Chapter 3 Permit to Construct Design Report

Yellowstone Modular Housing Project

Mammoth Government Area

Park County

July 21, 2026

Prepared for:

National Park Service

Wyoming Department of Environmental Quality

Prepared by:

Stantec Consulting Services, Inc.

Sign-off Sheet

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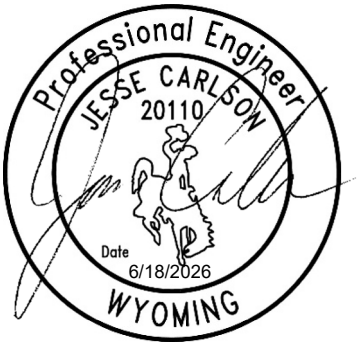
Project Manager _____

Signature

Jesse Carlson, PE

Printed Name



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Abbreviations

ADD	Average Day Demand
CIP	Cast Iron Pipe
DEQ	Wyoming Department of Environmental Quality
DIP	Ductile Iron Pipe
FT	Feet
GPM	Gallons Per Minute
NPS	National Park Service
PHD	Peak Hour Demand
PDD	Peak Day Demand
PSI	Pounds per Square Inch
PVC	Polyvinyl Chloride
VC	Vitrified Clay
WWDC	Wyoming Water Development Commission
WYDOT	Wyoming Department of Transportation

1.0 INTRODUCTION

The National Park Service (NPS) is planning to construct modular housing developments for utilization by employees working in the Mammoth, Canyon and Northeast Entrance Government Areas. This report addresses the proposed work at the Mammoth Government Area. Separate reports have been prepared for the Northeast and Canyon Government Areas. Four new prefabricated modular housing units are proposed at Mammoth Government Area. This report will address the utility design consisting of potable water service, fire suppression, and sanitary sewer mains and services (hereby referred to as the Project). No additional water treatment, wastewater treatment, pumping facilities or water storage are proposed with this project.

An initial review of existing information and site reconnaissance was performed to determine the location and capacity of existing potable water and sanitary sewer infrastructure for the Project. The NPS is proposing to connect four new water services to the existing 6-inch mains that run along Powerhouse Rd and Boneyard Service Rd.

In addition to the waterline replacement, the NPS is proposing replacement of approximately 430 linear feet of 8-inch vitrified clay (VC) with 8-inch PVC. The new PVC will be connected to an existing manhole to the east at Pinyon Terrace St. and Highland Terrace Ave. New sanitary services will be installed at each unit.

The purpose of this design report is to provide DEQ, as required by Chapter 11 and Chapter 12 of the Wyoming Water Quality Rules and Regulations, information regarding the construction of the proposed water services, sanitary sewer main replacement and proposed sanitary services. The Project is designed according to the requirements of Chapters 11 and 12. This report includes a brief description of the Project area, the Project, the proposed design, and appendices containing supporting information. Construction of the Project is anticipated to begin Fall of 2026.

2.0 PROJECT AREA DESCRIPTION

The Project is located in Mammoth Government Area in the SE ¼ of Section 30 and NE ¼ of Section 31, Township 58 N, Range 114 W in Park County, WY. A project location map is included in the Permit Drawings presented in Appendix A.

3.0 PROPOSED PROJECT SYSTEM IMPROVEMENTS

The NPS proposes to add 2-inch HDPE water and fire water service lines at each unit. The NPS also proposes to replace an existing 8-inch VC sanitary sewer main with 8-inch SDR 26 PVC.

This work will replace one section of existing sewer main that runs from Powerhouse Rd to Highland Terrace Ave. Two manholes will be added and a connection to an existing manhole will be completed as a part of the Project. New 4-inch sanitary services will be installed at three of the units and 2-inch force service will be installed at one of the units. The proposed water distribution line and sewer main will be constructed to meet the Wyoming Public Works Standard Specifications (2023 edition), herein referred to as the State Specifications. The proposed improvements are shown in Appendix A.

4.0 WATER SYSTEM DEMANDS

An initial review of existing information and site reconnaissance was performed to determine the location and capacity of existing potable water infrastructure for each area of the Project. Yellowstone National Park owns and maintains the Mammoth water treatment and distribution system. The proposed modifications to the water distribution system will continue to be owned and maintained by Yellowstone National Park. The existing water treatment system has adequate capacity for the water demands described below.

4.1 WATER DEMANDS

The proposed water service lines are in an area that is looped, allowing flow in either direction to meet water demands occurring in any area of the associated pressure zone. EPANET® was used to model the water demands in the proposed water distribution line for peak hour and fire suppression scenarios.

Stantec utilized field hydrant testing for the analysis presented below. The following estimated maximum water demands were used to analyze the water system modifications:

• Average Daily Demand: 1,500 gallons per day (Wyoming DEQ Water Quality Rules and Regulations – Chapter 12, Section 8)

• Maximum Daily Demand: 4,080 gallons per day (Wyoming DEQ Water Quality Rules and Regulations – Chapter 12, Section 8)

• Peak Hour Demand: 11.3 gallons per minute (Wyoming DEQ Water Quality Rules and Regulations – Chapter 12, Section 8)

• Automatic Fire Suppression Demand: 55 gallons per minute (Modular Building Design Narrative)

Stantec believes the EPANET model provides an acceptable assessment for this Project. Analyses are included in Appendix C – Potable Water Hydraulic Analysis.

The modified system provides dynamic pressures range from 85.99 psi minimum to 100.3 psi maximum during peak hour demand conditions. The system maintains a minimum of 87.03 psi of residual pressure, during fire suppression demand conditions. However, this does not include additional 7.5 psi drop from the water meter and pit at 55 gpm per the manufacturer's documents for the Sensus iPerl 1" water meter. The maximum pressure fluctuation at any location within the pressure zone between peak hour demand and minimum hour demand does not exceed 30 psi.

4.2 FIRE FLOW DEMANDS

The existing water distribution line includes the two existing hydrants that hydrant testing was completed with. The EPANET model was also used to show that the existing system worked under fire flow conditions with both hydrants flowing 1000 gallons per minute. The following estimated maximum water demands were used to analyze the water system:

1-hour Site Fire Flow: 1,000 gallons per minute (2018 International Fire Code - Section B105.1, Table B105.1(1) for Residential Group R-3 and R-4 (0-3, 600SF)

The existing system fire flow analysis are included in Appendix C – Potable Water Hydraulics Analysis. This analysis confirms that the proposed system meets the Chapter 12 requirement to maintain a minimum of 20-psi during all flow scenarios. **Table 1** shows the modeled pressures in the Project area during the fire flow analysis.

Table 1: Project Area Pressures during Fire Flow Plus Peak Hour Demand Scenario

Hydrant Name	Fire Flow Required (gpm)	Calculated Residual Pressure at Available Fire Flow (psi)
Hydrant M1	1,000	33.90
Hydrant M3	1,000	23.26

5.0 WATER DISTRIBUTION LINE

The proposed water distribution system modifications to the Mammoth Hot Springs Government Area consist of the installation of 2” HDPE service connections to each of the 4 modular units. Each unit will require approximately 35 LF of service line from the existing potable water mains. The proposed services to the units along Lower Mammoth Service Road will need to tie to a potable water main extension running along the Lower Mammoth Service Road. As only water services are being constructed, no gate valves or air release valves are being placed in this project. Refer to Appendix D – Product Data Sheets for material data. A summary of the Chapter 12 requirements and the design parameters are provided in **Table 2**.

Table 2: Water Distribution Line Chapter 12 Requirements and Design Parameters

Chapter 12 Section	Requirement	Design Parameter
16.b.i.	PVC pipe: Less than four inches diameter, ASTM D 2241; or four inches and larger diameter, AWWA C900	These materials are not proposed.
16.b.ii	Ductile iron, AWWA C151	These materials are not proposed.
16.b.iii	Fiberglass pressure pipe, AWWA C950	These materials are not proposed.
16.b.iv	Polyethylene pipe: 3/4 inch through three inches diameter, AWWA C901; four inches through 65 inches diameter, AWWA C906	Service connections will be 2" HDPE water pipe certified to meet AWWA C901 standards.
16.b.v	Other material submitted with the permit application and approved by the Administrator	These materials are not proposed.
16.c	Flanged piping shall not be allowed for buried pipe except for connection to valves.	These materials are not proposed.

Chapter 12 Section	Requirement	Design Parameter
16.d	New water mains shall be sized after the hydraulic analysis required by Section 9(l)(i) of this Chapter and the design shall demonstrate that: (i) At maximum day demand plus current State of Wyoming-required fire flow, or the fire flow of an authority having jurisdiction, the pressure in the municipal distribution system will not fall below 20 pounds per square inch (psi); and (ii) The normal system working pressure shall be greater than 35 psi.	Refer to the hydraulic calculations. The calculations show the fire flow scenario and associated pressures; residual pressures are maintained above 20-psi in all cases.
16.e	When fire protection is provided, the water main system shall be designed to also serve fire flows.	Refer to the hydraulic calculations. The distribution line has been designed to carry fire flows.
16.f	Hydrants shall: (i) Have hydrant leads that are a minimum of six inches in diameter; (ii) Have valves installed; (iii) Be protected from freezing at hydrant leads and barrels; (iv) Where groundwater levels are above the gravel drain area, hydrants shall be pumped dry or otherwise dewatered and hydrant weep holes shall not be used; and (v) Have drains that are not connected to or located within 10 feet of a sanitary sewer or storm drain.	These materials are not proposed.
16.g	Fire hydrants or active service taps may be substituted for air relief in 6- and 8-inch lines.	These materials are not proposed.
16.h	Where excavation is performed for distribution systems: (i) The trench bottom shall be excavated for the bell of the pipe; (ii) All rock shall be removed within six inches of the pipe; and (iii) The trench shall be dewatered for all work.	The trench shall be over excavated to provide a minimum depth of cradle of 6 inches.
16.i	Distribution system bedding for rigid pipe shall be designed in accordance with ASTM C12 Classes A, B, or C. Flexible pipe bedding shall be designed in accordance with ASTM D2321 Class I, II, or III.	Bedding used will meet Type I or II in accordance with ASTM D2321.
16.j	Distribution system pipe shall be joined to ensure a watertight fitting and installed in accordance with the following standards, as applicable: (i) For ductile iron pipe, AWWA C600; (ii) For PVC pipe, AWWA M23; and (iii) For HDPE pipe, AWWA M55.	The water services will be installed to the manufacture's recommendations, and AWWA M55. Pressure and leakage testing will be performed on all installed pipe. All fittings will be watertight.
16.k.i	Backfill for distribution systems shall: (i) Be performed without disturbing pipe alignment; (ii) Not contain debris, frozen material, unstable material, or large clods; (iii) Not contain rocks or stones that are greater than three inches in diameter within two feet of pipe; and (iv) Be compacted to a density equal to or greater than the surrounding soil	Backfill will be performed to meet State Specifications.

Chapter 12 Section	Requirement	Design Parameter
16.I.i	Separation of water mains from sanitary and storm sewers: Where the minimum vertical or horizontal separation distances required by incorporation by reference of 2018 TSS parts 8.8.2 and 8.8.3 of paragraph (a) of this Section cannot be met, the sewer or water line shall be placed in a separate conduit pipe or meet the flow-fill requirements of paragraphs (ii) and (iii) of this Paragraph (I)	Separation from sewers will be maintained. If unanticipated conditions necessitate the use of flow fill, cement-treated backfill shall be installed in accordance with Chapter 12 requirements.
16.I.ii.A	Flow-fill for pipelines shall comply with the following: Cement-treated fill, non-shrink backfill, low-density concrete backfill, or structural backfill may be used as flow-fill when the material has a 28-day compressive strength of 30-60 psi	These materials are not proposed.
16.I.ii.B	Flow-fill for pipelines shall comply with the following: The pipe to be encased shall be laid on a four to six-inch bed of washed gravel that has been widened, with the walls of the trench benched away from the center-line of the trench, so the pipe is uniformly supported over the length or supported on blocks no further than 10 feet apart	These materials are not proposed.
16.I.ii.C	Flow-fill for pipelines shall comply with the following: The flow-fill and washed gravel or blocks shall rest on an undisturbed trench bottom	These materials are not proposed.
16.I.ii.D	Flow-fill for pipelines shall comply with the following: The pipe shall not move laterally or float during placement of the flow-fill and the line and grade of the pipe shall be maintained	These materials are not proposed.
16.I.ii.E	Flow-fill for pipelines shall comply with the following: The flow-fill shall extend from trench sidewall to trench sidewall and extend at least two inches above the top of the pipe	These materials are not proposed.
16.I.iii.A	Flow-fill for pipe crossings shall comply with the following: To the extent possible, there shall be no joints or taps within nine feet of the crossing	These materials are not proposed.
16.I.iii.B	Flow-fill for pipe crossings shall comply with the following: The flow-fill shall extend from undisturbed earth at the bottom of the lower pipe to at least two inches above the top of the upper pipe	These materials are not proposed.
16.I.iii.C	Flow-fill for pipe crossings shall comply with the following: The block of flow-fill shall be wide enough to ensure the structural integrity of the installation	These materials are not proposed.
16.I.iii.D	Flow-fill for pipe crossings shall comply with the following: Pipes that cross one another shall be separated by a minimum of two inches when encased in flow-fill	These materials are not proposed.
16.m.i.A.I	Require backflow prevention devices for each water service connection in accordance with Table 4 of this Section, with the exception of (B)(I) residential water service connections	All water connections are considered residential water service connections.

Chapter 12 Section	Requirement	Design Parameter
16.m.i.B.I	Residential water service connections shall be considered to be low hazard back-siphonage connections unless determined otherwise by a Hazard Classification.	All connections will be considered low hazard back-siphonage.
16.m.i.E	All backflow prevention devices shall be in-line serviceable (repairable), in-line testable except for devices meeting ASSE 1024, and installed in accordance with manufacturer instructions and applicable plumbing codes.	Backflow prevention devices will be in-line serviceable (repairable), in-line testable except for devices meeting ASSE 1024, and installed in accordance with manufacturer instructions and applicable plumbing codes.
16.m.i.F	All backflow prevention devices must have a certification by an approved third-party certification agency. Approved certification agencies are: (I) American Society of Sanitary Engineers (ASSE); (II) International Association of Plumbing/Mechanical officials (IAPMO); and (III) Foundation for Cross-Connection Control and Hydraulic Research, University Of Southern California (USC-FCCCHR).	Backflow prevention devices will be certified by an approved third party.
16.m.i.G.I	Backflow prevention devices at water service connections shall be inspected and certified by a certified backflow assembly tester at the time of installation. Certification of the assembly tester shall be by one of the following: (I) The American Society of Sanitary Engineers (ASSE); or (II) American Backflow Prevention Association (ABPA)	Backflow prevention devices at water service connections will be inspected and certified by a certified backflow assembly tester at the time of installation.

5.1 WATER STORAGE

The proposed Project will include no additional storage capacity for the Mammoth Government Area.

5.2 PUMPING SYSTEM

The proposed Project will include no pumping system.

5.3 TREATMENT FACILITIES

The proposed Project does not include any treatment facilities or revisions to the current water treatment plant.

6.0 EXISTING SANITARY SEWER SYSTEM

An initial review of existing information and site reconnaissance was performed to determine the location and capacity of existing sanitary sewer infrastructure for each area of the Project. Yellowstone National Park owns and maintains the sanitary sewer collection infrastructure serving the project areas. The proposed sewer collection modifications will also be maintained and owned by Yellowstone National Park. The existing sanitary sewer main to be replaced on this project includes the 8-inch main that runs along Powerhouse Rd to Highland Terrace Ave. The

existing temporary Mammoth wastewater treatment plant was designed to treat 1.2 MGD and has adequate capacity with the average inflows in 2025 being less than 0.1 MGD (See Mammoth Temporary Wastewater Treatment Plant Basis of Design Report).

6.1 EXISTING SEWER MAIN SLOPE

Invert elevations measured at manhole locations, were used to establish the existing sewer main slopes and identify system components for design purposes within the Project area. Invert elevation measurements indicate that the existing 8-inch sewer main has a slope of 0.0193 ft/ft.

7.0 PROPOSED SANITARY SYSTEM IMPROVEMENTS

7.1 SANITARY SEWER MAIN DESIGN

The Project will consist of replacing the sanitary sewer main and manholes as shown in Appendix A – Permit Drawings. The proposed 8-inch replacement sewer consists of approximately 400 feet of PVC and two new 48-inch manholes along Powerhouse Rd. The proposed 8-inch sewer main on Main St. will be constructed at a different slope as the existing sewer main to tie in at a different location within the system. The proposed slopes of the new sewer main ranges from 2.0 and 3.5 feet per 100 foot.

The capacity of the 8-inch main has been evaluated, and adequate capacity exists to allow for these new connections (See Appendix E – Sewer Main Capacity Calculations for the design calculations.).

The existing 8-inch VC pipe will be replaced with bell and spigot, 8-inch SDR 26 PVC pipe. The thicker SDR 26 pipe is preferred by the NPS and exceeds the minimum DEQ pipe material requirements. The existing sewer main will be abandoned during construction of the replacement sewer main and the sewer entering the next downstream manhole at on the project site will be plugged and abandoned.

Design calculations comparing the capacities of the existing sewer main and proposed sewer main are summarized in **Table 3** and provided in Appendix E – Sewer Main Capacity Calculations.

Table 3: Proposed Sewer Main Capacities

Sewer Main	Material Type	Size (in)	Slope (ft/ft)	Full Flow Capacity (gpm)	Full Flow Velocity (ft/sec)
Proposed Sewer Main	PVC	8	0.0200	589	3.755
Proposed Sewer Main	PVC	8	0.0346	775	4.939

A summary of the Chapter 11 requirements and DEQ policies and the design parameters are provided in **Table 4**.

