CITY OF Grand Junction COLORADO

CITY MANAGER'S OFFICE

July 29, 2020

Colorado Water Conservation Board:
Finance Section
Attn: Matt Stearns, P.E.
1313 Sherman Street, Room 718
Denver, CO 80203

Dear Mr. Stearns,

Please find enclosed a Loan Feasibility Study and Loan Application for the Purdy Mesa Flowline Replacement Project that the city of Grand Junction is proposing to complete in 2021. We are requesting a $7 million loan for this project through the CWCB Water Project Loan Program.

Should you have any questions, please contact our Utilities Director, Randi Kim at 970-244-1429 or randik@gjcity.org.

Thank you for your consideration.

Sincerely,

Greg Caton, ICMA - CM
City Manager

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Water Project Loan Program

Projects financed by the Water Project Loan Program must align with the goals identified in Colorado's Water Plan and its measurable objectives.

Application Type

☐ Prequalification *(Attach 3 years of financial statements)* ☑ Loan Approval *(Attach Loan Feasibility Study)*

Agency/Company Information

Company / Borrower Name: City of Grand Junction

Authorized Agent &Title: Greg Caton, City Manager

Address: 250 N. Fifth Street, Grand Junction, CO 81501

Phone: (970) 244-1508 | Email: gregc@gjcity.org

Organization Type: ☐ Ditch Co, ☐ District, ☑ Municipality ☐ other:_____ | Incorporated? ☑ YES ☐ NO

County: Mesa | Number of Shares/Taps: 9,967 taps

Water District: | Avg. Water Diverted/Yr 5,300 acre-feet

Number of Shareholders/Customers Served: 30,000 | Current Assessment per Share $_____ (Ditch Co)

Federal ID Number: | Average monthly water bill $ 22.62 (Municipality)

Contact Information

Project Representative: Randi Kim

Phone: ( )970-244-1429 | Email: randik@gjcity.org

Engineer: John Eklund

Phone: ( )970-244-1558 | Email: johne@gjcity.org

Attorney: Jamie Beard

Phone: ( )970-256-4032 | Email: jamieb@gjcity.org

Project Information

Project Name: Purdy Mesa Flow Line Replacement

Brief Description of Project: (Attach separate sheets if needed)

The Purdy Mesa Flow Line is a gravity transmission main of approximately 17.5 miles and is the primary structure that conveys raw water from the Juniata Reservoir to the City of Grand Junction's Water Treatment Plant.

The flow line has reached the end of its useful life and needs replacement. The City has already replaced 11 miles of the line. This project will replace the remaining 6.5 miles of the Purdy Mesa Flow Line.

Project Start Date(s) Design: May 2020 Construction: February 2021

General Location: (Attach Map of Area)

Project Costs - Round to the nearest thousand

Estimated Engineering Costs: $120,000 | Estimated Construction Costs: $6,880,000

Other Costs (Describe Above): | Estimated Total Project Costs: $7,000,000

Requested Loan Amount: $7,000,000 | Requested Loan Term(10, 20, or 30 years): 20 Years

Signature

City Manager 7/29/2020

Signature / Title Date

Return to: Finance Section Attn: Matt Stearns
1313 Sherman St #718
Denver, CO 80203
Ph. 303/866.3441
e-mail: matthew.stearns@state.co.us

Loan Feasibility Study
City of Grand Junction
Purdy Mesa Flow Line

1.0 Background

1.1 Purpose

This section provides a brief overview of the project, including the type of project and amount of loan funding being requested, and a statement of what the project and study is intended to accomplish. It should describe the need for the project, the problems and opportunities to be addressed, the expectations of the study participants, and why the project is important to the borrower. It should also discuss relevant project history and identify any regulatory compliance issues that are being addressed, such as dam safety, water quality and flood control.

The Purdy Mesa Flow Line is a gravity transmission main of approximately 17.5 miles and is the primary structure that conveys raw water from the Juniata Reservoir to the City of Grand Junction's Water Treatment Plant. The flow line has reached the end of its useful life and needs replacement. The City already replaced approximately 6.1 miles of the PMFL with 24-inch PVC in 2001, another 3.7 miles with 20-inch PVC in 2009, and, 1.25 miles with 20-inch PVC in 2019. This project will replace the remaining 6.5 miles of the Purdy Mesa Flow Line. This last segment of the flow line was installed in 1948. It was later lined with mortar in 1966 to extend the service life. The estimated cost of replacement is $7 million. The City of Grand Junction is requesting a Water Project Loan of $7 million to fund the construction phase of this project. Replacement of the last segment of this supply line is intended to restore the service life of the Purdy Mesa Flow Line to 100 years and increase the flow capacity to 9.8 million gallons per day.

Feasibility Study participants include the City of Grand Junction and the Colorado Water Conservation Board. City staff will serve as the Project Engineer and plan to bid the construction phase of the project.

1.2 Study Area Description

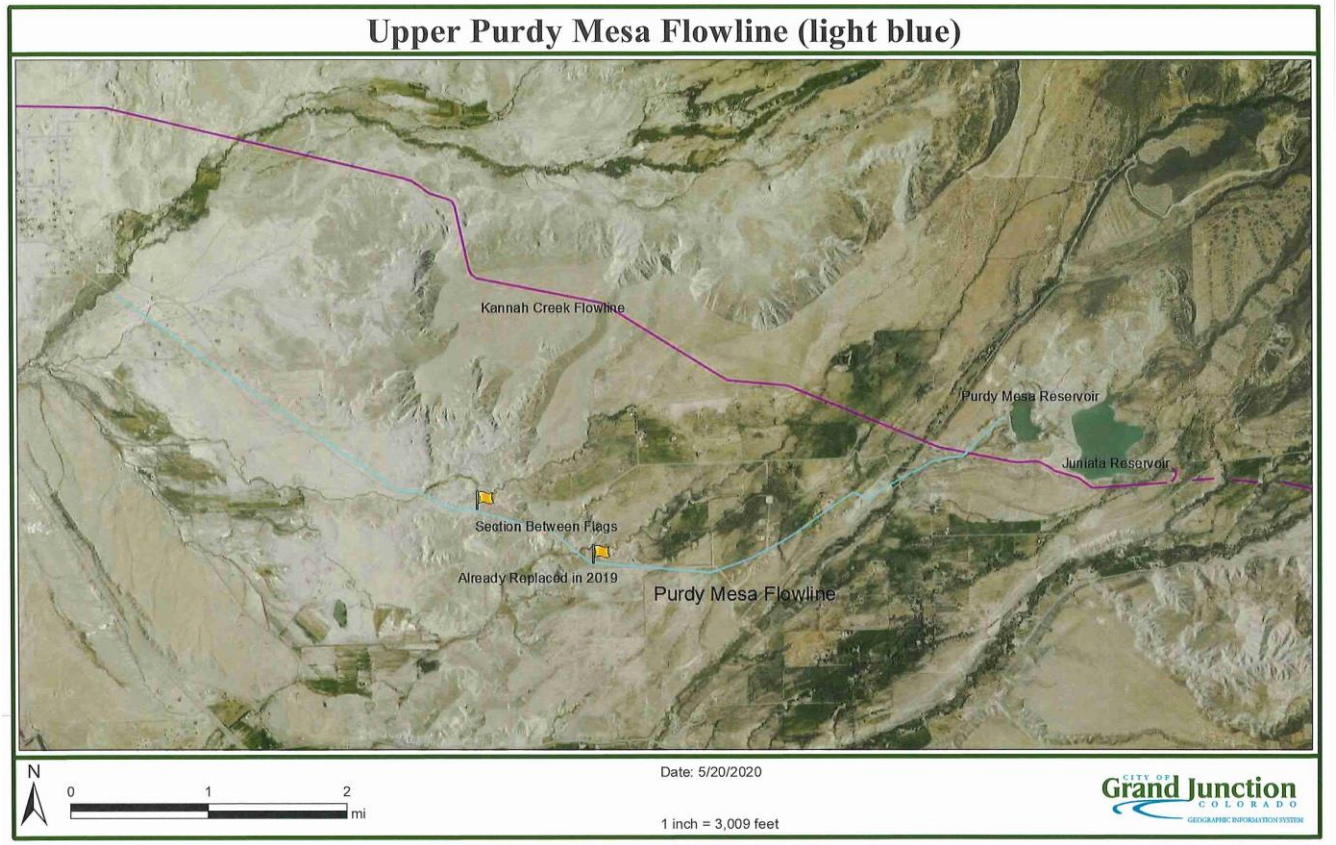
The study area/service area is generally the geographic area to be served by the proposed project. The study area description should include the following items:

a. *A narrative description of the study area to include the county, the location of towns or cities, topography, and locations of major streams.*
b. *A study area map showing each of the items above, as well as the locations of existing facilities, proposed project facilities and boundaries of lands to be served.*
c. *Socio-economic characteristics of the study area such as population, employment and land use. For irrigation projects, the tabulation should provide a description of cropping patterns and crop yields on existing agricultural lands.*

The study area encompasses the 6.5 miles of the Purdy Mesa Flow Line near Whitewater, Mesa County, Colorado depicted in **Figure 1**. The flowline traverses arid high desert country. This 6.5-mile section is split in half by the Sullivan Draw section that has already been replaced. The upper 3 miles starts at Juniata Reservoir, crosses some irrigated pastures and follows a gradual slope along the rocky crest of Purdy Mesa

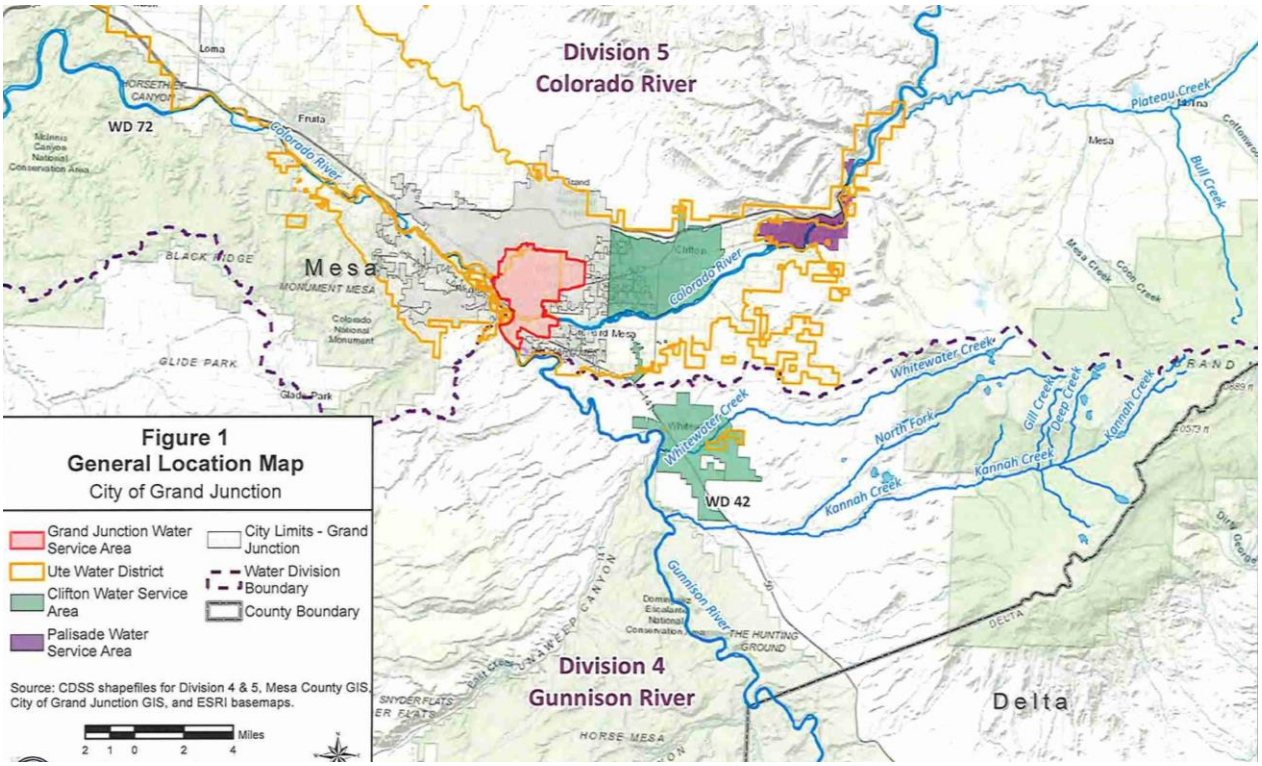
before joining the Sullivan Draw section, which is where the flowline drops off of Purdy Mesa. The proposed project then resumes about 1.25 miles downstream where it crosses alkaline flats and mancos shale to connect to existing PVC pipe at the Whitewater Creek crossing.

Figure 1 – GIS map of 6.5 miles of Purdy Mesa Flow Line



The project will serve the City of Grand Junction municipal water service area as shown in **Figure 2**.

Figure 2 – GIS map of City of Grand Junction Water Service Area



The City of Grand Junction's water service area covers only a portion of the City of Grand Junction city limits. Other portions of the City are served by Ute Water District and Clifton Water District. The City currently serves a population of 29,500 with an average demand of 4.9 million gallons per day (mgd) and a peak demand of 9.8 mgd. Based upon water supply analysis conducted by DiNatale Water Consultants for the City of Grand Junction, the 50-year population projection for the City's service area is 49,000 in 2069 with an average demand of 6.5 mgd and a peak demand of 13.0 mgd. The City's service area includes residential, commercial, and government customers.

The City's highest peak demand day since since 2017 has been 9.7 MGD. Though the Water Treatment Plant is capable of producing 16 MGD, our 5-year annual production average is 12% lower than it was 10 years ago, and 29% lower than the peak 5-year span seen in the mid-1990's. An options assessment conducted by Burns and MacDonnell estimated flowline replacement cost to be $4.9 million greater for a 24" line replacement versus a 20". While the City does realize the 50-year projection to be above what a 20" flowline can deliver, we feel we have adequate reservoir storage on-site at the treatment plant as well as the Kannah Creek flowline serving as the secondary conveyance pipeline to be able to adequately meet these anticipated higher demands under normal operating conditions.

1.3 Previous Studies

To the maximum extent possible, the results of any previous studies and investigation should be utilized for the current Loan Feasibility Study. If the Loan Feasibility Study was preceded by a reconnaissance-level study, the results of the reconnaissance study should be summarized.

The following studies were completed that support the basis for design of the Purdy Mesa Flow Line Replacement project:

1. Purdy Mesa Flowline Hydraulic Evaluation, Black & Veatch, April 2018. This report is included as **Appendix A**.
2. Water Supply Modeling Model Documentation and Firm Yield Determination Report, DiNatale Water Consultants, January 2019. This report is included as **Appendix B**.
3. Water Supply Analysis, DiNatale Water Consultants, July 2019. This report is included as **Appendix C**.
4. Options Assessment for the City of Grand Junction Water Supply, Burns & McDonnell, July 2020. This report is included as **Appendix D**.

2.0 Project Sponsor

Each Loan Feasibility Study should include a description of the entity (municipality, irrigation district, conservancy district, ditch company, etc.) that is sponsoring the proposed project. The project sponsor may be a public or private entity. The description should include the following:

a. Type of organization, official name, the year formed, and the statutes under which the entity was formed. For private entities, a copy of the Articles of Incorporation and By-laws should be appended to the report.
b. For public entities, the number of customers, taps, etc. served, and current water usage, and future growth plans.
c. For private entities, the number of members or shareholders and shares of stock outstanding or a description of other means of ownership, and current water delivery.
d. A brief history of the sponsoring entity.
e. Identification of revenue sources (existing service charges, tap fees, share assessments, etc.).
f. A description of existing water supply facilities owned and/or operated by the entity.

The City of Grand Junction is the project sponsor. The City of Grand Junction is a Colorado Home Rule municipality organized under Article XX, section 6 of the Colorado Constitution. As a Home Rule Municipality, the City adopted a Charter on September 14, 1909. The Constitution was adopted after the City Charter and Grand Junction is specifically cited in the Constitution and the City Charter is adopted and ratified by reference.

The Constitution, the Charter, the laws of the State of Colorado and the ordinances, resolutions and regulations of the City serve as "bylaws" for the conduct of City business.

The City of Grand Junction's serves a population of 29,500 with about 9,800 taps. Current average water demand is 4.9 million gallons per day (mgd) with a peak demand of 9.8 mgd. The 50-year population projection for the City's service area is 49,000 in 2069 with an average demand of 6.5 mgd and a peak demand of 13.0 mgd.

The City's Utilities Department oversees the Water Services Division which is responsible for operation and maintenance of the water supply, treatment and distribution system. Operations expenses and capital projects are funded by the Water Enterprise Fund. Revenue sources for the Water Enterprise Fund include water service charges and tap fees.

The City's water supply is the Kannah Creek watershed which covers 200 square miles on the top and west side of the Grand Mesa. The City has a number of water diversion and storage rights within this watershed including a paramount water right on the Kannah Creek and storage rights in 19 reservoirs. Water is conveyed from the City's terminal Juniata Reservoir to the City's water treatment plant via the Purdy Mesa Flow Line.

3.0 Water Rights

3.1 Water Availability

The Loan Feasibility Study should provide a detailed description and analysis of each water supply source to be utilized by the proposed project. (A brief description of existing sources may be adequate for projects that involve only rehabilitation of existing facilities). Each source of supply should be described in terms of location, yield, extent of development, and water rights status. Maps and schematic diagrams should be included as a part of the description.

For surface water sources, the description should include a numerical and graphical tabulation of annual flows and average monthly flows for the period of record on each stream. For groundwater sources, the source aquifer(s) and the expected yields and reliability of wells should be identified. A complete tabulation of water rights for each surface water source should also be provided to include appropriation dates, adjudication dates, status of adjudication (absolute or conditional), and amounts decreed to direct flow or to storage. For groundwater sources, the status of well permits and history of use should be provided.

For new water supply facilities or the expansion of existing facilities, an analysis of the expected yield of water supply sources should be included in the Loan Feasibility Study. The analysis should be performed in such a way as to take into account a reasonable range of variations in flow due to hydrologic and meteorological conditions as well as the operation of the water rights priority system.

The City's water supply is the Kannah Creek watershed which covers 200 square miles on the top and west side of the Grand Mesa. The City has a number of water diversion and storage rights within this watershed including a paramount water right on the Kannah Creek and storage rights in 19 reservoirs. Water is conveyed from the City's terminal Juniata Reservoir to the City's water treatment plant via the Purdy Mesa Flow Line.

Water Supply Modeling conducted by DiNatale Water Consultants determined a firm yield for the Kannah Creek watershed of between 5,800 and 6,275 acre-feet per year A copy of the Water Supply Modeling report is included in **Appendix B**.

3.2 Water Supply Demands

Existing and future water demands are analyzed, as well as the adequacy of water rights/existing yields, and water demand and availability are compared. Study area water demands are generally estimated for a selected planning horizon or period of time. Typically, a planning horizon should be at least as long as the CWCB loan period. Demands are estimated for the study planning horizon and compared with the yields of existing supplies. If the comparison indicates a water supply deficit at some point during the planning horizon, alternatives are formulated to meet the deficit by reducing demands or increasing supplies, or both. Alternatives are then formulated to supply water to the project service area under

varying degrees of reliability.

In support of its water rights due diligence filings, DiNatale Water Consultants analyzed current and future water supply demands for a 50-year timeframe. Using the current per capita potable water demand and the projected population for 2069, the City's annual treated water demand is 8,760 acre-feet (AF) as measured as production at the water treatment plant. This is 3,460 AF more than the current (2018) potable water treatment plant production demand of 5,300 acre-feet. A copy of the Water Supply Analysis (July 2019) is included in **Appendix C**.

4.0 Project Description - Analysis of Alternatives & Selected Alternative

This section further documents the project need by assessing existing and future conditions, identifying problems and deficiencies, and formulating and evaluating potential solutions.

4.1 Analysis of Alternatives

Each study should include the formulation and evaluation of a reasonable number of alternatives for accomplishing the study objective(s). The number of alternatives will depend upon the objective and scope of the Loan Feasibility Study. Generally a minimum of three alternatives should be presented, one of which should be the "no-action alternative." Each alternative should be described in terms of its various components (both structural and non-structural) and the manner in which the proposed facility will operate. Examples of non-structural elements are improvements in the management of developed water supplies, water transfers from existing to new uses and new or revised institutional arrangements.

Evaluation Factors - Alternatives should be evaluated to distinguish the differences between them, in accordance with evaluation factors suggested below: Project evaluation factors typically used are as follows:

a. *Outputs/yields - Project outputs are typically expressed in terms of acre-feet of water supply or in units of energy for hydropower. For municipal water supply projects, the estimated safe annual yield of the project should be given. The safe annual yield is the amount of water the project is expected to yield during each year of a critical dry period. For irrigation projects, the yield should be expressed in terms of acre-feet of water supplied to the project service area on an annual basis. The degree of reliability or firmness of a particular yield should also be given. For projects that involve the rehabilitation of existing facilities, the yield should be expressed as the incremental difference in water supply with and without the project.*
b. *Costs (capital, operations and maintenance (O & M), total annual costs and costs per unit) - A cost comparison should be made between alternatives. The cost analyses should consist of: (1) an estimate of total capital costs and total annual (O & M) and replacement costs for each alternative, and (2) a total annual cost for each alternative calculated by adding O & M to amortized capital costs, and (3) a cost per unit of project output, i.e. annual project cost per acre-foot of water delivered.*
c. *Impacts – Identifies and compares potential impacts to the man-made environment and the natural environment:*
    1. *impacts on the man-made environment – residential or commercial buildings affected; utility relocations; acreages of developed lands impacted; historical and archaeological sites impacted; impacts on outdoor recreation activities.*
    2. *impacts on the natural environment - acres of forest, grasslands, etc. to be impacted; streamflow impacts; water quality impacts; impacts on vegetation, aquatic wildlife and*

terrestrial wildlife; threatened and endangered species in the project area; impacts to federal land national forests, wilderness areas or other areas.

d. *Economic analysis and feasibility - The level of economic analysis will vary from project to project, but generally will include an assessment of benefits and costs. An estimate of the number of shareholders, members, households, etc., expected to benefit from the project should be provided.*
e. *Institutional requirements – Identify and evaluate permits, court actions, contracts, agreements, etc. that are required for project implementation.*
f. *Special considerations - These are extraordinary situations likely to be encountered during design and/or construction. They may relate to special technical considerations, the need for further investigations, uncertainty or risk associated with demand projections or cost estimates, or the possibility of new technologies affecting project.*

The results of the alternatives evaluation should be described and displayed in such a manner that the differences between alternatives are apparent. The report should identify the differences between alternatives and comparative costs, and should describe the process (evaluation methodology) used in selecting one of the alternatives as the preferred plan.

The purpose of this project is to provide a means for the City of Grand Junction to continue providing potable water to City customers by increasing the reliability of the primary water supply line and increasing the capacity to meet future demands. Three alternatives were considered:

1. The no-action alternative.
2. Replace the remaining steel section of the Purdy Mesa Flow Line with 20-inch PVC ($7,00,000).
3. Replace the remaining steel section of the Purdy Mesa Flow Line with 24-inch PVC ($11,900,000).

Alternative No. 1 was considered unacceptable because the existing 1948 steel pipe has reached its useful life. The pipe was mortar lined in 1966 which extended its useful life but the steel shell is still susceptible to corrosion especially in the corrosive soil environment in this area.

Alternative No. 2 was selected because it is the least costly reliable alternative. This alternative provides reliability and capacity to meet current and future demands. It does not provide full capacity on peak demand days 50 years into the future. However, the City also maintain reservoir storage capacity at the water treatment plant that can be utilized to supplement water supply on peak demand days.

Alternative No. 3 was ruled out due to the additional cost for additional capacity that would only be needed on peak demand days. The City can utilize reservoir storage capacity at the water treatment plant to supplement water supply on peak demand days. Further, the City has already replaced 3.7 miles of the Purdy Mesa Flow Line with 20-inch PVC in 2009. This segment would have to be replaced with 24-inch diameter pipe to achieve the higher capacity. Therefore, a decision was made in 2018 to replace the 1.25-mile Sullivan Draw segment with 20-inch diameter pipe and continue with 20-inch pipe for the remaining 6.5 miles of the Purdy Mesa Flow Line.

The City of Grand Junction has prepared a comparative cost estimates for the project alternatives. The cost breakdown is summarized in **Tables 1** and **2**.

Table 1. Alternative 2 Cost Estimate (Selected Alternative: 20-Inch PVC)

Cost Estimate Item	Quantity	Unit	Unit Price $	Amount $
Mobilization	1	LS	$170,000.00	$170,000
20-inch PVC	33,000	LF	$90.00	$2,970,000
Fittings	170	Each	$2000.00	$340,000
Air Vacs	10	Each	$6,500	$65,000
Contingency	1	LS	$340,000	$340,000
Total				**$7,000,000**

Table 2. Alternative 3 Cost Estimate (Evaluated Alternative: 24-Inch PVC)

Cost Estimate Item	Quantity	Unit	Unit Price $	Amount $
Mobilization	1	LS	$225,000.00	$225,000
24-inch PVC	33,000	LF	$120.00	$3,960,000
Fittings	170	Each	$2600.00	$442,000
Air Vacs	10	Each	$8,500	$85,000
Contingency	1	LS	$450,000	$450,000
Total				**$11,900,000**

4.2 Selected Alternative

A detailed description of the Selected Alternative should be provided and should include the following:

a. *Project Description – A narrative description of project components and operation to indicate how the entire project will function.*
b. *Map - A map of the entire project area showing the locations of existing and proposed project components, and other features like floodplains, spillway inundation zones, etc.*
c. *Conceptual Plan/Cross-Section - Layout and cross-sections for each major structure to include dimensions and hydraulic properties. Profile and typical sections for canals and pipelines with water surface and hydraulic gradeline elevations.*
d. *Conceptual Design Features - Hydraulic, hydrologic, and structural design criteria for all proposed facilities including:*

- *Sizing criteria for all hydraulic features such as reservoirs, outlet works, canals, pipelines, pumping plants, etc. with associated energy losses where appropriate.*
- *Preliminary structural design criteria including loadings, stresses, geotechnical considerations, and assumptions used for stability analyses.*
- *Derivation of the reservoir inflow design flood with volume, peak discharge and routing through the reservoir.*
- *Spillway sizing for the inflow design flood.*
- *The number, size and operating characteristics of pumping units.*
- *Other site factors such as erosion hazard, icing and cold-weather conditions, special construction requirements, and sedimentation.*

e. *Field Investigations - A description of all field investigations including the date of the investigations,*

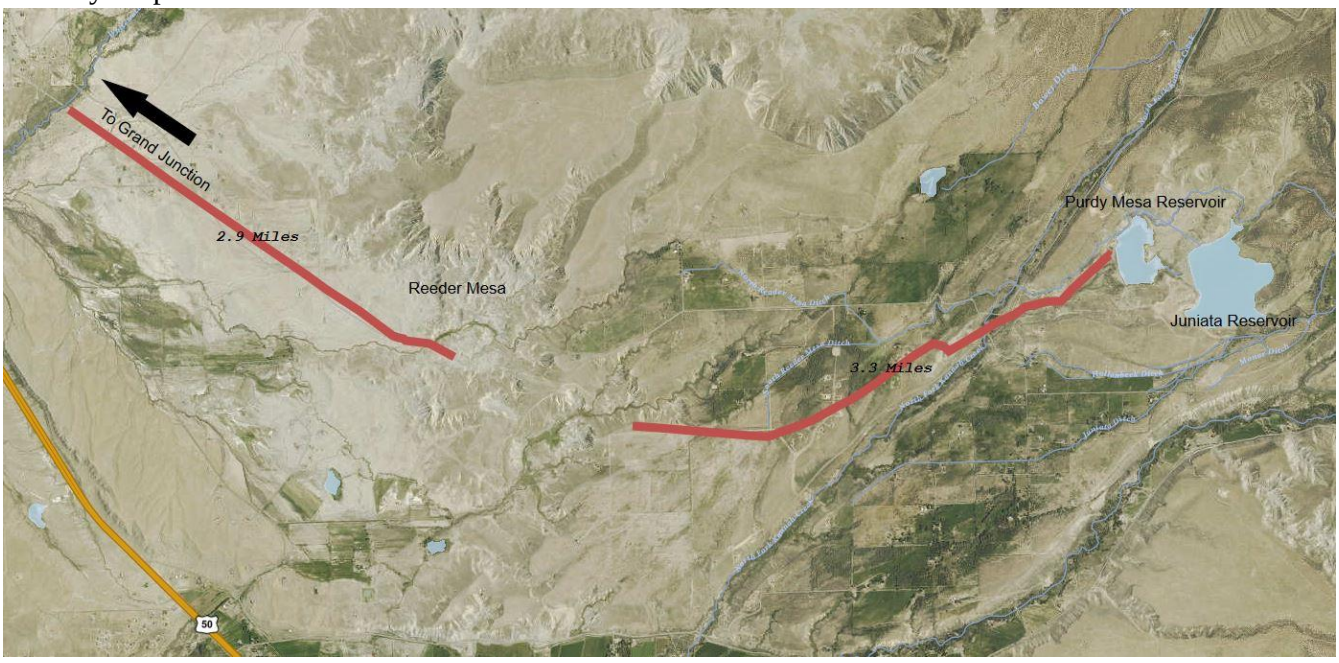
type of investigations, methodology used and results. For all major structures, the Loan Feasibility Study should describe site conditions, engineering geology, geologic mapping, source and availability of construction materials, and subsurface investigations used in the design of the structure. Where geologic conditions are poor or may require intensive exploration and evaluation, a comprehensive report by a qualified engineering geologist may be necessary.

f. Right-of-Way/Land - Land and right-of-way requirements for the proposed project and a tabulation of land ownership at the site of proposed facilities.

a) The two proposed segments, totaling 33,000 LF (approximately 6.2 miles) of the Purdy Mesa Flowline (PMFL), are the last portion of the pipeline to be replaced. Replacement pipe will be installed approximately 15' offset from existing alignment and is proposed C900 PVC. Standard minimum cover is 4' using standard elbows for abrupt changes in alignment. Up to 10 air vacs are required to prevent air binding. Up to 3 drains are required; one is a replacement and 2 are proposed in new locations (TBD). If new drain locations are added, isolation valves will be included to shorten losses due to repairs or maintenance.

