uniform support.

5) A gap of 0.75" to 1.5" between the foundation and the baseplate shall be allowed for grouting.

6) Adjustment of the metal leveling and support wedges shall be made until the shafts of the pump and motor are level - 0 degrees, the pump and driver coupling face are at 90 deg, and the suction and discharge flanges are at 90 deg. Once pump assembly is level and true, place level on flat area of baseplate and make note of baseplate's relative position for final alignment team.

7) Parallel and angular alignment shall be spot checked with a straight edge and taper gauge, or you may use a set of feeler gauges. Rough side to side and elevation corrections to the driver's position can be made at this time. DO NOT UNBOLT, ADJUST, OR MOVE THE PUMP FROM ITS ORIGINAL FACTORY MOUNTED BASEPLATE POSITION AT ANY TIME. This may cause serious difficulty with final alignment. If you cannot rough-in the side to side alignment by moving the driver, you may have run into the end of adjustability, make a note of for the final alignment team.

b. Grouting

1) Grout shall conform to the requirements of section 03600 Structural Grout.

2) Once rough alignment is set, and while monitoring the level position of coupling face, shafts, and flanges, tighten the foundation bolts evenly, but not fully.

3) Apply gout, completely filling the space between the foundation and the baseplate and leaving no air pockets.

4) Use the grout holes provided in the baseplate to backfill the voids within the chamber.

5) Once the grout has hardened, and while monitoring the level settings at the motor and pump shaft, the suction and discharge flanges, and the coupling faces, completely tighten all bolts.

c. Final Alignment

1) Prior to official startup, the pump manufacturer's representative shall verify the proper alignment of the pump and driver and make corrective adjustments using the following guidelines:

2) Shim Size: Shims shall be selected from the proper size pre-cut series (A, B, C, D, etc.) to match the machine mounting bolt size and to maximize coverage of the machine footprint being supported. Multiple or oversized shims shall be used where the area of the machine footprint is 150% or greater than the

proper size pre-cut series shim footprint.

3) Number of Shims: Maximum of 4 under any one mounting foot.
4) Brass and Tapered Shims: Shall not be used.
5) Micrometer: ± 0.0003 inch lead error; spindle hardness RC 58-62.
6) Dial Indicators: One inch dial range in 0.001 increments. One inch plunger range with accumulator.
7) Lasers: Acceptable manufacturers include Ludeca, MMS React, Smart Align and Combi.
8) Feeler Gauges: Mechanics flat hand gauges. Acceptable manufacturers include: Starrett, Sears Craftsman, Armstrong, Stanley, Proto, and Snap-On.
9) Shaft Keys
   i. Key Length: Rotating equipment shaft keys shall be made to a length equal to: the sum of the total length through the bore of the mounted device plus the straight length of the shaft keyway. Divide by two.
   ii. Keyway Offset: The keyways of the driver and driven rotating machine shaft coupling shall be offset 180 degrees from each other when connected.
10) Soft Foot: Correct soft foot for all feet of the driver
   i. Allowable contribution of the uncorrected soft foot component to actual total shaft misalignment shall be less than a maximum of 0.0005 inch as read (½ of indicator reading) at both the coupling alignment indicators.
   ii. Actual allowable uncorrected soft foot at any machine foot shall be less than a maximum of 0.0002 inches of required shim (subject to “d.1” above which will task precedence). This includes soft food caused by angled food or base conditions.
   iii. Machine foot mounting bolts shall be fully tightened. Partial tightened shall not be used to correct soft foot. Bolts will be torqued where specifically called out.
11) Rotating shaft alignment
   i. Fixture shall be set up on the driver and driven machine, machined shaft surfaces.
   ii. Primary alignment method for direct driven machines is when coupled. Uncoupled alignment shall be used only when approved by the owners Representative.
   iii. Account for possible coupling flex by always rotating coupled machines in the same direction during alignment.
   iv. Uncoupled machines must be connected so that both shafts turn together without relative motion during alignment.
   v. With Reverse Dial Indicator method, the maximum allowable misalignment, vertical and horizontal from the desired targets of 0.000 inches (for a non-thermal growth machine) or from the given target readings (for a thermal growth machine) must meet BOTH of the following conditions: ½ the final total indicator reading at each

indicator shall be no more than shown in the table below AND the final remaining correction at each machine foot shall be no more than 0.001 inches of required movement.

	Total
Machine Speed *	Misalignment **
(RPM)	(inches)
Up to 1700	0.002
1700 and greater	0.002

* Machine speed is the speed of the highest RPM machine in the drive train based on the maximum nameplate RPM of the driver

** ½ the indicator reading

vi. With laser alignment, the maximum misalignment from the desired target of 0.000 (for a non-thermal growth machine) or from the given target readings (for a thermal growth machine) is:

		Angle
	Parallel	between
	Offset at	shaft
Machine Speed*	Coupling	coupling
	Midpoint	faces
RPM	Inches	Inches
Up to 1700	0.002	0.002
1700 and greater	0.002	0.002

* Machine speed is the speed of the highest RPM machine in the drive train based on the maximum nameplate RPM of the driver

12) Reporting: Report final tolerances and settings of factory assembled and other equipment on the “Rotating Machinery Alignment Data Sheet”. Hold final alignment for inspection and approval by Owner’s Representative. Laser alignment users should download and print all files as soon as convenient.

15. Sump Design

The following items apply for lift station dry well sump pumps:

a. Dual submersible sump pumps, each with a minimum capacity of 1000 gallons per hour (gph), shall be provided.

b. The design head of the sump pumps should be the static head from the sump to one foot above the top of the wet well.

c. Sump piping shall be galvanized steel with a minimum diameter of two (2) inches.

d. Sump discharge from the dry well shall be installed through the wall of the wet well at a point not less than 12 inches above the top of the wet well and grouted in place with a water tight seal.

e. The dry well floor shall slope toward the sump pit.

16. Specific Station Requirements
    a. All stations will be required to have an equipment lifting device.
    b. Station engineering calculations are required showing that temperatures inside the dry well do not exceed 85°F, while the pumps are operating.
    c. Stations deeper than 30 feet, measured from the finished floor to the top of the entrance tube, shall require an electrically powered personnel lift.
    d. Entrance hatches larger than 40 inches in diameter shall be spring loaded.
    e. Valves higher than six (6) feet above the floor shall have chain operators.
    f. Any potable water supply below the overflow elevation of the wet well shall be protected by an air gap.
    g. All lift stations must be evaluated for back up power requirements.
    h. Flow monitoring will be provided for all lift stations.
    i. Telog recording telemetry unit required for all lift stations.
        1) Telog R-3307 Recorder for stations with 2 or less pumps.
        2) Telog R-3314 Recorder for stations with more than 2 pumps.

17. Exceptions

    Exceptions to these design criteria must be requested in writing. Written approval from NBU or a designee must be obtained before any exceptions will be allowed.

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