Table 4: Sewer Line Chapter 11 Requirements and Design Parameters

Chapter 11 Section	Requirement	Design Parameter
9.a	Separate sewers. Separate sewers shall be provided for collection of stormwater and wastewater. Roof, areaway, drive or foundation drains shall not be connected to sanitary sewers.	Refer to the Permit Drawings. No storm collection systems are connected to the sanitary sewer system.
9.b.i	Wastewater characteristics. Pipe materials shall resist acid and alkaline solutions, organic solvents, and other wastewater constituents and environmental conditions encountered.	All sewer pipe will be manufactured of PVC plastic.
9.b.ii	Pipe loadings. Pipe materials shall be chosen and the pipeline shall be designed to withstand all trench and superimposed surface live loads with a minimum factor of safety. Rigid pipes shall have a minimum factor of safety of 1.5, and flexible pipes shall have a minimum factor of safety of 1.25.	Refer to the Permit Drawings for a typical sanitary sewer trench detail.
9.b.iii	Soil characteristics. Pipe materials shall be chosen to resist corrosion due to aggressive soil characteristics by the soil it contacts. Iron or steel pipe shall be protected from corrosion with polyethylene encasement or cathodic protection.	All sewer pipe will be manufactured of PVC plastic.
9.b.iv	Joints. Pipe joints shall be flexible, durable and designed to minimize infiltration/exfiltration and exclude roots.	All sewer pipe will be bell and spigot type with rubber gasket type joints.
9.b.v	Performance tests. Piping shall be subjected to leakage tests. Leakage tests shall be infiltration, exfiltration, or air tests.	All constructed sewer pipe will be subjected to an exfiltration test.
9.b.v.D	Deflection. Maximum five percent deflection after flexible pipe is backfilled for 30 days. A mandrel of 95 percent of pipe diameter shall be used. No mechanical pulling of mandrel is permitted.	Sewer line will be installed using a laser to ensure grade and a mandrel test will be conducted on the constructed sewer main.
9.b.vi	Approved pipe material specifications. Type of commercial pipe approved for gravity sanitary systems include: (B) PVC sewer pipe and fittings: ASTM D3034-80, SDR35, ASTM F679-81, or ASTM F794-83.	All sewer pipe will be SDR 26 PVC manufactured in accordance with ASTM D3034.
9.c.i.A	Depth. Sewers shall be located to protect them from freezing and frost heave as prudently possible.	The proposed sanitary sewer lines will have depths of cover over 6 feet in all locations.
9.c.i.B	Size. Sewers to be aligned straight shall be 8-inch diameter or larger except 6-inch sewers may be used in cul-de-sacs, or other dead end locations where the sewer cannot be extended in the future. Eighteen-inch or larger sewers may be laid on curves. Lines shall be sized for 200 percent of maximum daily flow or more. In the absence of data deriving maximum daily flow, the chart on Figure 1-1 shall be used to determine maximum daily flow.	The proposed sewer mains are 8-inch. Refer to Section 7.1 of this report for an explanation of sewer main capacity.

Chapter 11 Section	Requirement	Design Parameter
9.c.i.C	Slope. Sewers shall be laid with uniform slope between manholes. Minimum slopes shall be: 0.40' per 100' for 8" pipe	The proposed 8-inch sewer main has slopes of 2.00 feet to 3.46 feet per 100 foot. An explanation of this slope is contained in Section 7.1.
9.c.i.D	Velocity. Minimum velocities shall be 2 fps when flowing full. Velocities greater than 10 fps require special design considerations.	The proposed 8-inch sewer main has a velocity of 3.8 fps when flowing full. Refer to Section 7.1 of this report for an explanation of sewer main velocities.
9.c.i.E	Increasing size. All sewer pipe size changes shall be at manholes. Pipe size shall not be decreased in the direction of flow. The energy gradient line should be maintained when a smaller sewer joins a larger one.	Refer to the Permit Drawings. Proposed sewer does not change size between manholes.
9.c.i.F.I	Excavation. Trench width from the trench bottom to a point one foot above the top of the pipe shall be no less than the outside diameter of the pipe plus 8 inches but not more than 24 inches plus the pipe O.D. The trench bottom shall be excavated for the pipe bell. All rock shall be removed within six inches of pipe. The trench shall be dewatered for all work.	Refer to the Permit Drawings. The trench width will be the pipe O.D. plus 24 inches.
9.c.i.F.II	Bedding. Bedding shall be designed in accordance with: Flexible pipe. Types I, II, III, ASTM D2321-74.	Bedding used will meet Type I or II in accordance with ASTM D2321.
9.c.i.F.III	Backfill. Backfill shall be performed without disturbing pipe alignment. Backfill shall not contain debris, frozen material, unstable material, or large clods. Stones greater than three inches in diameter shall not be placed within two feet of pipe. Compaction shall be to a density equal to or greater than the surrounding soil.	Backfill will be performed to meet Wyoming Public Work Sections 02225.
9.c.ii.A	Depth. Force mains shall be located to protect them from freezing and frost heave.	The pressurized sewer service will be a minimum of 6 feet in depth.
9.c.ii.B	Pressure sewer collection system piping shall be one (1) inch (2.5 cm) minimum.	The pressurized sewer service will be 2-inch PVC
9.c.ii.C	Velocity. Minimum velocity shall be 2.5 fps (0.76 mps).	Velocity is 2.84 fps
9.c.ii.D	Air release. Air release facilities shall be provided at the high point in the piping whenever the pipe crown elevation falls below the pipe invert elevation. Access to air release manholes shall not be in traffic-ways.	No air release facilities will be necessary.
9.c.ii.E	Cleanouts. Cleanouts shall be provided at 400-foot (122 m) maximum spacing in pressure piping four-inch diameter or less.	The pressurized service line is less than 400 feet.
9.c.ii.F	Pressure sewer systems. Pressure sewer collection systems shall be preceded by grinder pumps or septic tanks.	The grinder pump will be Zoeller 922 Simplex 48”x120“ Grinder Package with M803 Pump or approved equal.
9.c.ii.G	Pressure sewer collection system pumps. Pumps shall be provided with isolation and check valves. If a septic tank is not provided before the pump, a grinder pump shall be	The grinder pump will be Zoeller 922 Simplex 48″ x 120″ Grinder Package with M803 or approved equal. The sump is ~200 gallons.

Chapter 11 Section	Requirement	Design Parameter
	required. Pump holding sumps shall not be steel, iron, or coated metal. The sump chamber shall be fifty (50) gallon (189 liters) volume, minimum.	
9.c.iii.A	Size: minimum size shall be four (4) inches (10.2 cm).	Services will be 4 inches.
9.c.iii.B	Slope: minimum slope shall be 2 feet/100 feet (2 m/100 m).	The minimum slope for services will be 2 feet per 100 foot.
9.c.iii.C	Flow: flow shall be determined from a fixture unit count and the sewage size based on flowing full.	Flow is based on sewer size flowing full.
9.c.iii.D	Connections: all service connections to sewage collection lines shall be made with a wye or tee for new construction and a tapping saddle for connection to existing collection lines.	Service connections will be made with a wye.
9.d.i	Location. Manholes shall be located at all changes in pipe size, vertical or horizontal alignment, pipe intersections, and the end of lines. Maximum spacing for various line sizes are as follows: maximum M.H. spacing of 400 ft for line size 15 in or less	Spacing of the proposed manholes are less the maximum spacing requirement.
9.d.ii	Size. Minimum manhole interior size is four feet.	All proposed manholes are 4 feet in diameter.
9.d.iii	Drop manhole. Drop manholes must be constructed where the change in elevation between two lines is greater than 24 inches. Concrete encasement shall be provided around the drop pipe.	The Project does not contain drop manholes.
9.d.iv	Invert. Manhole inverts shall be constructed to conform to the shape of the sewer. The bench shall drain to the invert. Connections to the manhole shall be watertight and allow differential settlement between the manhole and pipe. Minimum fillet height shall be one half of the pipe diameter.	Refer to the Permit Drawings. The manhole inverts will be grouted to allow smooth flow through the manhole and benches will drain to the invert. The flow-through channel will be 1/2 the pipe diameter and the manhole will have a watertight connection.
9.d.v	Cover. The manhole cover shall be suitable to withstand all loads, including impact loading without deformation, slip or rattle. The manhole cover shall be watertight in areas subject to flooding and a bolt-down type in areas subject to unauthorized dumping or vandals.	Manhole covers will be rated for HS-20 loading. The manholes are not located within a floodplain and therefore are not prone to flooding.
9.d.vi	Steps. Access to manholes shall be with portable ladders, or with cast iron manhole steps spaced at 16 inches maximum.	Access to the proposed manholes will be by cast steps at appropriate spacing.
9.d.vii	Materials. Manholes shall be constructed watertight and durable using cast-in-place concrete, or precast concrete with gasketed joints. Where precast concrete bases are used, the first 12 inches of wall will be monolithically cast with the base.	The manhole will be precast reinforced concrete with a monolithic base.

Chapter 11 Section	Requirement	Design Parameter
9.d.viii	Access. A 22 inch minimum diameter clear opening shall be provided on all manholes. All manholes shall be located to be accessible by motorized equipment for maintenance.	The covers will be 24-inch covers with 22-inch openings.
9.e	Special structures.	No special structures are proposed on this Project.
9.f.i	Cross connections. There shall be no cross connections between sewer lines and potable water lines.	No cross connections between sewer lines and water lines will occur.
9.f.ii	Horizontal and vertical separation from water mains. Minimum horizontal separation shall be ten feet where the water main is less than 1.5 feet above the elevation of the sewer. Minimum vertical separation shall be 1.5 feet at crossing. Joints in sewers at crossing shall be located at least ten feet from water mains. The upper line of a crossing shall be specially supported. Where vertical and/or horizontal clearances cannot be maintained, the sewer shall be placed in a separate conduit pipe.	Separation from water mains will be maintained.

7.2 SANITARY SEWER SERVICES

All sanitary sewer service connections to the sewer main will be placed with new PVC SDR 26 pipe. The sizes of the sanitary sewer services will be 4” with a minimum slope of 2%. Each unit will require a service of approximately 35 feet in length. The following estimated maximum sanitary sewer generation was used to analyze the sewer system modifications for each of the new services (serving 4 units total) on the site:

• Maximum daily generation: 1,560 gallons per day for the site

• Peak hour generation: 4.3 gallons per minute for the site using a peak factor of 4

There will be a pressurized sewer service for one of the houses. The sump will be located in the garage. Zoeller 922 Simplex 48”x120” Grinder Package with M803 system or engineer approved equal will be specified (Appendix E – Pump Curve Calculations). The service line will run to a proposed manhole approximately 82 feet away. Inside the manhole, the service line will transition to a gravity service that connects to the existing 8-inch gravity main that is an additional 13 feet further away. Cleanouts for both the force and gravity service portions will be accessible inside of the manhole. This force service line portion will be 2-inch SDR26 PVC and the gravity service line portion will be 4-inch SDR26 PVC. Both portions will be buried a minimum of 6 feet below final grade.

7.3 SANITARY SEWER MANHOLES

Manholes for the Project will be 4-foot diameter precast reinforced concrete flattop manholes with barrel sections. A flexible watertight gasket will be used to connect the sewer pipe to the manhole. The exterior of each manhole will be coated with two coats of approved asphalt sealant. Details of a typical manhole installation are provided in Appendix A – Permit Drawings.

APPENDIX/DIVIDER TITLE

APPENDIX A - PERMIT DRAWINGS

APPENDIX B - SPECIFICATIONS

SECTION 33 30 00 - SANITARY SEWERAGE

PART 1 GENERAL

1.1 WORK SUMMARY

A. This section covers the requirements to perform work including but not limited to furnishing and installing gravity and force sewer system piping, sanitary sewer manholes, and all associated connections and appurtenances as shown on the Drawings, and as otherwise directed by NPS.

B. Provide all labor, materials, tools, equipment, services, and incidentals as necessary to perform the work as described in this section and in accordance with the Contract Documents and Drawings and to the satisfaction of NPS.

C. All sewage system materials and construction work shall conform to local, state and federal health standards for sewage disposal systems.

1.2 RELATED WORK

A. Attention is directed to the General Requirements and related work specified in other sections includes, but is not limited to:

1. Section 03 30 50 - Minor Concrete
2. Section 31 23 00 - Excavation and Fill
3. Section 31 50 00 - Excavation Support and Protection
4. Section 32 16 00 - Concrete Curbs, Sidewalks, Aprons, and Pads

1.3 DEFINITIONS

A. Not used.

1.4 SUBMITTALS

A. Submittals shall be in conformance with Contracting Requirements, Specifications, and Division 1 - General Requirements.

B. Submit supporting documentation, certificates of compliance, shop drawings, and supplier or manufacturer information at least fourteen days (14) prior to ordering materials or placement in the work for each proposed material and product, for review and acceptance of NPS for conformance to the material specifications.

1. For precast structures, submit design drawings, details, and supporting calculations for review and approval prior to casting. Design drawings, shop drawings and calculations

must be sealed and signed by an engineer who is registered as a civil engineer in the State of Wyoming.

2. Contractor must account for lead times on manufacture and delivery and allow for review of submittals by NPS. Design drawings, shop drawings and calculations shall include the following:
   a. Design parameters, loadings, earth cover, buoyancy, and design standards (i.e. ASTM, AASHTO, ACI) used for anticipated field conditions
   b. Dimensions, location of openings, and invert elevations
   c. Reinforcement, splice type and location, joint details, and gaskets
   d. Frames, covers, risers, fittings, seals, hardware and other accessories

C. Submittals include but are not limited to construction methods, manufacturer's descriptive literature, performance and test data, and manufacturer's data for sizes, pressure rating, rated capacity, listing/approval stamps, labels and other marking on equipment made to the specified standards for materials and settings of selected models for the following:

1. Pipe and fittings
2. Cleanouts, caps, covers, and utility boxes
3. Gaskets, couplings, sleeves, and assembly hardware
4. Dye for sanitary sewer tracing
5. Force sanitary main components
6. Grinder pump

D. Provide the following test reports where applicable.

1. Leakage Testing (*structures/vaults*): Provide copy of standard test procedures; and certified test results to NPS for compliance. For failing tests, provide proposed corrective actions to NPS for review/approval.
2. Low-air Pressure Testing (*sewer pipelines, exceeding 50-ft*): Provide copy of standard test procedures; and certified test results to NPS for compliance. For failing tests, provide proposed corrective actions to NPS for review/approval.

1.5 REFERENCES

A. The Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects (FP-24), dated 2024; and published revisions thereto. https://flh.fhwa.dot.gov/resources/specs/

1. Payment descriptions in the FP-24 Standard Specifications shall not apply. Refer to Section 01 27 00 – Definition of Contract Line Items
2. In case of conflict with the FP-24 Standard Specifications, the most stringent specification shall apply.

B. Wyoming Public Works Standard Specifications (WPWSS), 2023 Edition.

C. Applicable ASTM, AASHTO, American Concrete Institute (ACI), American National Standards Institute (ANSI), and Underwriters Laboratory (UL) standards.

D. Uniform Plumbing Code, 2024 Edition (International Association of Plumbing and Mechanical Officials, IAPMO/ANSI UPC1-2024).

E. A reference within parentheses to a law or regulation is included in the Contract for convenience only and is not a comprehensive listing of related laws and regulations. Lack of a reference does not indicate no related laws or regulations exist.

F. Where the version of a referenced document is not specified, use the most recent version in effect on the date of the Notice to Bidders.

G. A code not specified as a federal code is a Wyoming code.

H. An agency or a department not specified as a federal or local agency or department is a Wyoming agency or department.

1.6 QUALITY ASSURANCE

A. Conform to the Contract Documents including but not limited to Permits, Technical Conditions, Drawings, and Standard Specifications.

B. The Contractor shall furnish manufacturer's certificates of compliance. A certificate of "Compliance with Specification" or suitable alternative shall be furnished for all materials to be supplied.

C. All 'Quality Control' materials testing shall be based upon applicable ASTM and/or Plumbing Code test methods referenced herein for the materials specified, including manufacture recommendations for testing procedures. All equipment, material, and labor necessary for Quality Control testing shall be supplied by and all costs borne by the Contractor.

1. Provide copies of all applicable testing procedures and standards (per ASTM, Plumbing Code, and manufacture recommendations).
2. Provide certifications for calibration of all testing equipment.
3. A report of the test results shall be furnished.
4. All defects, which become present from testing shall be rectified, and the system shall be retested, until passed.
5. All tests shall be performed in the presence of the Contracting Officer.

D. For precast concrete structures, units may be rejected at the site upon visual inspection and where exhibiting any of the following:

1. Cracks passing through walls more than 1/16 inch wide
2. Nonrepairable honeycombed or spalled areas of more than 6 square inches
3. Noncompliance with reinforcement tolerances or cross sectional area shown
4. Wall, floor or lid less than minimum thickness
5. Internal dimensions less than plan dimensions by 1 percent or 1/2 inch, whichever is greater
6. Defects affecting performance or structural integrity

1.7 PROJECT CONDITIONS AND REQUIREMENTS

A. In confined linear areas where protection of existing infrastructure, vegetation, and/or soils is specified only equipment that can be safely operated in the confined construction corridor will be permitted.

B. Work performed under this Section shall meet the requirements of the Uniform Plumbing Code, 2024 Edition.

C. Deliver materials to site in unopened cartons or bundles as appropriate, clearly identified with manufacturer's name, standards label, grade or identifying number.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect equipment and material from dirt, water, construction debris, and traffic.

1.8 TOLERANCES

A. Horizontal locations, grades and elevations for sanitary sewer system facilities are to be established from referenced benchmarks, as shown on the Drawings, and as otherwise directed by NPS.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials shall conform to sizes, capacities, qualities and quantities as shown on the Drawings or described in the specifications.

B. All pipe and fittings of a similar material type shall be from a single manufacturer, who is fully experienced, reputable and qualified to provide continuous quality control through plant inspection and certification of materials.

1. The pipe manufacturer must certify compliance with the specified materials and standards.

C. Materials shall be from new stock, delivered in good condition, and no used or damaged stock is allowed.

D. Where no material certification or method of test materials is specified, the latest certification or test specified by ASTM or applicable Code shall be enforced.

2.2 PIPE AND FITTINGS

A. All new force sewer lines should be SDR 26 PVC of the size shown on the Drawings.

B. Gravity sewer pipe/conduit shall be of the size shown on the Drawings. The pipe shall be PVC, have a minimum pipe wall thickness equivalent to SDR 26, and conform to the requirements of ASTM D3034. Joints with bell and spigot ends, and reinforced gasket joints. The rubber gasket shall be of composition rubber suitable for sewer service.

C. All fittings and accessories shall be from the same manufacturer of the pipe and have bell and/or spigot configurations compatible with that of the pipe.

D. Connections shall consist of PVC fittings, gaskets, couplings, adapters and other accessories for a watertight connection. Connections to structures shall consist of couplings precast into structure wall, or mechanical fittings for a watertight connection.

2.3 BEDDING, FOUNDATION AND BACKFILL

A. Sanitary sewer (solid) pipe 'bedding material' shall be as shown on the Drawings, and conforming to Section 704.01 of FP-24 Standard Specifications and Section 31 23 00 - Excavation and Fill.