Pressure Control Tank. A pressure control tank is proposed as part of this project. The tank is designed to allow hydraulic equalization in the pipeline when the flows are adjusted to ensure that the pipe stays full, prevents air entrainment, and does not overflow. A design for this has been created as part of a previous project. However, the volume determined in that design was for a larger pipe size. The City is under Contract with a consultant to determine the appropriate design volume for the 20" pipeline utilizing the most recent operating data following replacement of the Sullivan Draw segment of the Purdy Mesa Flow Line.

b) Vicinity Map



c) Conceptual plans for the pipeline and the tank can be reference in **Appendix E**.

d) The pipeline replacement design is based on the recommendations from two studies performed for the City of Grand Junction:
    5. Purdy Mesa Flowline Hydraulic Evaluation, Black & Veatch, April 2018
    6. Options Assessment for the City of Grand Junction Water Supply, Burns & McDonnell, July 2020.

    The study by Black & Veatch recommended upsizing the entire length of the Purdy Mesa Flowline to 24-inches to achieve a maximum flow capacity of 9.8 mgd and 24-inches to achieve 14.4 mgd. The study by Burns & McDonnell suggested that the selecting the 20-inch option would allow the City to meet peak demand for future buildout and rely on the Kannah Creek Flowline as backup and redundancy. Pipeline hydraulics can be found in the Black and Veatch study.
e) Geotechnical investigation is forthcoming. It will be a fairly minor part of the overall design cost since most of the land is open adjacent to existing pipe. The ground is known to be Badland and Killpack soil types that are high in stone and boulder content. Up to 12 test pits will be observed prior to final design (approximate every ½ mile along pipeline).
f) ROW is expected to be a minor part of the design effort portions of the pipeline are on BLM lands and predate the Federal Land Policy and Management Act of 1976. In these parcels, the City has ROW 50 feet on either side of the existing pipeline (100' total width). All new pipeline installation will be within this ROW. Easements exist on private properties for the City Pipelines with the same dimensions as the BLM easement. A records search is underway to ensure all easements are properly recorded. A small ROW budget is designated to purchase easement that are not already recorded.

4.3 Cost Estimate

Provide a detailed estimate for all capital costs of project implementation such as planning and permitting activities, engineering design, construction inspection, administrative and legal costs, land and right-of-way acquisition, relocation costs, construction costs, financing costs and an appropriate contingency factor. Detailed construction cost estimates should include a tabulation of quantities, unit costs and total costs. Allowance should be made for cost escalation expected between the date of the construction cost estimate and the award of the construction contract. For large projects with multi-year construction schedules, cost escalation during construction should also be estimated.

A cost estimate for capital project implementation for the selected alternative is presented in **Table 3**.

Table 3 – Detailed Cost Estimate for Selected Alternative

			20" Pipe (Selected Alternative)	
	Unit	Qty	Price	Extended
Design				
Geotechnical Investigation	LS	1	$15,000	$15,000
Historical Documentation	LS	1	$10,000	$10,000
Environmental Consulting	LS	1	$20,000	$20,000
ROW (Easement Acquisition)	Each	15	$5,000	$75,000
			Subtotal:	$120,000
Construction				
Mobilization (5%)	LS	1	$201,750	$201,750
20" C900	LF	33000	$110	$3,630,000
Fittings	Each	170	$2,000	$340,000
Air Vacs	Each	10	$6,500	$65,000
Pressure Control Tank	LS	1	$1,500,000	1,500,000
Contingency (20%)	LS	1	$553,500	1,147,350
			Subtotal:	6,884,100
			Project Total (rounded):	**$7,000,000**

4.4 Implementation Schedule

Provide a project implementation schedule showing the beginning and completion dates for all activities required for project implementation such as planning studies, permits, design, contracts, land and right-of-way acquisition, financing, and construction.

The following is a project implementation schedule for the Purdy Mesa Flow Line Replacement Project:

Project Activity	Start Date	Completion Date
Preliminary Engineering	May 2020	August 2020
Environmental/Cultural Study	May 2020	December 2020
Geotechnical Investigation	July 2020	December 2020
Survey	June 2020	August 2020
Permitting	June 2020	December 2020
Easements	July 2020	December 2020
Design	May 2020	December 2020
Bidding	January 2021	February 2021
Construction	February 2021	August 2021

4.5 Impacts

Provide plans for addressing impacts identified in Section 4.1.c. Also include consideration of the impact of the proposed project on local and/or regional plans for water resource development, land use, recreation, water quality management, economic development, and other social and environmental effects.

The replacement of aging transmission pipe has important several important impacts. It reduces the risk of pipe failures. This ensures more reliable and resilient delivery of water to customers, increase safety to City Staff, reduces annual maintenance and repair cost, reduces loss of water due to undetected leaks and breaks, which can cause erosion and degrade sensitive desert landscape and potentially increase sediment and air entrainment to the City of Grand Junction Water Treatment Plant.

An Inventory of Endangered or Threatened Species, Cultural and Paleontological Resources will be performed as part of the SF299 Permit Application (see Section 4.6). Any species or resource noted in the project area will be appropriately protected using methods including, but not limited to adjusting construction schedule, fencing protected sites, moving protected species, reconfiguring pipe alignment as identified in the corresponding Treatment Plans. Any fenced areas will be shown on the final Construction Plans.

4.6 Institutional Feasibility

Address institutional considerations such as actions or proceedings that must be undertaken to obtain compliance from governmental agencies, or other parties involved in design, construction and financing, to allow project implementation. They include permits, court actions, contracts, agreements, other agency approvals, etc. Coordination on the project may be required with other Department of Natural Resources Departments such as Division of Wildlife and Division of Parks.

The U.S. Corps of Engineers 404 (Dredge and Fill) Permit is generally the key approval for water diversion and storage projects. The 404 permit may trigger the U.S. Environmental Protection Agency - National Environmental Policy Act (NEPA) process, which can require an Environmental Impact Statement (EIS) or an Environmental Assessment (EA) for smaller projects.

Other typical federal, state, and local permits that could be encountered are:
- *U.S. Forest Service – special use permit*
- *U.S. Fish and Wildlife – endangered species consultation*
- *U.S. Bureau of Reclamation – right-of-way/permit, lease, license agreement, easement, carriage contract, etc.*
- *State Division of Water Resources – well permits, engineering plan approval*
- *State Water Quality Control Division – water quality*
- *County Commissioner approval - conditional or special use, HB 1041 activities of "state interest"*

The Bureau of Land Management requires the City to submit an Application for Transportation, Utility Systems, Telecommunication and Facilities on Federal Lands and Property (SF299). While this will include environmental studies and possibly a Cultural Resource Inventory, the permit will be expedited due to the pipeline being installed prior to the aforementioned 1976 Act.

The City will also submit a Pre-Construction Notification (PCN) application to United States Army Corps of Engineers (USACE) to seek approval for the Wetlands – 404 permit with regard to the ephemeral washes that the pipeline crosses in these reaches.

5.0 Financial Feasibility Analysis

This section documents the financial feasibility of the selected alternative. It provides a detailed financial program to describe financing arrangements and the sources and uses of funds for the proposed project. It provides an analysis of the project sponsor's ability to repay all existing and projected debt service, as well as normal operating expenses. This section includes:

1. Loan Amount - Discuss total project costs, the amount of CWCB loan requested, and the term and interest rate sought.

2. Financing Sources – Identify sources of funding for the project, including how the local share will be provided. Describe each method of financing to be utilized, such as CWCB loan, loans from other agencies, bonds, etc.

3. Revenue and Expenditure Projections – Include a detailed schedule of estimated annual revenues and annual expenditures for the entire period of debt retirement. Annual revenues should be estimated and displayed for each source of funds (assessments, water sales, property taxes, etc.). Annual expenditures should be displayed for debt retirement payments to each category of debt, for operation and maintenance costs, and for payments to reserve funds. For CWCB loans, borrowers are required to accumulate the equivalent of one annual loan payment in a loan reserve fund, over the first 10 years of loan repayment. (i.e. place in reserve 10% of the annual loan payment for each of the first 10 years of the loan.) An example of a schedule of annual revenues and expenditures is provided herein, and an electronic version and an example of how to use it, are included in the CWCB website at www.cwcb.state.co.us.

4. Loan Repayment Sources - Describe sources of funds for loan repayment, such as assessments, water sales, property taxes and grants. Discuss current water rates/ assessments/fees. Feasibility studies for projects with a hydropower component should include an assessment of the potential market for the hydropower.

5. Financial Impacts – Discuss financial impacts of the project on total debt, water rates, assessments of users, and property taxes. Determine future rates needed to cover CWCB loan obligations and additional operating costs. Discuss savings or new revenues generated.

6. TABOR (Taxpayer's Bill of Rights) Issues - Provide a full discussion of TABOR issues, particularly regarding the ability to incur multi-year debt, and limits on increased tax revenues and spending. An election may be required for public entities not havingSince the status of a qualified enterprise. The provisions of TABOR are complex and may require an attorney and/or accountant opinion.

7. Collateral - Discuss specifics of the loan collateral or security being offered by the borrower (in accordance with CWCB Policies) to assure repayment of the CWCB loan. The type of collateral will vary based on the type of organization, and typically may include a pledge of revenues/assessments, project facilities/water rights, or real property. If real property is offered as collateral, the applicant will be required to submit supporting documentation of land values, based on current land use and including improvements financed by the CWCB, from a Colorado Certified General Appraiser. If water rights are being purchased or offered as collateral, the applicant will be required to submit a written appraisal or opinion of value from a qualified water rights appraiser supporting the purchase price and value.

8. Sponsor Creditworthiness - Provide information to be used by staff to evaluate creditworthiness and financial need (in accordance with CWCB Policies) as follows:

a) Current schedule of rates or assessments.
b) Copies of the three most recent audit reports of financial statements.
c) A current credit report, if requested.

Loan Amount
The City of Grand Junction is requesting a loan amount of $7,000,000 to cover estimated construction costs. The City is requesting a 20-year term at the low-income interest rate of 1.6%. resulting in annual payments of $411,750. To this would be added $41,175 per year for the first 10 years to fund the loan reserve account, for a total annual cost of $452,925.

Financing Sources
The City is requesting 100% funding from the CWCB Water Project Loan.

Revenue and Expenditures Projections
The **Table 4** presents a summary of revenue and expenditures projections for the loan period. Revenue projections are based upon the assumption that the City will increase water rates by 5% annually between 2022 and 2025 and then by 2% thereafter. The projected 2021 beginning balance (reserve funds) for the City's Water Enterprise is $4.2 million.

Table 4 – Revenue and Expenditure Projections

	Revenue		Expenses					
Year	**Annual Revenue**	**Other Revenue (Loan Proceeds)**	**Operating Expense**	**Capital Expense**	**CWCB Loan Reserve Fund**	**Existing Debt Service**	**Payments on CWCB Loan*** **	**Total Expenditures**
2021	$9,110,783	$10,000,000*	$5,480,298	$13,755,318		$737,500		$19,973,116
2022	$9,325,826	$3,500,000**	$5,629,724	$5,547,778	$41,750	$735,744	$411,751	$12,366,747
2023	$9,546,782	$3,000,000**	$5,783,257	$5,211,511	$41,750	$487,919	$411,751	$11,936,188
2024	$9,773,815		$5,941,015	$1,756,556	$41,750	$487,919	$411,751	$8,638,991
2025	$10,007,091	$2,500,000**	$6,103,109	$4,342,953	$41,750	$487,919	$411,751	$11,387,482
2026	$10,246,780		$6,269,665	$1,940,741	$41,750	$487,919	$411,751	$9,151,826
2027	$10,493,065		$6,440,802	$2,039,964	$41,750	$487,919	$411,751	$9,422,186
2028	$10,746,121		$6,616,650	$1,990,663	$41,750	$487,919	$411,751	$9,548,733
2029	$11,006,136		$6,797,340	$2,042,883	$41,750	$487,919	$411,751	$9,781,643
2030	$11,224,725	$10,000,000**	$6,983,005	$12,146,669	$41,750	$365,551	$411,751	$19,948,726
2031	$11,448,232		$7,173,783	$2,205,069	$41,750	$243,181	$411,751	$10,075,534
2032	$11,676,769		$7,369,816	$2,265,222		$243,181	$411,751	$10,289,970
2033	$11,910,449		$7,571,252	$3,027,178		$243,181	$411,751	$11,253,362
2034	$12,149,384		$7,778,238	$2,390,993		$243,181	$411,751	$10,824,163
2035	$12,393,697		$7,990,932	$2,456,723		$243,181	$411,751	$11,102,587
2036	$12,643,507		$8,209,490	$2,524,425		$243,181	$411,751	$11,388,847
2037	$12,898,936		$8,434,073	$2,594,157		$151,866	$411,751	$11,591,847
2038	$13,160,114		$8,664,853	$2,665,982		$102,107	$411,751	$11,844,693
2039	$13,427,169		$8,902,000	$2,739,961		$102,107	$411,751	$12,155,819
2040	$13,700,232		$9,145,692	$2,816,160		$51,054	$411,751	$12,424,657
2041	$13,979,438		$9,396,110	$2,894,644				$12,290,754

*Includes $7 million CWCB loan for Purdy Mesa Flowline Project and additional $3 million CWCB loan for Carson Lake Dam Rehabilitation Project.

**Future anticipated loans

***Payments on $7 million loan, does not include future loan payments.

Loan Repayment Sources
Sources of funds for loan repayment are water service charges.

Financial Impacts
This loan of $7 million will increase total debt service from $6 to $13 million. The City anticipates increasing water rates by 5% annually between 2022 and 2025 and then by 2% thereafter to cover CWCB loan obligations.

TABOR
Since revenues are from Water sales and not from City taxes, there are no TABOR issues associated with this project.

Collateral
Collateral for this loan consists of a pledge of Water revenues.

Sponsor Creditworthiness
The following information is included to support the City of Grand Junction's creditworthiness:

a) Current schedule of Water Rates (**Appendix F**).
b) 2016, 2017, and 2018 Comprehensive Annual Financial Reports (**Appendix G**)

6.0 Conclusions and Recommendation

Provide a summary of study conclusions, and an opinion and recommendation as to the overall feasibility of the project and the feasibility of loan repayment.

In conclusion, the City has determined that the Purdy Mesa Flowline Replacement project is technically feasible and repayment of the $7 million loan is feasible for the City's Water Enterprise Fund to repay over the 20-year loan period. City staff are recommending application of this loan through the CWCB Water Loan Program.

Appendices

A Purdy Mesa Flowline Hydraulic Evaluation, Black & Veatch, April 2018

B Water Supply Modeling Model Documentation and Firm Yield Determination Report, DiNatale Water Consultants, January 2019

C Water Supply Analysis, DiNatale Water Consultants, July 2019

D Options Assessment for the City of Grand Junction Water Supply, Burns & McDonnell, July 2020.

E Conceptual Design Plans for Purdy Mesa Flow Line and Pressure Control Tank

F Water Rates Resolution

G Three Most Recent Audit Reports

FINAL

PURDY MESA FLOW LINE HYDRAULIC EVALUATION

Grand Junction, Colorado

B&V PROJECT NO. 197600

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PREPARED FOR

City of Grand Junction

6 APRIL 2018

BLACK & VEATCH

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1 Introduction

The Purdy Mesa Flow Line (PMFL) is a gravity transmission main of approximately 17.5 miles which currently conveys up to 7.6 mgd of raw water from the Juniata Reservoir to the Grand Junction Water Treatment Plant (WTP) in the City of Grand Junction, Colorado (City) as shown in Figure 1. The PMFL runs through the Sullivan Draw, which is an area of extreme elevation relief with grades of up to 40%. Approximately 1.25 miles of 18-inch and 20-inch steel pipe (shown in red in Figure 1) is approaching the end of its useful life and is in need of replacement. Due to the challenging site conditions associated with the steep terrain, the City would like the new Sullivan Draw pipeline to be installed with a diameter large enough that the segment does not create a hydraulic restriction (which the Sullivan draw currently does) or limit the ultimate desired flow rates of the PMFL in the future. The City has already replaced approximately 6.1 miles of the PMFL with 24-inch PVC and 3.7 miles with 20-inch PVC. An additional 6.5 miles of the PMFL are also planned to be replaced in the future.

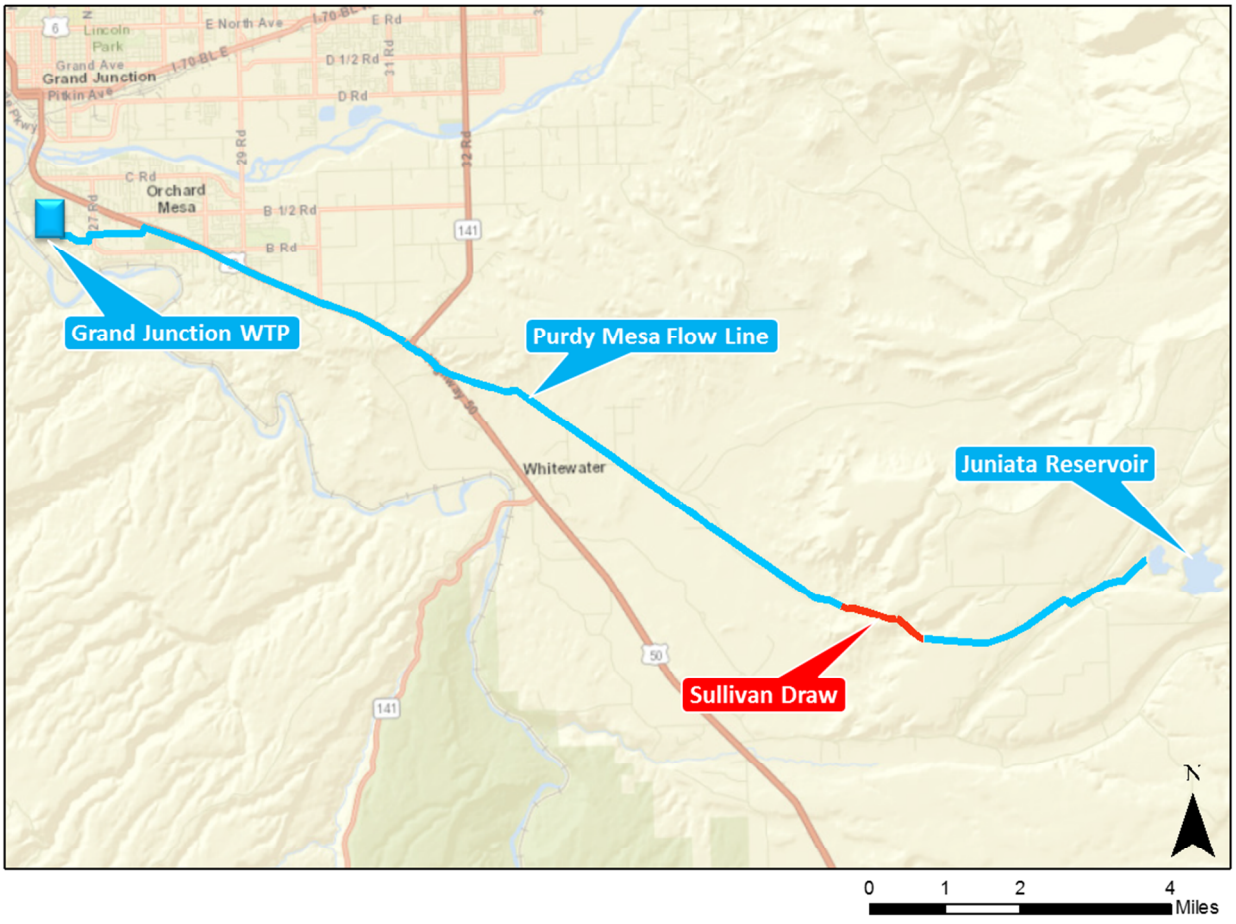


Figure 1 Purdy Mesa Flow Line Overview

In addition to the replacement of the pipeline which runs through the Sullivan Draw, the City also recognizes that the PMFL is operationally challenging due to the existing flow control infrastructure and hydraulics under varying flow rates, which can cause air entrainment (manifested as milky

water at the Grand Junction WTP) because of a variety of factors including partially full pipe flow and cavitation.

The primary objectives of the analyses described in this Technical Memorandum were to:

- Construct and validate a WaterGEMS hydraulic model of the PMFL to enable detailed analysis of the pipeline hydraulics under a variety of flow rates and system conditions
- Use the hydraulic model to confirm the existing hydraulic capacity of the 0.8 mile 18-inch segment of the Sullivan Draw portion of the PMFL
- Use the hydraulic model to evaluate the hydraulic benefits (and associated increases in maximum potential PMFL flow rates) of upsizing the 18-inch Sullivan Draw pipeline to 20-inch or 24-inch
- Use the hydraulic model to investigate potential causes for air entrainment in the PMFL and develop potential hydraulic improvement recommendations to both improve pipeline operation and reduce air entrainment in the future

2 Hydraulic Model Development and Validation

A hydraulic model of the PMFL was constructed in Bentley WaterGEMS as described in the following section.

2.1 DATA SOURCES

The City provided the following data sources to Black & Veatch which were used to build and calibrate the hydraulic model. In addition to the data listed below, a workshop was held with The City on 11/29/17 to confirm understanding of the current operation of the PMFL.

- 05019800-CleaningLiningHallenbeckWaterline-1968.pdf
- 05020200-HWY50_RawWaterlineRelocation-1998.pdf
- 05100600-PurdyMesaFlowlineReplacement-2008.pdf
- WaterLines.shp
- Purdy Mesa Flowline Hydraulic calcs.xlsx
- Roll Seal info to Cla-Val.doc
- Roll_Seal_Catalog.pdf

2.2 PURDY MESA FLOW LINE FACILITIES AND OPERATIONAL DESCRIPTION

Figure 2 displays a detailed overview of the PMFL from the Juniata Reservoir to the Grand Junction WTP and Figure 3 displays the pipeline profile, which was developed based on the data received as well as conversations with the City. The PMFL is currently operated as described below:

1. Raw water from the Juniata Reservoir (nominal water surface elevations of 5,741 ft to 5,754 ft) is released into the PMFL by an automatic Flow Control Valve (FCV) which can be set remotely to deliver a desired flow rate. The FCV automatically modulates to maintain the desired flow rate.

2. Raw water flows through approximately 3.4 miles of 20-inch steel pipe and discharges to atmosphere at the Pressure Control Tower (PCT). Because flow is controlled by the FCV at the upstream side of the PMFL, this section of pipe is not under constant positive pressure. Instead, it flows under a combination of partially full and full pipe flow between the FCV and the PCT. Based on conversations with the City, this section of pipe is currently in poor condition.

3. The PCT is a cylindrical tank 12 ft in height with a diameter of 5 ft and a total volume of 235 ft^3 (1,760 gallons). Raw water flows into the PCT from the 20-inch steel pipe and flows out of the PCT through the 18-inch steel Sullivan Draw pipe.

4. Flow continues from the PCT through 0.8 miles of 18-inch steel pipe to the Upper Roll Seal PSV, which is a 12-inch Cla-Val Roll Seal. The Upper Roll Seal is bypassed at flow rates of less than approximately 6.1 mgd and is used to control flow downstream of the PCT at flows greater than 6.1 mgd by manually adjusting the upstream pressure setting between approximately 63 psi to 68 psi.

5. Flow continues from the Upper Roll Seal PSV through 0.4 miles of 20-inch steel pipe to the Lower Roll Seal PSV, which is also a 12-inch Cla-Val Roll Seal. The Lower Roll Seal is bypassed at flows of less than approximately 6.1 mgd and is used to reduce pressures in the 20-inch steel pipeline between the Upper and Lower Roll Seals at flows of greater than 6.1 mgd by using an upstream pressure setting of approximately 101 psi.

6. Flow continues from the Lower Roll Seal PSV through 3.1 miles of 20-inch steel pipe, 3.7 miles of 20-inch PVC pipe and finally 6.1 miles of 24-inch PVC pipe before discharging to atmosphere at the raw water vault at the Grand Junction WTP at a water surface elevation of approximately 4,831 ft.

It is noted that the WaterGEMS hydraulic modeling software cannot accurately simulate hydraulics under partially full pipe flow conditions due to the unpredictable formation and movement of air pockets (which can cause hydraulic restrictions, air entrainment and flow anomalies). For this reason, the hydraulic model was developed for the PMFL from the PCT to the Grand Junction WTP only (as shown in Figure 3), excluding the 3.4 miles of 20-inch steel pipe from the FCV to the PCT.

It is also noted that there are five raw water taps along the PMFL between the PCT and the Grand Junction WTP which had a total combined 2017 average day usage of approximately 0.04 mgd. Because this usage is negligible (less than 1% of the total PMFL flow), these raw water taps were not included in the hydraulic model.

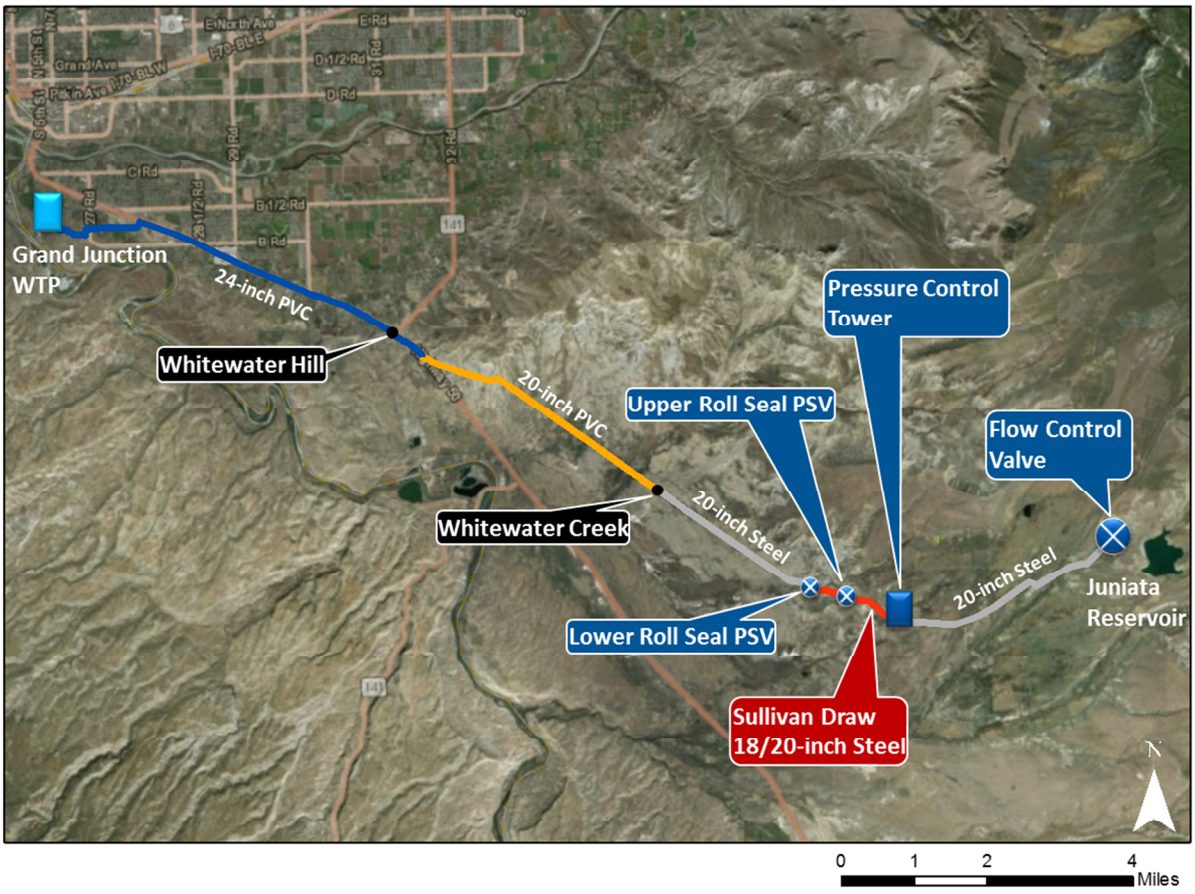


Figure 2 Purdy Mesa Flow Line and Facilities

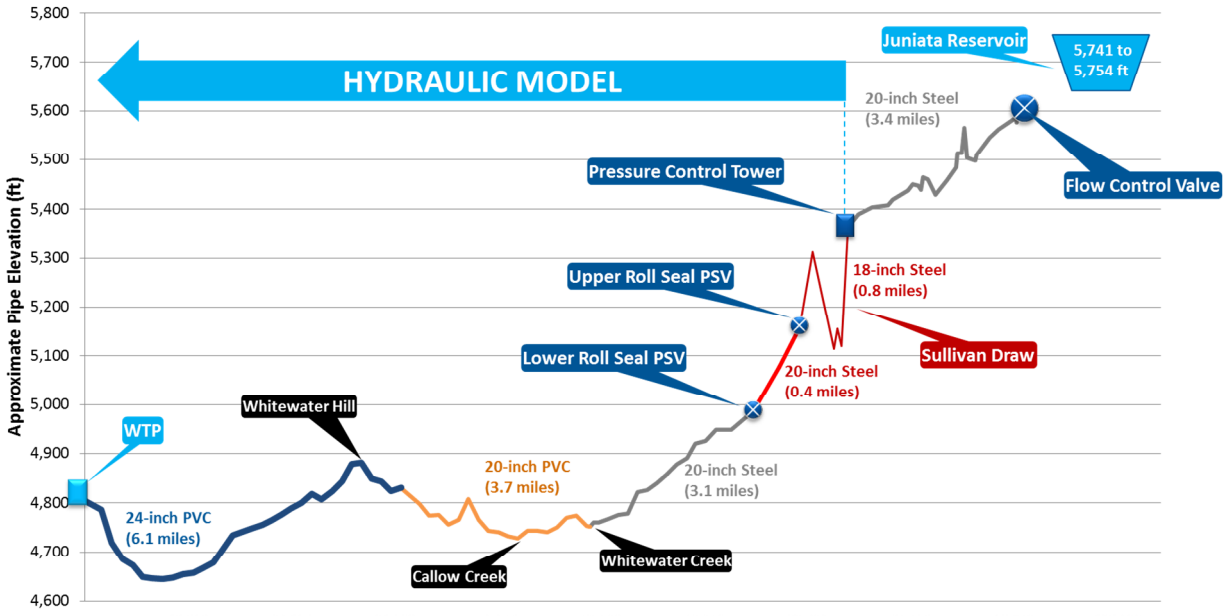


Figure 3 Purdy Mesa Flow Line – Profile

Table 1 displays a detailed summary of the PMFL pipelines based on information provided by the City. This information was used to build and validate the hydraulic model.

Table 1 Purdy Mesa Flow Line Pipe Summary

PIPE SIZE	MATERIAL	INTERNAL DIAMETER[1]	C-FACTOR[1]	LENGTH	INSTALLATION OR REHAB YEAR	DESCRIPTION
20-inch	Steel	19-inch	124	3.4 miles	Cleaned and cement mortar lined in 1968	Juniata Reservoir to PCT
18-inch	Steel	17-inch	112[2]	0.8 miles	Cleaned and cement mortar lined in 1968	PCT to Upper Roll Seal PSV
20-inch	Steel	19-inch	124	0.4 miles	Cleaned and cement mortar lined in 1968	Upper Roll Seal PSV to Lower Roll Seal PSV
20-inch	Steel	19-inch	124	3.1 miles	Cleaned and cement mortar lined in 1968	Lower Roll Seal PSV to Whitewater Creek
20-inch	PVC	19.75-inch	130	3.7 miles	Installed in 2009	Whitewater Creek to approximately the Orchard Mesa Park and Ride on US-50
24-inch	PVC	23.59-inch	130	6.1 miles	Installed circa 2001	Approximately Orchard Mesa Park and Ride on US-50 to Grand Junction WTP
Total				**17.5 miles**		

[1]Based on Purdy Mesa Flowline Hydraulic calcs.xlsx
[2]Based on model validation

2.3 HYDRAULIC MODEL CONSTRUCTION

Based on the information detailed in Section 2.2, a hydraulic model of the PMFL was constructed in Bentley WaterGEMS. The pipeline alignment and critical pipeline elevations were based on spatial, as-built and GPS information provided by the City. Pipe lengths, materials, internal diameters and C-Factors were based on the information summarized in Table 1.

As described previously, the hydraulic model was built to represent the existing PMFL from the PCT to the Grand Junction WTP, excluding the 20-inch steel pipe from the Juniata Reservoir to the PCT, which flows under partially full pipe conditions (and cannot be simulated with the hydraulic model) under all existing PMFL flow rates. Figure 4 displays a screenshot of the PMFL Bentley WaterGEMS hydraulic model.

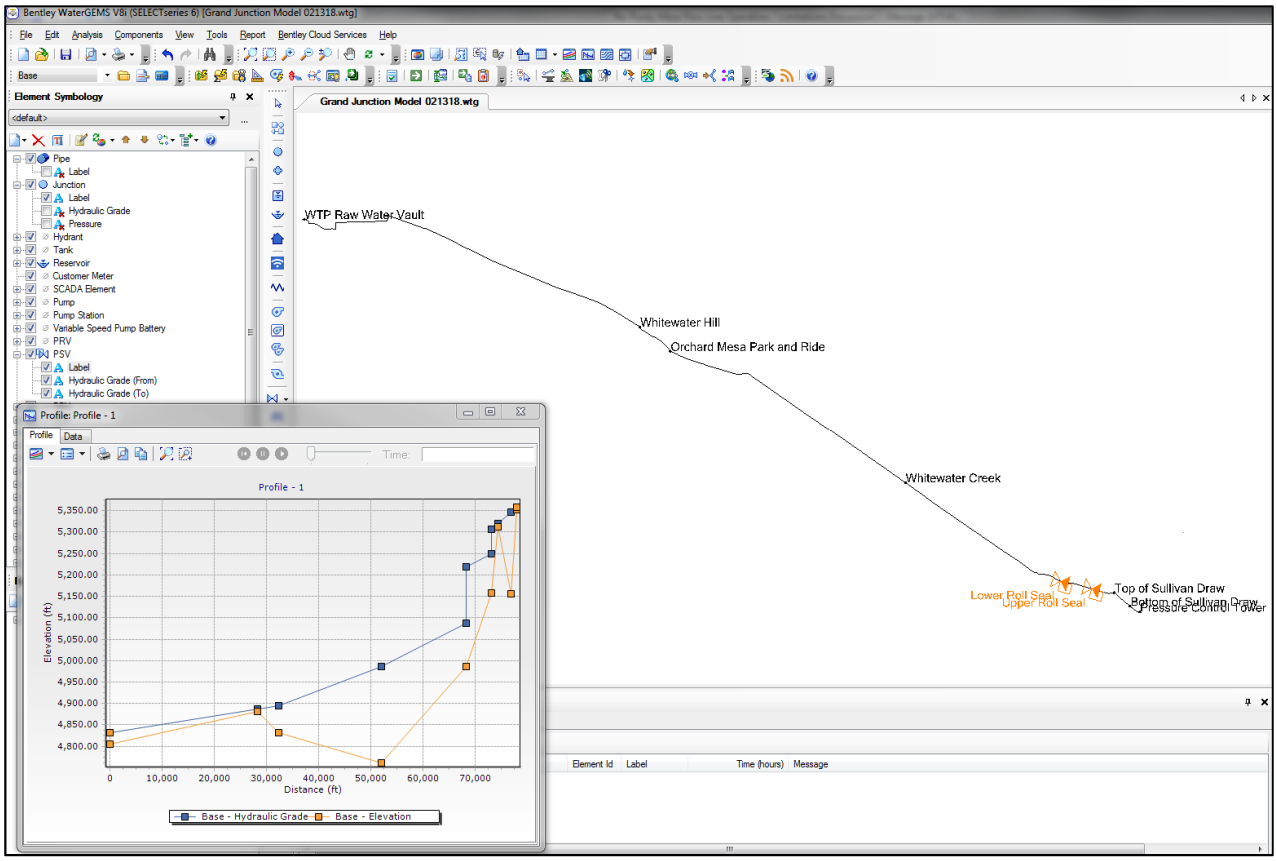


Figure 4 Purdy Mesa Flow Line Bentley WaterGEMS Hydraulic Model Screenshot

3 Hydraulic Model Validation

Validation of a hydraulic model is generally completed using recent field data (e.g. pressures and flow) to ensure that the model accurately simulates reality. Recent field data (specifically pressures along the PMFL) was not available, so model validation was completed using the hydraulic spreadsheet provided by the City (Purdy Mesa Flowline Hydraulic calcs.xlsx) which was developed based on field data collected in 2010.

It is noted that length discrepancies were noted between the hydraulic spreadsheet and the as-built drawings, survey and GIS records for the Sullivan Draw pipeline between the PCT and the Lower Roll Seal PSV. The C-Factor of the 18-inch steel pipe was reduced from 124 to 112 in order to maintain the calculated hydraulics of the spreadsheet with the reduced pipe lengths. A C-Factor of 112 was also used for the 18-inch steel pipeline in the WaterGEMS hydraulic model.

Model validation was completed by comparing pressures / hydraulic grade line (HGL) simulated by the Bentley WaterGEMS hydraulic model to the hydraulic spreadsheet under a high flow condition, which produced the high dynamic head losses required to validate the model with a high degree of confidence.

Key model validation assumptions:

- PMFL Flow Rate: 7.45 mgd
- PCT Water Surface Elevation: 5,358 ft
- Upper Roll Seal PSV Setting: 64 psi (5,305 ft)
- Lower Roll Seal PSV Setting: 101 psi (5,220 ft)
- Grand Junction WTP Water Surface Elevation: 4,831 ft (12 psi in raw water vault)

Figure 5 displays the results of the model validation simulation (shown as the simulated blue HGL line) compared at key locations to the hydraulic spreadsheet. Table 2 displays the model validation results in tabular form. As shown, the Bentley WaterGEMS hydraulic model was shown to simulate HGLs within 1 ft of the HGLs in the hydraulic spreadsheet, indicating a high degree of agreement. Based on this validation, the PMFL Bentley WaterGEMS hydraulic model could be used with confidence as an analysis tool to analyze existing hydraulics and evaluate potential improvement alternatives for the PMFL.

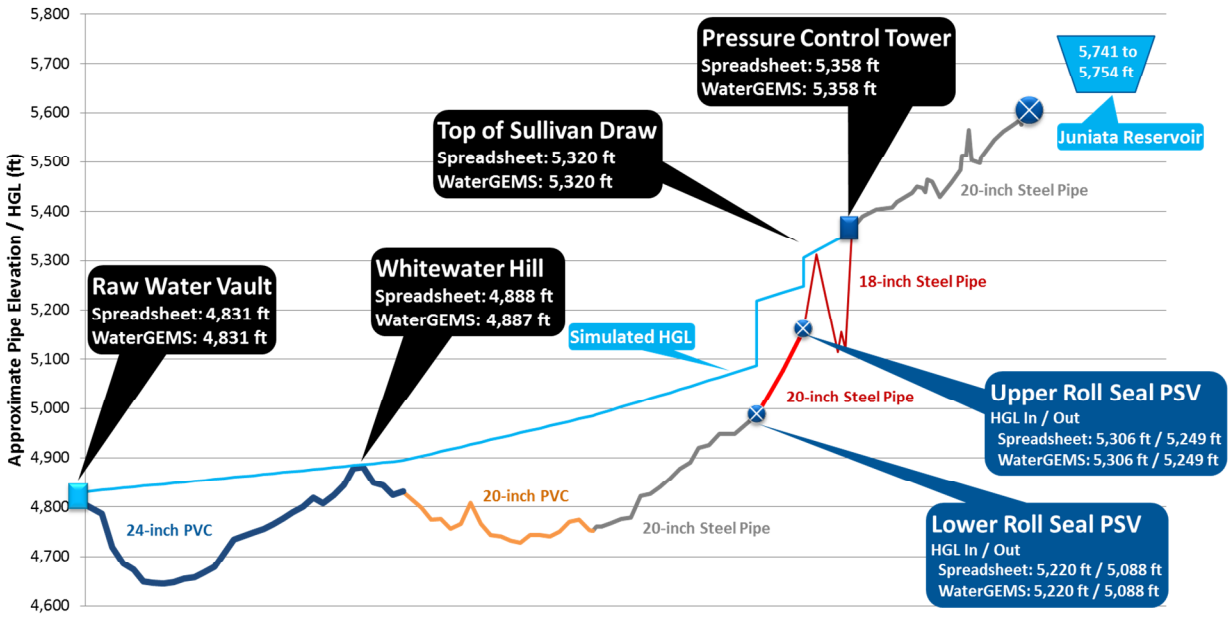


Figure 5 Model Validation Results Figure

Table 2 Model Validation Results Table

LOCATION	GRAND JUNCTION HYDRAULIC SPREADHEET HGL	BENTLEY WATERGEMS HYDRAULIC MODEL SIMULATED HGL	DIFFERENCE[1]
Pressure Control Tower	5,358 ft	5,358 ft	0 ft
Top of Sullivan Draw	5,320 ft	5,320 ft	0 ft
Upper Roll Seal PSV (Upstream)	5,306 ft	5,306 ft	0 ft
Upper Roll Seal PSV (Downstream)	5,249 ft	5,249 ft	0 ft
Lower Roll Seal PSV (Upstream)	5,220 ft	5,220 ft	0 ft
Lower Roll Seal PSV (Downstream)	5,088 ft	5,088 ft	0 ft
Whitewater Hill	4,888 ft	4,887 ft	1 ft
Raw Water Vault	4,831 ft	4,831 ft	0 ft

[1]Grand Junction Hydraulic Spreadsheet HGL – Bentley WaterGEMS Hydraulic Model Simulated HGL

4 Hydraulic Analyses

The validated Bentley WaterGEMS hydraulic model of the PMFL was used to analyze the pipeline hydraulics under six scenarios as described in the following section.

- Sullivan Draw Pipeline Analyses
  - Scenario 1: Existing 18-inch Sullivan Draw Pipeline
  - Scenario 2: New 20-inch Sullivan Draw Pipeline
- Existing Purdy Mesa Flow Line Analyses
  - Scenario 3: Existing Purdy Mesa Flow Line, 3.0 mgd
  - Scenario 4: Existing Purdy Mesa Flow Line, 6.7 mgd
  - Scenario 5: Existing Purdy Mesa Flow Line, 7.6 mgd
- Future Purdy Mesa Flow Line Analysis

  Scenario 6: Purdy Mesa Flow Line Upsized to 24-inch

4.1 SULLIVAN DRAW PIPELINE ANALYSES

4.1.1 Scenario 1: Existing 18-inch Sullivan Draw Pipeline

4.1.1.1 Objective

The existing 0.8 miles of 18-inch steel pipe which runs from the PCT through the Sullivan Draw to the Upper Roll Seal PSV is the smallest diameter pipe in the PMFL. Additionally, the pipeline experiences significant elevation relief which includes a low point of approximately 5,114 ft and a high point of approximately 5,312 ft, before terminating at the Upper Roll Seal at an elevation of approximately 5,158 ft.

Due to the 18-inch diameter as well as the 5,312 ft high point, the 18-inch Sullivan Draw steel pipe is currently the hydraulic bottleneck of PMFL, limiting the total flow rate which can be delivered from the Juniata Reservoir to the Grand Junction WTP.

The objective of this analysis was to evaluate the hydraulic performance of the existing 18-inch Sullivan draw pipeline under two flow conditions:

- 6.7 mgd: Normal “high flow” rate for PMFL
- Maximum Flow: Maximum flow rate which can be conveyed through the existing 18-inch Sullivan Draw pipeline

4.1.1.2 Assumptions

- PCT water surface elevation: 5,358 ft (approximately half full)
- Upper Roll Seal PSV Setting: modulated to produce desired flow rate through Sullivan Draw pipeline

4.1.1.3 Results

The hydraulic model was used to evaluate the existing 18-inch Sullivan Draw pipeline under a 6.7 mgd flow rate as shown in Figure 6. A flow rate of 6.7 mgd was simulated by adjusting the setting of the Upper Roll Seal PSV to 68 psi (5,315 ft). HGLs between the Upper Roll Seal PSV and the PCT were predicted by the model based on dynamic head loss due to the flow rate, the pipe diameter, pipe length and pipe C-Factor. At a flow rate of 6.7 mgd the model predicted an HGL of 5,327 ft at the Sullivan Draw high point, which exceeds the pipe elevation at a positive pressure of approximately 6 psi.

The maximum flow rate which can be conveyed from the PCT through the Sullivan Draw is the flow rate which results in dynamic head losses between the PCT and the Sullivan Draw high point such that the HGL at the high point is just above the pipe elevation of 5,312 ft. In practicality, 1-2 psi of positive pressure (HGL of 5,316 ft) should be maintained at the Sullivan Draw high point. The maximum flow rate of the existing 18-inch Sullivan Draw pipeline was determined using the hydraulic model by iteratively adjusting the upstream setting of the Upper Roll Seal PSV until the HGL at the Sullivan Draw high point was approximately 1 psi above the pipe elevation. As shown in Figure 6, the maximum flow rate through the Sullivan Draw was predicted to be approximately 8.0 mgd, corresponding to an upstream pressure setting of the Upper Roll Seal PSV of approximately 61 psi (5,298 ft).

Based on this analysis, the existing 18-inch Sullivan Draw pipeline limits the overall maximum flow rate of the PMFL to 8.0 mgd.

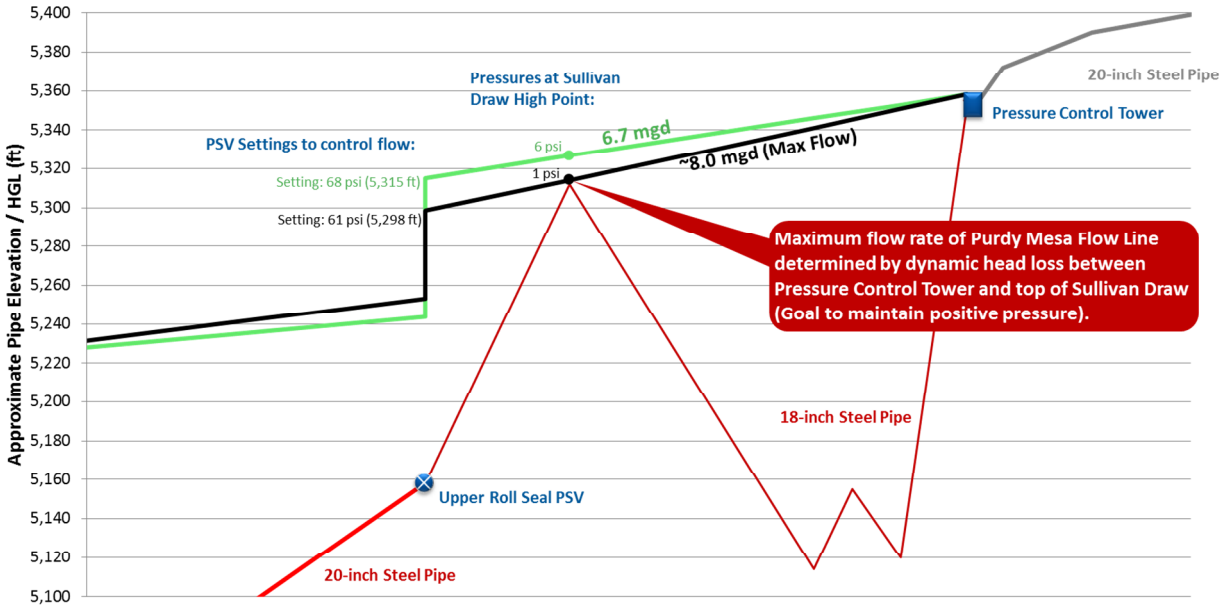


Figure 6 Existing 18-inch Sullivan Draw Hydraulic Analysis

4.1.2 Scenario 2: New 20-inch Sullivan Draw Pipeline

4.1.2.1 Objective

Replacement of the existing 0.8 miles of 18-inch steel pipe which runs from the PCT to the Upper Roll Seal PSV as well as the 0.4 miles of 20-inch steel pipe from the Upper Roll Seal PSV to the Lower Roll Seal PSV is currently part of the City's 10 Year CIP. Currently, the City Plans to replace (abandon in place) the existing 18-inch and 20-inch steel pipe and replace them with a new 20-inch PVC pipe.

The objective of this analysis was to evaluate the hydraulic performance of the proposed new 20-inch Sullivan draw pipeline under two flow conditions:

- 6.7 mgd: Normal "high flow" rate for PMFL
- Maximum Flow: Maximum flow rate which can be conveyed through the proposed new 20-inch Sullivan Draw pipeline to the Grand Junction WTP

4.1.2.2 Assumptions

- 1.25 miles of PMFL from PCT to Lower Roll Seal PSV replaced with 20-inch pipe (internal diameter: 19-inch, C-Factor: 130)
- PCT water surface elevation: 5,358 ft (approximately half full)
- Upper Roll Seal PSV Setting: modulated to produce desired flow rate through Sullivan Draw pipeline
- Grand Junction WTP Water Surface Elevation: 4,831 ft

4.1.2.3 Results

The hydraulic model was used to evaluate the proposed 20-inch Sullivan Draw pipeline under a 6.7 mgd flow rate as shown in Figure 7. A flow rate of 6.7 mgd was simulated by adjusting the upstream setting of the Upper Roll Seal PSV to 77.7 psi (5,337 ft). HGLs between the Upper Roll Seal PSV and the PCT were predicted by the model based on dynamic head loss due to the flow rate, the pipe diameter, pipe length and pipe C-Factor. At a flow rate of 6.7 mgd the model predicted an HGL of 5,344 ft at the Sullivan Draw high point, which exceeds the pipe elevation at a positive pressure of approximately 14 psi.

The maximum flow rate of the PMFL with the proposed 20-inch Sullivan Draw pipeline was estimated by bypassing the Upper Roll Seal PSV and allowing water to flow unrestricted from the PCT to the Grand Junction WTP. As shown in Figure 7, the maximum flow rate with the Upper Roll Seal PSV bypassed was predicted to be 10.1 mgd. At this flow rate, the HGL at the Sullivan Draw high point was predicted to be approximately 5,329 ft (7 psi of positive pressure), which confirms that the proposed 20-inch Sullivan Draw would no longer be the bottleneck restricting flow through the PMFL.

Figure 8 displays the PMFL hydraulic profile from the PCT to the Grand Junction WTP with the proposed 20-inch Sullivan Draw pipeline and both the Upper and Lower Roll Seal PSVs bypassed. As shown, the maximum flow rate of 10.1 mgd is limited by dynamic head losses through the existing PMFL pipelines downstream of the Lower Roll Seal PSV. The maximum pressure along the

PMFL was predicted to be 159 psi in the vicinity of Whitewater Creek, which is below the 160 psi pressure rating of the 20-inch steel pipe. If flow rates of more than 10.1 mgd are desired in the future, upsizing of other segments of the PMFL must be completed.

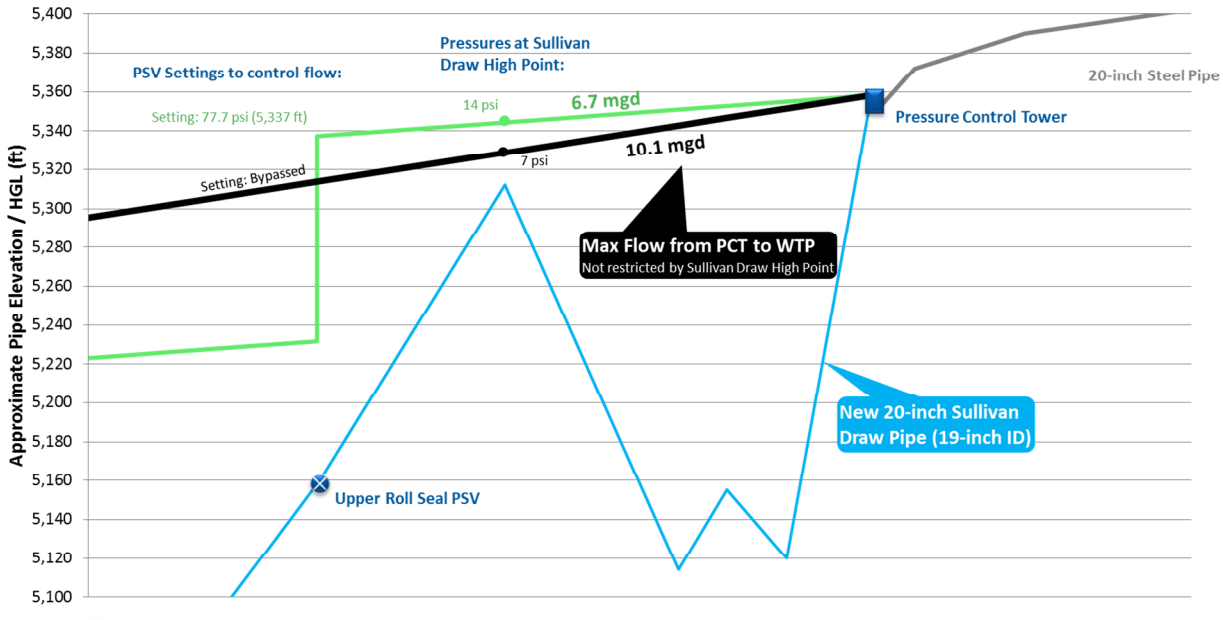


Figure 7 Proposed 20-inch Sullivan Draw Hydraulic Analysis

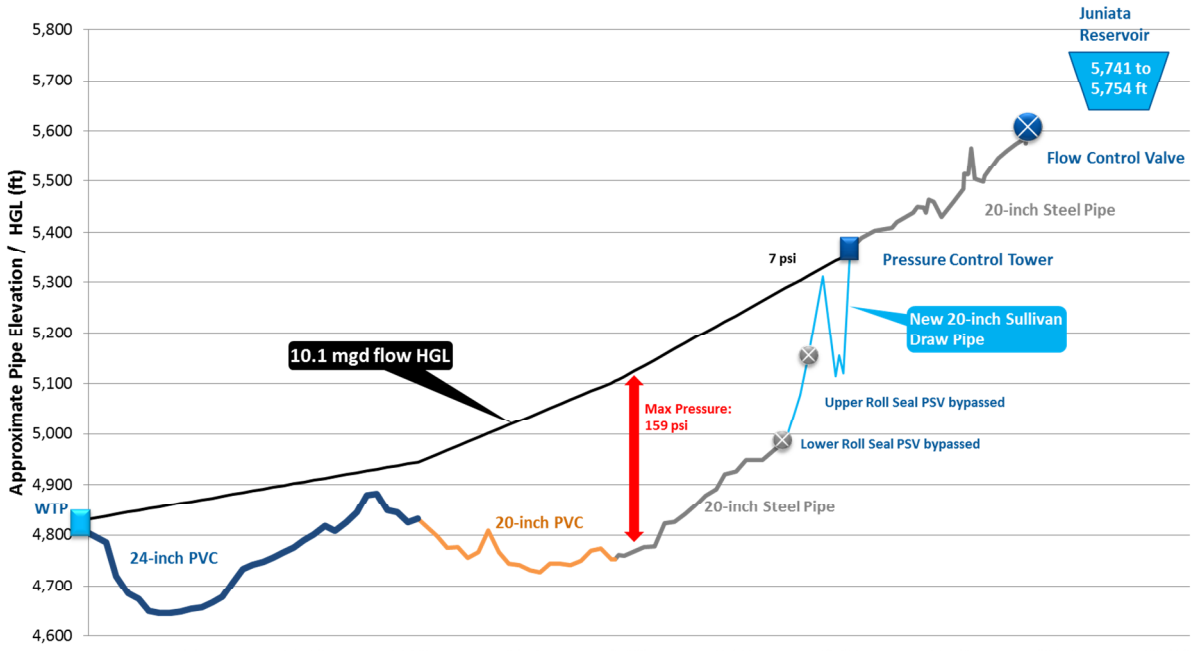


Figure 8 Purdy Mesa Flow Hydraulic Profile - Maximum Flow Rate with 20-inch Sullivan Draw Pipe

4.2 EXISTING PURDY MESA FLOW LINE ANALYSES

The PMFL is operationally challenging due to the existing flow control infrastructure and hydraulics under varying flow rates, which can cause air entrainment (manifested as milky water at the Grand Junction WTP) due to a variety of factors including partially full pipe flow and cavitation. The existing PMFL was analyzed under three flow rates to facilitate understanding of existing hydraulics and enable identification of operational issues and the development of potential hydraulic solutions. The following scenarios were evaluated and are detailed in the following section:

- Scenario 3: Existing Purdy Mesa Flow Line, 3.0 mgd
  - PMFL under a normal "low flow" condition
- Scenario 4: Existing Purdy Mesa Flow Line, 6.7 mgd
  - PMFL under a normal "high flow" condition
- Scenario 5: Existing Purdy Mesa Flow Line, 7.6 mgd
  - PMFL under a near maximum flow condition

4.2.1 Scenario 3: Existing Purdy Mesa Flow Line, 3.0 mgd

4.2.1.1 Objective

Based on conversations with the City, during low flow rates (e.g. 3.0 mgd), the FCV at the Juniata Reservoir is set to the desired flow rate and Upper and Lower Roll Seal PSVs are bypassed. The objective of this scenario was to evaluate the PMFL hydraulics at a flow rate of 3.0 mgd.

4.2.1.2 Assumptions

- Flow rate of 3.0 mgd delivered to the PCT from the Juniata Reservoir FCV (modeled as a 3.0 mgd inflow at the PCT)
- Upper and Lower Roll Seal PSVs bypassed
- Grand Junction WTP Water Surface Elevation: 4,831 ft

4.2.1.3 Results

The hydraulic model was used to evaluate the existing PMFL under a 3.0 mgd flow rate as shown in Figure 9. A flow rate of 3.0 mgd was simulated using an inflow of 3.0 mgd at the PCT, mimicking the actual system conditions of 3.0 mgd being delivered to the PCT by the Juniata Reservoir FCV.