B. Sanitary sewer structure foundation material shall be a coarse aggregate granular backfill as shown on the Drawings, and conforming to AASHTO M43, and Section 703, Aggregate of the FP-24 Standard Specifications.

C. Sanitary sewer structure and plastic pipe 'backfill material(s)' shall be as shown on the Drawings, and conforming to Section 704.01 of FP-24 Standard Specifications and Section 31 23 00 - Excavation and Fill.

2.4 CLEANOUTS

A. Cleanouts shall be installed at the locations shown on the Drawings or marked in the field by the Contracting Officer. Cleanouts shall be of the same size and material as the sewer line it serves.

2.5 UTILITY BOXES

A. Contractor shall verify utility box sizes required for sewer system facilities as shown on the Drawings, and actual sizes and dimensions of materials placed in the work.

B. Provide precast concrete boxes with steel or cast iron covers marked "SEWER" and traffic rated for H20 loading. Provide risers and extensions as required.

C. Concrete collars around utility boxes shall conform to Section 03 30 50 - Minor Concrete.

2.6 MARKING TAPE AND TRACING WIRE

A. Marking tape shall be minimum 3 inches wide, colored in APWA approved green color, and imprinted with "Caution Buried Sewer Line Below" in black uniformly located along its entire length. Tape shall be minimum 5-mil tape with aluminum backing for locate using a non-ferrous locator. Where more than one utility is located in a common trench, marking tape shall be 6 inches wide with the imprint "Caution – Buried Utility Lines Below".

B. Locating wire shall be minimum No. 14 gauge solid, coated, soft drawn copper wire (#14-AWG). Locating wire shall be strapped to any run of sewer pipeline (over 5-ft in length) to facilitate pipe location, stubbed inside valve/utility boxes, and marked with an irremovable aluminum tag with the corresponding utility. Connection of any bare wire ends shall be approved splice kit for underground use to secure electrical joint.

2.7 GRINDER PUMP

A. The grinder pump shall be installed as shown on the Drawings. The pump shall be provided with isolation and check valves. The sump shall be over 50 gallons.

B. The pump shall be a Zoeller 922 Simplex 48″ x 120″ Grinder Package with M803 pump or approved equal in terms of size, performance and functionality.

C. The operating point for the pump is 27.8 gpm @ 13.7 ft of total dynamic head.

D. The control panel for the pump shall include hand / off / auto switches, an elapsed time meter, and a pump cycle counter.

E. As shown on the Drawings, the wet well shall include a bolted solid fiberglass cover.

2.8 SEWER SYSTEM PRECAST MANHOLES

A. Manholes for sewer systems shall be precast concrete, conforming to the applicable requirements of ASTM C478 (manhole sections).

B. Structural design loads for precast concrete structures shall meet anticipated field conditions (as shown on Drawings), and conform to minimum design loading under ASTM C890 and ACI 318 and 350 codes, whichever is more stringent.

C. All underground sewer structures, and inlet/outlets and access openings shall be constructed to withstand corrosion and/or decay and shall be watertight. All joint seals, gaskets, connectors and fittings shall be watertight conforming to applicable ASTM and AASHTO standards for anticipated hydrostatic pressures and field conditions.

D. Manholes shall be of the general size and dimensions as shown on the Drawings, including:

1. Manholes shall be designed to withstand AASHTO HS20 (MS10) loading.
2. Manholes shall be constructed of precast concrete rings with frames and covers and steps in accordance with AASHTO M199 and as shown in the Drawings.
3. Adjusting rings may be used for adjusting the manhole top elevation to coincide with existing ground elevations, except the total height of adjusting rings used per manhole shall not exceed 12 inches. Adjusting rings shall be reinforced with the same percentage of steel as the riser and top.
4. Precast concrete rings shall conform to ASTM C478.
5. When required, noncorrosive steps of rubber encased steel, aluminum, or nylon shall be used. Steps shall withstand vertical loads of 400 pounds and pull out resistance of 1,000 pounds.

PART 3 EXECUTION

3.1 GENERAL

A. Conform to Section 612, Sanitary Sewer Systems or the FP-24 Standard Specifications and WPWSS 2023. In case of conflict, the most stringent specification shall apply.

B. Applicable construction operations for excavation, bedding and backfill shall conform to Section 31 23 00 - Excavation and Fill.

C. Conform to state and federal guidance criteria for the separation of potable water and sanitary sewer pipelines/facilities. Refer to Drawings and provide additional materials for proper construction as required.

D. Care shall be taken in loading, transporting and unloading to prevent damage to materials. Store and protect materials according to manufacture recommendations.

E. All structures, pipe, fittings, accessories and materials shall be examined before installation, and no piece or facility shall be installed which is found to be defective. If any defective materials is discovered after it has been installed, it shall be removed and replaced in a satisfactory manner as directed by NPS.

F. Provide temporary blockage, plugs, caps and diversions in existing facilities, and dewatering of excavations as necessary to complete the work.

G. Install all pipe, structures and facilities at minimum or maximum depths as specified on the Drawings.

H. Excavation width shall be as shown on the Drawings but should be no wider than what is required to safely install proposed improvements.

I. Excavations shall meet all applicable safety provisions as described in Section 31 50 00 - Excavation Support and Protection.

J. Open excavations shall not be permitted during non-working hours. Cover pipe and facility openings and backfill all excavations, and/or cover with temporary trench plate protection at the end of each working day, for protection and public safety.

K. Clean the interior of pipe and structures as work progresses. All finished sanitary sewer system piping, structures and facilities shall be flushed, clean and free of any debris and sediment before final acceptance.

3.2 SANITARY SEWER TRACING

A. Prior to commencing with construction, the Contractor shall dye test the existing 4-plex in the Northeast Entrance project area to determine the location and connectivity of the existing sanitary service(s). Available survey records show multiple cleanouts on the exterior of the building. The Contractor shall provide the Contracting Officer with the test results immediately. If it is determined that the existing sanitary service(s) for the 4-plex will be impacted by the proposed sanitary main, and the Contracting Officer approves the work, the existing sanitary service(s) shall be connected to the proposed sanitary main. Continuous operation of the 4-plex’s existing sanitary service(s) shall be maintained throughout construction activities.

B. Dye for sanitary sewer tracing shall be non-toxic, biodegradable and environmentally safe fluorescent dye certified for use in sanitary sewer systems. Dilution limits shall follow the dye manufacturer's recommendations.

C. All materials and labor associated with the sanitary sewer tracing test and connection of existing services to the proposed sanitary main, if completed, are considered incidental to the work and no additional payment shall be made.

3.3 SEWER SYSTEM PIPING

A. Install all pipe, fittings and cleanouts to the lines and grades as shown on the Drawings, in accordance with the pipe manufacturer’s specifications, ASTM D2321, and as otherwise directed by NPS.

B. In-situ trench foundation shall be undisturbed earth no less than 90% relative compaction; any materials placed to stabilize trench bottom foundation shall be no less than 95% relative compaction.

C. No pipe shall be laid until the trench, foundation, sub-grade preparation and bedding have been inspected and approved by the Contracting Officer.

D. All piping, fittings, and accessories shall be assembled per the manufacturer's recommendations. Lay pipe from the lower end with spigot ends pointing in the direction of flow.

E. Do not damage pipe sections, fittings, joints or gaskets during assembly. Use pipe lubricant, installation stub, etc. and follow manufacture recommendations to ensure all pipe sections are pushed "home." A come-along or other suitable method should be used; construction equipment such as an excavator bucket, etc. must not have direct contact with the plastic pipe end sections unless an installation stub and large timber or other suitable cushioning medium is utilized.

F. Only upon authorization of NPS may changes in direction, without the use of elbows or other fittings, be accomplished through joint deflection or longitudinal bending, but not both on the same length of pipe. Allowable joint deflection or longitudinal bending is dependent on pipe size and/or joint design, and shall not exceed the pipe manufacturer's published limits. Deflection testing will be required. The Contractor shall complete this work in accordance with ASTM D3034 and Section 2700 of the WYPWSS.

G. Install sewer cleanouts at locations as shown on the Drawings, and within 5-feet of a building footprint or facility connection pad on sewer export/discharge lines. Cleanouts require a utility box enclosure as specified, except where installed within footprint of the concrete apron of a utility host site connection pad.

H. Install tracing wire and marking tape as shown on the Drawings, per manufacture recommendations.

I. Do not drive or operate equipment directly over sewer system piping during backfilling, or until minimum cover is achieved per the manufacture installation requirements.

J. Contractor is responsible to protect sewer system piping from damage during the course of the project work.

K. Restore and stabilize barren soils and disturbed areas according to Section 32 90 00 - Restoration.

3.4 SEWER SYSTEM PRECAST STRUCTURES

A. Install all structures at the locations and to the lines and grades as shown on the Drawings, in accordance with the manufacturer's specifications, and as otherwise directed by the Contracting Officer.

B. Field repair precast concrete structures to correct damage from handling or manufacturing imperfections before installation, where authorized by the Contracting Officer.

C. Applicable construction operations for excavation, foundation, bedding and backfill shall conform to Section 31 23 00 - Excavation and Fill.

D. Precast concrete structures shall be constructed and/or assembled and placed in excavations on properly compacted foundations as shown on the Drawings and details. Structures shall be set to grade and oriented for connections, and to provide the required dimensions and clearances from other facilities.

E. In-situ excavation foundation shall be undisturbed earth no less than 90% relative compaction; any materials placed to stabilize excavation bottom foundation shall be no less than 95% relative compaction.

F. No structure shall be installed until the excavation, foundation, sub-grade preparation and any bedding have been inspected and approved by the Contracting Officer.

G. Pipe connections and access openings for precast structures shall be watertight and constructed to the tank manufacturer's recommendations. Center pipes in openings and seal with resilient connectors or mechanical seals. Fittings, couplings, adapters, gaskets, seals, band clamps, grout, concrete collars and other miscellaneous materials as required for completion of the work is included in payment for the structure bid item of work involved.

H. Match fit any keyed joints to ensure uniform alignment of walls and lids. Clean keyed joint surfaces and seal for a watertight structure per manufacturer requirements. Joint surfaces must be free of imperfections that may affect the joint integrity.

I. Construct manhole access openings to grade using risers, extensions or grade rings, and install frame and cover as shown on the Drawings, and conforming to manufacturer requirements. All extensions and access openings shall be watertight and sealed.

J. Prior to backfilling of precast structures, all lifting holes, cracks, and other remnant voids shall be filled with non-shrink grout and polyurethane sealant to provide for a watertight structure.

K. Do not drive or operate equipment directly over sewer system structures during backfilling, or until minimum cover is achieved per the manufacture installation requirements.

L. Contractor is responsible to protect sewer system structures from damage during the course of the project work.

M. Restore and stabilize barren soils and disturbed areas according to Section 32 90 00 - Restoration.

3.5 TESTING

A. Sewer system structures and tanks shall be inspected and tested for leakage prior to final backfill, and being finished and accepted. Hydraulic or vacuum testing is permitted. Leakage testing shall conform to manufacturer recommendations and Section 02700 of the WPWSS.

B. The Contractor shall perform a light test between manholes to check alignment and grade for displacement of pipe in accordance with Section 02700 of the WPWSS.

C. New sewer line will not be accepted until deflection and leakage tests have assured the Contracting Officer that pipe laying and joint are satisfactory. Deflection testing shall be performed in accordance with Section 02700 of the WPWSS and shall consist of pulling a mandrel through the pipe. Maximum deflection shall not exceed 5 percent of the pipe's internal diameter for final inspection.

D. Water Test

1. Where groundwater is a minimum of 2 feet above the sewer line, tests shall be made by sealing off the section of lines between manholes and measuring the infiltration by collecting or pumping the discharge into barrels or other approved methods. Tests shall be continued over a period of at least 4 hours for each section tested. Sufficient time shall be allowed to soak lines and manholes in advance of performing tests.
2. When groundwater is not above the pipe, testing shall be as follows:
    a. On flat slopes where the depth over the centerline of the pipe in the lower manhole of the section being tested will be not more than 10 feet, the upper manhole shall be filled to a depth of 2 feet over the top of the pipe and the lower manhole blocked. When the above conditions cannot be met, the Contracting Officer may order the Contractor to test the line in sections between manholes. The leakage shall be measured by checking the drop in water level in the manhole over a period of 4 hours.
    b. The maximum allowable infiltration or exfiltration, including manholes, shall not exceed 200 gallons per day per mile of sewer, per inch of pipe diameter. This does not preclude the fact that obvious and concentrated leaks, such as open joints, pinched gaskets, cracked barrels or bells, etc will not be allowed. The Contractor shall make repairs on concentrated leaks, and as necessary to reduce infiltration or exfiltration below the specified rate, and at their own expense.
    c. Manhole joints shall be checked by leakage by means of water testing as specified above.

E. Air Test (Alternate)

1. As an alternate to water testing, Contractor may utilize low pressure air as a means of testing the sewer mains. Sewer system pipelines (solid/tight lines) in excess of 50-feet shall be tested for leakage using low-pressure air testing (dry conditions), conforming to ASTM F1417, manufacturer recommendations, industry standards and Section 02700 of the WPWSS.

F. All testing shall be completed in the presence of the Contracting Officer. Provide all test results to NPS.

G. Existing manholes to which new connections are made shall be subject to the same testing requirements as new manholes.

H. Disposal of testing waters is the responsibility of the Contractor and shall be carried out in strict observance of the water pollution control requirements, permits and specifications.

3.6 DEMONSTRATION AND TRAINING

A. The Contractor shall provide demonstration and training on the operation and maintenance of the grinder pump to the NPS. The training shall be completed by a factory-authorized service representative.

B. The Contractor shall provide demonstration and training, as requested by the Contracting Officer, on the operation and maintenance of valve or manhole components. All training shall be completed by a factory-authorized service representative.

END OF SECTION 33 30 00

APPENDIX C - POTABLE WATER HYDRAULIC ANALYSIS

PROPOSED WATER DEMAND CALCULATIONS

AVERAGE DAY DEMAND [1]	125	gpd
MAXIMUM DAY DEMAND [1]	340	gpd
PEAK HOUR FACTOR [3]	4	PHF

MAMMOTH HOT SPRINGS GOVERNMENT AREA: PROPOSED WATER DEMAND						
	OCCUPANCY PER UNIT [5]	NUMBER OF UNITS [5]	TOTAL OCCUPANCY [4]	AVERAGE TOTAL, GPD	MAXIMUM TOTAL, GPD	PEAK HOUR, GPM
3- BEDROOM UNIT	3	4	12	1,500	4,080	11.3
TOTAL WATER DEMAND				1,500	4,080	11.3
FIRE FLOW	B105.1 ONE-AND-TWO FAMILY DWELLINGS. THE MINIMUM FIREFLOW AND FLOW DURATION REQUIREMENTS FOR ONE AND TWO FAMILY DWELLINGS HAVING A FIRE FLOW CALCULATION AREA THAT DOES NOT EXCEED 3,600 SQUARE FEET (344.5 M2) SHALL BE 1,000 GALLONS PER MINUTE (3785.4 L/MIN) FOR 1 HOUR					

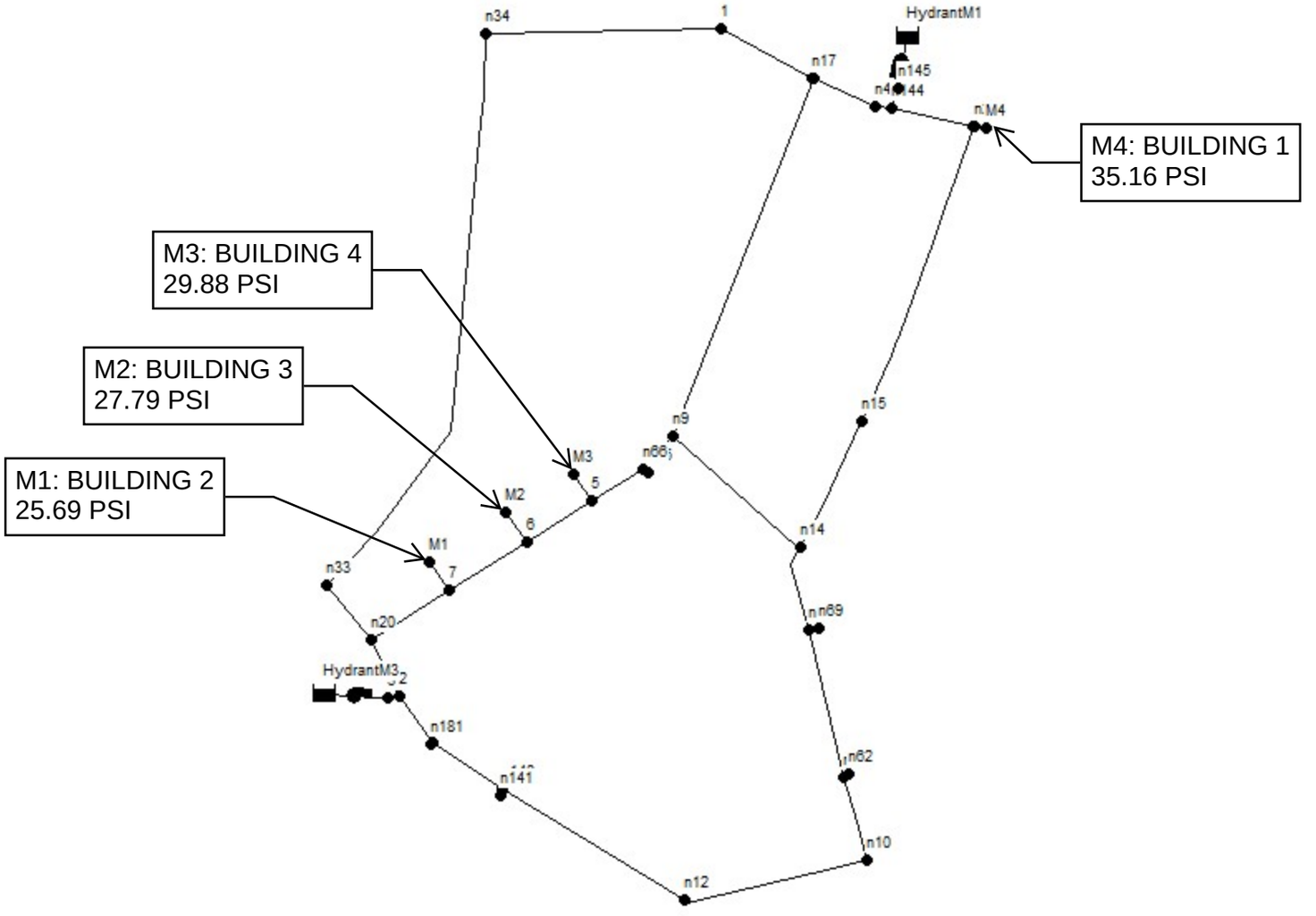
[1] water demand based on daily rates from the WYDEQ CH 12, Section 8