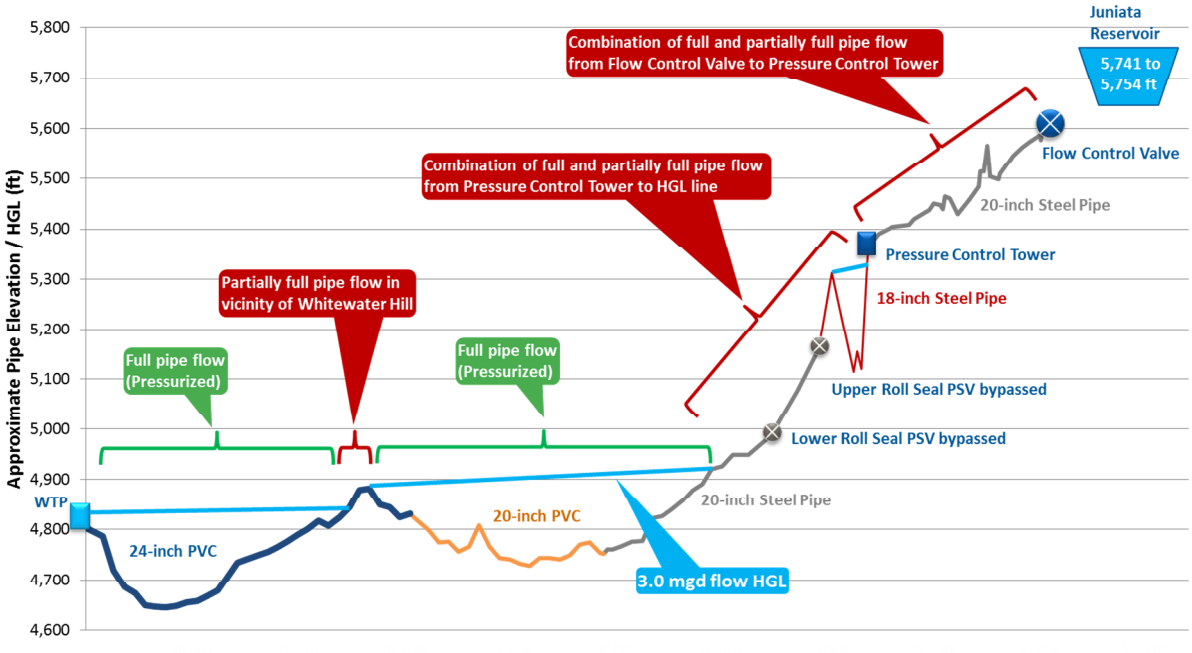


Figure 9 - Existing Purdy Mesa Flow Line, 3.0 mgd- Hydraulic Profile

The following is a description of the predicted PMFL hydraulics from the Juniata Reservoir to the Grand Junction WTP under a flow rate of 3.0 mgd:

- Water from the Juniata Reservoir is released into the 20-inch steel PMFL by the FCV at a flow rate of 3.0 mgd
- A combination of full and partially full pipe flow occurs in the 20-inch steel pipe from the FCV to the PCT. The pipe will be full upstream of high points (where water will "back up" in the pipeline until a sufficient HGL is established to flow over the high point. On the downstream side of high points, the pipe will flow partially full (with the rest of the pipe filled with air)
- Water will flow into the PCT, however, without a sufficient downstream HGL to maintain water level in the PCT, the PCT will drain into the 18-inch Sullivan Draw pipe
- An HGL will be established through the Sullivan Draw which is defined by the high point of the Sullivan Draw and the dynamic head losses associated with the 18-inch Sullivan Draw pipe at a flow rate of 3.0 mgd
- Downstream of the Sullivan Draw high point, partially full pipe flow will occur as water falls from the high point. Significant air accumulation is likely to occur in this portion of the PMFL. Partially full pipe flow was predicted to continue until reaching the HGL established by the Whitewater Hill high point and the dynamic head loss in the PMFL at a flow rate of 3.0 mgd, at which point flow will continue full pipe (under pressure) to the White Water Hill high point
- Downstream of the Whitewater Hill high point, partially full pipe flow was predicted to occur as water falls from the high point. Significant air accumulation is likely to occur in this portion of the PMFL. Partially full pipe flow was predicted to continue until reaching the HGL established by the water surface elevation at the Grand Junction WTP and the dynamic head loss in the

pipeline at 3.0 mgd, at which point flow was predicted to continue full pipe (under pressure) to the Grand Junction WTP

As described and detailed above, significant air accumulation was predicted to be likely to occur in the existing PMFL under flow rates of 3.0 mgd. Accumulated air (air pockets) are unpredictable and can become lodged in various locations, causing hydraulic restrictions (by artificially reducing the flowable cross-sectional area of the pipe) when flow rates in the PMFL are increased.

4.2.2 Scenario 4: Existing Purdy Mesa Flow Line, 6.7 mgd

4.2.2.1 Objective

Based on conversations with the City, during high flow rates (e.g. 6.7 mgd), the FCV at the Juniata Reservoir is set to the desired flow rate and the upstream setting of the Upper Roll Seal PSV is manually set to establish a constant water surface elevation in the PCT. In practice, the City manually adjusts the setting of the Upper Roll Seal PSV by having one staff member at the Upper Roll Seal PSV and one staff member at the PCT, communicating by radio. The staff member at the Upper Roll Seal PSV adjusts the upstream setting until the staff member at the PCT can visually see that the level has stabilized in the middle of the PCT head range. Under ideal circumstances, the Juniata Reservoir FCV will control flow into the PCT and the Upper Roll Seal PSV will control flow out of the PCT at an identical rate, allowing the PCT water surface elevation to remain constant. Based on conversations with the City, however, it was noted that following manual adjustment of the Upper Roll Seal PSV, flow in and out of the PCT generally becomes unbalanced quickly, leading to the PCT either draining or overflowing.

The objective of this scenario was to evaluate the PMFL hydraulics at a flow rate of 6.7 mgd under an ideal case where the flow into and out of the PCT are matched, enabling the PCT to float at a consistent water surface elevation in the middle of its head range of approximately 5,358 ft.

4.2.2.2 Assumptions

- PCT water surface elevation: 5,358 ft (middle of PCT head range, assumes flow into the PCT controlled by the Juniata Reservoir FCV is equal to the flow out of the PCT controlled by the upstream setting of the Upper Roll Seal PSV)
- Upper Roll Seal PSV upstream setting: 68 psi, 5,315 ft (set to control 6.7 mgd of flow downstream of the PCT)
- Lower Roll Seal PSV upstream setting: 101 psi, 5,220 ft (set to maintain positive pressure between the Lower Roll Seal PSV and Upper Roll Seal PSV and eliminate the partially pipe flow which would be otherwise predicted to occur downstream of the Upper Roll Seal PSV. It is noted that the Lower Roll Seal PSV does not impact the flow rate of the PMFL downstream of the PCT)
- Grand Junction WTP Water Surface Elevation: 4,831 ft

4.2.2.3 Results

The hydraulic model was used to evaluate the existing PMFL under a 6.7 mgd flow rate as shown in Figure 10. A flow rate of 6.7 mgd was simulated by setting the water surface elevation of the PCT to 5,358 ft and adjusting the upstream setting of the Upper Roll Seal PSV to 68 psi (5,315 ft).

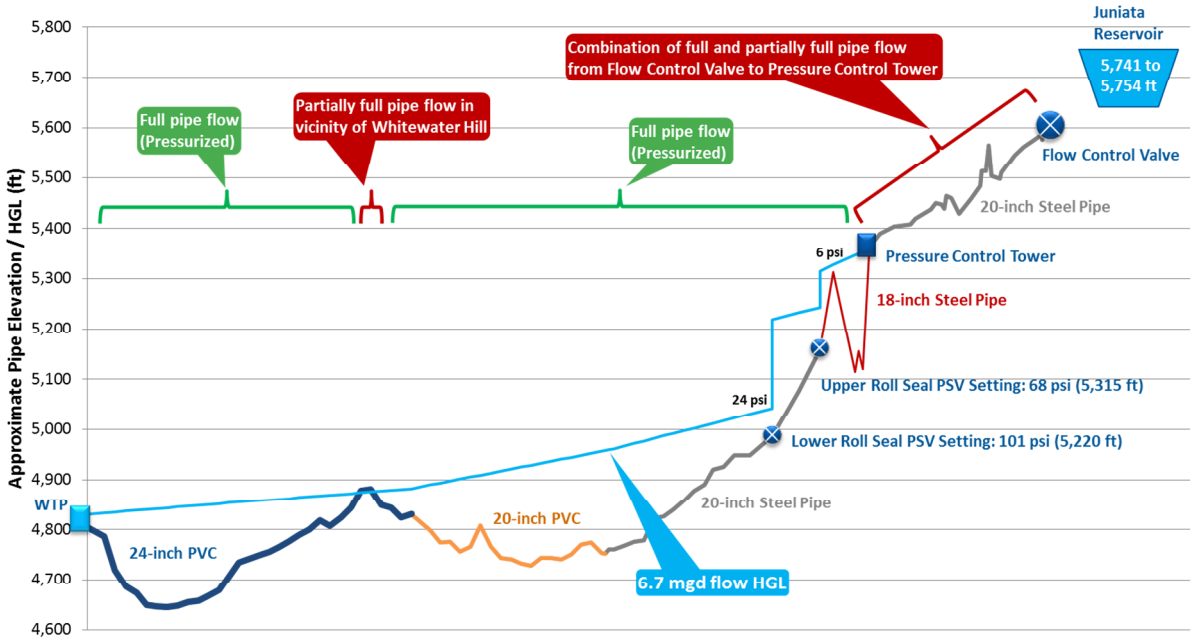


Figure 10 - Existing Purdy Mesa Flow Line, 6.7 mgd - Hydraulic Profile

The following is a description of the predicted PMFL hydraulics from the Juniata Reservoir to the Grand Junction WTP under a flow rate of 6.7 mgd:

- Water from the Juniata Reservoir is released into the 20-inch steel PMFL by the FCV at a flow rate of 6.7 mgd
- A combination of full and partially full pipe flow occurs in the 20-inch steel pipe from the FCV to the PCT. The pipe will be full upstream of high points (where water will "back up" in the pipeline until a sufficient HGL is established to flow over the high point. On the downstream side of high points, the pipe will flow partially full (with the rest of the pipe filled with air).
- Water will flow into the PCT, and, assuming that flow out of the PCT is effectively controlled by the Upper Roll Seal PSV to match the flow into the PCT, the water surface elevation will remain constant at 5,358 ft.
- Full pipe flow is predicted through the Sullivan Draw, including a positive pressure of approximately 6 psi at the Sullivan Draw high point.
- The Upper Roll Seal PSV was predicted to maintain an upstream pressure of 68 psi (5,315 ft).
- The Lower Roll Seal was predicted to maintain an upstream pressure of 101 psi (5,220 ft). Under this flow scenario, the Lower Roll Seal serves the critical function of creating back pressure which enables positive pressure to be maintained on the downstream side of the Upper Roll Seal PSV. Without the Lower Roll Seal PSV, the HGL downstream of the Upper Roll Seal PSV would be

controlled by the water surface elevation at the Grand Junction WTP as well as head loss in the PMFL.

- As shown in Figure 10, if the 6.7 mgd HGL line were to continue past the Lower Roll Seal PSV (without the HGL being raised by the automatic throttling of the PSV to maintain the upstream pressure setting), it would hit the pipe at an elevation of approximately 5,050 ft, which is more than 100 ft below the elevation of the Upper Roll Seal PSV. Without the Lower Roll Seal PSV creating back pressure, the Upper Roll Seal PSV would be likely to cavitate (due to low/negative pressures on the downstream side) and the PMFL would be predicted to experience partially full pipe flow, between the Upper Roll Seal PSV and the HGL line, which could lead to significant air accumulation.
- Following the Lower Roll Seal PSV, an HGL was predicted to be established based on the Whitewater Hill high point and the head loss through the PMFL at a flow rate of 6.7 mgd.
- Downstream of the Whitewater Hill high point, partially full pipe flow was predicted to occur as water falls from the high point. Some air accumulation is likely to occur in this portion of the PMFL. Partially full pipe flow was predicted to continue until reaching the HGL established by the water surface elevation at the Grand Junction WTP and the dynamic head loss in the pipeline at 6.7 mgd, at which point flow was predicted to continue full pipe (under pressure) to the Grand Junction WTP.

As described and detailed above, some air accumulation was predicted to be likely to occur in the existing PMFL under flow rates of 6.7 mgd in the vicinity of Whitewater Hill. Accumulated air (air pockets) are unpredictable and can become lodged in various locations, causing hydraulic restrictions (by artificially reducing the flowable cross-sectional area of the pipe) when flow rates in the PMFL are increased.

4.2.3 Scenario 5: Existing Purdy Mesa Flow Line, 7.6 mgd

4.2.3.1 Objective

Based on conversations with the City, during maximum flow rates (e.g. 7.6 mgd), the FCV at the Juniata Reservoir is set to the desired flow rate and the upstream setting of the Upper Roll Seal PSV is manually set to establish a constant water surface elevation in the PCT. In practice, the City manually adjusts the setting of the Upper Roll Seal PSV by having one staff member at the Upper Roll Seal PSV and one staff member at the PCT, communicating by radio. The staff member at the Upper Roll Seal PSV adjusts the upstream setting until the staff member at the PCT can visually see that the level has stabilized in the middle of the PCT head range. Under ideal circumstances, the Juniata Reservoir FCV will control flow into the PCT and the Upper Roll Seal PSV will control flow out of the PCT at an identical rate, allowing the PCT water surface elevation to remain constant. Based on conversations with the City, however, it was noted that following manual adjustment of the Upper Roll Seal PSV, flow in and out of the PCT generally becomes unbalanced quickly, leading to the PCT either draining or overflowing.

The objective of this scenario was to evaluate the PMFL hydraulics at a flow rate of 7.6 mgd under an ideal case where the flow into and out of the PCT are matched, enabling the PCT to float at a consistent water surface elevation in the middle of its head range of approximately 5,358 ft.

4.2.3.2 Assumptions

- PCT water surface elevation: 5,358 ft (middle of PCT head range, assumes flow into the PCT controlled by the Juniata Reservoir FCV is equal to the flow out of the PCT controlled by the upstream setting of the Upper Roll Seal PSV)
- Upper Roll Seal PSV upstream setting: 63 psi, 5,304 ft (set to control 7.6 mgd of flow downstream of the PCT)
- Lower Roll Seal PSV upstream setting: 101 psi, 5,220 ft (set to maintain positive pressure between the Lower Roll Seal PSV and Upper Roll Seal PSV and eliminate the partially pipe flow which would be otherwise predicted to occur downstream of the Upper Roll Seal PSV. The Lower Roll Seal PSV does not impact the flow rate of the PMFL downstream of the PCT)
- Grand Junction WTP Water Surface Elevation: 4,831 ft

4.2.3.3 Results

The hydraulic model was used to evaluate the existing PMFL under a 7.6 mgd flow rate as shown in Figure 11. A flow rate of 7.6 mgd was simulated by setting the water surface elevation of the PCT to 5,358 ft and adjusting the upstream setting of the Upper Roll Seal PSV to 63 psi (5,304 ft).

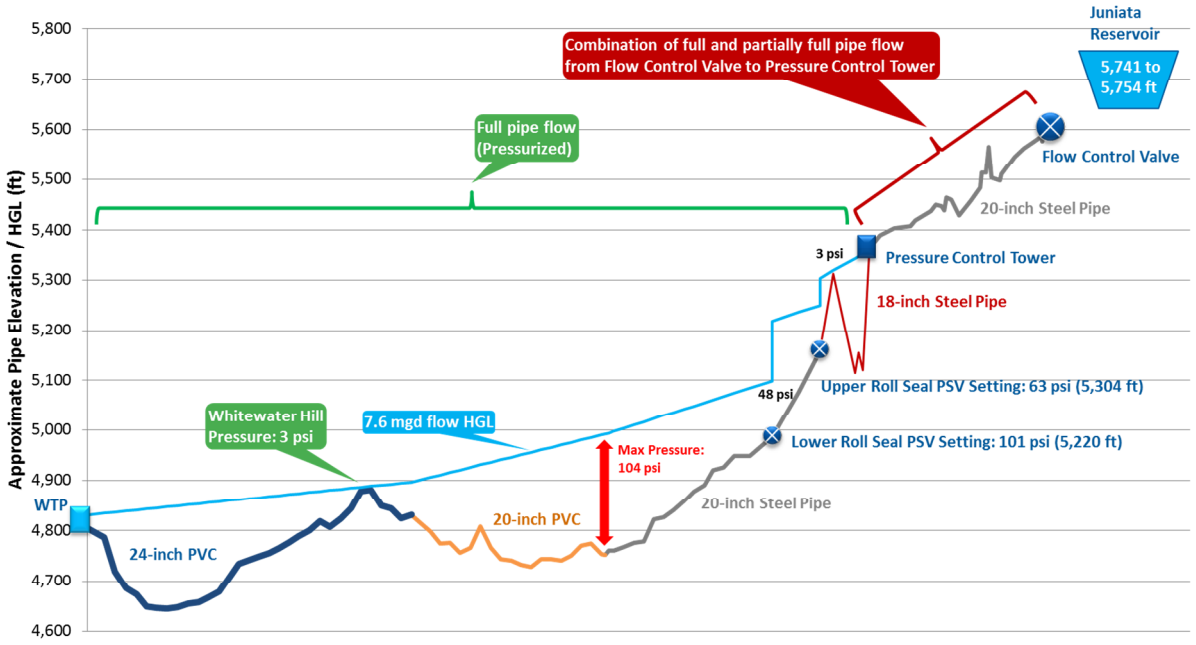


Figure 11 - Existing Purdy Mesa Flow Line, 7.6 mgd - Hydraulic Profile

The following is a description of the predicted PMFL hydraulics from the Juniata Reservoir to the Grand Junction WTP under a flow rate of 7.6 mgd:

- Water from the Juniata Reservoir is released into the 20-inch steel PMFL by the FCV at a flow rate of 7.6 mgd
- A combination of full and partially full pipe flow occurs in the 20-inch steel pipe from the FCV to the PCT. The pipe will be full upstream of high points (where water will "back up" in the pipeline

until a sufficient HGL is established to flow over the high point. On the downstream side of high points, the pipe will flow partially full (with the rest of the pipe filled with air)

- Water will flow into the PCT, and, assuming that flow out of the PCT is effectively controlled by the Upper Roll Seal PSV to match the flow into the PCT, the water surface elevation will remain constant at 5,358 ft
- Full pipe flow is predicted through the Sullivan Draw, including a positive pressure of approximately 3 psi at the Sullivan Draw high point
- The Upper Roll Seal PSV was predicted to maintain an upstream pressure of 63 psi (5,304 ft)
- The Lower Roll Seal was predicted to maintain an upstream pressure of 101 psi (5,220 ft). Under this flow scenario, the Lower Roll Seal serves the critical function of creating back pressure which enables positive pressure to be maintained on the downstream side of the Upper Roll Seal PSV. Without the Lower Roll Seal PSV, the HGL downstream of the Upper Roll Seal PSV would be controlled by the water surface elevation at the Grand Junction WTP as well as head loss in the PMFL. As shown in Figure 11, if the 7.6 mgd HGL line were to continue to the past the Lower Roll Seal PSV (without the HGL being raised by the automatic throttling of the PSV to maintain the upstream pressure setting), it would hit the pipe at an elevation of approximately 5,130 ft, which is below the elevation of the Upper Roll Seal PSV. Without the Lower Roll Seal PSV creating back pressure, the Upper Roll Seal PSV would be likely to cavitate (due to low/negative pressures on the downstream side) and the PMFL would be predicted to experience partially full pipe flow, between the Upper Roll Seal PSV and the HGL line, which could lead to significant air accumulation.
- Following the Lower Roll Seal PSV, an HGL was predicted to be established based on the water surface elevation at the Grand Junction WTP and the dynamic head loss in the PMFL at 7.6 mgd. It is noted that under this high flow rate, dynamic head losses were predicted to be sufficient maintain full pipe (pressurized) flow from the PCT to the Grand Junction WTP, including a positive pressure of approximately 3 psi at Whitewater Hill.

At a PMFL flow rate of 7.6 mgd, full pipe flow was predicted to occur in the PMFL from the PCT to the Grand Junction WTP. With the PMFL fully pressurized, no air accumulation was predicted.

4.3 FUTURE PURDY MESA FLOW LINE ANALYSIS

4.3.1 Scenario 6: Purdy Mesa Flow Line Upsized to 24-inch

4.3.1.1 Objective

Based on conversations with the City, it may be desirable to increase the flow capacity of the PMFL in the future both to be capable of meeting the required capacity of future growth and to enable the delivery of sufficient raw water capacity to the Grand Junction WTP with the Kannah Creek Flow Line out of service.

If flow capacities of more than approximately 9.8 mgd (maximum flow capacity with new 20-inch Sullivan Draw pipeline) are desired in the future, it may be beneficial to upsize the Sullivan Draw pipe now so it supports the future desired PMFL flow rate without causing a hydraulic bottleneck.

The objective of this analysis was to analyze and determine the maximum hypothetical flow rate of the PMFL (from the PCT to the Grand Junction WTP) it were upsized to 24-inch.

4.3.1.2 Assumptions

- PMFL upsized to 24-inch from the PCT to the existing 24-inch PVC pipe in the vicinity of the Orchard Mesa Park and Ride
- New 24-inch assumed to have an internal diameter of 23.6-inch, C-Factor of 130
- This analysis was focused on the flow capacity of a future 24-inch PMFL from the PCT to the Grand Junction WTP only, and did not consider the flow capacity of 20-inch steel pipe between the Juniata Reservoir and the PCT.
- PCT water surface elevation: 5,358 ft (middle of PCT head range, assumes flow into the PCT controlled by the Juniata Reservoir FCV is equal to the flow out of the PCT)
- Upper and Lower Roll Seal PSVs bypassed
- Grand Junction WTP Water Surface Elevation: 4,831 ft

4.3.1.3 Results

The hydraulic model was used to evaluate the flow capacity of a future 24-inch PMFL from the PCT to the Grand Junction WTP. With the Upper and Lower Roll Seal PSVs bypassed, the model predicted a maximum flow rate of approximately 14.8 mgd as shown in Figure 12.

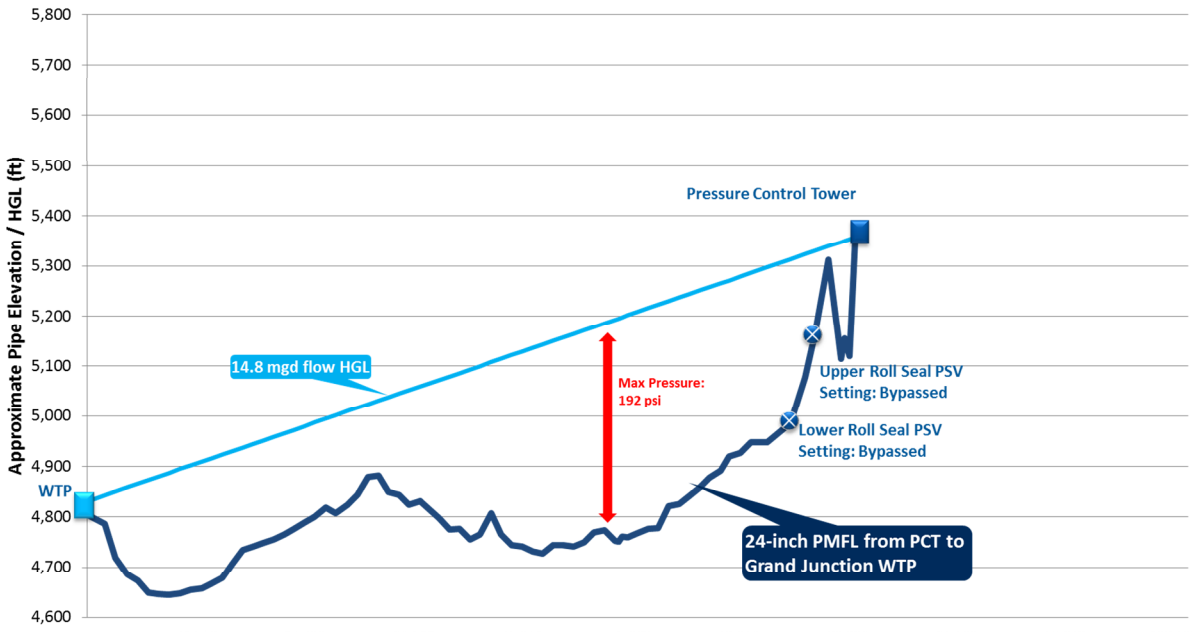


Figure 12 - Purdy Mesa Flow Line Upsized to 24-inch - Hydraulic Profile

The following is a description of the predicted PMFL hydraulics from the PCT to the Grand Junction WTP with the entire pipeline 24-inch and a flow rate of 14.8 mgd:

- It is noted that this analysis did not consider the capacity of the existing 20-inch steel pipe

between the Juniata Reservoir and the PCT. While this existing 20-inch steel pipe could be sufficient to support a flow rate of 14.8 mgd depending on the prevailing C-Factor, it is likely undersized as the velocity under full pipe flow would exceed 10 ft/sec. If the City desires to upsize the PMFL to 24-inch (from the PCT to the Grand Junction WTP) in the future, the existing 20-inch between the Juniata Reservoir and the PCT should be evaluated and likely upsized in kind.

- The maximum flow rate of 14.8 mgd was determined using the hydraulic model such that the dynamic head loss in the 24-inch PMFL was equal to the static head difference between the PCT water surface elevation of 5,358 ft and the Grand Junction WTP water surface elevation of 4,831 ft. At this flow rate, a straight HGL line was established between the Grand Junction WTP and the PCT as shown in Figure 12.
- At a flow rate of 14.8 mgd, velocities of approximately 7.5 ft/sec were predicted in the future 24-inch PMFL.
- Based on the HGL line and the ground elevations of the 24-inch pipe, pressures of up to 192 psi were predicted in the vicinity of Whitewater Creek under a flow rate of 14.8 mgd.

With a future 24-inch PMFL from the PCT to the Grand Junction WTP, the maximum flow capacity was predicted to be approximately 14.8 mgd. It is noted that due to high dynamic head losses at the high flow rate, pressures along the PMFL at low points were predicted to be as high as 192 psi. Any new pipeline should be designed with a sufficient pressure class to sustain the highest predicted dynamic pressures.

5 Hydraulic Issues

Based on the hydraulic analyses conducted and described previously, four primary hydraulic issues were identified as likely causes for the air entrainment observed by the City at the Grand Junction WTP as well as the operational challenges with the PMFL. The following four hydraulic issues are described in this section:

- Roll Seal PSV Cavitation
- Pipeline Air Accumulation
- Pressure Control Tower Volume
- Flow Control Upstream and Downstream of the Pressure Control Tower

5.1 ROLL SEAL PSV CAVITATION

A Roll Seal PSV modulates to maintain an upstream pressure setting. Pressures on the downstream side are determined by system hydraulics independent of the PSV. In the case of the PMFL, the HGL downstream of the Lower Roll Seal PSV is determined by two factors: the water surface elevation at the Grand Junction WTP and the dynamic head loss (determined by pipe diameter, length, C-Factor and flow rate) between the Lower Roll Seal PSV and the Grand Junction WTP.

Cavitation can occur downstream of a Roll Seal PSV if the relationship between the inlet pressure and outlet pressure is within the Cavitation Zone shown in Figure 13 (from the Roll_Seal_Catalog.pdf). The City currently operates the Lower Roll Seal PSV at an upstream pressure setting (inlet pressure) of approximately 101 psi. As shown, this corresponds to a minimum downstream pressure (outlet pressure) of approximately 10 psi to avoid cavitation.

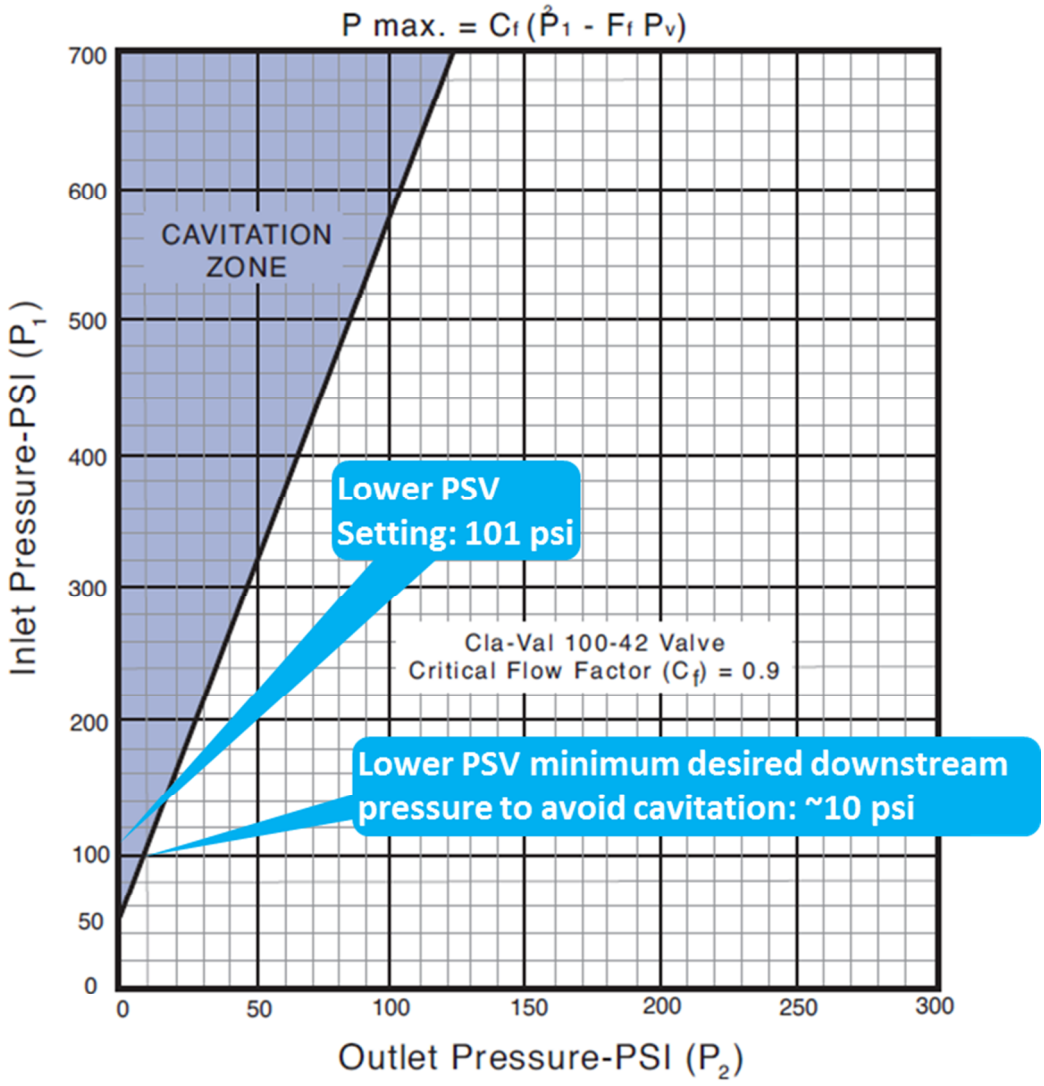


Figure 13 Cla-Val 100-42 Valve Cavitation Chart

Because the outlet pressure of Lower Roll Seal PSV is controlled by the water surface elevation at the Grand Junction WTP (which was assumed to be constant at approximately 4,831 ft) and the dynamic head loss in the PMFL (which varies based on flow rate), it was possible to calculate the minimum required PMFL rate to avoid cavitation of the Lower Roll Seal PSV. Figure 14 displays the relationship between flow rate in the PMFL and outlet pressure of the Lower Roll Seal PSV. As shown, at flow rates of approximately 6.1 mgd and below, the Lower Roll Seal PSV will be predicted to operate within the cavitation zone, which could lead to cavitation and subsequent air entrainment in the PMFL. At PMFL flow rates of greater than 6.1 mgd, the Lower Roll Seal PSV will not be predicted to cavitate.

Based on the analysis detailed above, to avoid cavitation the Lower Roll Seal PSV should be used under PMFL flow rates of approximately 6.1 mgd or greater. Under flow rates of less than 6.1 mgd, the Lower Roll Seal PSV should be bypassed to avoid cavitation. Additionally, the Upper Roll Seal PSV should also be bypassed any time that the Lower Roll Seal PSV is bypassed to avoid cavitation at the Upper Roll Seal PSV.

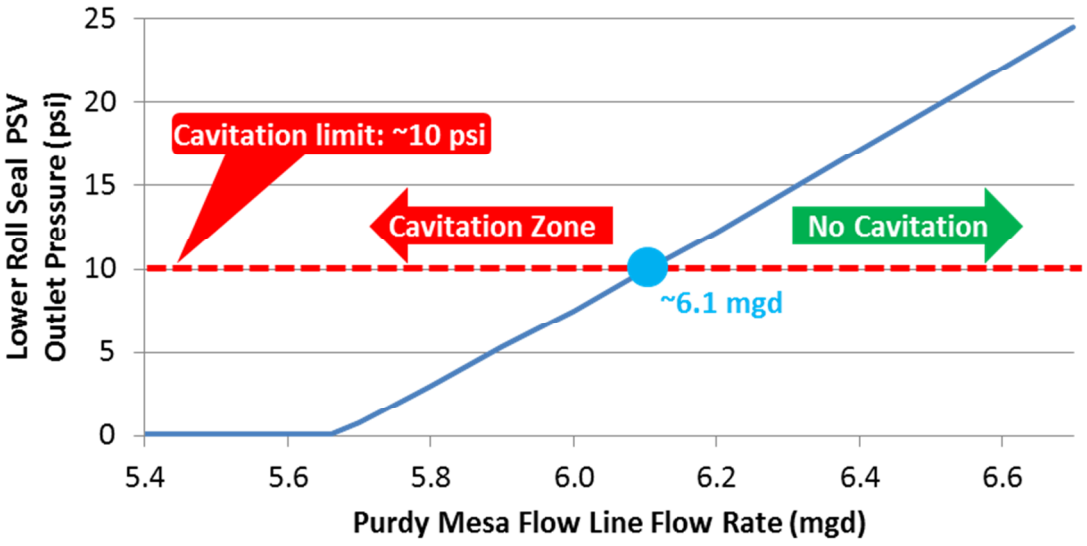


Figure 14 Lower Roll Seal PSV – Required Flow Rate to Avoid Cavitation

5.2 PIPELINE AIR ACCUMULATION

When pipelines flow under positive pressure, they flow full and minimize the accumulation of air within the pipeline. When the HGL of water within a pipeline drops below the elevation of the pipeline, partially full pipe flow can occur, which can lead to the accumulation of air. Accumulated air in the pipeline can lead to a variety of negative consequences including the unpredictable formation and movement of air pockets, temporary hydraulic restrictions due to air pockets (which effectively reduce the flowable cross-sectional area of a pipe until the air is expelled through an air valve), uncertain time durations to fully expel air from the pipeline as well as air entrainment and other flow anomalies.

Based on the hydraulic analyses described in the previous section, there is potential for air accumulation due to partially full pipe flow between the PCT and the Grand Junction WTP under the following flow conditions:

- PMFL flow rates of less than 6.1 mgd with the Upper and Lower Roll Seal PSVs bypassed
  - Significant potential for air accumulation between the PCT (which was predicted to operate fully drained with the outflow pipe flowing partially full) and the dynamic HGL determined by the flow rate (illustrated in Figure 9).
  - Additional potential for air accumulation on the downstream side of the Whitewater Hill high point. Utilizing the Roll Seal PSVs under PMFL flow rates of less than 6.1 mgd are not recommended due to the cavitation potential of the Lower Roll Seal PSV (as described in Section 5.1)
- PMFL flow rates between 6.1 mgd and 7.1 mgd with the Upper Roll Seal PSV upstream setting set to match the flow rate of the Juniata Reservoir PSV and the Lower Roll Seal PSV upstream setting of 101 psi

- Potential for air accumulation on the downstream side of the Whitewater Hill point, which was predicted to flow partially full at PMFL flow rates of less than approximately 7.1 mgd and flow full at PMFL flow rates in excess of approximately 7.1 mgd

5.3 PRESSURE CONTROL TOWER VOLUME

Under flow rates in excess of approximately 6.1 mgd, the City currently attempts to maintain the water surface elevation of the PCT by manually adjusting the Upper Roll Seal PSV such that the outflow of the PCT is equal to the inflow to the PCT from the Juniata Reservoir FCV. Based on discussions with the City, maintaining a consistent water surface elevation in the PCT is challenging, with the City generally observing either the overflowing of the PCT (inflow greater than outflow) or draining of the PCT (outflow greater than inflow) shortly after adjusting the water surface elevation by manually adjusting the upstream setting of the Upper Roll Seal PSV.

An overview of the PCT is shown in Figure 15. The cylindrical PCT is 12 ft in height (approximately 5,252 ft to 5,364 ft) with a diameter of 5 ft and a nominal total volume of approximately 235 ft^3 (1,760 gallons). Water flows into the PCT from the 20-inch steel pipe which conveys water from the Juniata Reservoir and flows out through the existing 18-inch steel Sullivan Draw pipe. As shown, the outflow pipe is located approximately 4 ft above the bottom of the PCT and the overflow pipe (which discharges water out of the PCT if inflow is greater than outflow) is located approximately 2 ft below the top. In practice, this leaves a 6 ft desired level range (between 5,256 ft and 5,362 ft) in the PCT. When operating the PCT within this desired level range, the outflow pipe flows full (no air accumulation) and the PCT does not overflow.

The volume corresponding to the desired PCT level range of 6 ft is approximately 118 ft^3 (881 gallons), which is a small volume relative to the normal flow rates of the PMLF. For example, under a flow rate of 6.7 mgd, a 1% discrepancy in flow in versus flow out of PCT would be predicted to result in the PCT either overflowing or draining within 10 to 15 minutes. Increasing the volume of the PCT would result in an increased ability to maintain the water surface elevation of the PCT without overflowing or draining.

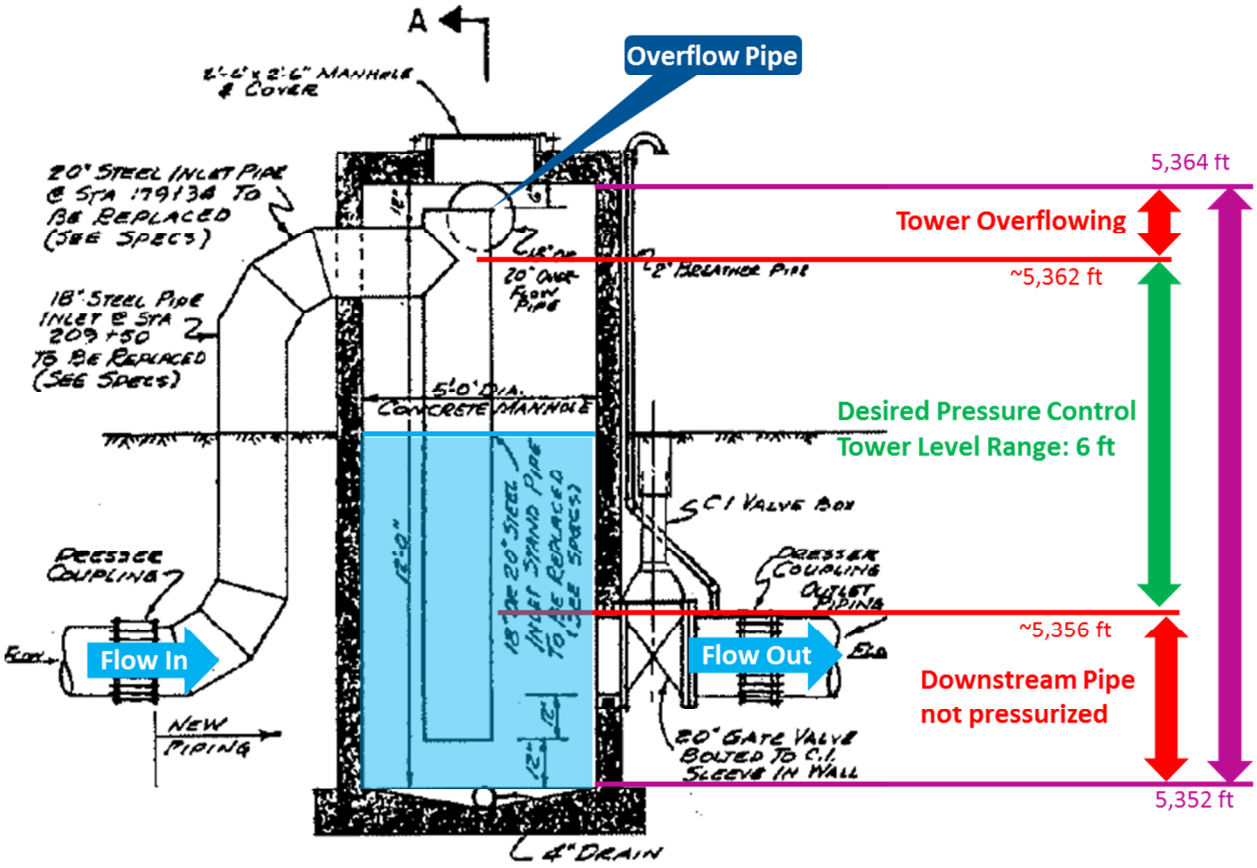


Figure 15 Pressure Control Tower Overview

5.4 FLOW CONTROL UPSTREAM AND DOWNSTREAM OF THE PRESSURE CONTROL TOWER

Based on conversations with the City, maintaining a consistent, stable water level in the PCT is a challenge. This challenge is primarily due to the small volume of the PCT as described in Section 5.3 as well as the difficulty of matching flow into the PCT with flow out of the PCV, which is necessary to maintain a stable water level. Existing flow control into and out of the PCT is described below:

- Flow into PCT
  - At all PMFL flow rates, flow into the PCT is controlled by the FCV at the Juniata Reservoir as shown in Figure 16
  - The flow rate delivered to the PMFL (and subsequently delivered to the PCT) is set by the City and the FCV automatically modulates to maintain the flow setpoint.
- Flow out of PCT
  - At PMFL flow rates of approximately 6.1 mgd or greater, flow out of the PCT is controlled by manually adjusting the upstream pressure setting of Upper Roll Seal PSV until the flow out of the PCT is equal to the flow into the PCT and City staff can visually confirm that the PCT water level has stabilized within its desired head range.

- At PMFL flow rates of less than 6.1 mgd, cavitation of the Lower Roll Seal PSV is likely (Section 5.1) and both the Upper and Roll Seal PSVs should be bypassed, leaving no ability to control flow out of the PCT. Without the Upper Roll Seal PSV controlling flow (and creating back pressure to full pipe flow through the Sullivan Draw), the PCT was predicted to drain completely (as shown in Figure 9).

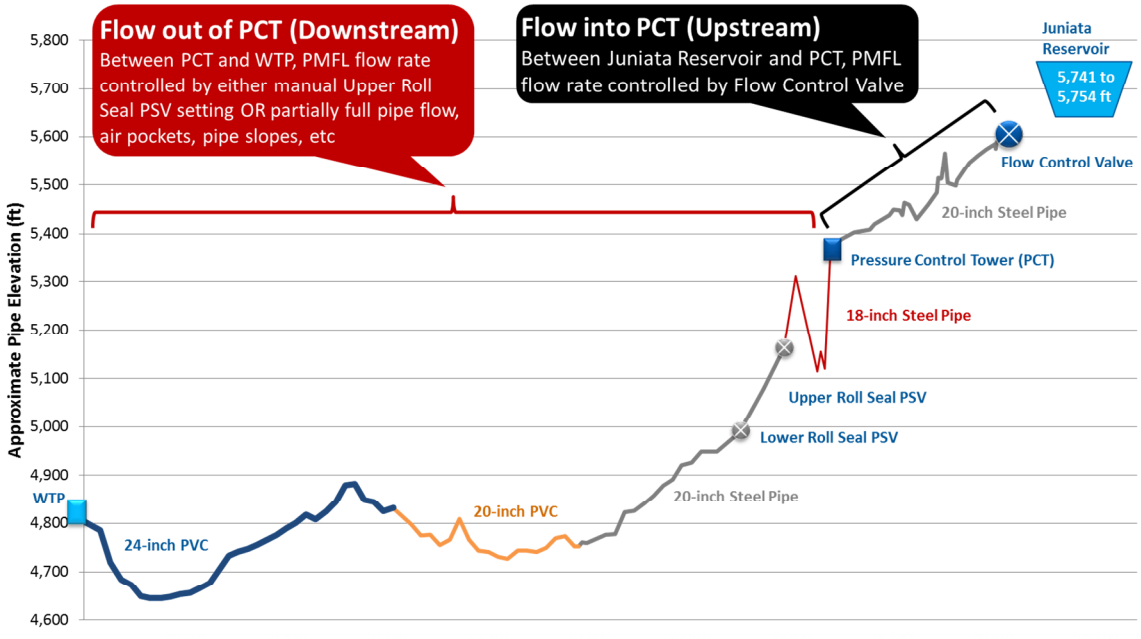


Figure 16 Flow Control Upstream and Downstream of the Pressure Control Tower

6 Potential Hydraulic Improvements

Based on the hydraulic analyses detailed in Section 4 and the hydraulic issues described in Section 5, potential hydraulic improvements were developed for the PMFL to accomplish two primary objectives:

1. Enable the PMFL to flow fully pressurized between the PCT and the Grand Junction WTP under all desired flow rates. This will significantly reduce the potential for air accumulation in the pipeline and cavitation of the Roll Seal PSVs, which are currently believed to be the primary causes of air entrainment seen by City staff at the Grand Junction WTP.

2. Simplify operation of the PMFL for the City by enabling automatic flow control on both the upstream and downstream side of the PCT.

The potential hydraulic improvement projects identified as part of this analysis are shown in Figure 17 and detailed in the following section.

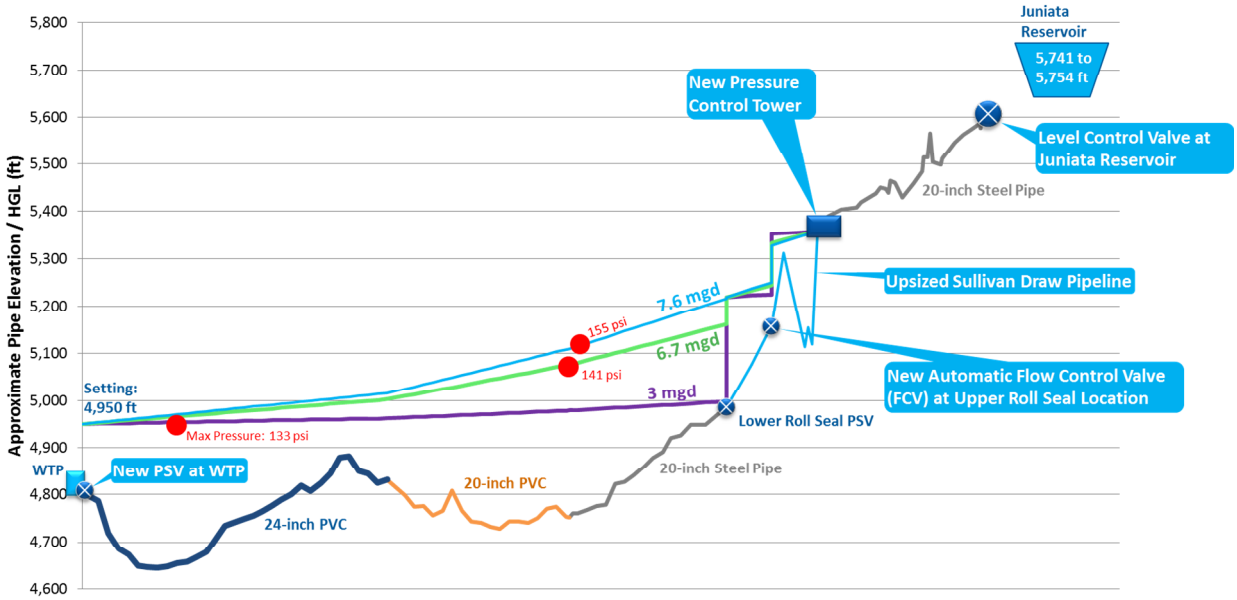


Figure 17 Purdy Mesa Flow Line - Potential Hydraulic Improvements

6.1 UPSIZED SULLIVAN DRAW PIPELINE

Upsizing of the Sullivan Drive pipeline from the PCT to the Lower Roll Seal PSV to 20-inch to facilitate future PMFL flow rates of up to 9.8 mgd as described in Section 4.1.1. If PMFL flow rates in excess of 9.8 mgd are desired in the future (which will requiring upsizing additional portions of the PMFL), the Sullivan Drive pipeline should be upsized to support that desired future flow rate. As described in Section 4.3, a 24-inch PMFL from the PCT to the Grand Junction WTP was predicted to be capable of delivering flows of up to 14.4 mgd.

6.2 NEW AUTOMATIC FLOW CONTROL VALVE AT UPPER ROLL SEAL LOCATION

Installation of a new automatic flow control valve at the current Upper Roll Seal PSV location would enable the City to send a desired PMFL flow setpoint to the new FCV, which would modulate to deliver that flow rate from the PCT to the Grand Junction WTP. The key benefit of locating the new FCV at this location is that this valve will naturally create back pressure while modulating to control flow. This back pressure will ensure that the PMFL is fully pressurized (full pipe flow) from the PCT to the new automatic FCV at the Upper Roll Seal PSV location under all potential PMFL flow rates.

The Upper Roll Seal PSV location is a desirable location for the new automatic flow control valve as it allows the City to maintain the Lower Roll Seal PSV at its current location while maintaining PMFL pressures of less than approximately 100 psi between the new automatic flow control valve and the Lower Roll Seal PSV. If the new automatic flow valve is desired to be installed at an alternate location (with easier access, better site conditions, available power), between the Sullivan Draw High point and the Lower Roll Seal PSV, the setting of the Lower Roll Seal PSV would need to be modified and the City could expect to see PMFL pressures as high as 150 psi, depending on the selected location of the new automatic flow control valve. If an alternate location is selected, the new Sullivan Draw pipeline should be designed with pressure class which exceeds the predicted pressures.

The automatic FCV will require reliable power to modulate continuously. Options for electrification of the Upper Roll Seal site location could include working with the Grand Valley Rural Power Authority, installation of a hydropower turbine, or a combination.

6.3 AUTOMATIC LEVEL CONTROL VALVE AT JUNIATA RESERVOIR

With the PMFL flow rate controlled by the new automatic FCV at the Upper Roll Seal location, the existing FCV at the Juniata Reservoir would be proposed to be modified to an automatic level control valve, which would modulate to maintain a desired water surface elevation in the PCT under all potential PMFL flow rates.

6.4 NEW PRESSURE CONTROL TOWER

As described in Section 5.3, the existing PCT volume is small, leading to significant operational challenges when attempting to maintain a consistent water level, which is required to achieve fully pressurized full pipe flow from the PCT to the Grand Junction WTP. With the proposed new automatic flow control valve at the Upper Roll Seal PSV location and the automatic level control valve at the Juniata Reservoir, a consistent water level in the PCT could theoretically be maintained under ideal hydraulic conditions. However, in reality, changes in flow rate (due to transient events, etc.) would be likely to cause rapid level change in the existing PCT due to its small volume, causing the level control valve at the Juniata Reservoir to constantly "hunt" for the correct level and leading to system instability.

Installation of a new, larger PCT at or near the existing PCT site would give the automatic level control valve at the Juniata time to modulate while maintaining the PCT within a desired head range and enable full automatic control of the PMFL from the Juniata Reservoir to the Grand Junction WTP.

The exact size of the larger PCT should be confirmed with detailed design, but is preliminarily anticipated to be approximately 430,000 gallons (maximum PMFL flow rate of 10.1 mgd) to 610,000 gallons (maximum PMFL flow rate of 14.8 mgd), depending on the desired maximum flow rate of the PMF, as detailed in the following section.

6.4.1 Preliminary New Pressure Control Tower Sizing Calculations

A preliminary PCT sizing tool was developed as shown in Figure 18. This tool is based on a given maximum PMFL (assumed to be 14.8 mgd in the example shown) as well as a cylindrical PCT geometry. If the City determines the maximum future flow rate of the PMFL to be less than 14.8 mgd, the new PCT volume could be reduced accordingly.

The new PCT was sized based on three primary components: Operating Range, Deadband and Freeboard:

6.4.1.1 Operating Range

The volume required for the operating range of the PCT was assumed to be 30 minutes at the maximum anticipated flow rate of the PMFL. At a maximum potential future flow rate of 14.8 mgd, this corresponds to a volume of 308,000 gallons as shown in Figure 18. An operating range of 8 ft (corresponding to 38,500 gal/ft) was selected to give the automatic level control valve at the Juniata Reservoir sufficient buffer time to modulate and maintain the level near the desired level setpoint, even if the PMFL flow rate is modified significantly at the new automatic flow control valve located at the Upper Roll Seal PSV.

6.4.1.2 Deadband

Deadband is the volume of water required below the operating range to ensure that vortexing does not occur. The deadband calculations are shown in Figure 18 and were predicted to require approximately 5.3 ft of height, corresponding to a volume of approximately 203,000 gallons.

6.4.1.3 Freeboard

Freeboard is the additional head in the tank above the operating range which is available to prevent overfilling/overflowing under certain conditions. For the PCT, this volume was assumed to be approximately 50% of the 20-inch steel pipe upstream of the PCT to the intermediate high point, which could potentially flow into the tank by gravity following the shutdown of flow through the PMFL at the new automatic flow control valve at the Upper Roll Seal location. The approximate required freeboard was calculated to be 2.5 ft of height, corresponding to a volume of 97,000 gallons.

6.4.1.4 Total Required PCT Volume and Dimensions

The total required volume of the PCT (assuming a maximum PMFL flow rate of 14.4 mgd) was calculated to be approximately 608,000 gallons as shown in Figure 18. With a cylindrical geometry, the required volume and total head range corresponds to approximate tank dimensions of 16 ft in height with a diameter 81 ft. If a cylindrical geometry does not fit the available site or right of way, the shape of the PCT could be modified while maintaining the same volume per ft of head range (gal/ft) and height. Potential alternate dimensions would be a square tank 16 ft in height with sides of 71 ft or a rectangular tank 16 ft in height with dimensions of 60 ft by 85 ft.

Operating Range Calcs	PMFL Max Flow Rate	14.8	mgd	*Entered Value*
	Desired Duration of Max Flow Rate	30	min	*Entered Value*
	Required Working Volume of PCT	**308,000**	**gal**	*Purdy Mesa Max Flow Rate * Duration*
	Desired Working Head Operating Range	8.0	ft	*Entered Value*
	Operating Range gal/ft	38,500	gal/ft	*Gallons per ft of Operating Range*
	Required Balance Tank Diameter	81	ft	
Deadband Calcs	Assumed Balance Tank Outlet Pipe Diameter	36	in	*Entered Value*
	Outlet Velocity at Purdy Mesa Max Flow Rate	3.2	ft/s	*Purdy Mesa Max Flow Rate / Outlet Pipe Area*
	Froude Number	0.33		*Fd = V / sqrt(g*D)*
	Required Deadband to Prevent Vortexing	5.3	ft	*S = Outlet Pipe Diameter * (1 + 2.3*Fd)*
	Required Deadband Volume	**203,000**	**gal**	*Assuming cylindrical tank*
Freeboard Calcs	Pipe Distance From High Point Upstream of PCT	11,943	ft	*Entered Value*
	Pipe Diameter Upstream of PCT	20	in	*Entered Value*
	Total Potential Volume in Pipeline Upstream of PCT to High Point	194,896	gal	*Pipe Area x Length*
	Assume % Pipe Volume Potential to Flow into PCT on Shutdown	50%		*Entered Value*
	Required Freeboard Volume	**97,000**	**gal**	
	Required Freeboard	2.5	ft	
	Total Required PCT Volume	**608,000**	**gal**	Working + Deadband + Freeboard Volume
	Tank Diameter	81	ft	
	Tank Height	16	ft	

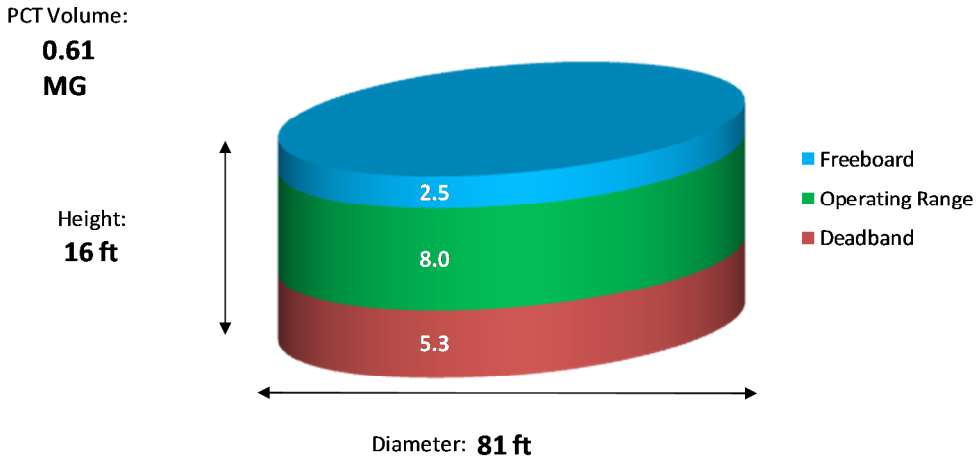


Figure 18 Preliminary Pressure Control Tower Sizing Tool – 14.8 mgd Maximum PMFL Flow Rate

6.5 NEW PRESSURE SUSTAINING VALVE AT GRAND JUNCTION WTP

As described in Section 5.1, the Lower Roll Seal PSV is predicted to cavitate due to low downstream pressures at PMFL flow rates of less than approximately 6.1 mgd. This is because the HGL on the downstream side of the Lower Roll Seal PSV is determined by the water surface elevation of the Grand Junction WTP and the dynamic head loss in the PMFL – and the dynamic losses are only sufficient to create sufficient downstream pressure at flow rates greater than 6.1 mgd. In order to prevent cavitation of the Lower Roll Seal PSV under all potential PMFL flow rates (including flow

rates below 6.1 mgd), a new pressure sustaining valve is proposed to be installed at the Grand Junction WTP, which will enable the HGL to be raised to any desired level between the Grand Junction WTP and the Lower Roll Seal PSV.

Figure 17 displays an example hydraulic profile with all potential hydraulic improvements described above in place under PMFL flow rates of 3.0, 6.7 and 7.6 mgd. As shown in this example, the new PSV at the Grand Junction WTP was set to maintain an upstream setting of 4,950 ft, which enables the HGL at 3.0 mgd to exceed the elevation of the Lower Roll Seal PSV (creating positive downstream pressure and preventing cavitation). Without this PSV operational, the HGL line at 3.0 mgd would be predicted to be below the elevation of the Lower Roll Seal PSV as shown in Figure 9 in Section 4.2.1.

With the new PSV at the Grand Junction WTP, the upstream setting could be modified to enable pressurized (full pipe) flow from the PCT to the Grand Junction WTP under all potential desired PMFL flow rates. It is noted that at higher flow rates the City would be required to lower the upstream setting of the new PSV at the Grand Junction WTP to maintain maximum pressures along the PMFL to within the 160 psi pressure rating of the existing pipe.

7 Summary

A Bentley WaterGEMS hydraulic model was built and validated to facilitate analysis of the PMFL under a variety of conditions. A summary of the key findings and conclusions detailed in this technical memorandum is included below:

7.1 SULLIVAN DRAW PIPELINE

The existing 18-inch Sullivan Draw pipeline was predicted to be an existing hydraulic bottleneck, limiting the maximum flow rate of the PMFL to approximately 8.0 mgd. If the Sullivan Draw pipeline is upsized to 20-inch (as currently planned), the maximum flow rate of the PMFL was predicted to be increased to approximately 9.8 mgd.

7.2 EXISTING PURDY MESA FLOW LINE

Accumulation of air – which could lead to hydraulic issues, including air entrainment – was predicted to occur within the PMFL at all flow rates up to approximately 7.1 mgd, with more significant potential for air accumulation at lower flow rates.

7.3 FUTURE PURDY MESA FLOW LINE

If the PMFL from the PCT to the Grand Junction WTP (including the Sullivan Draw pipeline) was upsized to 24-inch in the future, the maximum flow capacity was predicted to be approximately 14.4 mgd. It was noted that if the PMFL downstream of the of the PCT were upsized to 24-inch, it is likely that the existing 20-inch steel pipe upstream of the PCT (from the Juniata Reservoir to the PCT) would also likely be required to be upsized in kind.

7.4 HYDRAULIC ISSUES

7.4.1 Roll Seal PSV Cavitation

To avoid cavitation (and potential air entrainment) of the Roll Seal PSVs, the PSVs should be bypassed if the PMFL flow rate is 6.1 mgd or lower. The PSVs should be utilized under all PMFL flow rates greater than 6.1 mgd. The Upper Roll Seal PSV should not be utilized if the Lower Roll Seal is bypassed.

7.4.2 Pipeline Air Accumulation

Potential for pipeline air accumulation – which can lead to a variety of negative consequences including the unpredictable formation and movement of air pockets, temporary hydraulic restrictions due to air pockets uncertain time durations to fully expel air from the pipeline as well as air entrainment and other flow anomalies – was predicted under all PMFL flow rates of less than 7.1 mgd.