[2] sewer demand based on daily flow rates from the WYDEQ CH 25, Section 5, Table 1

[3] peak hour factor based on busiest hour occuring during the busiest quarter of the day

[4] IFC - appendix b, Table B105.1, one-and two family dwellings period each night

[5] occupancy/bedroom count based on current developmental program


n34
1
HydrantM1
n17
n145
n144
n4
n M4
M4: BUILDING 1
35.16 PSI
M3: BUILDING 4
29.88 PSI
M2: BUILDING 3
27.79 PSI
M1: BUILDING 2
25.69 PSI
n9
n15
M3
n66
5
M2
6
M1
7
n33
n14
n20
n n89
HydrantM3
2
n181
n62
n141
n10
n12

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*                            E P A N E T                            *
*                     Hydraulic and Water Quality                   *
*                     Analysis for Pipe Networks                    *
*                           Version 2.2                             *
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Input File: mammoth_water.net

prueba

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
p6	n1	n10	147	6
p8	n12	n10	311.1	4
p9	n9	n14	281.9	6
p10	n14	n15	220.7	12
p11	n4	n16	110.6	6
p12	n16	n17	3.985	6
p15	n14	n21	147.2	6
p21	n15	n27	540.9	6
p26	n66	n9	72.49	6
p27	n33	n34	999	4
p28	n33	n20	118.8	6
p49	n1	n62	7.627	1
p51	n65	n66	6.995	1
p53	n21	n69	18.31	1
p96	n140	n141	12.12	1
p98	n144	n145	34	6
p118	n180	n181	4.012	1
2	n34	1	400	8
5	n9	n16	650	6
6	n4	n144	1000	6
7	n144	n3	600	6
8	n12	n140	300	4
9	n140	n180	200	4
10	n180	2	100	4
11	2	n20	100	4
12	2	3	10	4
14	1	n17	200	8
15	n1	n21	200	6
16	n3	n27	10	6
17	H4	n3	200	2
18	n66	5	200	6
19	6	5	200	6
20	6	7	200	6
21	7	n20	200	6
22	H1	7	60	2
23	H2	6	60	2
24	H3	5	60	2

Link - Node Table: (continued)

Link ID	Start Node	End Node	Length ft	Diameter in	
M1	M1	n145	#N/A	#N/A	Pump
M3	M3	3	#N/A	#N/A	Pump

Energy Usage:

Pump	Usage Factor	Avg. Effic.	Kw-hr /Mgal	Avg. Kw	Peak Kw	Cost /day
M1	100.00	75.00	26152.48	86.35	86.35	0.00
M3	0.00	0.00	0.00	0.00	0.00	0.00
				Demand Charge:		0.00
				Total Cost:		0.00

Node Results:

Node ID	Demand GPM	Head ft	Pressure psi	Quality
n1	0.00	6243.13	96.68	0.00
n3	0.00	6243.23	100.19	0.00
n4	0.00	6243.17	98.87	0.00
n9	0.00	6243.12	96.68	0.00
n10	0.00	6243.13	96.68	0.00
n12	0.00	6243.08	92.33	0.00
n14	0.00	6243.14	96.68	0.00
n15	0.00	6243.14	96.69	0.00
n16	0.00	6243.16	98.86	0.00
n17	0.00	6243.16	98.86	0.00
n20	0.00	6242.97	87.95	0.00
n21	0.00	6243.13	96.68	0.00
n27	0.00	6243.22	100.19	0.00
n33	0.00	6242.97	85.78	0.00
n34	0.00	6243.15	96.69	0.00
n62	0.00	6243.13	96.68	0.00
n65	0.00	6243.10	94.94	0.00
n66	0.00	6243.10	94.94	0.00
n69	0.00	6243.13	96.68	0.00
n140	0.00	6243.03	90.14	0.00
n141	0.00	6243.03	90.14	0.00
n144	0.00	6243.32	99.37	0.00
n145	0.00	6243.34	99.21	0.00
n180	0.00	6243.00	87.96	0.00
n181	0.00	6243.00	87.96	0.00
1	0.00	6243.15	98.86	0.00
2	0.00	6242.98	87.09	0.00
3	0.00	6242.98	87.09	0.00

Node Results: (continued)

Node ID	Demand GPM	Head ft	Pressure psi	Quality	
H4	0.00	6243.23	100.19	0.00	
5	0.00	6243.05	94.48	0.00	
6	0.00	6243.00	92.29	0.00	
7	0.00	6242.95	90.11	0.00	
H1	55.00	6235.86	87.03	0.00	
H2	0.00	6243.00	92.29	0.00	
H3	0.00	6243.05	94.48	0.00	
M1	-55.03	0.00	0.00	0.00	Reservoir
M3	0.00	0.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
p6	9.51	0.11	0.02	Open
p8	-9.51	0.24	0.16	Open
p9	-18.49	0.21	0.07	Open
p10	-28.01	0.08	0.01	Open
p11	27.02	0.31	0.15	Open
p12	10.30	0.12	0.12	Open
p15	9.51	0.11	0.02	Open
p21	-28.01	0.32	0.16	Open
p26	-35.21	0.40	0.25	Open
p27	-10.30	0.26	0.18	Open
p28	10.30	0.12	0.02	Open
p49	0.00	0.00	0.00	Open
p51	0.00	0.00	0.00	Open
p53	0.00	0.00	0.00	Open
p96	0.00	0.00	0.00	Open
p98	-55.03	0.62	0.56	Open
p118	0.00	0.00	0.00	Open
2	-10.30	0.07	0.01	Open
5	-16.72	0.19	0.06	Open
6	-27.02	0.31	0.15	Open
7	28.01	0.32	0.16	Open
8	9.51	0.24	0.16	Open
9	9.51	0.24	0.16	Open
10	9.51	0.24	0.16	Open
11	9.49	0.24	0.16	Open
12	0.03	0.00	0.00	Open
14	-10.30	0.07	0.00	Open
15	-9.51	0.11	0.02	Open
16	28.01	0.32	0.15	Open
17	0.00	0.00	0.00	Open
18	35.21	0.40	0.24	Open
19	-35.21	0.40	0.25	Open

Link Results: (continued)

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status	
20	35.21	0.40	0.24	Open	
21	-19.79	0.22	0.08	Open	
22	-55.00	5.62	118.16	Open	
23	0.00	0.00	0.00	Open	
24	0.00	0.00	0.00	Open	
M1	55.03	0.00	-6243.34	Open	Pump
M3	0.00	0.00	0.00	Closed	Pump

```
*********************************************************************
*                          E P A N E T                              *
*                   Hydraulic and Water Quality                     *
*                   Analysis for Pipe Networks                      *
*                         Version 2.2                               *
*********************************************************************
```

Input File: mammoth_water.net

prueba

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
p6	n1	n10	147	6
p8	n12	n10	311.1	4
p9	n9	n14	281.9	6
p10	n14	n15	220.7	6
p11	n4	n16	110.6	6
p12	n16	n17	3.985	6
p15	n14	n21	147.2	6
p21	n15	n27	540.9	6
p26	n66	n9	72.49	6
p27	n33	n34	999	4
p28	n33	n20	118.8	6
p49	n1	n62	7.627	1
p51	n65	n66	6.995	6
p53	n21	n69	18.31	1
p96	n140	n141	12.12	1
p98	n144	n145	34	6
p118	n180	n181	4.012	1
2	n34	1	400	8
5	n9	n16	650	6
6	n4	n144	1000	6
7	n144	n3	600	6
8	n12	n140	300	4
9	n140	n180	200	4
10	n180	2	100	4
11	2	n20	100	4
12	2	3	10	4
14	1	n17	200	8
15	n1	n21	200	6
16	n3	n27	10	6
17	M4	n3	140	2
18	n66	5	200	6
19	6	5	200	6
20	6	7	200	6
21	7	n20	200	6
22	M1	7	60	2
23	M2	6	60	2
24	M3	5	60	2

Link - Node Table: (continued)

Link ID	Start Node	End Node	Length ft	Diameter in	
M1	HydrantM1	n145	#N/A	#N/A	Pump
M3	HydrantM3	3	#N/A	#N/A	Pump

Energy Usage:

Pump	Usage Factor	Avg. Effic.	Kw-hr /Mgal	Avg. Kw	Peak Kw	Cost /day
M1	100.00	75.00	25521.11	1335.89	1335.89	0.00
M3	100.00	75.00	25533.98	1727.53	1727.53	0.00
				Demand Charge:		0.00
				Total Cost:		0.00

Node Results:

Node ID	Demand GPM	Head ft	Pressure psi	Quality
n1	0.00	6093.79	31.97	0.00
n3	0.00	6093.14	35.16	0.00
n4	0.00	6093.46	34.00	0.00
n9	0.00	6093.74	31.95	0.00
n10	0.00	6093.83	31.99	0.00
n12	0.00	6094.40	27.90	0.00
n14	0.00	6093.70	31.93	0.00
n15	0.00	6093.54	31.86	0.00
n16	0.00	6093.54	34.03	0.00
n17	0.00	6093.54	34.03	0.00
n20	0.00	6094.46	23.60	0.00
n21	0.00	6093.74	31.95	0.00
n27	0.00	6093.15	35.16	0.00
n33	0.00	6094.44	21.42	0.00
n34	0.00	6093.56	31.87	0.00
n62	0.00	6093.79	31.97	0.00
n65	0.00	6093.80	30.25	0.00
n66	0.00	6093.80	30.25	0.00
n69	0.00	6093.74	31.95	0.00
n140	0.00	6094.95	25.97	0.00
n141	0.00	6094.95	25.97	0.00
n144	0.00	6092.71	34.10	0.00
n145	1000.00	6092.62	33.90	0.00
n180	0.00	6095.31	23.97	0.00
n181	0.00	6095.31	23.97	0.00
1	0.00	6093.55	34.03	0.00
2	0.00	6095.50	23.18	0.00
3	1000.00	6095.69	23.26	0.00

Node Results: (continued)

Node ID	Demand GPM	Head ft	Pressure psi	Quality	
M4	0.00	6093.14	35.16	0.00	
5	0.00	6093.97	29.88	0.00	
6	0.00	6094.13	27.79	0.00	
7	0.00	6094.29	25.69	0.00	
M1	0.00	6094.29	25.69	0.00	
M2	0.00	6094.13	27.79	0.00	
M3	0.00	6093.97	29.88	0.00	
HydrantM1	-872.41	0.00	0.00	0.00	Reservoir
HydrantM3	-1127.60	0.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
p6	-35.92	0.41	0.26	Open
p8	35.92	0.92	1.83	Open
p9	27.28	0.31	0.15	Open
p10	63.19	0.72	0.73	Open
p11	-64.40	0.73	0.75	Open
p12	-24.23	0.27	0.12	Open
p15	-35.91	0.41	0.26	Open
p21	63.19	0.72	0.72	Open
p26	67.45	0.77	0.82	Open
p27	24.23	0.62	0.88	Open
p28	-24.23	0.27	0.12	Open
p49	0.00	0.00	0.00	Open
p51	0.00	0.00	0.00	Open
p53	0.00	0.00	0.00	Open
p96	0.00	0.00	0.00	Open
p98	127.59	1.45	2.67	Open
p118	0.00	0.00	0.00	Open
2	24.23	0.15	0.03	Open
5	40.17	0.46	0.31	Open
6	64.40	0.73	0.75	Open
7	-63.19	0.72	0.72	Open
8	-35.92	0.92	1.83	Open
9	-35.92	0.92	1.83	Open
10	-35.92	0.92	1.84	Open
11	91.68	2.34	10.41	Open
12	-127.60	3.26	19.19	Open
14	24.23	0.15	0.03	Open
15	35.91	0.41	0.25	Open
16	-63.19	0.72	0.73	Open
17	0.00	0.00	0.00	Open
18	-67.46	0.77	0.82	Open
19	67.46	0.77	0.82	Open

Link Results: (continued)

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
20	-67.45	0.77	0.82	Open
21	-67.45	0.77	0.82	Open
22	0.00	0.00	0.00	Open
23	0.00	0.00	0.00	Open
24	0.00	0.00	0.00	Open
M1	872.41	0.00	-6092.62	Open Pump
M3	1127.60	0.00	-6095.69	Open Pump

APPENDIX D - SEWER MAIN CAPACITY CALCULATIONS

PROPOSED SANITARY SEWER DEMAND CALCULATIONS

RESIDENTIAL DESIGN FLOW RATES PER 2 BEDROOM UNIT [2]	280	gpd
RESIDENTIAL DESIGN FLOW RATES PER 3 BEDROOM UNIT [2]	390	gpd
AVERAGE DAILY DEMAND [2]	60%	gpd
PEAK HOUR FACTOR [3]	4	PHF

MAMMOTH HOT SPRINGS GOVERNMENT AREA: PROPOSED SANITARY SEWER DEMAND

	DESIGN FLOW PER UNIT	NUMBER OF UNITS [5]	AVERAGE TOTAL, gpd	MAXIMUM TOTAL, gpd	PEAK HOUR, gpm
3- BEDROOM UNIT	390	4	936	1,560	4.3
TOTAL MAMMOTH SANITARY SEWER DEMAND				1,560	4.3

[1] water demand based on daily rates from the WYDEQ CH 12, Section 8

[2] sewer demand based on daily flow rates from the WYDEQ CH 25, Section 5, Table 1

[3] peak hour factor based on busiest hour occuring during the busiest quarter of the day

[4] IFC - appendix b, Table B105.1, one-and two family dwellings period each night

[5] occupancy/bedroom count based on current developmental program

Manhole A to B (8" PVC)

Full Flow Capacity

Inputs				Calculations			
Pipe Diameter	=	0.667	(ft)	Area	=	0.349	(ft2)
k	=	1.49	(constant)	Perimeter	=	2.095	(ft)
Manning's n	=	0.017	(PVC)	Radius	=	0.167	(ft)
Slope	=	0.02000	(ft/ft)	Velocity	=	3.755	(ft/s)
				Flow Rate	=	1.312	(cfs)
				Flow Rate (90%)	=	1.181	(cfs)

City Data (Real Time Flow)

Scenario	Flow (cfs)	Depth (in)	Average Velocity (fps)
Average Day	0.0133	0.36	2.010
Peak Day	0.0222	0.48	2.340
Peak Hour	0.0887	0.96	3.580

Manhole B to C (8" PVC)

Full Flow Capacity

Inputs				Calculations			
Pipe Diameter	=	0.667	(ft)	Area	=	0.349	(ft2)
k	=	1.49	(constant)	Perimeter	=	2.095	(ft)
Manning's n	=	0.017	(PVC)	Radius	=	0.167	(ft)
Slope	=	0.03460	(ft/ft)	Velocity	=	4.939	(ft/s)
				Flow Rate	=	1.726	(cfs)
				Flow Rate (90%)	=	1.553	(cfs)

City Data (Real Time Flow)

Scenario	Flow (cfs)	Depth (in)	Average Velocity (fps)
Average Day	0.0133	0.48	1.880
Peak Day	0.0222	0.48	2.180
Peak Hour	0.0887	1.08	3.340

	DESIGN FLOW PER UNIT	NUMBER OF UNITS	AVERAGE TOTAL, gpd	MAXIMUM TOTAL, gpd	PEAK HOUR, gpm
2- BEDROOM UNIT	280	7	1176	1,960	5.4
3- BEDROOM UNIT	390	3	702	1,170	3.3
YCC (Lake Employee Housing Report)			5790	9,650	26.8
TOTAL MAMMOTH EXISTING SANITARY SEWER DEMAND			7668	12780	35.5

Flow Data				
Scenario	**Existing**	**Proposed**	**Total**	**Total (cfs)**
Average Day	7668	936	8604	0.013312353
Peak Day	12780	1,560	14340	0.022187255
Peak Hour	35.5	4.3	39.8	0.088715664

APPENDIX E - PUMP CURVE CALCULATIONS

Reference: 2026_02_12_Mammoth Plumbing Plan for 3-Bedroom Unit

Grinder

Fixture Units

1.25" Trap	0	BR Group (flush valve)	0	Shower Stall	1
1.5" Trap	0	Dental Unit	0	Sink Flush Valve	0
2" Trap	1	Dishwasher	1	Sink Scullery	0
2.5" Trap	0	Drinking Fountain	0	Sink Service	0
3" Trap	1	Kit Sink w/Disposal	1	Sink Surgeon's	0
4" Trap	0	Kitchen Sink	0	Swim Pool / 1000 gal	0
Bathtub 1.5" Trap	0	Laundry Tray	0	Urinal Flush Valve	0
Bathtub 2" Trap	1	Lav. Barber / Beauty	0	Water Softener	0
Bidet 1.5" Trap	0	Lavatory 1.5" Trap	2	WC (flush tank)	2
BR Group (flush tank)	0	Shower Group / Head	0	WC (flush valve)	0

Total Fixture Units: 26

GPM: 20.0000

Edit Continue

Zoeller Company

System Head Curve and Pump Selection Tool

Static Head Information	
Static Head - elevation difference from low water to outfall	11.6 feet
System high point above outfall?	No

Friction Head Information		
Pipe		
How many different pipes in the system (not counting laterals)?	1	
Pipe 1 Length	82 feet	
Pipe 1 Size	2 inches	
Pipe 1 Class	SDR-21/Class 200	
Pipe 2 Length		
Pipe 2 Size		
Pipe 2 Class		
Pipe 3 Length		
Pipe 3 Size		
Pipe 3 Class		
Pressurized Laterals?	No	
How many are dosed at once?		
Length of one lateral		
Size of lateral		
Class of lateral		

Fittings & Discharge Assemblies

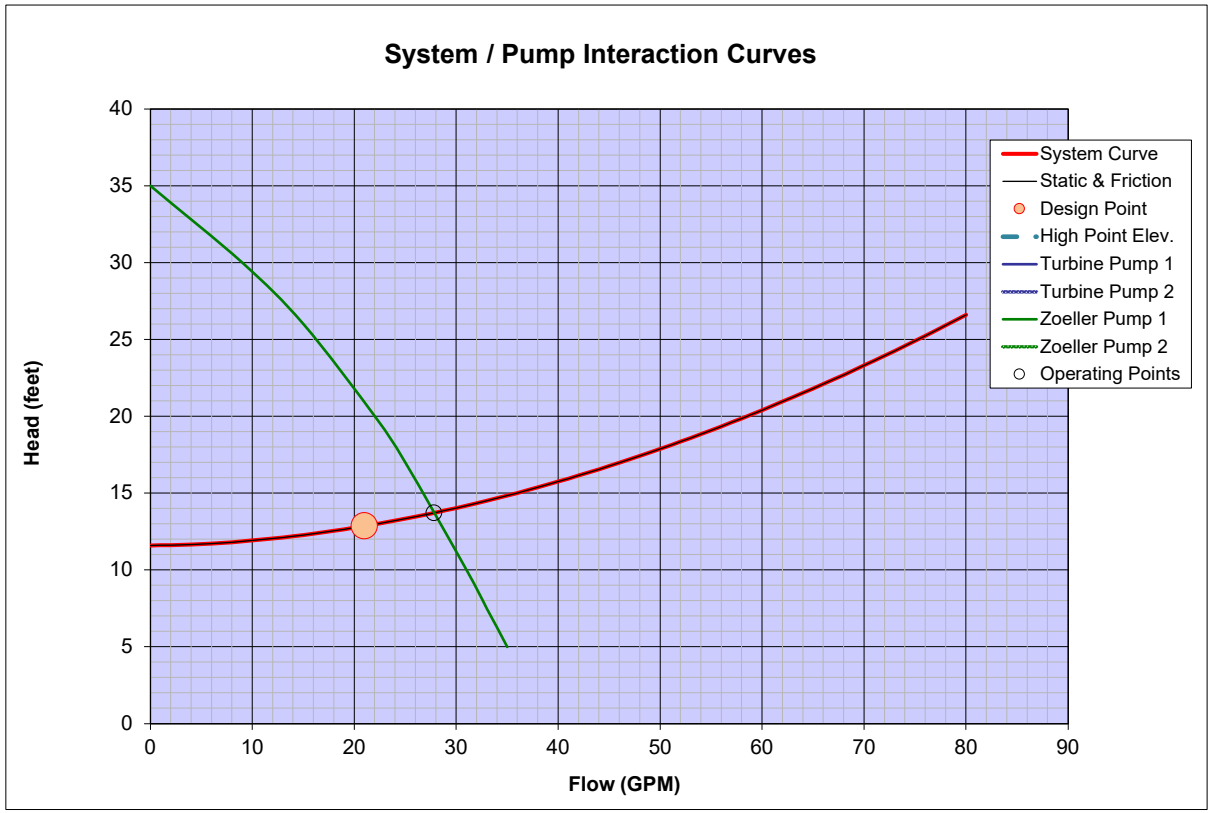
Type	Size	Quantity	Flow
90 Elbow	2 inches	4	100 %
Check Valve	2 inches	1	100 %
45 Elbow	2 inches	2	100 %
Gate Valve (full open)	2 inches	1	100 %

Special Friction Considerations	
Weep Hole	No
Add-In Friction	15 % of Pipe Loss
Automatic Multizone Valve?	No
Pressure Filter?	No

Operating Head Information		Specify Flow Requirement?
System Type	Non-Pressurized	
Required Pressure		Yes
Number of Orifices		
Size of Orifices		
Spider Valve Orifice Sizes		
Data originates from Spider Valve Sizing Tab)		

Flow Requirement	21. GPM

Factors and Coefficients	
Hazen-Williams C Factor	130
Discharge Coefficient (Cd)	0.61
Lateral Design Mode	Off



Pump Selection	60 Hz	Frequency	Operating Points
Zoeller Turbine Effluent Pumps			
Turbine Pump 1			
Flow Control Orifice?			
Turbine Pump 2			
Flow Control Orifice?			
Zoeller Centrifugal and Progressing Cavity Pumps			
Zoeller Pump 1	803, 0.5hp, 60Hz		27.8 GPM @ 13.7'
Zoeller Pump 2			

Design Point
21.0 GPM
@ 12.9 ' TDH

Curve Zoom Range	80 GPM

Project Data	Notes:
Project Name:	
Project Address	
Contact Info:	

Version 4.53

Project:	Construct Modular Housing for Federal Partners and Replace Lost Lapeyre Housing for Park Staff						
	Mammoth Area - Boneyard Service Road - Building 1						
Date of Plans:	6/18/2026						
Calc'd by:	Paul Southworth		Date:	7/21/2026			
Design Flow:	20	gpm		0.045	cfs		
Fixture Units:	26						
Grinder Pump:	Zoeller 803, 0.5 hp, 60Hz						
Design Point:	21.0 gpm @ 11.7' TDH		=	0.047	cfs @ 12.9' TDH		
Operating Point:	27.8 gpm @ 13.7' TDH		=	0.062	cfs @ 13.7' TDH		Q
Pipe Outlet Size	2.0	inches	=	0.167	feet		
Cross-Sectional Area	3.14	in^2	=	0.022	ft^2		A
Flow velocity (V)	2.84	fps		2.5 fps > V > 5.0 fps		**Yes**	V=Q/A
Wet Well Diameter	48	inches	=	4	feet		
Wet Well Area	1809.56	in^2	=	12.57	ft^2		
Pump On/Off Float Difference	26	inches	=	2.17	feet		
Volume to Fill before On/Off Float is Activated	203.66	gals	=	27.23	ft^3		
Flow in	20.00	gpm	=	0.045	cfs		
Time to Fill before On Float is Activated	610.98	secs	=	10.18	min		

APPENDIX F - TREATMENT PLANT BASIS OF DESIGN REPORT

YELLOWSTONE NATIONAL PARK MAMMOTH TEMPORARY WASTEWATER TREATMENT PLANT

BASIS OF DESIGN REPORT
PMIS: YELL 326108

National Park Service

HDR Project No. 10347138

March 13, 2023

Contents

Tables

Figures

Appendices

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Introduction and Purpose

From June 10th through June 13th, 2022, a historic rainfall event combined with rapid snowmelt caused catastrophic flooding along the Gardner and Yellowstone Rivers north of Yellowstone National Park's (YNP) North Entrance. Numerous areas of YNP's existing wastewater conveyance system, existing roadways, and stormwater drainage system along Highway 89 were destroyed or damaged during the flooding event, which resulted in the catastrophic failure of the pipeline that conveys Mammoth Hot Springs wastewater to the Gardiner wastewater system for treatment. The National Park Service (NPS) issued HDR Engineering, Inc. (HDR) an emergency response task order to provide an onsite assessment, predesign services, and schematic design documents for new a wastewater infrastructure project that will provide a temporary solution to meet Mammoth Hot Spring's immediate wastewater treatment and conveyance needs. The North Entrance is one of five entrances into YNP and is the second most popular entrance, underscoring the urgency and necessity to implement a temporary wastewater treatment and conveyance system to meet the immediate wastewater needs of Mammoth Hot Springs but to also allow YNP to open back up to full operation.

The Mammoth Hot Springs wastewater collection and conveyance system has historically conveyed wastewater from Mammoth Hot Springs to the community of Gardiner, MT for treatment at the Gardiner WWTP. Conveyance occurred through a 4 ½ mile long pipeline installed approximately forty years ago and consisted of ductile iron and asbestos-cement pipe. As a result of the historic flood damage, six sections of the pipeline were washed out along the Gardner River forcing Mammoth Hot Springs to scale back operations and minimize the amount of wastewater being generated.

The NPS commissioned a Project Scoping Assessment (PSA) by Jacobs Engineering exploring the idea of constructing a permanent WWTP in Mammoth vs conveying the wastewater to the Gardiner wastewater system. The PSA was completed in July. Based on this and other factors, by August the park had decided to pursue a temporary wastewater treatment solution in Mammoth for the short-term with a long-term intention of sending wastewater back to Gardiner.

While the focus of this Basis of Design Report (BDR) is primarily on the evaluation and implementation of a temporary wastewater solution, significant consideration has been given to incorporating the selected alternative into the NPS's overall long-term goals.

This BDR identifies alternatives that were evaluated and summarizes each project component that was selected for implementation. The intent of this BDR is to be used in conjunction with the mini-Value Analysis (VA) findings to provide additional information and supporting documentation for the evaluation and selection of alternatives for onsite wastewater treatment. Alternatives presented herein were discussed at the mini-VA workshop that was held on July 26, 2022, and throughout various progress meetings.

Project Objectives

The alternatives discussed herein were evaluated with a goal of providing for an immediate and short-term solution to meet Mammoth Hot Spring's wastewater needs, allowing for YNP to become fully operational, and also have the ability to fit within a long-term solution at another NPS facility. It is understood the long-term conveyance and treatment approach will be to reinstate the pipeline in some form and continue to deliver wastewater to the Gardiner WWTP.

Maintenance of Active Wastewater Flow

Following the June 2022 flood event, wastewater generated from Mammoth Hot Springs was diverted from the infrastructure that conveyed flow to Gardiner, to the existing 1930's era infrastructure which was left in place for emergencies when the gravity pipeline to Gardiner was constructed. Existing infrastructure for emergency use includes a 50,000-gallon septic tank, sewer vault / diversion structure, infiltration ditches, and two ponds. Wastewater flow is currently being diverted from the existing lift station to the 50,000-gallon septic tank through the sewer vault / diversion structure. From the septic tank, effluent flows through the first infiltration ditch which is approximately 900-feet long before discharging into Pond 1. Once Pond 1 reaches a depth of approximately 2-3 feet, it overflows to Pond 2. Flow from Pond 2 discharges into the second infiltration ditch which is approximately 1,050-feet long. Based on hydraulic flow measurements, current wastewater flows being diverted into the emergency infrastructure range from 95,000 gpd to 125,000 gpd. Prior to the emergency use, the septic tank was only used during power outages at the lift station and was pumped out regularly.

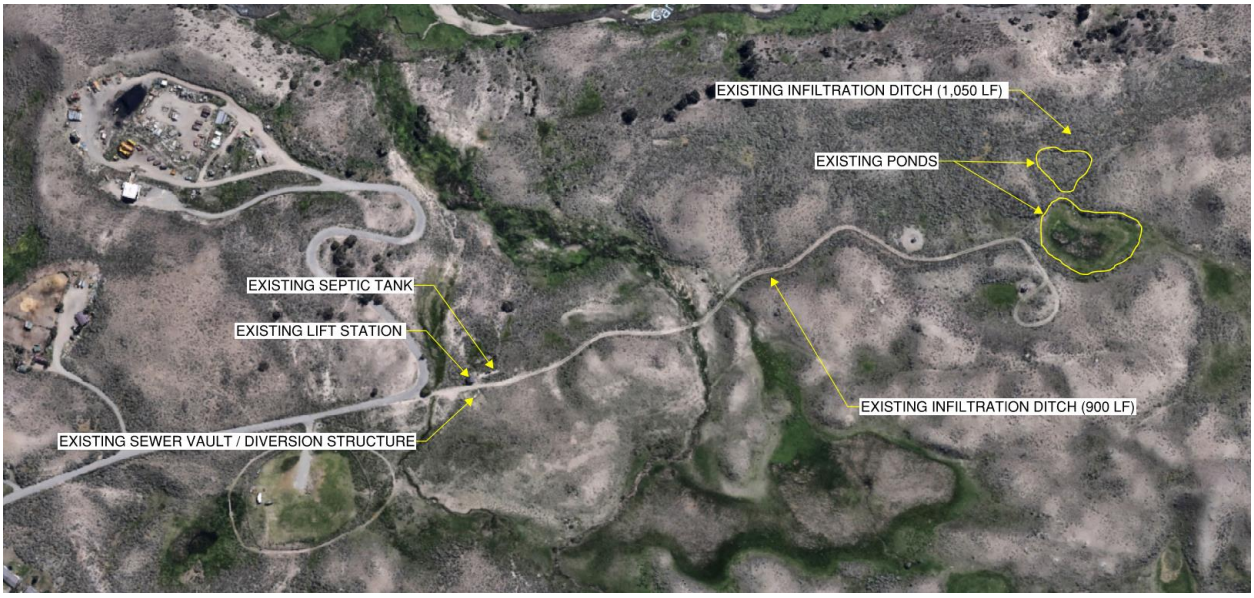


Figure 1: Existing Emergency Infrastructure Overview

Involved Parties

Table 1: Involved Parties

Individual	Assignment	Phone	Email
National Park Service – Yellowstone National Park (YNP)			
Molly Ohlen	Civil Engineer	307-344-2311	Molly_Ohlen@nps.gov
Jason Murphy	Facility Manager Utility System Operations	406-640-0035	Jason_Murphy@nps.gov
Dan Hallett	Deputy Chief of Facility Management	307-344-2305	Daniel_Hallett@nps.gov
National Park Service – Denver Service Center (DSC)			
Mike Giller	DSC Portfolio Manager	303-969-2007	Mike_Giller@nps.gov
Josh Hooper	DSC Project Manger	303-882-3133	joshua_hooper@nps.gov
HDR Engineering, Inc. (HDR)			
Chris Bailey	Project Manager	605-791-6104	christopher.bailey@hdrinc.com
Jarrett Moran	Project Engineer	406-577-5037	jarrett.moran@hdrinc.com
Robert Moore	Civil Engineer	970-416-4400	robert.moore@hdrinc.com
Sara Race	Civil Engineer	970-416-4424	sara.race@hdrinc.com
Terry Stulc	Electrical Engineer	406-532-3943	terry.stulc@hdrinc.com

Regulatory Compliance Review

Current Regulations

The project site is located in Northwest Wyoming. Applicable state regulations that apply to the project include:

- Wyoming Department of Environmental Quality (WYDEQ) Water Quality

Evaluated Alternatives and Recommendation

This section outlines alternatives that were evaluated and identifies a recommended alternative.

Value Analysis Workshop

A Value Analysis is a structured process of evaluating a complex issue or problem and arriving at a preferred alternative through a reasoned analysis. The primary purpose of a VA is to increase project value through identification of the NPS long-term goals, future considerations, and potential cost savings. Due to the need for this project to be expedited, a "mini-VA" was utilized to evaluate alternatives. The overall goals of the mini-VA, which was held on July 26th, 2022, was to use the VA process, discuss the best available information the NPS and HDR team has to date, to improve the quality of the decisions being made, and document those decisions. The NPS was working with the HDR team for approximately one month prior to the mini-VA. Evaluation criteria and key attributes discussed within the VA are noted below in Table 2:

Table 2: Mini-VA Evaluation Criteria Descriptions

Evaluation Criteria	Descriptions
Implementation Schedule	How quickly can the alternative be implemented and be made operational?
Scalability	How easily can the alternative be scaled up to meet additional demands? Ability to expand treatment to meet future requirements, contribution towards long-term solutions?
Constructability	What is the perceived level of risk associated with the construction of the alternative?
Operability/Reliability	Once installed, what is the perceived risk of operation of the system as installed? Human factors, data, technical issues, etc.
Resiliency	How will the system react to and survive unpredictable events?
Permitting and Environmental Factors	Ability to secure required permits, impacts to environmental resources. What will be the impact of the alternative on native resources within the project area?
Compatibility with Long Term Planning	Does the preferred solution agree with the NPS long-term plan?
Cost	Are there significant cost differences between alternatives and do they offer additional value?

The mini-VA evaluated several alternatives developed by HDR for consideration which included two MBR packaged WWTP systems (MBR Alternative 1 - StreamGo and MBR Alternative 2 - BluBox), a non-MBR treatment alternative, and several pipeline alternatives that included an alignment along Old Gardiner Road and an alignment along the existing gravity pipeline that included a number of river-crossing bypass pump setups for washed out sections of roadway and infrastructure. The mini-VA workshop was administered by the NPS with presentations from HDR on the various alternatives. The mini-VA workshop presentation is included in Appendix A.

Following general introductions of the alternatives, a detailed discussion was held on the advantages, disadvantages, and key attributes of each alternative. The idea of a "hybrid alternative" was discussed that would utilize a temporary MBR packaged WWTP at Mammoth Hot Springs while a proposed permanent pipeline design is performed. Following installation of the proposed new pipeline, the MBR packaged WWTP could be relocated to another facility within YNP. The recommended alternatives listed below in this section are the result of the mini-VA conducted on July 26th, 2022.

MBR Packaged WWTP Alternatives Summary

An overview of advantages and disadvantages for the two MBR packaged plant alternatives are summarized below in Table 3.

Table 3: MBR Packaged WWTP Alternatives Summary

Alternative	Advantages	Disadvantages
StreamGo MBR Packaged WWTP	• MBR system is anticipated to be online by the end of 2022. • Permanent facility can meet short-term and long-term wastewater treatment needs or be relocated to another NPS facility within YNP in the future.	• Requires civil, power supply, and communication upgrades. • Residuals handling and disposal (more robust than BluBox, but still a maintenance item for the NPS). • Gardiner WWTP designed for Mammoth wastewater flows.
BluBox Modular MBR WWTP	• MBR system is capable of being onsite and ready for treatment within several weeks of order (120,000 gal/day unit is available and ready to ship). • Provides short-term solution for wastewater treatment needs. • Minimal impact to environment (tanks are above grade, etc.)	• Requires civil, power supply, and communication upgrades. • Increased residuals handling and disposal maintenance (less robust than StreamGo). • The NPS leases the unit and would not own the asset for future use.

MBR Packaged WWTP Alternatives Recommendation

The StreamGo MBR packaged WWTP was selected as the preferred alternative, uniquely able to provide the NPS with near-term wastewater treatment in Mammoth Hot Springs which will provide for extremely high-quality effluent, allow YNP to be fully operational by the end of 2022, and will also provide a facility that is able to be reused and relocated at another facility within YNP at a later date to provide for advanced wastewater treatment. StreamGo has extensive experience in the relocation of packaged WWTPs and has provided an approximated cost for the relocation of the packaged WWTP proposed for Mammoth Hot Springs.

Due to the condensed project schedule, the MBR Packaged WWTP was evaluated in two separate phases (Phase 1 and Phase 2). Phase 1 includes an MBR Packaged WWTP sized to treat up to 150,000 gpd of wastewater generated in Mammoth Hot Springs, but hydraulically be able to handle up to 350,000 gpd. It was expected that there is some amount of I/I within the collection system, so the overall hydraulic capacity was considered important. Phase 2 includes additional tankage that would be added to Phase 1 and allow the MBR Packaged WWTP to treat up to 350,000 gpd and handle up to 600,000 gpd hydraulically.