7.4.3 Pressure Control Tower Volume

In order for the level in the PCT to remain constant, flow into the PCT must equal flow out of the PCT. Due to the small volume of the existing PCT, small discrepancies in flow in versus flow out lead to rapid changes in the water level in the PCT, leading to the tank either overflowing or draining.

7.4.4 Flow Control Upstream and Downstream of the Pressure Control Tower

Flow into the PCT is controlled by the Juniata Reservoir FCV at all flow rates, which is modulated to maintain the given flow setpoint. Flow out of the PCT is controlled by manual adjustment of the upstream setting of the Upper Roll Seal PSV (at flow rates greater than 6.1 mgd) or uncontrolled (dictated solely by open channel pipe hydraulics) when the PSVs are bypassed at flow rates of less than 6.1 mgd. The lack of precise control of flow going both into and out of the PCT at all flow rates leads to operational challenges for the City.

7.5 POTENTIAL HYDRAULIC IMPROVEMENTS

Hydraulic improvements were identified which were predicted to enable the PMFL to be operated automatically (no manual adjustments required) while flowing fully pressurized (no air accumulation, no Roll Seal cavitation) from the PCT to Grand Junction WTP. The potential improvements are listed below and detailed in Section 6.

- Upsize Sullivan Draw pipeline to 20-inch
- New automatic flow control valve at the Upper Roll Seal PSV location which modulates to maintain a PMFL flow setpoint given by the City
- Automatic level control valve at the Juniata Reservoir which modulates to maintain a water level within a desired range at the PCT
- A new PCT with a volume of approximately 430,000 to 610,000 gals (depending on maximum future PMFL flow rate) to enable stable automatic level control
- A new pressure sustaining valve at the Grand Junction WTP to prevent partially full pipe flow and/or cavitation of the Lower Roll Seal PSV under all PMFL flow rates

7.6 OPINION OF PROBABLE CONSTRUCTION COSTS FOR POTENTIAL HYDRAULIC IMPROVEMENTS

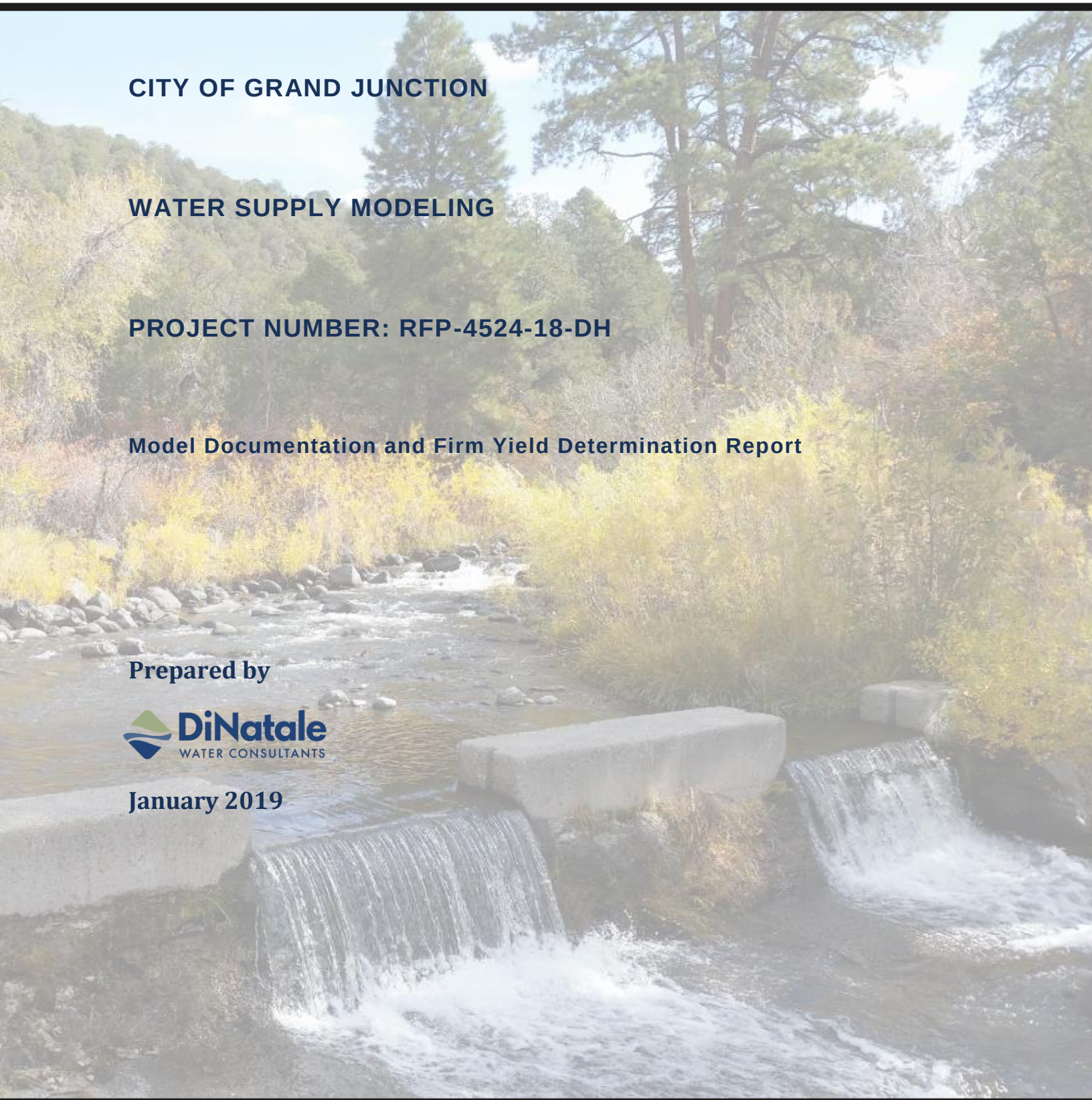
Estimated construction costs were developed for the improvements identified as well as two other segments of the pipeline: Reservoir to the PCT and from the Lower Roll Seal to the Whitewater Creek. The cost estimates included in this TM are considered to be Class 5, as outlined by the Association for the Advancement of Cost Engineering (AACE) Cost Estimate Classification System. Costs are based on the current design information from April 2018 with a scope development at approximately a 10% stage of design. The opinion of construction costs includes factors for construction general conditions, contingencies, engineering, and construction management. No allowance was made for irregular construction or environmental difficulties.

The estimate was based on PVC pipe, a prestressed concrete balance tank, and 1.5 miles of electrical power distribution lines. Table 3 summarizes the construction costs for the various segments.

Table 3 Opinion of Probable Construction Costs

DESCRIPTION	LENGTH/ VOLUME	CONSTRUCTION COST
Sullivan Draw		
Pipeline	1.25 miles	2,247,000
Electrical Power to Site	1.5 miles	892,000
Valve Vaults	2	234,000
Balance Tank	0.5 MG	1,208,000
Existing Flow Control Vault SCADA Upgrades	N/A	97,000
SubTotal		4,678,000
Pipeline – Reservoir to PCT	3.4 miles	5,251,000
Pipeline – Lower Roll Seal to Whitewater Creek	3.1 miles	4,644,000
Total		**14,574,000**

CITY OF GRAND JUNCTION COLORADO UTILITIES



CITY OF GRAND JUNCTION

WATER SUPPLY MODELING

PROJECT NUMBER: RFP-4524-18-DH

Model Documentation and Firm Yield Determination Report

Prepared by

DiNatale WATER CONSULTANTS

January 2019

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EXECUTIVE SUMMARY

Grand Junction contracted with DiNatale Water Consultants (DiNatale Water) to develop a hydrologic model that could determine the firm yield of the City's water supply system. In addition, specifications for the model included the ability to test a number of different future scenarios. The RiverWare software package was selected for the model development based on its flexibility in simulating a wide variety of system operations while also simulating the Colorado prior appropriation system of water rights administration.

The scope of this project included development of a baseline model that computes the system firm yield using historical hydrologic conditions (1975 through 2016) and current operational protocol. This baseline can be compared to existing demands and Grand Junction will be able to analyze and compare results of other scenarios to the existing system and current operations. The firm yield is amount of water that can be delivered through a critical drought period while maintaining at least approximately one year's supply in storage. The firm yield was tested by developing three storage-related criteria that maintain this amount of water in storage and include operational targets the City has used in its historical operations:

1) Juniata Reservoir must be at least 90% full by the end of runoff (May 1-July 1)
2) Juniata Reservoir must be at least 60% full going into winter (November 1)
3) Storage of at least 1,800 AF in Upper Reservoirs going into winter (November 1)

Figure ES-1 shows the firm yield criteria graphically along with the total reservoir capacity and the average annual demand from 2013 to 2017.

The firm yield was determined by simulating annual water demand and incrementally increasing or decreasing this demand, and determining the highest demand where all three firm yield criteria were satisfied for the entire period of record. The firm yield does not include use of Gunnison River or Colorado River supplies because these sources cannot currently be treated in the City's direct filtration water treatment plant.

The model results show that Grand Junction's current firm yield is between 5,800 and 6,275 AF per year (**Figure ES-2**). This amount includes 44 AF delivered to the Kannah Creek Water Treatment Plant and 300 AF of non-potable water used for irrigation of the cemetery and Las Colonias park. This amount does not include treatment and distribution system losses, which have been about 9% over the past decade. Deducting the Kannah Creek WTP, non-potable use, and treatment and distribution losses, the firm yield of water delivered to customer taps is between 4,960 AF and 5,400 AF per year (1,600 to 1,750 million gallons).

Model inputs were derived from observed hydrologic data and simulation of operations was based on discussions with Grand Junction staff. Due to lack of historical observed reservoir inflow data and observed evaporation data, some model inputs were estimated. Model results were tested for sensitivity to assumptions used to estimate model inputs. This sensitivity testing provides a high level of confidence that the firm yield falls within the range described above.

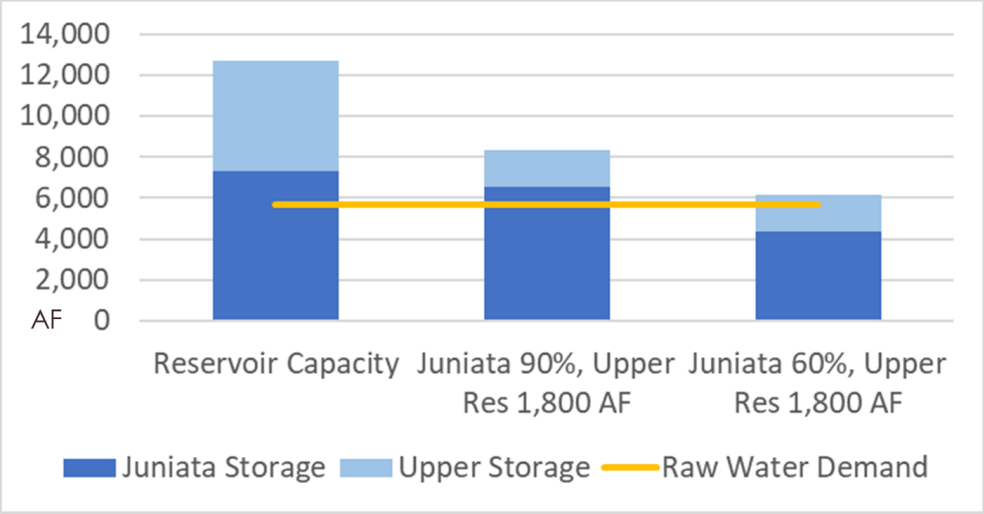

Figure ES-1. Firm yield criteria compared to full reservoir capacity and average annual raw water demand from 2013 to 2017

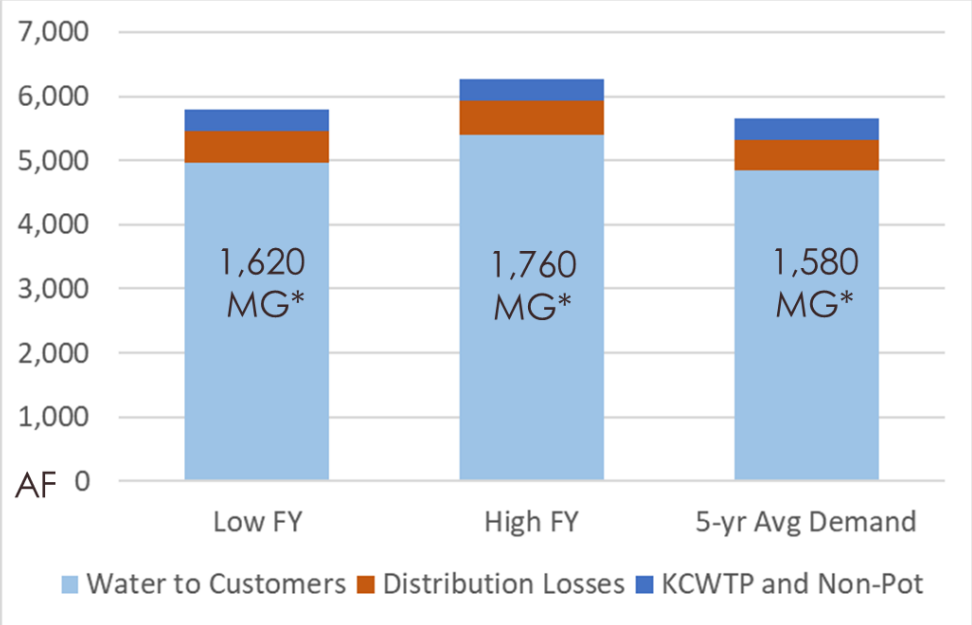

Figure ES-2. Baseline firm yield compared to five-year average annual demand (2013 to 2017)

Model Limitations and Recommendations

Hydrologic models attempt to simulate a wide range of natural phenomena that are always changing. Models by nature simplify the complex natural system to provide useful information and insight about the system. Therefore, every model has certain limitations that should be understood so that future analysis and results obtained from the model can be considered in the proper context. The following are key limitations to the current version of the RiverWare model developed for this project and associated recommendations. Additional detail and explanation for these limitations and recommendations can be found in Section 7.

1. The model was based on a repeat of historical hydrology. Future hydrology may differ from historical in terms of severity or duration of droughts.

   Recommendation A: *Consider testing various methods of hydrologic input development in addition to the percent reduction tested in Section 6.1. Examples include resequencing, more in-depth climate change considerations variations and daily-to-monthly flow considerations.*

2. System reliability criteria for the baseline RiverWare model development were based primarily on historical operating protocol and institutional knowledge. Additional evaluation of the criteria may provide additional insight into other opportunities to operate the system in a more efficient and/or reliable manner.

   Recommendation B: *Consider attempting additional outreach to regional water providers to understand other water provider system reliability criteria and assess whether such criteria would be appropriate for Grand Junction's system.*

   Recommendation C: *Consider evaluating the effect of each of its reliability criteria on firm yield. This recommendation was carried out in part as described in Section 6.1 when the Upper Reservoir criterion was relaxed for certain model runs but may also be useful for other reliability criteria.*

3. Colorado River and Gunnison River sources were not included as a source in the baseline model due to current inability to treat this water with the existing water treatment system.

   Recommendation D: *Consider evaluating potential potable and non-potable water uses for Gunnison River or Colorado River supplies, including water treatment technologies that could best serve Grand Junction.*

4. A potential Colorado River Compact call was not simulated because no such call has been placed historically. This could impact Grand Junction's reservoir water rights,

in particular the use of junior 1990's-era storage rights for municipal use in place of more senior changed agricultural water rights.

Recommendation E: *Consider evaluating the potential effect of the Colorado River Compact on Grand Junction's operation of junior water rights and develop a plan for operation under and maintenance of Grand Junction's more senior rights.*

5. The model simulates historical operational protocol. Different operational procedures can be tested using the RiverWare model to explore opportunities for increased efficiency and reliability. These changes can be evaluated in conjunction with firm yield criteria changes as described in item 2 and Recommendation C, above.

   Recommendation F: *Consider evaluating operational changes that differ from historical protocol using the RiverWare model.*

1. INTRODUCTION

The City of Grand Junction provides treated and raw water to customers within its two service areas. The primary service area is located in the downtown area of Grand Junction and the second area is located near its water sources in the Kannah Creek basin and is known as the Kannah Creek service area. Other areas of the City of Grand Junction are served by the Ute Water Conservancy District (Ute Water). For the purposes of this report, references to Grand Junction mean only the water service areas of the City of Grand Junction.

Grand Junction contracted with DiNatale Water Consultants (DiNatale Water) to develop a hydrologic model that could determine the firm yield of the water supply system. In addition, specifications for the model included the ability to test a number of different future scenarios. This report documents the model developed for this purpose and presents results of the firm yield determination. Grand Junction's water supply is derived primarily from the Kannah Creek basin, located on the western side of the Grand Mesa. Grand Junction has several direct flow and storage water rights that it uses to meet the demands of its customers, as well as delivering water to ranches it owns and to other water users who lease Grand Junction's excess water in some years. Raw water is delivered from this area via two pipelines to Grand Junction's water treatment plant located on the south side of the city, near the Redlands Canal diversion dam. The pipelines are known as the Kannah Creek Flow Line and the Purdy Mesa Flow Line. A small amount of water is delivered to the Kannah Creek/Purdy Mesa water treatment plant and delivered to the Kannah Creek water service area. Grand Junction also has water rights on the Gunnison River and the Colorado River. These two sources have lower water quality and are difficult to treat with the current direct filtration process used at Grand Junction's existing facilities. A detailed water resource inventory was developed by the City of Grand Junction in early 2018 that provides additional details on the infrastructure, water rights and historical operations (2018 Water Resources Inventory; Spronk Water Engineers 2018).

The water supply model developed for this project was designed to be able to simulate other future scenarios, including the ability assess:

- which water rights are needed to meet demands under current and drought conditions
- potential operational changes at the City's reservoirs
- adequacy of emergency backup sources
- short-term operational strategies (e.g. carryover storage)
- other planning scenarios

Due to the lack of hydrologic records for some streams and reservoirs, sensitivity testing was performed on some hydrologic modeling inputs that were estimated rather than

directly measured to assess the sensitivity of firm yield. Specifically, sensitivity to evaporation rates, the distribution of inflow above and below the Grand Mesa Reservoirs, as well as the total inflow above Grand Junction's point of diversion on Kannah Creek were tested. This testing is described further in Section 6.

2. MODEL SELECTION

In July 2018, DiNatale Water presented four modeling platforms to the City of Grand Junction: RiverWare, Excel spreadsheet-based model, the State of Colorado's StateMod modeling, and MODSIM. DiNatale Water facilitated a discussion with City staff regarding the advantages and disadvantages of each of the model platforms as it relates to the City's needs for the model. The City elected the RiverWare modeling platform in part due to its ability to develop custom operational rules, simulate Colorado's prior appropriation water rights administration system, and its stakeholder interface product, RiverWISE.

DiNatale Water developed the model using the schematic of the Grand Junction system produced in the 2018 Water Resources Inventory. This system schematic is reproduced in this report as **Figure 1**. The RiverWare model layout is shown as **Figure 2**. In addition to the model layout, RiverWare includes a set of operational rules that are applied to the model during each time step. These operational rules are written in the RiverWare Policy Language (RPL) and are required for running the model. The ruleset developed for the firm yield determination is described in more detail in Section 4.

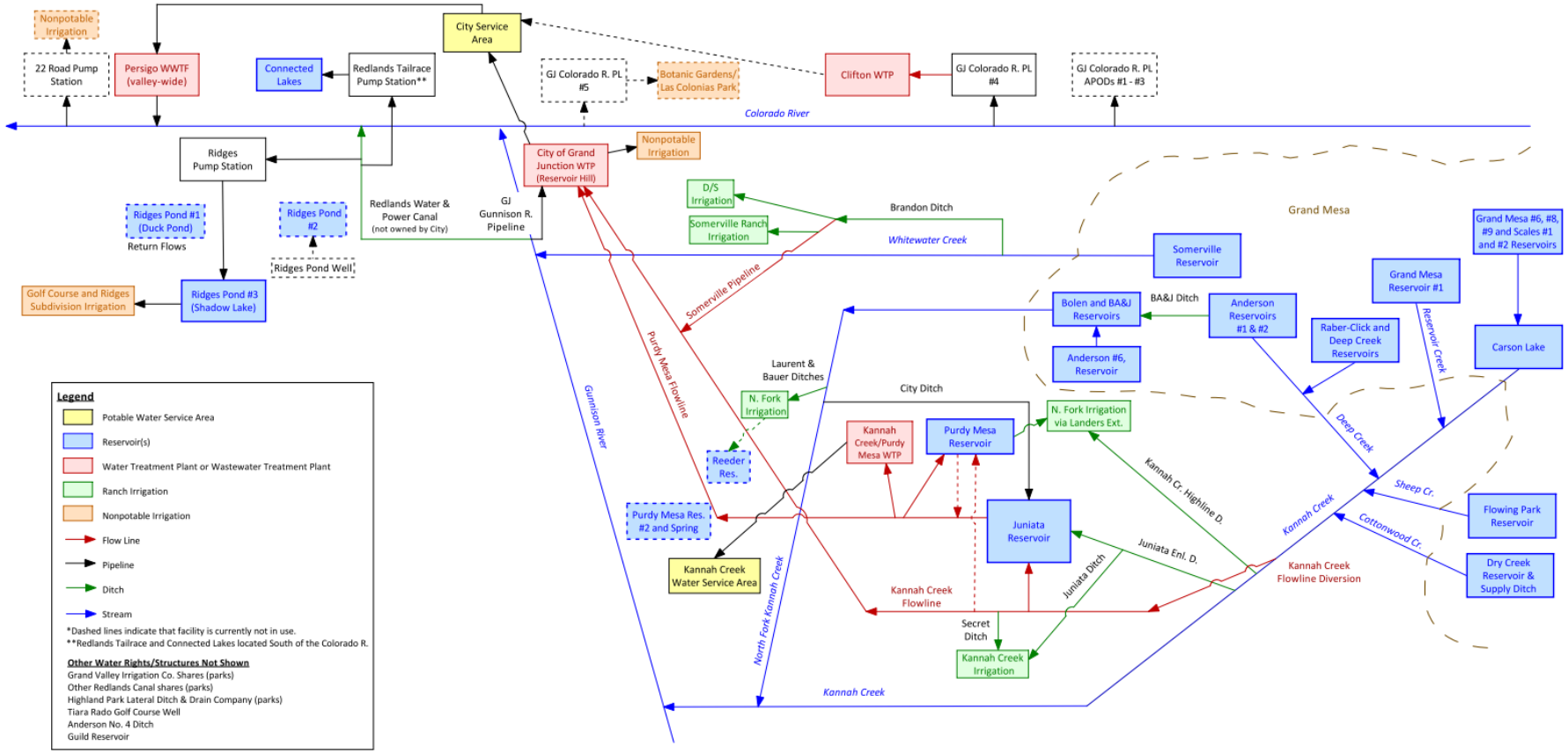

Figure 1. Schematic diagram of Grand Junction water system (from 2018 Water Resources Inventory)

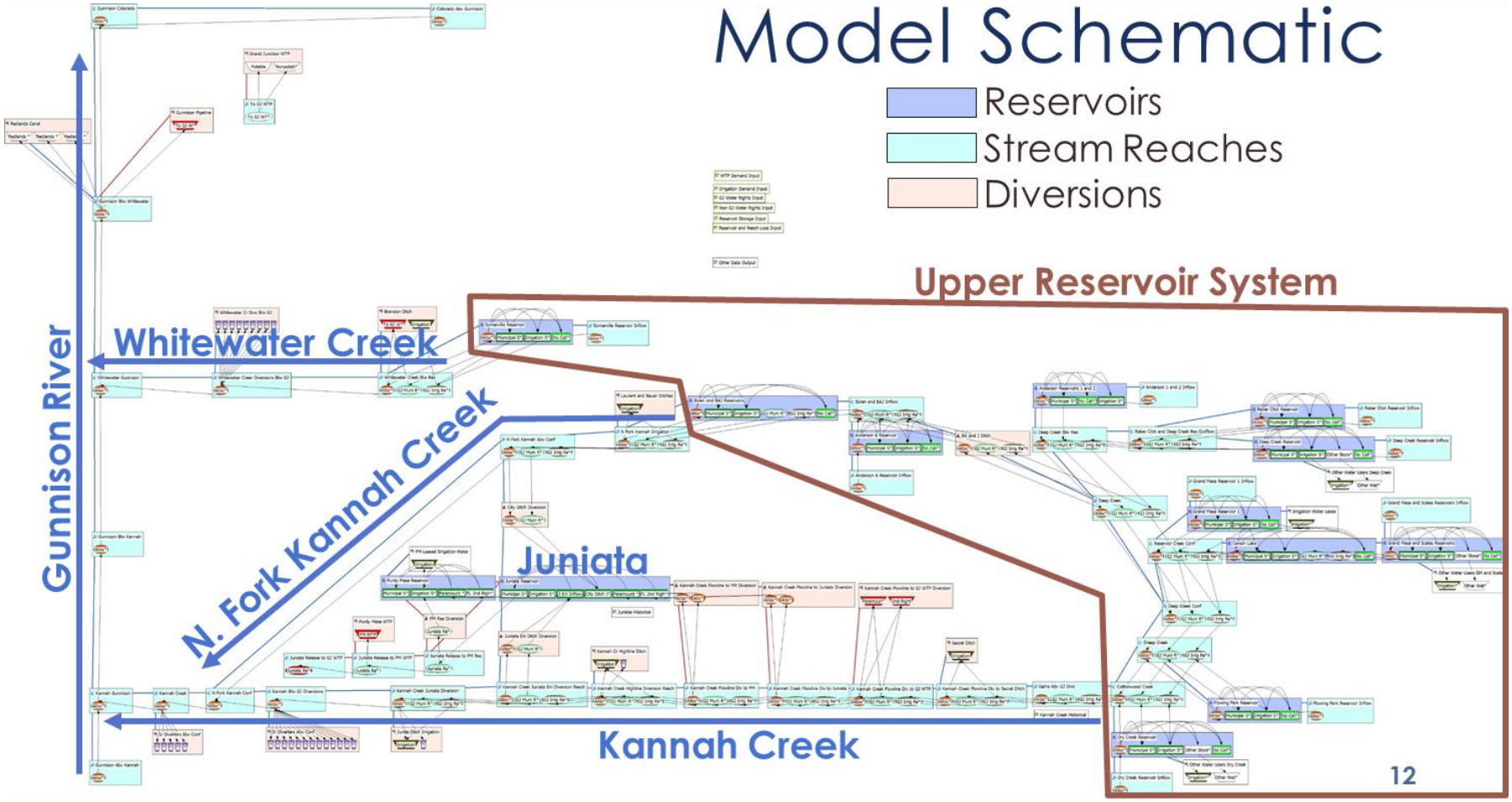

Figure 2. RiverWare model layout

3. MODEL INPUTS AND CONFIGURATION

3.1 Model Time Step and Time Period

The RiverWare model was configured with a monthly timestep from 1975 through 2016. Historical hydrology is used as a model input and current operational protocol is simulated using the historical hydrology. Historical monthly data is more readily available from reservoir records than daily data. In addition, monthly data can effectively simulate the yield of a water supply system, especially systems such as Grand Junction's that have storage facilities that can buffer some intra-month variability typically seen in daily data. From a pragmatic point of view, a monthly model is simpler to manage and modify for various scenarios simply because the amount of input and output data into and from the model is much less than a daily model.

A daily model was considered due to the frequent nature of changing river calls and fixed pipeline capacity. In addition, we discussed the possibility of Grand Junction needing a 404(b) permit from the U. S. Corps of Engineers (Corps). The Corps' regulatory process favors daily models due to its requirement to evaluate impacts to aquatic resources to issue a permit. Impacts to aquatic resources, such as fisheries and other habitat are more difficult to evaluate with monthly modeled data. Grand Junction staff indicated that it did not foresee any projects that would require a Corps permit. In addition, Grand Junction's Paramount water right is the most senior water right in the Kannah Creek basin and therefore is not susceptible to daily changing calls from other water rights. Demand and administrative calls from other water rights are generally located downstream of Grand Junction's supplies at agricultural ditches that place calls during the irrigation season. This means that although the call may change between different water rights on a daily basis during the irrigation season, the call will always be junior to the Grand Junction Paramount water right. During the winter storage filling season and during peak runoff, these downstream water rights do not typically call and Grand Junction's reservoirs will usually store during this period.

The difference between monthly and daily flow input above the Grand Junction flowline diversion was considered. Monthly input data can mask the effects of having insufficient water available on some days if the flow exceeds the diversion capacity in other days. As an example, consider a hypothetical month that had no flow available for the first half of the month, and then twice the diversion capacity available for the second half. On a monthly basis, this would show the water right fully satisfied for the entire month. But on a daily basis, only half the water could have been diverted.

Daily flows at the Grand Junction flowline diversion for 1991 through 2016 were developed as part of the 2018 Water Resources Inventory. The critical period for the firm yield modeling is 2003 and during this period the potential error introduced by daily and monthly discrepancies is approximately 10 AF. This is a relatively small potential error because at least 7.81 cfs has nearly always been available historically at the Grand Junction flowline diversion to satisfy the Paramount Right on a daily average basis, even during dry periods. As discussed in Recommendation A, analysis of more extreme drought conditions and the potential effects of climate change should further evaluate the possibility of more days within a month with less than 7.81 cfs. We understand that during the winter, flow can fall below 7.81 cfs for part of the day due to icing and freezing, but typically increases to more than 7.81 cfs later in the day as temperatures increase. This diurnal fluctuation is captured in the daily average flow evaluated above.

The time period used for the firm yield model includes several periods of dry, average, and wet years. There is significantly less hydrologic data prior to 1991 due to a lack of Kannah Creek stream gage between 1982 and 1991 along with generally sparse reservoir and diversion records. However, because 1977 is widely considered to be one of the driest water years on the West Slope, we developed model data back to that time period to evaluate system performance through that year. In addition to 1977, 2002 and into 2003 was a very dry year (Kannah Creek flows at 50% of average). At the time of writing of this report, water year 2018 is proving to be a very dry year, although the lasting effects on water supply will not be apparent until the amount of winter precipitation is known.