Key design requirements for the MBR Packaged WWTP as discussed during the VA are summarized below:

- Preliminary Design Flow Rates:

Description Value Unit	Value	Unit
Phase 1 ADF (Biological)	150,000	gal/day
Phase 1 PDF (Hydraulic)	350,000	gal/day
Phase 2 ADF (Biological)	350,000	gal/day
Phase 2 PDF (Hydraulic)	600,000	gal/day

ADF: Average Daily Flow
PDF: Peak Daily Flow

- Preliminary Target Effluent Discharge Criteria:

Limited Constituent and Required Reporting Units	Monthly Avg.	Weekly Avg.	Daily Max
BOD5 (mg/L)	30	45	90
BOD5, percent removal	85%	-	-
TSS (mg/L)	30	45	90
TSS, percent removal	85%	-	-
E. coli, MPN (colonies/100 mL)	126	-	-
Ammonia, Nitrogen (as N) (mg/L)	0.5	-	-
Nitrates/Nitrites (mg/L)	10	-	-
pH	Range of 6.5-9.0		

WWTP Discharge Alternatives Summary

Four discharge alternatives were evaluated for the potential packaged WWTP effluent. These alternatives consist of surface water discharge, percolation ponds, land application/irrigation, and groundwater discharge via infiltration/percolation (IP) basins. However, the existing location of the packaged plant and surrounding topography may provide considerable challenges for the construction of effluent discharge infrastructure. A summary of the advantages and disadvantages for each discharge alternative are summarized in Table 4.

Table 4: WWTP Discharge Alternatives Summary

Alternative	Advantages	Disadvantages	Decision
Alternative 1. Surface Water Discharge	• Simple • Minimal O&M	• WYDEQ will not permit a discharge to the Gardner River.	• Not feasible and dismissed.
Alternative 2. Percolation Ponds	• Does not require a permitted discharge.	• Significant surface area required to evaporate entirety of wastewater.	• Feasible discharge option, but key soil characteristics to determine viability are unknown at this time and need to be determined.
Alternative 3. Land Application/Irrigation	• Relatively minimal infrastructure needed to irrigate.	• Assimilative capacity of existing flora uncertain, likely low. • WYDEQ requires slopes of application areas be less than 15%. • No irrigation during the winter, storage pond required.	• Not feasible as a standalone solution due to need for large winter storage pond and irrigation area. • Could supplement another discharge method during the summer months.
Alternative 4. Groundwater Discharge via IP Basins	• Less surface area needed than other discharge alternatives.	• Local soil hydraulic conductivity and percolation parameters unknown. • Permitting feasibility unknown.	• Feasible discharge option, but key soil characteristics to determine viability are unknown at this time and need to be determined.

WWTP Discharge Alternatives Recommendation

Percolation ponds are the predominant discharge method for the Park's larger WWTPs and is the discharge method that is currently in operation at Old Faithful, Grant Village, Madison, and Fishing Bridge WWTPs. Staff that operate the Park's existing percolation ponds have a sound understanding of the percolation pond process and familiarity with the operational requirements necessary to implement this discharge method. Due to the Park's familiarity with this discharge method and their previous permitting efforts for other WWTPs within the Park, they have been able to find efficiencies in the percolation pond permitting process, which are particularly advantageous for this project given the condensed timeline. For the abovementioned reasons, the Park has selected percolation ponds as the standard discharge method for Park WWTPs; therefore, it is the recommended discharge method for the Mammoth Hot Springs WWTP.

Basis of Design

Following selection of the StreamGo MBR Facility as the treatment alternative, the project design progressed forward to implement the WWTP in the fall of 2022. The basis of design for required improvements to the Mammoth Hot Springs WWTP Project are listed below.

Projected Wastewater Flow

To inform the basis of design and develop applicable design criteria, Mammoth Hot Springs billing data from the Gardiner WWTP flowmeter was evaluated from 2010 to 2022. From 2010 through 2019, average flows were approximately 245,000 gpd with peak flows reaching 400,000 gpd. However, in June 2019, the NPS performed a number of rehabilitation improvements within the Mammoth Collection System which had a significant impact on inflow and infiltration (I/I), most notably the replacement of a sanitary sewer manhole that was reported to have a substantial amount of inflow. Following these improvements, the NPS evaluated new wastewater flows and calculated a max month of approximately 240,000 gpd, generally occurring during August. In comparison to the average flow from the previous nine (9) years, it can be inferred that a post-I/I rehabilitation average flow would be considerably less than the average flows from 2010 through June 2019. However, to ensure the Mammoth Hot Springs Temporary WWTP and supporting infrastructure is adequately sized to accommodate full NPS operations, the Mammoth Hotel, YACC Camp Housing, Mammoth Campground, concessioners, etc., the peak hour design flow is 1,200,000 gpd (1.2 MGD / 833 gpm) and the maximum month design flow is 350,000 gpm (0.35 MGD / 243 gpm).

Percolation Ponds

The previous section of this report outlined the major components of the project, listed the alternatives that were evaluated and recommended, and identified the WWTP effluent discharge method as percolation ponds. To verify the feasibility of this discharge method and inform the size of the proposed percolation ponds, in-situ infiltration testing was performed by ALLWEST Testing & Engineering, Inc. prior to any site excavation occurring. During the Week of August 21, 2022, that included two (2) tests in general accordance with the methods outlined in WYDEQ Chapter 25, Appendix A and two (2) double ring infiltrometer tests in general accordance with the methods outlined in ASTM D3385. During their testing and with the NPS' assistance, ALLWEST excavated small areas within the footprint of each pond to allow their infiltration testing to occur at the original pond bottom design elevation (Pond No. 3 5970 and Pond No. 4: 5965). An overview map showing the infiltration testing locations by ALLWEST is shown below in Figure 2 and a summary of their infiltration test results are shown below in Table 5 and Table 6.

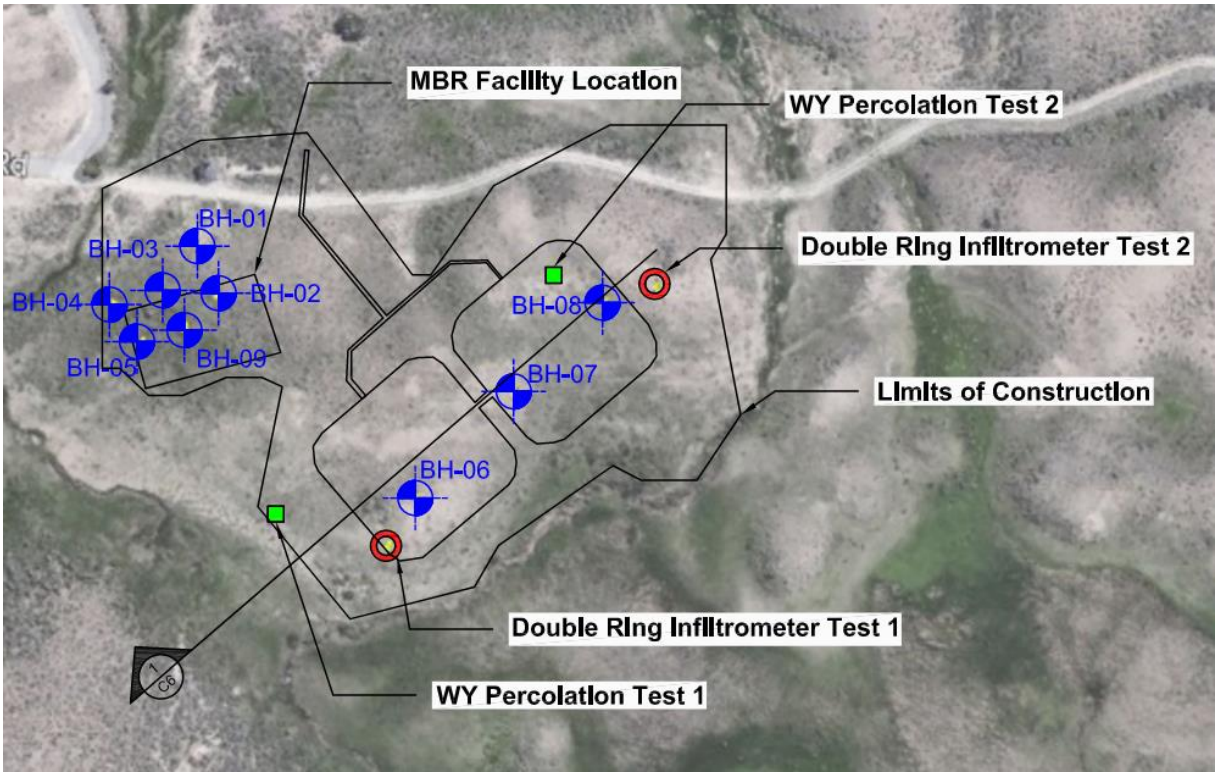


Figure 2: ALLWEST Infiltration Testing Locations

Table 5: WYDEQ Chapter 25, Appendix A Test Results (ALLWEST)

Test Type / Date Performed	Latitude (°)	Longitude (°)	Average Infiltration Rate (in/hr)
Wyoming Perc. Test 1 (ALLWEST), 8.23.2022, near BH-08 & Pond No. 3	44.969018	-110.686243	12.0
Wyoming Perc. Test 2 (ALLWEST), 8.23.202, near BH-06 & Pond No. 4	44.969317	-110.687855	9.5

Table 6: Double Ring Infiltrometer (ASTM D3385) Test Results (ALLWEST)

Test Type / Date Performed	Latitude (°)	Longitude (°)	Inner Ring Infiltration Rate (in/hr)	Outer Ring Infiltration Rate (in/hr)
Double Ring Infiltrometer Test 1 (ALLWEST), 8.24.2022, near BH-08 & Pond No. 3	44.968737	-110.686018	2.6	2.59
Double Ring Infiltrometer Test 2 (ALLWEST), 8.24.2022, near BH-06 & Pond No. 4	44.968968	-110.687680	1.6	1.59
		Infiltration Rate	2.1	2.1

Percolation Pond Application Area

Based on ALLWEST's infiltration test results, the double ring infiltrometer test yielded more conservative infiltration rates; therefore, that test method was utilized for sizing of each pond's infiltration application area. To calculate the infiltration application area, a wastewater design flow of 350,000 gpd (0.35 MGD) and ALLWEST's infiltration rate of 2.1 in/hr (0.81 gal/hr) was used in conjunction with EPA's equation for determining land area requirements from the EPA Process Design Manual, Land Treatment of Municipal Wastewater Effluents. The resulting infiltration application area for both Pond Nos. 3 and 4 was calculated to be 0.5 acres per pond.

$$A = \frac{Q(3.06)}{Lw}$$

Where:
A = Application Area (acres)
Q = Average design flow (MGD)
L_w = hydraulic loading (in/hr)

Pond Nos. 3 and 4 Infiltration & Volume Calculations

To account for soil conductivity unknowns, the expected infiltration rate was restricted by 50% and a rate of 1.0 in/hr (0.40 gal/hr) was used for percolation pond infiltration and volume calculations based on an infiltration application area of 0.5 acres per pond. Infiltration and volume calculations are summarized below in Table 7.

Table 7: Pond Nos. 3 and 4 Infiltration & Volume Calculations

Infiltration & Volume Calculations (with 50% Restriction)			
DAY	VOL IN [gal/day]	VOL OUT [gal/day]	NET
1	350,000.00	372,743.65	-22,743.65
HOUR	VOL IN [gal/hr]	VOL OUT [gal/hr]	NET
1	14,583.33	15,530.99	-947.65
MIN	VOL IN [gal/min]	VOL OUT [gal/min]	NET
1	243.06	258.85	-15.79
SEC	VOL IN [gal/s]	VOL OUT [gal/s]	NET
1	4.05	4.31	-0.26

Pond No. 4 Winterization

Pond Nos. 3 and 4 were designed using the same parameters; however, Pond No. 4 was further designed to include a cell for use during winter operations, as well as a cell for summer operations, see Figure 3 and Figure 4 below.

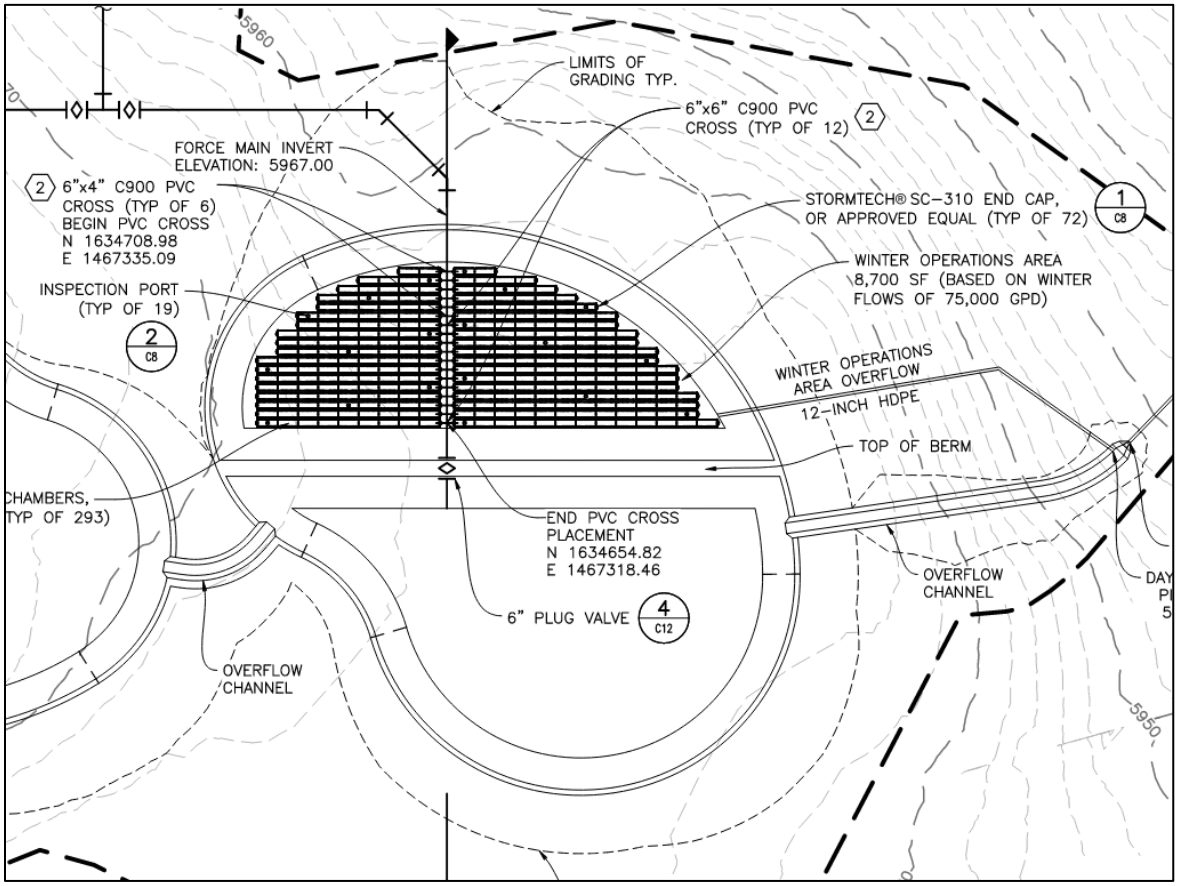


Figure 3: Winterization of Pond No. 4 Plan View

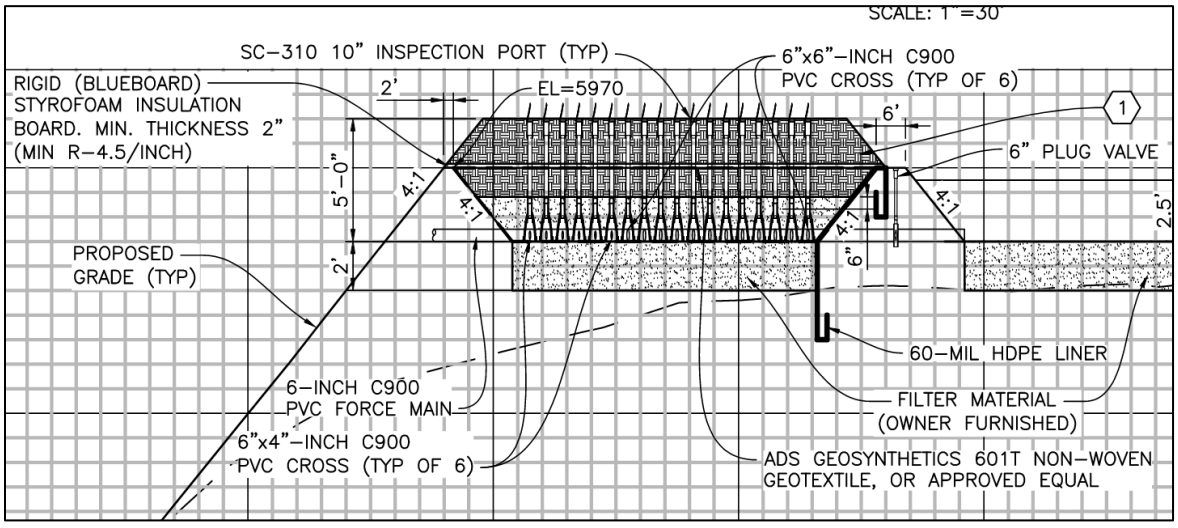


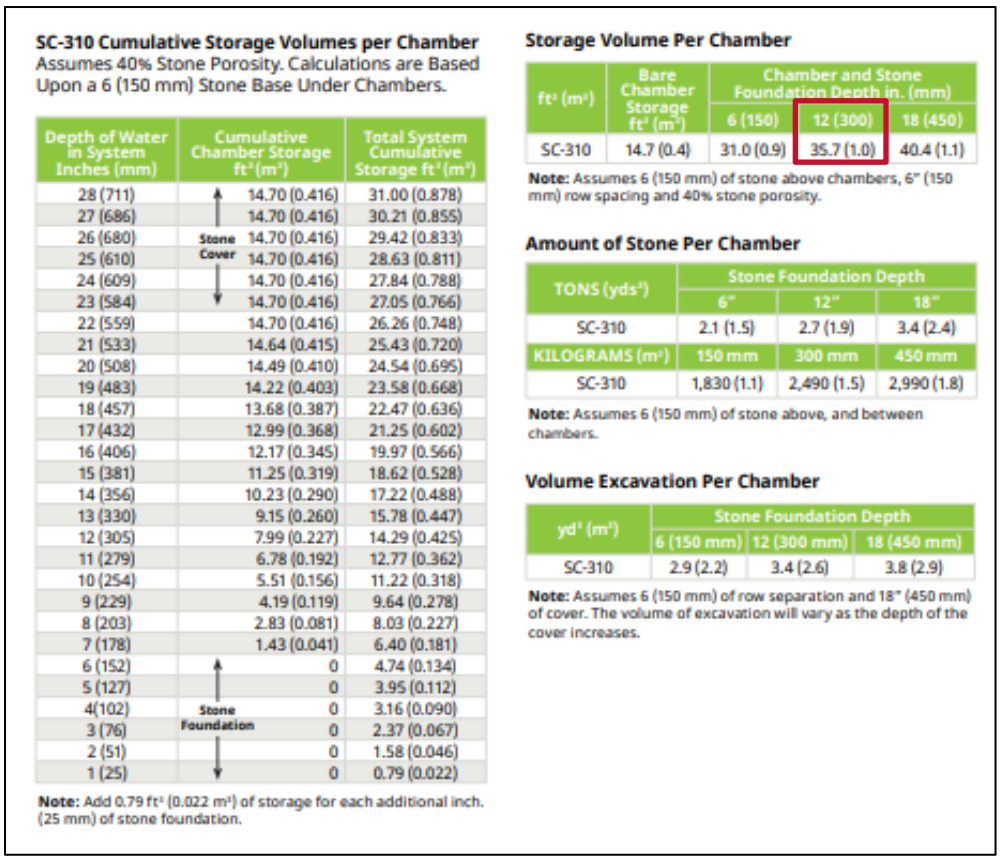
Figure 4: Winterization of Pond No. 4 Section View

A winter design flow of 75,000 gpd (0.075 MGD) was determined using the existing Gardiner WWTP flowmeter data from October through March for the past eight (8) years. Using an infiltration rate of 1.02 in/hr results in a required application area for the winterization cell of 0.11 acres.