3.2 Stream Inflows

Stream inflows to the model were developed above the Grand Mesa reservoirs, gains to Kannah Creek between the Grand Mesa reservoirs and the Kannah Creek flowline diversion point, North Fork of Kannah Creek, Whitewater Creek, and the Gunnison River.

In general, there is only very limited data available at the Grand Mesa reservoirs. State of Colorado records available on HydroBase (the State's online hydrologic database) have infrequent data, and at times only a single record of an annual amount released or stored. Generally, the records are better since 2007, but are not sufficient to develop a long-term time series of reservoir operation records.

The 2018 Water Resources Inventory provided an estimate of average inflows to each reservoir using the USGS's StreamStats tool, which uses basin drainage area and other hydrologic factors to estimate average inflows (www.usgs.gov/media/files/streamstats-colorado). Measurements of snow-water-equivalent (SWE) are available for portions of the Grand Mesa going back to the 1970's. Both NRCS Snotel sites and the City's snow course sites were used to determine average SWE for the basin. We made an initial estimate of

reservoir inflow by multiplying each year's peak SWE percent of average by the StreamStats average monthly inflow estimates. Using this data, we then compared the estimated reservoir inflow to the flow records at the Kannah Creek gage. Gains to creeks from the contributing basin below the reservoirs were similarly estimated using StreamStats data at the Kannah Creek Flowline diversion point and subtracting the estimated inflows from the contributing drainage area of each reservoir.

Using this amount as inflow to the model, we compared the simulated flow to the historical flow above Grand Junction's Kannah Creek Flowline diversion point. Historical flow at this location can be estimated prior to 1982 using the Kannah Creek Near Whitewater gage and can be estimated beginning in 1991 when the Kannah Creek at Juniata Enlarged Diversion stream gage was installed. The 2018 Water Resources Inventory computed the total flow in Kannah Creek upstream of Grand Junction's Diversions for the period from 1991 to 2016 using gage records for the Colorado Division of Water Resources (DWR) Kannah Creek at Juniata Enlarged Diversion gage station and adding in known diversions at facilities upstream of the gage. Similarly, we calculated the total flow in Kannah Creek upstream of Grand Junction's diversions prior to 1982 using the Kannah Creek near Whitewater Gage and adding in Diversions made at the Kannah Creek Flowline. This location is upstream of all major diversions on Kannah Creek except the upstream Grand Mesa reservoirs. The Kannah Creek flowline diversion point is one of the key locations where model calibration could occur. **Figure 3** is a map from the 2018 Water Resources Inventory showing this location as well as other key areas included in the modeling.

In general, using the StreamStats estimate of inflows above the Grand Mesa reservoirs and for the gains to the Kannah Creek basin below the reservoirs resulted in simulated flows that were significantly greater than the historical flows during the irrigation season at the Kannah Creek Flowline diversion point. To better fit the historical flow at the Kannah Creek Flowline diversion point, we multiplied the estimated irrigation season inflows by 52.5 percent, and further performed manual calibration to better fit monthly variations in flow. Manual calibration was necessary because the StreamStats estimates provide only an average monthly flow values that does not include any variation naturally seen in the historical flows (e.g. peak flow occurring in May in some years, but in June in others). StreamStats uses generalized watershed parameters that are generally calibrated to a region, but are not specific to the Kannah Creek watershed which necessitated the site-specific calibration to total flow volume as well as year-to-year variability.

Using the inflows described above, the simulated streamflow compares very well to the historical flow at the Kannah Creek Flowline diversion point. The simulated total volume of flow at this location over the historical period of record is within approximately 1 percent of the historical flow, well within the presumed gage error in the historical flow amount. Monthly variations do exist (**Figure 4**) in part based on the inflows using the average monthly StreamStats and also variation in historical operations of Grand Mesa reservoirs.

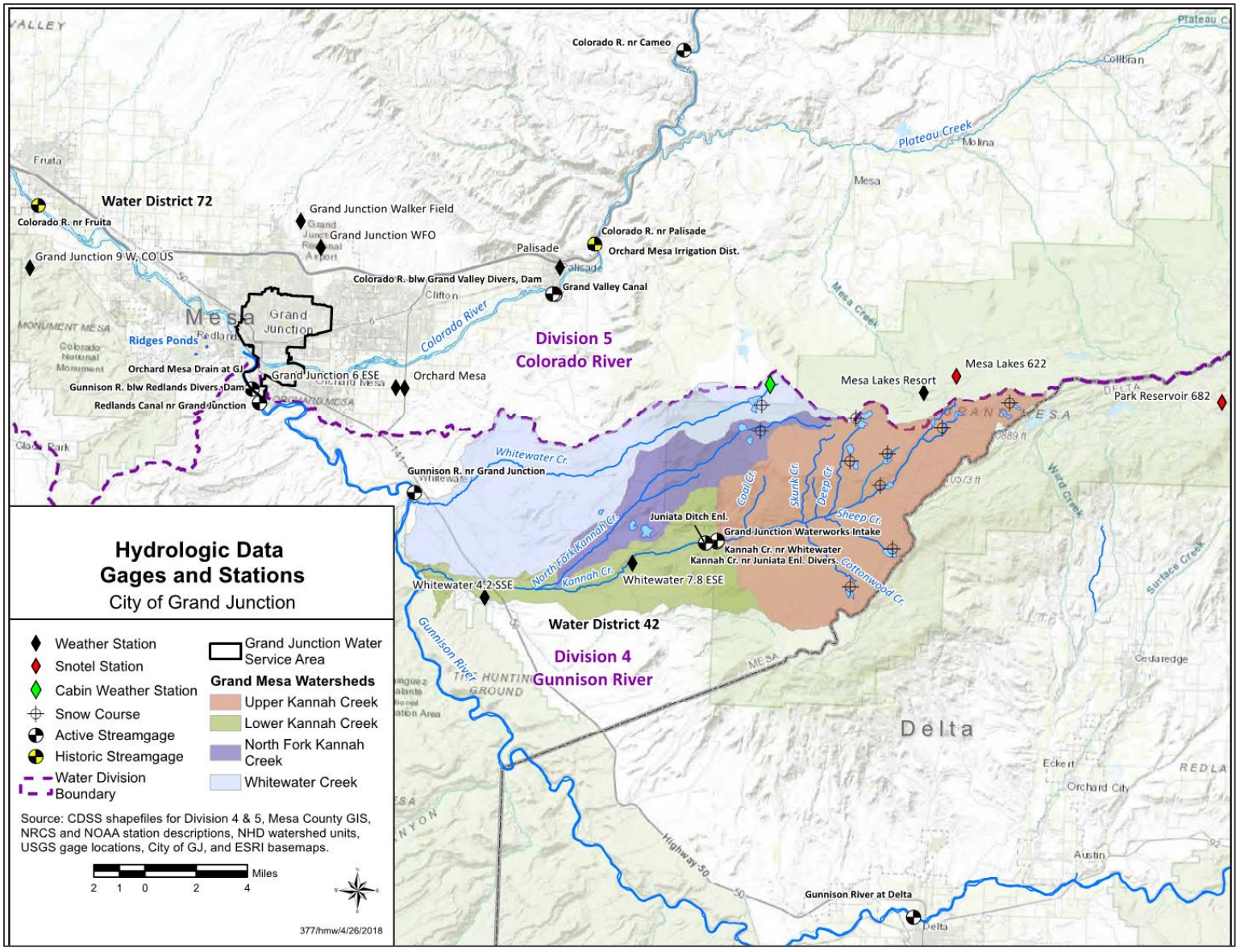

Figure 3. Map of Grand Junction water supply features (replicated from Figure 1-2 of the 2018 Water Resources Inventory)

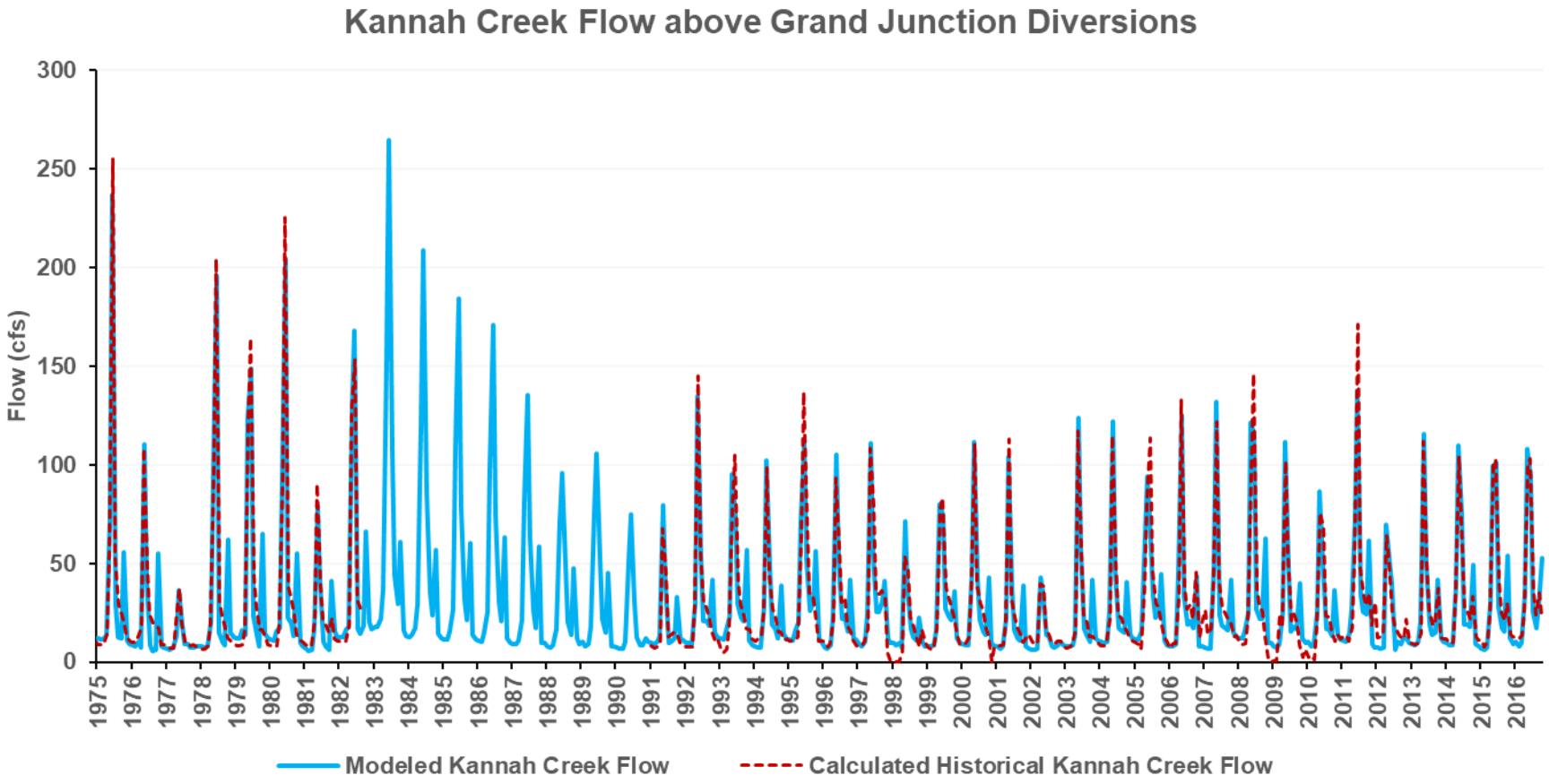

Figure 4. Historical observed flows (dashed line) and model simulated flows (solid line) at Kannah Creek above Grand Junction diversions

The coefficient of determination (R^2) between the historical and simulated flow at the Kannah Creek Flowline diversion using the calculated total flow from 1975-1982 and 1991-2016 is 0.89 (**Figure 5**), indicating a good calibration. Large differences often occur between modeled and observed flows in October because all releases from the Upper Reservoirs are modeled to occur in October, while in actual historical operations, municipal releases from the upper reservoirs appears to have occurred in other months. Our understanding is that more recent operations involve release of municipal water primarily in October, which is shown in several of the more recent years' historical flow amounts.

USGS stream gage 09152500, Gunnison River near Grand Junction, CO was used for the input inflow to the Gunnison River upstream of the Kannah Creek confluence. The Gunnison River was simulated because the Redlands Canal's senior rights can call out some of Grand Junction's water rights and could impact Grand Junction's firm yield **(Figure 3)**. For model input, we decreased the gaged Gunnison River flow by 4 percent because this gage is located downstream of both the Kannah Creek and Whitewater Creek confluence. This adjustment accounts for the additional drainage area between the actual location of the gage and the location where inflows are simulated in the model.

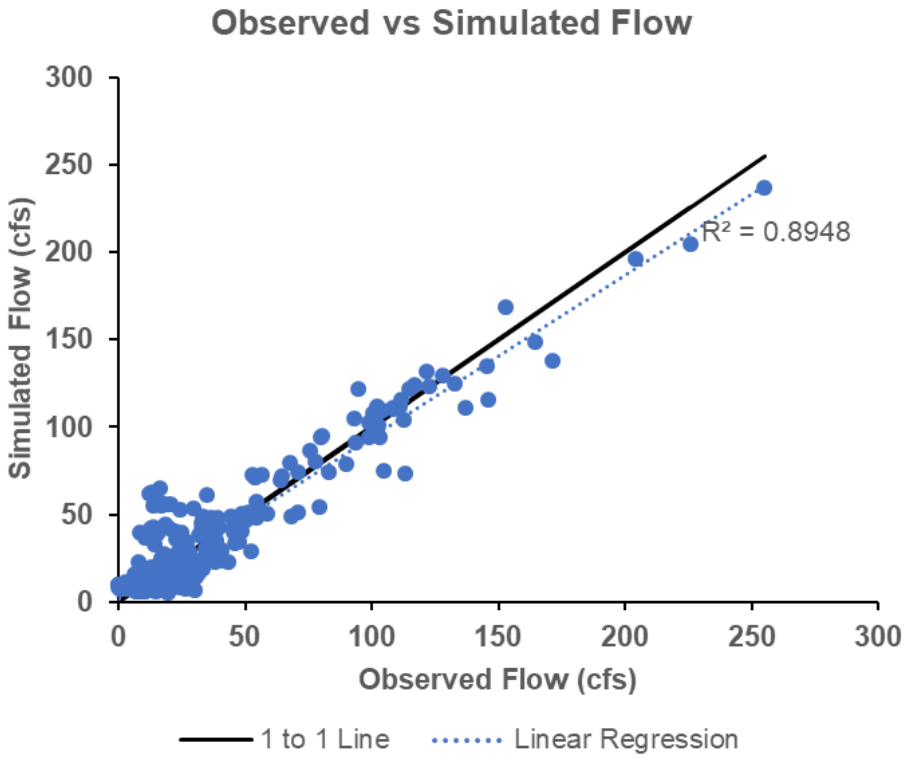

Figure 5. Observed vs simulated total Kannah Creek flow

3.3 Reservoirs

The firm yield model simulates 19 reservoirs, including 17 on the Grand Mesa, plus Juniata Reservoir and Purdy Mesa Reservoir (**Table 1**). The Grand Mesa Reservoir Nos. 6, 8, and 9 and Scales Reservoir Nos. 1 and 2 were grouped and simulated as a single reservoir due to their similar location and Grand Junction's storage ownership of 5.4% in each of these reservoirs. Anderson No. 1 and Anderson No. 2 were grouped and simulated as a single reservoir due to the similar location and Grand Junction's 100% storage in each. Bolen and Bolen, Anderson & Jacobs Reservoir No. 2 were similarly grouped into a single simulated reservoir. These reservoir groupings are indicated on **Table 1**. This grouping resulted in 13 simulated reservoir objects within the model.

Reservoir objects in the RiverWare model include both a municipal and irrigation storage accounts. Although not all reservoirs are used for irrigation or municipal use, the ability to do so was included in the model so that future modeling efforts could evaluate each reservoir in terms of value in the Grand Junction system for municipal or irrigation use. In the current modeling effort, reservoirs are simulated for either irrigation only or municipal only in the amounts shown in **Table 1**. Some reservoirs used for irrigation are partially owned by Grand Junction. These reservoirs are simulated by moving Grand Junction's pro-rata ownership into a separate Grand Junction account, while the remainder of the water is assumed to be released to other water rights owners by the end of each irrigation season

Reservoir evaporation data is input into the model in the "Reservoir and Reach Loss Input" data object. Evaporation rates are not recorded on-site at any of the Grand Junction Reservoirs and we are not aware of stage-area relationships for these reservoirs. Therefore, we developed an average annual evaporation rate in terms of a percentage of the average content of the reservoirs. Simulation of evaporation as a percent of contents is an effective method for simulating grouped reservoirs, notwithstanding the lack of observed evaporation data and stage-area relationships for these reservoirs.

The long-term average evaporation rate for Juniata Reservoir and Purdy Mesa Reservoir was determined by utilizing NOAA Technical Report NWS 33, which shows an average annual free water surface evaporation of approximately 42 inches. The surface area of Juniata Reservoir when full is approximately 155 acres, but typically reservoir levels fall during the summer months to surface area closer to approximately 130 acres. Using the average of these surface areas and applying the free water evaporation rate results in an average annual evaporation of approximately 500 AF, or about 7 percent of the typical summer contents. This same percentage was applied to Purdy Mesa Reservoir. In practice, evaporation at Purdy Mesa Reservoir as a percent of contents may be higher than Juniata Reservoir because it is shallower. However, Purdy Mesa Reservoir is not used in the determination of firm yield because it is only used to deliver water to agricultural users, and only fills after Juniata Reservoir is full. Use of the model to analyze a different use of

Purdy Mesa Reservoir should consider refining the evaporation rate to more accurately assess evaporative losses at that location.

Table 1. **Municipal and** irrigation storage in the RiverWare model

Municipal Reservoirs	Total Capacity (AF)	GJ Ownerthip (%)	GJ Capacity (AF)	Model Group
Juniata Reservoir	7,291	100%	7,291	
Bolen Reservoir	521	100%	521	a
Bolen Anderson & Jacobs Reservoir No. 2	240	100%	240	a
Anderson Reservoir No. 1	507	100%	507	b
Anderson Reservoir No. 2	595	100%	595	b
Anderson Reservoir No. 6	118	100%	118	
Raber Click Reservoir	459	100%	459	
Carson Lake	637	100%	637	
Flowing Park Reservoir	772	100%	772	
Sommerville Reservoir	973	100%	973	
Total Municipal Storage:	*12,113*		*12,113*	
Irrigation Reservoirs				
Purdy Mesa Reservoir	659	100%	659	
Deep Creek Reservoir	354	19.4%	69	
Dry Creek (Chambers) Reservoir	236	33%	78	
Grand Mesa Reservoir No. 1	559	100%	559	
Grand Mesa Reservoir No. 6	172	5.4%	9	c
Grand Mesa Reservoir No. 8	379	5.4%	20	c
Grand Mesa Reservoir No. 9	153	5.4%	8	c
Scales Lake No. 1	203	5.4%	11	c
Scales Lake No. 3	129	5.4%	7	c
Total Irrigation Storage:	*2,844*		*1,421*	

Model Group: no letter indicates reservoir simulated individually
Model Group a: Bolen Reservoir and Bolen Anderson & Jacobs Reservoir No. 2
Model Group b: Anderson Reservoir Nos. 1 and 2
Model Group c: Grand Mesa Reservoir Nos. 6, 8, 9 and Scales Lake Nos. 1 and 3
Note if Grand Junction ownership in reservoirs changes, update in the model data object "Reservoir Storage Input"

The 2018 Water Resources Inventory reported average annual evaporation from the upper reservoirs to be approximately 500 AF. This amount was confirmed by Grand Junction staff for normal years. Grand Junction's full storage capacity in of the Upper Reservoirs is approximately 5,500 AF and based on data of maximum and carry-over storage from 1999-2017, the average storage is approximately 3,150 AF. Based on the information from the 2018 Water Resources Inventory and Grand Junction staff, the long-term average evaporation as a percent of contents was estimated to be 14 percent (500 AF / (500 AF + 3,150 AF)).

While the actual evaporation rate as measured in inches of evaporation is likely lower at the Upper Reservoirs than the Lower Reservoirs (Juniata and Purdy Mesa), the Upper Reservoirs have a more surface area per unit of storage than the Lower Reservoirs. When

full, the Upper Reservoirs have approximately 1 acre of surface area for every 8 AF of storage compared to a 1 acre to every 40 AF ratio at the Lower Reservoirs. The greater surface area of the Upper Reservoirs is the reason evaporation as measured as a percent of contents is higher in the Upper Reservoirs than the Lower Reservoirs.

Year-to-year variability in evaporation rates for the modeled reservoirs was simulated by multiplying the annual evaporation rate (percentage of reservoir contents as described above) by a temperature adjustment factor to increase evaporation in warmer years and decrease in cooler years. The temperature adjustment was based on summer (May to September) temperature data from the NOAA Cedaredge and Mesa Lakes weather stations. Because observed evaporation rates were not available at the Grand Mesa Reservoirs, we based the variability on observed pan evaporation rates at the Grand Junction 6 ESE weather station. The Grand Junction 6 ESE weather station has pan evaporation data going back to 1962. The Cedaredge and Mesa Lakes weather stations have different average temperatures than the Grand Junction 6 ESE station, so we evaluated the deviation from the average temperature at each station. The deviation from average was also computed for the Grand Junction 6 ESE pan evaporation rates. In the observed data, the relationship between deviation from the mean temperature and deviation from the pan generally shows higher evaporation occurs with higher temperature. Though other climatic factors drive evaporation rates as well, such as wind and relative humidity, these data are less readily available. Using this approach, the annual variability in evaporation over the model time period ranged from 0.93 to 1.14 times the long-term average.

Using the general relationship between temperature and evaporation, we used the deviation from the average temperature at the Cedaredge and Mesa Lakes stations to calculate the model input for deviation from the long-term evaporation rate for the modeled reservoirs. **Figure 6** shows the observed data (blue triangles) and the calculated evaporation variability for the model (orange circles). To be conservative for the firm yield purposes, we attempted to fit the simulated evaporation rates to more of the above-average years than the below-average years. This is apparent in **Figure 5** from the modeled data more closely aligning with years with higher observed evaporation than years with lower observed evaporation.

The annual evaporation rate, as adjusted by the temperature factor, was distributed to monthly evaporation rates (as percent of contents) using the DWR's General Administration Guidelines for Reservoirs (2016). The monthly distributions for elevations under 6,500 ft msl were used for the Lower Reservoirs, and the distributions for elevations above 6,500 ft msl were used for the Upper Reservoirs **(Table 2)**.

The firm yield results were tested for sensitivity to the variation in evaporation. Grand Junction staff reported that evaporation for the Upper Reservoirs is approximately 500 AF per year in normal years, but in 2018, losses to evaporation were significantly higher at approximately 1,000 AF. This 100% increase in evaporation relative to the average is well

outside the range seen at the Grand Junction 6 ESE station **(Figure 6)** which shows a maximum evaporation rate maximum of approximately 14% above average, suggesting that seepage may have increased in 2018 or other climactic factors are present on the Grand Mesa that would cause significantly higher variability in evaporation rates than seen at the Grand Junction 6 ESE station. Additional discussion on the results of the evaporation sensitivity is provided in Section 6.2.

Table 2. Monthly evaporation distribution for reservoirs

Elevation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<6,500 ft msl	3.0%	3.5%	5.5%	9.0%	12.0%	14.5%	15.0%	13.5%	10.0%	7.0%	4.0%	3.0%
>6,500 ft msl	1.0%	3.0%	6.0%	9.0%	12.5%	15.5%	16.0%	13.0%	11.0%	7.5%	4.0%	1.5%

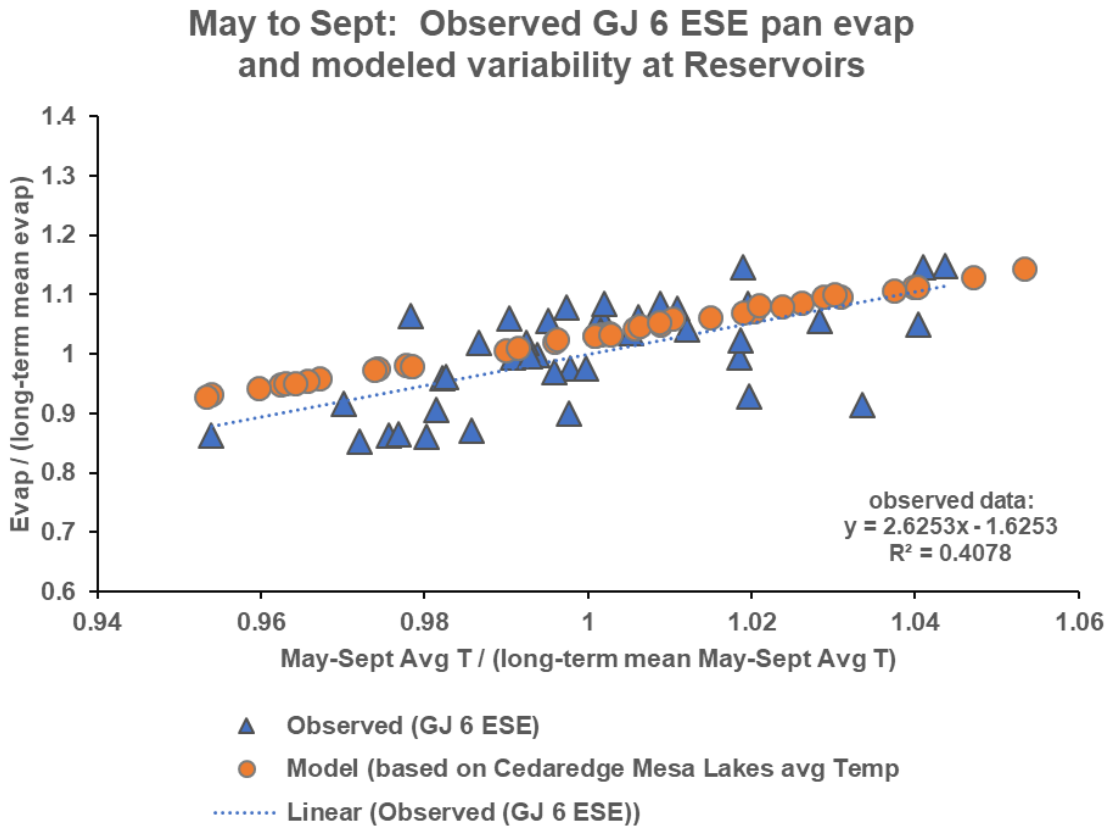

Figure 6. Observed pan evaporation at GJ 6 ESE and modeled evaporation variability

3.4 Water Rights

Direct flow water rights for both Grand Junction and non-Grand Junction water right were included in the model. Information associated with the direct flow water rights are stored within the RiverWare model in the "GJ Water Rights Input" and "Non GJ Water Rights Input" data objects. Input for each water right includes the amount of the water right for each month the water right is operated. Agricultural direct flow water rights are active April through October and are set to zero November through March. These inputs are used to set the modeled requested diversion amounts, and do not vary year by year. Actual diversions at each water right is governed by the prior appropriation system and is simulated in the RiverWare model.

Information on water rights owned by Grand Junction was obtained from the 2018 Water Resources Inventory, and HydroBase, Colorado's online hydrologic database. Information for water rights not owned by Grand Junction was obtained from HydroBase. Individual water rights were grouped into blocks based on their locations and priority dates (**Tables 3, 4 and 5**). Each block was initially given a demand equal to the total amount of the water rights during the irrigation season (April-October).

Modeled reservoirs request a diversion amount equal to the amount needed to fill the reservoir during the storage season (November-June). In the firm yield model, Upper Reservoirs that have a decreed junior (1993-1994) municipal right are operated only under this right and used only for municipal storage while reservoirs without a decreed municipal right are used for irrigation purposes (**Table 1**).

The Redlands Canal, located on the lower Gunnison River, has three water rights with appropriation dates of 1905, 1941, and 1994 for 670, 80, and 100 cfs respectively. Each of these rights has a modeled demand of the full amount year-round. In the model, the Redlands Canal can place a call on the river in dry years, as seen historically in 2002. However, based on the recent EIS for the Aspinall Unit, we understand that sufficient water will be released to Redlands to prevent a Redlands Canal call. Therefore, the firm yield was computed with the Redlands Canal water right deactivated (see also Section 5).

Because the model runs on a monthly timestep, the demands of some larger water rights were adjusted to better match their own historical diversions, and to make allocatable flow available to better match historical reservoir storage by Grand Junction. While these senior ditches may divert large flows for several days, these high flow rates will typically not be sustained throughout an entire month.

Senior diverters below the confluence of Kannah Creek and North Fork Kannah Creek include the Kannah Creek Extension Ditch, the Brown & Campion Ditch, and the Smith Irrigating Ditch. These ditches have water rights totaling 65.57 cfs with priority dates senior to most of Grand Junction's rights. The Smith Irrigating Ditch has priority no. 7 on

Kannah Creek for 19.6 cfs and the Brown & Campion Ditch has priority no. 8 for 22 cfs, totaling 41.6 cfs between the two rights. In the model, the total demand between the two rights was set to 20.8 cfs (half of the actual right) to better match the monthly maximum historical diversions at these ditches (**Figure 7**).

Similarly, we adjusted the irrigation demands at the Juniata Ditch Enlargement and the Kannah Creek Highline Ditch. Grand Junction owns a portion of the rights for each of these structures. The Grand Junction portion of the irrigation rights for the Juniata Enlarged Ditch was reduced from 114 cfs to 39 cfs (only the senior most priority) while the non-Grand Junction demands were kept at 15 cfs. The Grand Junction portion of the Kannah Creek Highline Ditch rights was reduced from 24.9 cfs to 12.45 cfs, and the non-Grand Junction portion was reduced from 43 cfs to 21.5 cfs.

To better match historical data and allow the upper reservoirs to fill, Grand Junction's direct flow irrigation rights were subordinated to the Upper Reservoirs filling. Within RiverWare, subordination works by the senior right forgoing a portion of the water that was legally and physically available for appropriation so that a junior right may take water instead. This prevents Grand Junction irrigation rights from calling out Grand Junction reservoir storage rights.