Winterization of Pond No. 4 includes the addition of StormTech SC310 chambers to provide insulation, prevent freezing, and promote infiltration in the winter. The winterization cell in Pond No. 4 was also designed to account for a storage scenario if infiltration does not occur as anticipated. The storage volume, including the StormTech SC310 chambers volume, a 12-inch aggregate base, and minimum 6-inch stone above the chambers per guidance from the StormTech SC310 product catalog shown below in Table 8 and Figure 5.

Table 8: Pond No. 4 Winterization Cell Volume Calculations

StormTech Chamber	Quantity	Volume per Chamber [ft3]	Total Chamber Storage [gal]	Application Area per Chamber [ft2]	Total Application Area [ac]	Volume per Chamber + Aggregate Voids [ft3]	Total Winterization Volume [gal]
SC310	293	14.7	32,217.12	20.16	0.14	35.7	78,242



SC-310 Cumulative Storage Volumes per Chamber
Assumes 40% Stone Porosity. Calculations are Based Upon a 6 (150 mm) Stone Base Under Chambers.

Depth of Water in System Inches (mm)		Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
28 (711)		14.70 (0.416)	31.00 (0.878)
27 (686)		14.70 (0.416)	30.21 (0.855)
26 (680)	Stone Cover	14.70 (0.416)	29.42 (0.833)
25 (610)		14.70 (0.416)	28.63 (0.811)
24 (609)		14.70 (0.416)	27.84 (0.788)
23 (584)		14.70 (0.416)	27.05 (0.766)
22 (559)		14.70 (0.416)	26.26 (0.748)
21 (533)		14.64 (0.415)	25.43 (0.720)
20 (508)		14.49 (0.410)	24.54 (0.695)
19 (483)		14.22 (0.403)	23.58 (0.668)
18 (457)		13.68 (0.387)	22.47 (0.636)
17 (432)		12.99 (0.368)	21.25 (0.602)
16 (406)		12.17 (0.345)	19.97 (0.566)
15 (381)		11.25 (0.319)	18.62 (0.528)
14 (356)		10.23 (0.290)	17.22 (0.488)
13 (330)		9.15 (0.260)	15.78 (0.447)
12 (305)		7.99 (0.227)	14.29 (0.425)
11 (279)		6.78 (0.192)	12.77 (0.362)
10 (254)		5.51 (0.156)	11.22 (0.318)
9 (229)		4.19 (0.119)	9.64 (0.278)
8 (203)		2.83 (0.081)	8.03 (0.227)
7 (178)		1.43 (0.041)	6.40 (0.181)
6 (152)		0	4.74 (0.134)
5 (127)		0	3.95 (0.112)
4(102)	Stone Foundation	0	3.16 (0.090)
3 (76)		0	2.37 (0.067)
2 (51)		0	1.58 (0.046)
1 (25)		0	0.79 (0.022)

Note: Add 0.79 ft³ (0.022 m³) of storage for each additional inch. (25 mm) of stone foundation.

Storage Volume Per Chamber

ft³ (m³)	Bare Chamber Storage ft³ (m³)	Chamber and Stone Foundation Depth in. (mm)		
		6 (150)	12 (300)	18 (450)
SC-310	14.7 (0.4)	31.0 (0.9)	35.7 (1.0)	40.4 (1.1)

Note: Assumes 6 (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% stone porosity.

Amount of Stone Per Chamber

TONS (yds³)	Stone Foundation Depth		
	6"	12"	18"
SC-310	2.1 (1.5)	2.7 (1.9)	3.4 (2.4)
KILOGRAMS (m³)	150 mm	300 mm	450 mm
SC-310	1,830 (1.1)	2,490 (1.5)	2,990 (1.8)

Note: Assumes 6 (150 mm) of stone above, and between chambers.

Volume Excavation Per Chamber

yd³ (m³)	Stone Foundation Depth		
	6 (150 mm)	12 (300 mm)	18 (450 mm)
SC-310	2.9 (2.2)	3.4 (2.6)	3.8 (2.9)

Note: Assumes 6 (150 mm) of row separation and 18" (450 mm) of cover. The volume of excavation will vary as the depth of the cover increases.

Figure 5: StormTech SC310 Storage Volumes

Pond No. 4 Infiltration & Volume Calculations (Winterized Section)

Daily pond infiltration and volume calculations were completed to evaluate flows into and out of Pond No. 4 Winterized Section based on the design infiltration and application area. Pond No. 4 winterization infiltration and volume calculations are summarized below in Table 9.

Table 9: Pond No. 4 Infiltration & Volume Calculations

Infiltration & Volume Calculations (with 50% Restriction)			
DAY	VOL IN [gal/day]	VOL OUT [gal/day]	NET
1	75,000.00	91,842.85	-16,842.85
HOUR	VOL IN [gal/hr]	VOL OUT [gal/hr]	NET
1	3,125.00	3,826.79	-701.79
MIN	VOL IN [gal/min]	VOL OUT [gal/min]	NET
1	52.08	63.78	-11.70
SEC	VOL IN [gal/s]	VOL OUT [gal/s]	NET
1	0.87	1.06	-0.19

Additional Infiltration Testing

As construction for the Mammoth WWTP Project commenced, the potential challenges and unknowns associated with infiltration rates identified during the abovementioned initial geotechnical investigation phase of the project became more apparent as excavation of the ponds continued and native material was exposed. The Contractor noted that the limiting clay layer identified in BH-06 seemed to expand across most of Pond No. 3, which will inhibit infiltration rates of that pond. On October 10, 2022, Terracon completed additional infiltration testing by performing four (4) infiltration tests in general accordance with the methods outlined in WYDEQ Chapter 25, Appendix A on October 10, 2022. Terracon's infiltration tests occurred following the excavation of Pond No. 3 and partial excavation of Pond No. 4. The test elevation for Terracon's infiltration testing occurred at the new Pond No. 3 pond bottom (EL: 5967) and at the original pond bottom elevation for Pond No. 4 (EL: 5965). As construction was occurring, it was determined in discussion with NPS and to over excavate Pond No. 3 by three (3) feet to remove a portion of the clay layer which may have inhibited infiltration, but to also allow for additional storage, in case the Pond No. 3 does not infiltrate as expected. Results of those infiltration tests are shown below in Table 10 and an overview of all infiltration testing that has occurred to date is shown in Figure 6.

Table 10: WYDEQ Chapter 25, Appendix A Test Results (Terracon)

Test Type / Date Performed	Infiltration Rate (in/hr)
WY Percolation Test I1 (Terracon), 10.10.2022, Pond No. 4	0.28
WY Percolation Test I2 (Terracon), 10.10.2022, Pond No. 4	1.94
WY Percolation Test I3 (Terracon), 10.10.2022, Pond No. 3	0.04
WY Percolation Test I4 (Terracon), 10.10.2022, Pond No. 3	0.38

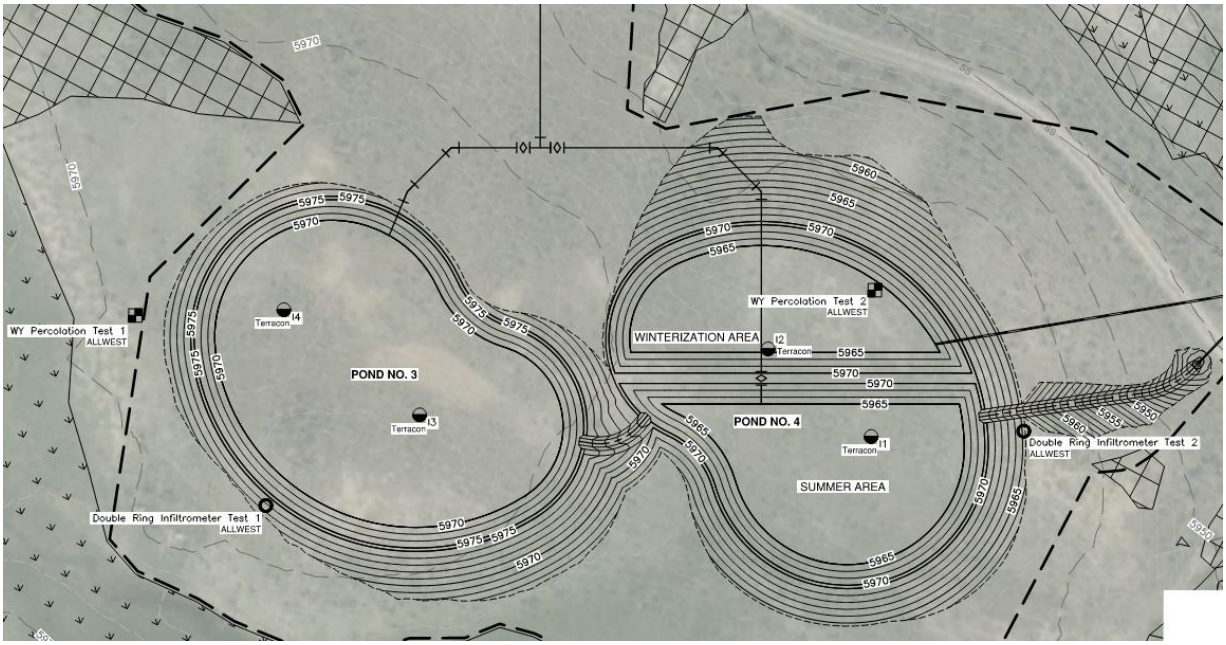


Figure 6: Overview of All Percolation Testing Locations

Pond Nos. 3 & 4 Storage Calculations

Pond storage was also evaluated in the event infiltration rates do not match the design rates identified during infiltration testing. Pond storage volumes include available pond area up to the overflow elevation and the aggregate voids. The plans call for a 2' depth of aggregate in the bottom of both ponds. A void ratio of 0.40 was used for the calculations, which is industry standard for washed and uniform aggregate used for infiltration basin filter bed material. Pond storage calculations utilized the following equation. Overall storage volumes for each pond are summarized in Table 11, Table 12, and Table 13.

$$V = \frac{D}{3}(A + B + \sqrt{AB})$$

Where:
V = Volume between two contours (ft)
D = Depth Between Contours (ft)
A = Area of Bottom Contour (ft^2)
B = Area of Top Contour (ft^2)

Table 11: Pond No. 3 Storage Calculations

Elevation [ft]	Depth [ft]	Area Top Contour [ft2]	Area Bottom Contour [ft2]	Incremental Volume [ft3]	Cumulative Volume [ft3]	Cumulative Volume [MG]
5967	0	25,199	0	0	0	0
5968	1	25,199	25,199	10,080	10,080	75,401
5969	1	25,199	25,199	10,080	20,159	150,801
5970	1	25,199	25,199	25,199	45,358	339,303
5971	1	25,199	25,199	25,199	70,557	527,804
5972	1	25,199	25,199	25,199	95,756	716,306
5973	1	27,432	25,199	26,308	122,064	913,101
5974	1	30,176	27,432	28,793	150,857	1,128,488
5974.5	0.5	31,374	30,176	15,387	166,243	1,243,587

Table 12: Pond No. 4 Storage Calculations (Summer Area)

Elevation [ft]	Depth [ft]	Area Top Contour [ft2]	Area Bottom Contour [ft2]	Incremental Volume [ft3]	Cumulative Volume [ft3]	Cumulative Volume [MG]
5965	0	11,786	0	0	0	0
5966	1	11,786	11,786	4,714	4,714	35,266
5967	1	11,786	11,786	4,714	9,429	70,532
5968	1	13,788	11,786	12,774	22,203	166,088
5969	1	15,646	13,788	14,707	36,910	276,105
5969.5	0.5	16,553	15,646	8,049	44,959	336,314

Table 13: Pond No. 4 Storage Calculations (Winter Area)

Elevation [ft]	Depth [ft]	Area Top Contour [ft2]	Area Bottom Contour [ft2]	Incremental Volume [ft3]	Cumulative Volume [ft3]	Cumulative Volume [MG]
5965	0	9,107	0	0	0	0
5966	1	9,107	9,107	3,643	3,643	27,249
5967	1	9,107	9,107	3,643	7,285	54,499
5968	1	10,273	9,107	6,295	13,580	101,586
5968.75	0.75	12,160	10,273	3,361	16,941	126,727

Percolation Pond Notes

Percolation Pond Nos. 3 and 4 were designed to meet EPA Process Design Manual for Land Treatment of Municipal Wastewater Effluents for application area. Each pond is intended to infiltrate faster than wastewater effluent flow enters the pond, over a 24-hour period, based on the available infiltration test results. Both ponds include a 2-ft over excavation of the pond bottom backfilled with Park-supplied aggregate to enhance infiltration. Larger air pockets will allow for faster water penetration and prevent dampness in the soil and water puddles in the ground while helping filter out any remaining particles in the wastewater effluent. Due to the unique geological features and site constraints associated with the project area and the limited amount of time that was available to perform a geotechnical investigation and subsequent evaluations, the percolation ponds were sized with n+1 redundancy using the initial infiltration rates determined by ALLWEST in August 2022. As originally designed, each pond is capable of infiltrating the design peak flow of 350,000 gpd over a 24-hour period.

The majority of the limiting clay layer encountered during the geotechnical borings, further discussed in the next report section, was located in Pond No. 3. Therefore, an open channel overflow was incorporated into the percolation pond design to allow for Pond No. 3 to overflow to Pond No. 4, in the event infiltration rates do not match the design rates identified during infiltration testing. Two additional overflows were incorporated into Pond No. 4; an open channel overflow to allow effluent to overflow to the existing 10-inch gravity pipeline downstream from the existing septic tank through a newly installed manhole, and subsequently into the infiltration ditch, Pond No. 1, and Pond No. 2. The second overflow for Pond No. 4 was incorporated into the winterized area, which includes a 12-inch HDPE pipe that originates in the aggregate layer above the StormTech® SC-310 chambers and daylights at the flared end section of the open channel overflow for Pond No. 4.

Geotechnical Considerations

Geotechnical borings were performed by ALLWEST on August 22nd and August 23rd, 2022, with boring locations shown in Figure 7.

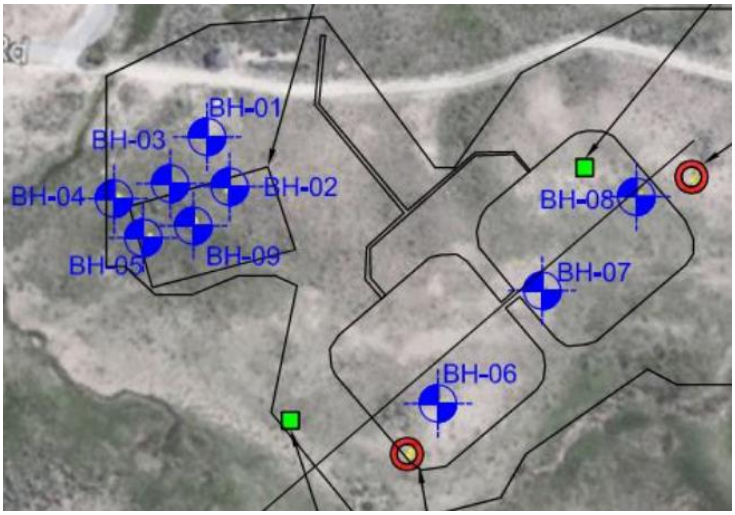


Figure 7: Geotechnical Boring Locations

Of the nine (9) borings that were performed, borings BH-06, BH-07, and BH-08 were applicable to the percolation ponds with BH-06 used for Pond No. 3, BH-08 used for Pond No. 4, and BH-07 used for both ponds. BH-06 hit auger refusal at 6.6-ft, and BH-07 encountered a clay layer from 7-ft to 18-ft depth, with no groundwater encountered up to 21.5-ft.

The clay layer identified in BH-07 was encountered by the Contractor, and the Contractor with input from the Engineer and NPS made the decision to over-excavate an additional 3-ft of the Pond No. 3 to both remove as much of the clay layer as practical without allowing groundwater to perch into the pond bottom and to increase the overall storage volume.

BH-08 encountered a clay layer at from 4.5-ft to 10-ft depth, with groundwater at 9.5-ft. Pond No. 4 was designed to be excavated no more than 2' to leave sufficient separation between bottom of pond and the clay layer for infiltration, as well as adequate separation from groundwater. The geotechnical evaluation, including all boring logs, are included in Appendix B.

Lift Station and Force Main

A new lift station equipped with submersible pumps will convey effluent wastewater to each percolation pond through a new force main. The lift station will intercept flow from the MBR Facility Effluent Tank. A schematic of the new lift station is shown below in Figure 8. Lift station design criteria for pump and force main sizing is located in Appendix C.

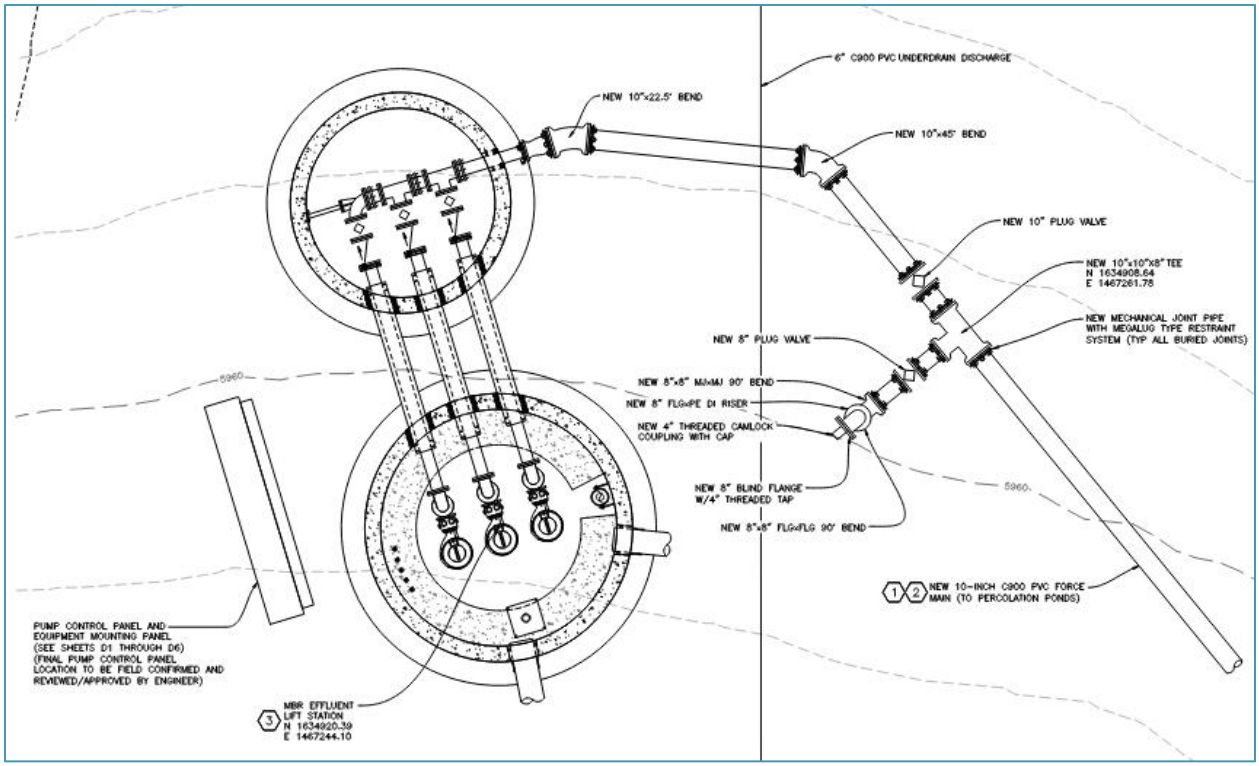


Figure 8: New Lift Station and Force Main

Infiltration Ditch Winterization

The design of the Mammoth Hot Springs WWTP Project relies on the existing infiltration ditch being able to function during the winter months while the MBR Facility is being constructed. Ditch winterization was initially proposed using StormTech chambers, backfill under and over the chambers with clean crushed angular aggregate supplied by the Park, and to meet insulation requirements associated with a frost depth of six feet, rigid styrofoam board insulation will be placed over the aggregate with 18-inches of native backfill material placed over the insulation. This winterization method was designed to allow for effluent within the ditch to be protected from freezing and allow infiltration to continue.

As the infiltration ditch winterization progressed and began to be implemented, it was determined by the Contractor that the installation of the chambers proved to be challenging due to the chambers not being able to follow the alignment of the ditch and sinking into the surrounding saturated soil as shown in Figure 9. The Contractor proposed to substitute the chambers with a 12-inch ADS double wall pipe with Contractor field modified perforations to facilitate seepage from the pipe where continued infiltration of effluent is desired. The NPS approved of the design revision.

Figure 9: StormTech Chamber Installation

Figure 10 below shows the finalized infiltration ditch winterization detail.

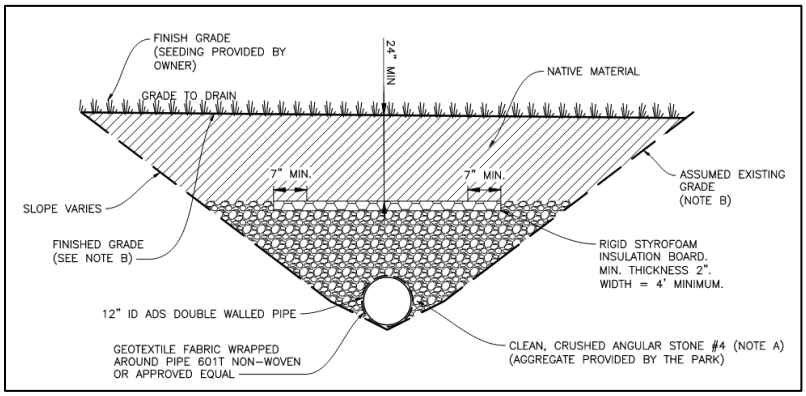


Figure 10: Infiltration Ditch Winterization Detail

Membrane Bioreactor (MBR) Facility

MBR Facility Selection

The StreamGo MBR packaged WWTP was the selected alternative for the Mammoth Hot Springs WWTP since it is uniquely able to provide the NPS with extremely high-quality effluent and meet the project schedule of allowing the Park to be fully operational by the end of 2022. It also provides the NPS a facility that is able to be reused and relocated to another facility within YNP at a later date.

MBR Facility Phasing

The MBR Facility will be implemented in a phased approach. Phase 1 will include required tankage and equipment to treat 150,000 gpd (biological) and 350,000 gpd (hydraulic). It will also include a lift station to intercept gravity wastewater flow and a temporary geotube building for solids dewatering and disposal. Phase 2 will include required tankage and equipment to treat 350,000 gpd (biological) and 600,000 gpd (hydraulic). It will also include a permanent sludge building for solids dewatering and disposal and a permanent generator.

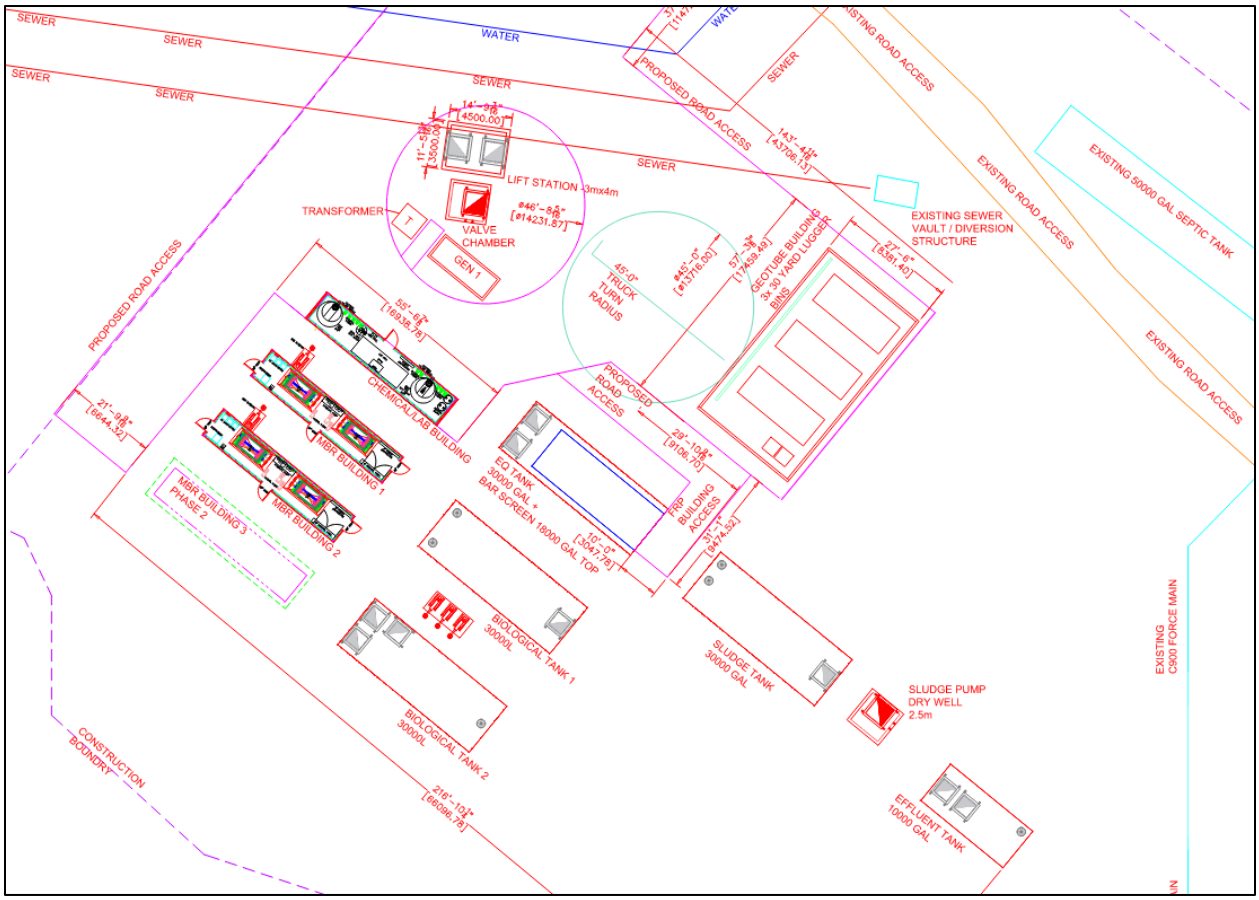


Figure 11: StreamGo MBR Facility Layout – Phase 1

MBR Facility Effluent Quality

Estimated influent wastewater characteristics and expected effluent discharge standards from the MBR Facility is shown below in Table 14.

Table 14: Expected Effluent Discharge Standards

	Aeration Tanks	Anoxic Tanks	BOD (mg/L)	TSS (mg/L)	TKN (mg/L)	Ammonia (mg/L)	Fecal Coliform (CFU/100 mL)
Influent	-	-	260	250	50	35	-
Phase 1	2	-	5	5	-	2	200

Since the MBR Facility will use the percolation ponds for discharge, it will be permitted through a Wyoming DEQ "Permit to Construct" rather than a WYPDES (Wyoming Pollutant Discharge Elimination System) Program surface-discharge permit or a Groundwater Section UIC (Underground Injection Control) Program permit. The Permit to Construct will contain any effluent discharge standards that the facility is expected to meet. Initial conversations with WYDEQ indicate that the standards listed above are likely acceptable.

The anticipated limits are contingent upon keeping the proposed percolation pond discharge method in addition to the system being temporary. Any discharge deviations made in the future (e.g., surface water discharge, etc.) or if the MBR Facility is expected to operate for more than five (5) years, WYDEQ may impose different effluent discharge standards. The StreamGo MBR drawings are included in Appendix D.

Electrical Power Supply Upgrades

The existing electrical service to the project area was found to be inadequate to support a new facility and thus a new service needed to be installed. Electrical power supply work associated with the Mammoth Hot Springs WWTP Project will generally include the following:

- Electrical Power Supply Upgrades:
  - NorthWestern Energy (NWE) will need to replace the existing 240VAC, 3Phase utility transformer currently serving the existing Lift Station with a new larger 480VAC, 3Phase transformer. During the project assessment phase, contact was made with NWE and subsequently they were able to locate an appropriate transformer and secure it for this project.
  - The new transformer will be of adequate size to serve a new 1200Amp, 480VAC, 3Phase distribution system. The 1200Amp distribution system will feed the existing lift station and all new loads associate with the new WWTP.
  - NWE has also determined that their primary distribution system to the site is adequate for this upgrade and additional work on the primary system will not be required.

  - NWE will remove the existing transformer, install a new transformer mounting base and the new transformer, as well connect all primary and secondary conductors at the new transformer.
- Utility Metering:
  - NWE has specific requirements for the utility metering for a 1200Amp service, including Current Transformer (CT) Enclosure and Meter Base, which will have to be adhered to.
- Main Disconnect Switch (MDS) and Automatic Transfer Switch (ATS):
  - Since the project will require standby power, there are two options for configuration of the service entrance main disconnect and transfer switch:
    - Provide a Service Entrance (SUSE) Rated ATS
    - Provide a separate Service Entrance Rated main disconnect and a non-SUSE rated ATS.
  - Due to cost, and procurement lead time, the use of a separate MDS and ATS is recommended.
- Automatic Transfer Switch:
  - The ATS will need to be installed early on, as part of the 1200Amp distribution system so as to avoid costly rework later on in the project phasing.
  - The ATS will be located next to the MDS, near the new utility transformer.
- Main Distribution Panel (MPD):
  - The MDP will be a 1200Amp rated switchboard with a main breaker and feeder breakers for:
    - Existing Lift Station
    - MBR Effluent Lift Station
    - Packaged WWTP loads
- Standby Power Generator:
  - The use of a standby power generator to provide backup power to the packaged WWTP will need to be further evaluated and discussed with the NPS.

Interim Operating Plan

To allow the NPS to evaluate and strategically schedule current and upcoming construction activities to successfully meet the project timeline and ensure Park operations remain uninterrupted, the below Order of Operations and Contingencies are being proposed:

Order of Operations

1. <u>Continued Emergency Infrastructure Use (Septic Tank, Winterized Infiltration Ditch, Pond No. 1, and Pond No. 2):</u>
   a. **Implementation Trigger:** currently implemented
   b. **Level of Wastewater Treatment:** primary
   c. **Plan Component:**
      i. Pond No. 1 freezing/ice: break ice with excavator bucket (NPS); as necessary.

2. Pump to Pond Nos. 3 and 4 via the **Existing Lift Station** / Pump & Haul a Portion of Wastewater to Gardiner:
    a. **Implementation Trigger:** existing emergency infrastructure is frozen or becomes unusable.
    b. **Level of Wastewater Treatment:** primary (for period of time wastewater spends in septic tank as it flows to the existing wet well).
    c. **Plan Component:**
        i. Pond No. 3 & 4: Add an 8" pipe and valve between the two ponds to connect them.
        ii. New NPS-installed force main: install a tee into existing force main and install new force main to Pond Nos. 3 and 4 (NPS Plumbing Shop); ASAP
        iii. Pump through NPS-installed force main to Pond Nos. 3 and 4 by using the existing septic tank and existing lift station on the gravity / collection side.
        iv. Regular pumping & hauling of septic tank to Gardiner once existing emergency infrastructure is no longer usable; NPS and/or Contractor (through combination of Park Service and Contracted Operations).

3. Pump to Pond Nos. 3 and 4 via the **New Lift Station** / Pump & Haul a Portion of Wastewater to Gardiner:
    a. **Implementation Trigger:** new lift station is constructed
    b. **Level of Wastewater Treatment:** primary
    c. **Plan Component:**
        i. Complete new lift station and new Contractor-installed force main to Pond Nos. 3 and 4; as soon as force main materials arrive and are installed.
        ii. Begin pumping wastewater through new Contractor-installed force main to Pond Nos. 3 and 4; as soon as lift station materials arrive and are installed
        iii. Regular pumping and hauling of septic tank to Gardiner once existing emergency infrastructure is no longer usable; NPS and/or Contractor (through combination of Park Service and Contracted Operations).

4. MBR Facility Online / MBR Effluent to Pond Nos. 3 and 4
    a. **Implementation Trigger:** MBR Facility startup and commissioning
    b. **Level of Wastewater Treatment:** tertiary
    c. **Plan Component:**
        i. MBR packaged plant components delivered; continue design coordination and StreamGo continue sourcing equipment; mid-December.
        ii. MBR packaged plant components installed, started up, and commissioned; mid-February.

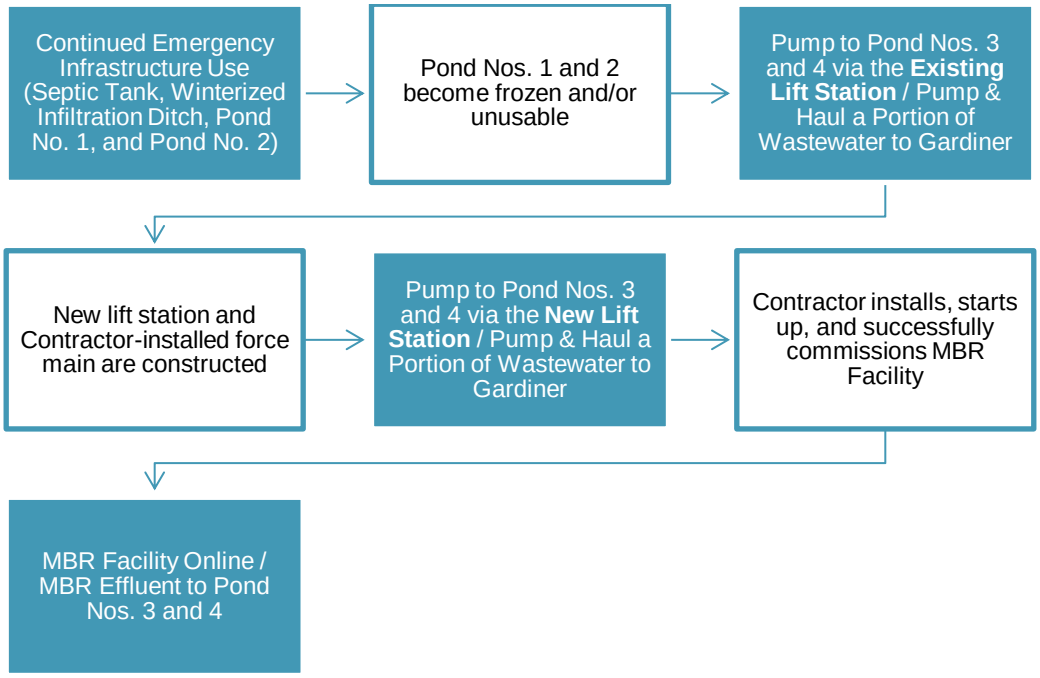


Figure 12: Mammoth WWTP Project – Interim Operating Plan

Appendix A.

Mini-Value Analysis Workshop Presentation

Appendix B.

Geotechnical Evaluation

Appendix C.

Lift Station Design Criteria and Pump Sizing

Appendix D.

StreamGo Drawings (Phase 1)

Appendix E.

Project Scoping Assessment

Appendix F.

Infiltration Data, Calculations, & Infiltration Test Summary

Appendix G.

Phase 1A Construction Documents (CDs)