Table 3. Modeled diversion blocks on Kannah Creek below the confluence with N. Fork Kannah Creek

Kannah Creek Below Confluence with N. Fork Kannah Creek					
Structure Name	**Adjudication Date**	**Previous Adj Date**	**Appropriation Date**	**Priority Admin No.**	**Right Amount (cfs)**
Block 1 Blw Confluence					**13.62**
KANNAH CREEK EXTENSION D	07/25/1888		11/01/1884	12724	7.65
BROWN & CAMPION D	07/25/1888		11/01/1884	12724	4.21
SMITH IRRIGATING DITCH	07/25/1888		11/01/1884	12724	1.76
Block 2 Blw Confluence					**1.3**
SMITH IRRIGATING DITCH	07/25/1888		08/11/1885	13007	1.3
Block 3 Blw Confluence					**8.6**
BROWN & CAMPION D	07/25/1888		11/14/1885	13102	8.6
Block 4 Blw Confluence					**41.6**
SMITH IRRIGATING DITCH	07/25/1888		03/26/1886	13234	19.6
BROWN & CAMPION D	07/25/1888		12/16/1886	13499	22
Block 5 Blw Confluence					**0.45**
SMITH IRRIGATING DITCH	7/25/1941	8/3/1934	5/1/1920	30895.25688	0.45

Table 4. Modeled diversion blocks on Kannah Creek above the confluence with N. Fork Kannah Creek

Kannah Creek Above Confluence with N. Fork Kannah Creek					
Structure Name	**Adjudication Date**	**Previous Adj Date**	**Appropriation Date**	**Priority Admin No.**	**Right Amount (cfs)**
Block 1 Abv Confluence					**0.6**
FLORENCE H BERRY DITCH	07/25/1888		12/31/1881	11688	0.6
Block 2 Abv Confluence					**0.58**
NORTHWESTERN DITCH	07/25/1888		11/01/1884	12724	0.29
BALES WILLIAMS MORRISON	07/25/1888		11/01/1884	12724	0.29
Block 3 Abv Confluence					**4**
NORTHWESTERN DITCH	07/25/1888		08/11/1885	13007	4
Block 4 Abv Confluence					**3.57**
BOWEN PRIVATE DITCH	07/25/1888		12/03/1885	13121	3.57
Block 5 Abv Confluence					**5.47**
WASHBURN & DOWNING DIT	07/25/1888		01/21/1888	13900	2.77
BALES WILLIAMS MORRISON	07/25/1888		01/23/1888	13902	2.7
Block 6 Abv Confluence					**1.27**
COULTER DITCH	6/1/1916	7/22/1912	08/01/1889	22848.14458	0.27
VANPELT COX SEEPAGE D	6/1/1916	7/22/1912	05/01/1890	22848.14731	1
Block 7 Abv Confluence					**3.775**
FLORENCE H BERRY DITCH	6/1/1916	7/22/1912	4/25/1914	23490	1.04
BOWEN PRIVATE DITCH	7/25/1941	8/3/1934	7/28/1914	30895.23584	0.26
BOWEN PRIVATE DITCH	7/25/1941	8/3/1934	8/8/1914	30895.23595	0.72
WILLIAM H. WILLIAMS DITCH	7/25/1941	8/3/1934	8/10/1914	30895.23597	0.585
BALES WILLIAMS MORRISON	7/25/1941	8/3/1934	8/10/1914	30895.23597	
RABER DAVIS DITCH	7/25/1941	8/3/1934	9/18/1915	30895.24001	1.17
Block 8 Abv Confluence					**0.34**
RABER DAVIS DITCH	7/25/1941	8/3/1934	10/27/1921	30895.26232	0.34
Block 9 Abv Confluence					**0.75**
BLACK DITCH	7/25/1941	8/3/1934	3/15/1933	30895.30389	0.62
SULLIVAN RANCH DRAIN	7/25/1941	8/3/1934	11/15/1937	32095	0.13
Block 10 Abv Confluence					**3.07**
NORTHWESTERN DITCH	7/25/1941	8/3/1934	11/1/1939	32811	1.78
BOWEN PRIVATE DITCH	7/25/1941	8/3/1934	11/1/1939	32811	1.29
Block 11 Abv Confluence					**1**
NORTHWESTERN DITCH	7/21/1959	3/27/1944	08/11/1885	34419.13007	0.5
BOWEN PRIVATE DITCH	7/21/1959	3/27/1944	12/03/1885	34419.13121	0.5
Block 12 Abv Confluence					**8.032**
NORTHWESTERN DITCH	7/21/1959	3/27/1944	6/1/1955	38502	1.5
FLORENCE H BERRY DITCH	12/31/1971	12/31/1970	6/1/1954	44194.38137	2.166
BLACK DITCH	12/31/1971	12/31/1970	6/1/1954	44194.38137	2.166
WILLIAM H. WILLIAMS DITCH	12/31/1971	12/31/1970	6/1/1954	44194.38137	2.2
Block 13 Abv Confluence					**0.056**
GARDNER DITCH	12/31/1993	12/31/1992	2/23/1993	52284	0.036
DALTON DITCH & PUMP #2	12/31/1993	12/31/1992	12/16/1993	52580	0.02

Table 5. Modeled diversion blocks on Whitewater Creek below Grand Junction's diversions

Whitewater Creek					
Structure Name	**Adjudication Date**	**Previous Adj Date**	**Appropriation Date**	**Priority Admin No.**	**Right Amount (cfs)**
Block 1					**3**
SHROPSHIRE DITCH	7/22/1912	1/4/1911	10/01/1897	22283.17441	3
Block 2					**3.6**
ADA SUPPLY DITCH	6/1/1916	7/22/1912	10/17/1907	22848.21108	3.6
Block 3					**1**
IRA VINCENT DITCH	7/21/1959	3/27/1944	6/1/1913	34419.23162	1
Block 4					**0.5**
IRA VINCENT PETTINGELL ENI	7/21/1959	3/27/1944	8/1/1947	35641	0.5
Block 5					**5.4**
IRA VINCENT DITCH	7/21/1959	3/27/1944	5/1/1950	36645	1.15
HOLLAND WASTE WATER D	7/21/1959	3/27/1944	10/1/1950	36798	4.25
Block 6					**4.2**
ELLIOT PUMP DITCH	12/31/1973	12/31/1972	10/01/1897	44925.17441	1
WILLIAMS DITCH	12/31/1976	12/31/1975	6/1/1960	46020.40329	3
OVERHOLT PUMP STATION	12/31/1982	12/31/1981	3/29/1982	48300	0.2
Block 7					**2**
BROKEN SPOKE R C D BOYLES	12/31/1985	12/31/1984	4/1/1900	49308.18353	2
Block 8					**0.344**
KOSANKE DIVERSION NO. 2	12/31/1987	12/31/1986	12/1/1987	50373	0.2
RUSSELL DITCH	12/31/1992	12/31/1991	6/22/1992	52038	0.144
Block 9					**1.708**
NOLAND WASTE DITCH #1	12/31/1997	12/31/1996	12/31/1970	53691.44194	0.01
NOLAND WASTE DITCH #2	12/31/1997	12/31/1996	12/31/1970	53691.44194	
OSCAR DITCH	12/31/1997	12/31/1996	9/4/1997	53938	1
TERRY DITCH	12/31/1997	12/31/1996	9/4/1997	53938	
GOODFELLOW PUMP DIV	12/31/1998	12/31/1997	6/1/1998	54208	0.25
GIRIN'S PUMP STATION NO1	12/31/1999	12/31/1998	1/6/1999	54427	0.044
J. WATSON PUMP	12/31/2005	12/31/2004	7/30/2004	56613.56459	0.25
GREEN POND DIVERSION	12/31/2006	12/31/2005	6/7/1982	56978.4837	0.1
PHIPPS PUMP	12/31/2006	12/31/2005	4/18/2006	57086	0.05
DESERT OASIS SPRING	12/31/2007	12/31/2006	6/1/1970	57343.43981	0.004

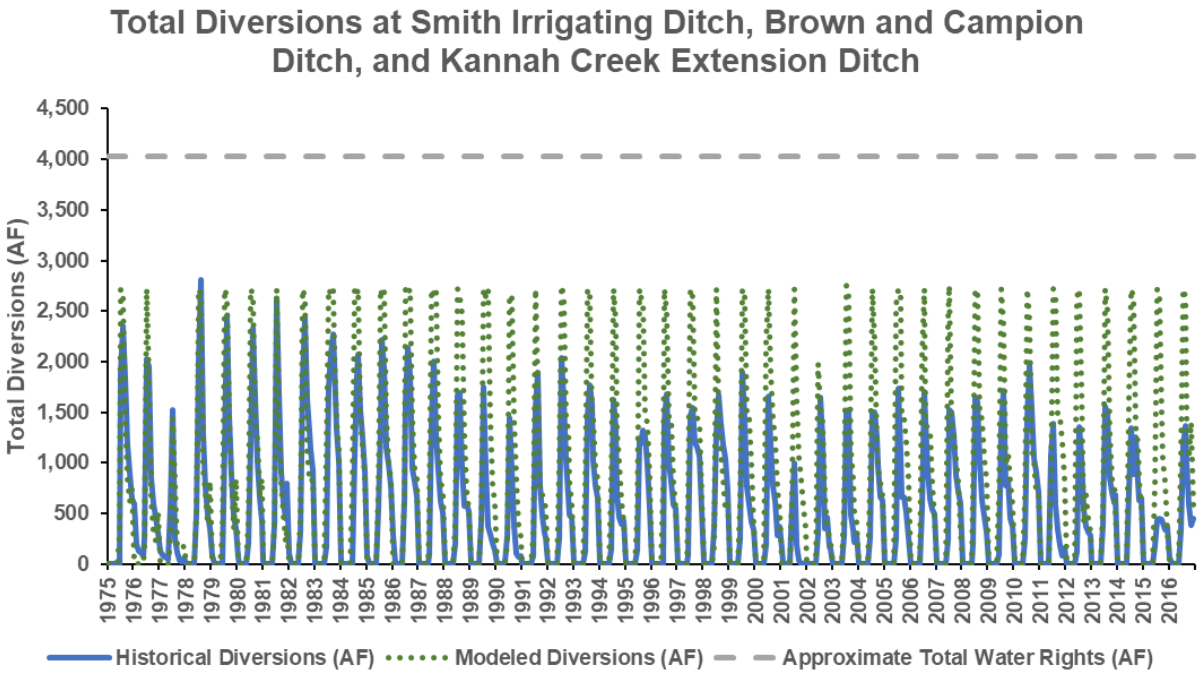

Figure 7. Historical and modeled diversions for ditches on Kannah Creek below the confluence with North Fork Kannah Creek

3.5 Conveyance Losses

The RiverWare model assesses conveyance losses to reservoir releases both as stream losses within Kannah Creek and ditch losses if delivered through a ditch. Conveyance losses are sometimes referred to as "shrink." Both stream loss and ditch loss estimates included in the model were based on conversations with Grand Junction staff. Releases from the Upper Reservoirs to Juniata Reservoir experience at 15 percent stream loss in most years and a 20 percent stream loss in dry years prior to diversion at the Kannah Creek Flowline diversion. These stream losses increase to 17 percent and 23 percent when delivered to the Juniata Ditch Enlargement diversion. In-ditch losses in the Juniata Enlargement were estimated at 30 percent in most years and 50 percent in dry years and losses in the City Ditch were estimated at 15 percent in most years and 20 percent in dry years. The higher losses in dry years were assessed in the RiverWare model when the peak SWE in the year was below 60 percent of the 1975-2016 average.

4. MODEL RULES AND OPERATIONS

The RiverWare model was configured with the RiverWare water rights solver. Use of the water rights solver requires a set of model instructions for other simulated system operations. This is accomplished using RiverWare's built-in language called RiverWare Policy Language (RPL). Model developers generate several instructions – called "rules" in RiverWare – that drive operations of the simulated river system. The rules are saved with the RiverWare model as a group called a ruleset. The ruleset provides the operational logic for the model run.

The firm yield RiverWare model contains 5 rules that run upon model initialization and the model ruleset contains 59 rules. A brief description of each rule is provided in **Appendix A**. The legal availability of water is controlled by the RiverWare water rights solver, which ensures that water rights are strictly administered within the prior appropriation system except when a water right is specifically subordinated. The ruleset is constructed to simulate the following operations if water is physically and legally available:

1) Divert the Paramount right via the Kannah Creek Flowline directly to the Grand Junction Water Treatment Plant (WTP) to meet immediate demands year-round.
    a. *Note:* In practice, Grand Junction diverts much of this water to Juniata Reservoir and concurrently releases water Juniata Reservoir to meet the immediate demands. Because this operation does not have a net effect of the mass balance of water stored in Junita Reservoir, it is modeled as a direct diversion.
2) During the winter months (November-March), divert Grand Junction's 3.91 cfs right at the Kannah Creek Flowline.
3) Store available flow under the Kannah Creek Flowline rights in excess of the immediate demand at the Grand Junction WTP in Juniata Reservoir.
4) If Juniata Reservoir is full, store water from the Kannah Creek Flowline rights in Purdy Mesa Reservoir.
5) Meet remaining GJ WTP demands via Brandon Ditch to Somerville Pipeline if Juniata storage is below 70 percent during the winter months. During the irrigation season (April-October), only divert water if storage in Juniata is Below 50 percent.
    a. *Note:* In the firm yield runs, storage in Juniata Reservoir is not allowed to go below 60 percent, so the Somerville Pipeline is never utilized during the irrigation season.
6) Meet remaining demands at the Grand Junction WTP from water stored in Juniata Reservoir via the Purdy Mesa flowline
7) Release water stored in Upper Reservoirs in excess of 2,000 AF to Juniata Reservoir in October. Stream losses are applied to these releases.

8) If Purdy Mesa Reservoir is greater than 75 percent full on April 1, lease 400 AF of irrigation water.
9) If Upper Reservoirs are greater than 90 percent full on April 1, lease 400 AF of irrigation water.
10) During irrigation season, meet irrigation demand on Grand Junction's ranches through use of irrigation direct flow rights and water stored in Upper Reservoirs and Purdy Mesa Reservoir.
11) During irrigation season, fill Juniata Reservoir from Juniata Ditch Enlargement under junior right, if available.
12) In winter, fill Juniata Reservoir from City Ditch.
13) Fill Purdy Mesa Reservoir from Juniata Reservoir overflow.
14) Fill Grand Mesa Reservoirs in winter and during peak runoff, when in priority.

The RiverWare model simulates the above operations in the order listed above. If any of the lower priority operations modify a variable that a higher priority operation depended on, RiverWare re-simulates the time step in an iterative fashion.

5. FIRM YIELD DETERMINATION

Firm yield is defined as the amount of water from a given supply that is reliably available through a defined drought condition while still maintaining defined system reliability criteria. Often, the firm yield is determined by simulating a repeat of historical hydrology and determining the maximum amount of demand that can be met through the entire historical period, including the most severe drought of that period. Firm yield runs differ from simply repeating historical operations because current demands and current operations are simulated using the historical hydrology. For example, demand for water in the Grand Junction service area has decreased since the early 2000's. The firm yield simulations do not attempt to replicate the higher demands of the early 2000's and the lower current demand. Instead, an annual demand is selected and simulated using the historical hydrology in each year and the system response is compared to the reliability criteria.

The scope of the initial firm yield model construction and firm yield development is based on current operational practices and historical hydrology. Additional testing and analysis for different scenarios and operations (as described in Section 1) can be accomplished using the RiverWare model and modifying inputs or operational rules and compared to results of the firm yield based on historical hydrology and current operational practices. The modeled historical hydrology period is from water years 1975 to 2016. Using historical hydrology is a common practice for determining the firm yield of a water supply system. However, use of historical hydrology does not consider the effects of drought for durations greater than those observed during the model period. It also does not consider the future effects on hydrology, including climate change. This means that the system could deliver less water than the firm yield should future hydrologic conditions be worse than those in the model period, or if other operations change relative to current practices.

A firm yield model run must successfully meet defined system reliability criteria. The reliability criteria used by Grand Junction were defined through the course of the project. The following criteria were used to govern a successful model run:

1) Juniata Reservoir must be at least 90% full by the end of runoff (May 1-July 1)
2) Juniata Reservoir must be at least 60% full going into winter (November 1)
3) Storage of at least 1,800 AF in Upper Reservoirs going into winter (November 1)

To determine the firm yield, we simulated the Grand Junction demand at several levels, adjusting iteratively until the maximum demand was determined and adjusted the demand at the Grand Junction WTP to the maximum amount where all of the reliability criteria are satisfied. The final firm yield amount is the sum of 300 AFY non-potable demand, 44 AFY demand at the Kannah Creek/Purdy Mesa WTP, and the iteratively adjusted demand at the Grand Junction WTP.

The annual demands used in determining the firm yield are distributed to monthly values based on historical water use in Grand Junction. The monthly distribution for potable demand is based on the total water production from 1989-2017, including water supplied to the Kannah Creek/Purdy Mesa WTP (**Table 6**). The monthly distribution for non-potable demand is based on the average usage for commercial and government irrigation from 2012-2014 (**Table 6**).

Under baseline conditions, the Grand Junction firm yield is between 5,800 AF and 6,275 AF per year. A range of values is presented due to uncertainty in some model inputs and based on the sensitivity analysis performed on key model inputs (see Section 6). This amount is the raw water delivery and does not include treatment and distribution system losses. To determine the amount of water that can be delivered to customers, any losses that occur during treatment or in the distribution system must be applied. The 2018 Water Resources Inventory indicates that treatment and distribution losses are approximately 9% over the last ten years. The firm yield of 5,800 AF to 6,275 AF, less 300 AF for non-potable use and 44 AF for the Kannah Creek WTP as delivered at customer taps is between 4,960 AF and 5,400 AF per year (1,600 to 1,750 million gallons) ((5,800 AF or 6,275 AF – 300 AF – 44 AF) * (100%-9%)).

Based on input from Water Division No. 4 Engineer, Bob Hurford, we understand that the recent environmental impact statement (EIS) currently governs operations of the Aspinall Unit (Blue Mesa Reservoir, Crystal Reservoir, and Morrow Point Reservoir), all located upstream on the Gunnison River. The EIS specifies that the Aspinall Unit will supply a sufficient amount of water to prevent a call from the Redlands Canal. Although operation of the Aspinall Unit is outside the scope of this modeling effort, we assumed that the Redlands Canal would not place a call in the future. The upper end of the range of firm yield was calculated both with and without allowing the Redlands Canal to call out Grand Junction's junior diversions for comparison purposes.

The upper range of the modeled raw water firm yield when the Redlands Canal is not allowed to place a call against Grand Junction's junior diversions and all of the above criteria are met is 6,275 AFY. In this run, the critical period occurs in spring of 2003, where Juniata is just able to meet criteria number 1 (**Figure 8**). In our opinion, this value is the most appropriate upper end of the range of current firm yield because it incorporates current operations and agreements at the Redlands Canal. However, the agreement between the Aspinall Unit operations and Redlands Canal may not be permanent.

Table 6. Potable and non-potable demand distribution

Demand	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Potable	5.3%	5.0%	5.6%	7.2%	9.9%	12.5%	13.6%	12.2%	9.9%	7.9%	5.5%	5.4%
Non-potable	0.6%	0.6%	0.8%	2.2%	10.1%	14.2%	19.8%	18.2%	15.8%	11.6%	5.1%	1.0%

When the Redlands Canal is allowed to place a call against Grand Junction's junior diversions, the upper range of the modeled firm yield decreases to 6,025 AFY. Again, in this run, the critical period occurs in spring of 2003, where Juniata is just able to meet criteria number 1 (**Figure 9**).

Figures 8 and 9 show that during the dry period, the modeled storage in Juniata does not track the historical storage well. However, this is due to the fact that the system demands were higher in the 1990's than the upper range of the current modeled firm yield. When the total system raw water demand is increased to 6,725 (as occurred in the 1990's), the modeled storage better tracks the historical data (**Figure 10**). This provides further confirmation that the model can reasonably simulate operations at different demand levels other than the firm yield amount.

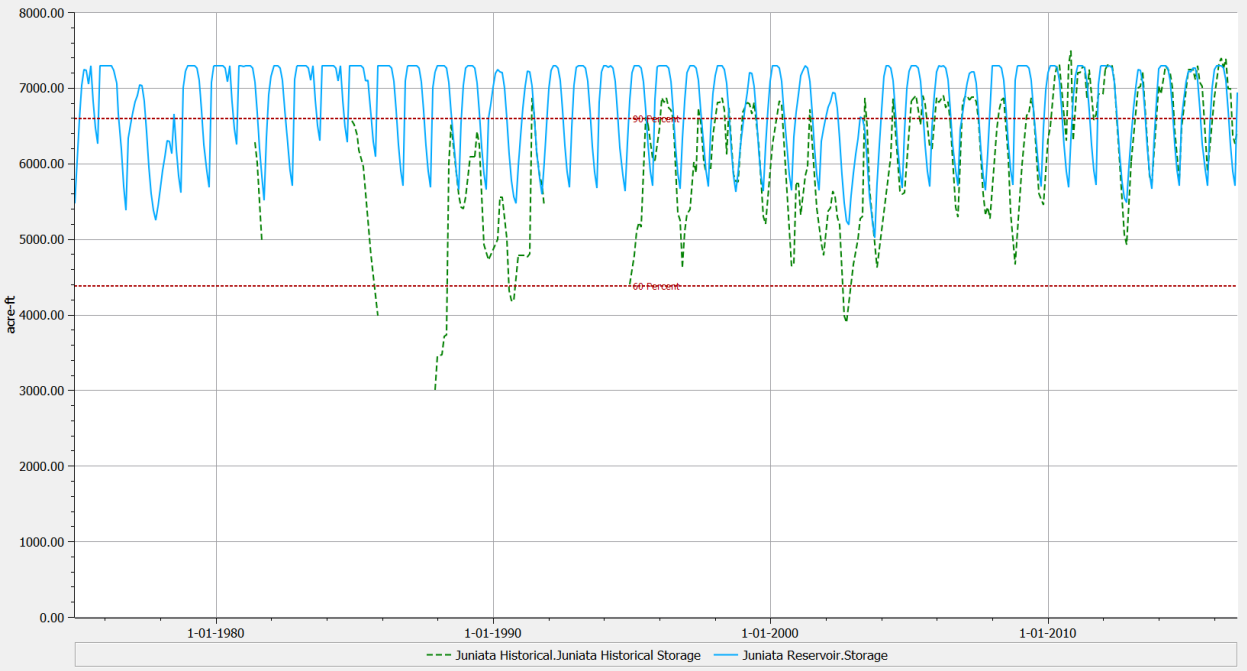

Figure 8. Modeled Juniata Reservoir storage for firm yield run not allowing Redlands Canal calls (firm yield 6,275 AF)

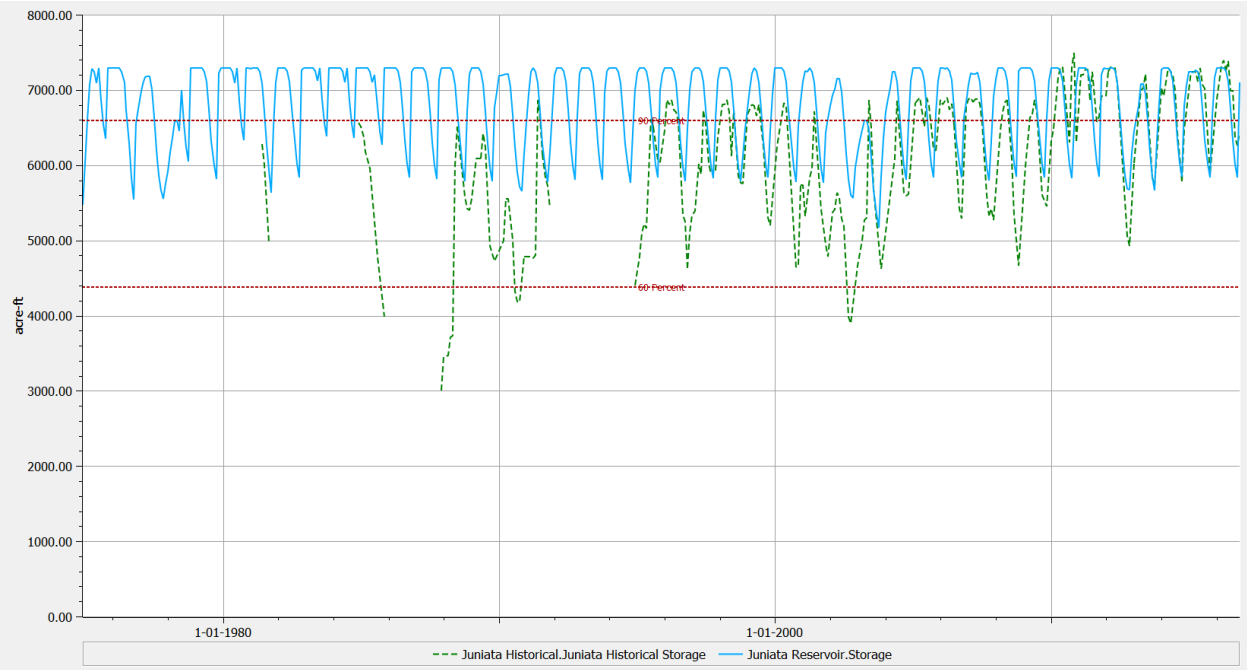

Figure 9. Modeled Juniata Reservoir storage for firm yield run allowing Redlands Canal calls (firm yield 6,025 AF)

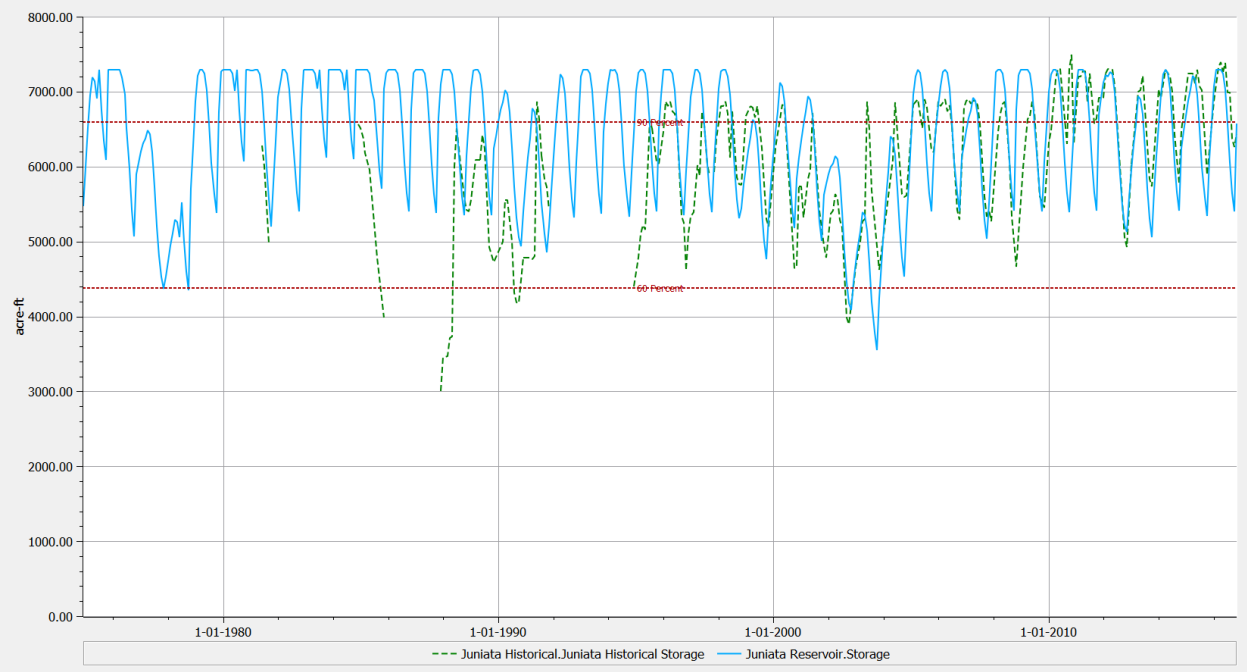

Figure 10. Modeled Juniata Reservoir storage with a total raw water demand of 6,775 AF (as occurred in the late 1990's)

6. SENSITIVITY TESTING

Lack of hydrologic data in many areas of the basin and over significant periods of time necessitated estimation of several inputs, including historical inflows to reservoirs, evaporation rates and variability, diversions at various structures, and streamflow at key locations. These inputs directly affect the firm yield of the water supply system. In our opinion, the estimates were developed with reasonable methods, and were calibrated to the extent possible to historical conditions. However, these inputs are estimates rather than measured observations.

In order to evaluate the relative impact these inputs have on the firm yield, we performed a sensitivity analysis. A sensitivity analysis involves multiple model runs where one input is systematically changed and the relative change in the input is compared to the relative change in the output. For the analysis, we tested inflows to Kannah Creek above the Grand Mesa reservoirs and evaporation rates. These two inputs were estimated due to lack of data and are the most likely inputs to have a significant impact on the firm yield.

The sensitivity testing provides the support for the range of system firm yield described in Section 5. When inputs were adjusted within a reasonable yet conservative range, the lower of the firm yield was determined to be 5,800 AF (raw water). While it is possible that the upper end of the firm yield range could increase based on the sensitivity testing (e.g. if hydrology is more favorable than was used to estimate model inputs), we do not recommend an increased amount for an upper end to the firm yield range that is higher than 6,275 AF as described in Section 5.

6.1 Inflow to Upper Reservoirs Sensitivity

Two different aspects of inflow to the Upper Reservoirs were tested: distribution of inflow above and below the Grand Mesa Reservoirs, and total flow in the Kannah Creek basin. During model input development, the total streamflow at the Kannah Creek Flowline diversion points, the simulated total flow above the Kannah Creek Flowline was within 1 percent of the historical amount (Section 3.2). However, the spatial distribution of flow originating above or below the Grand Mesa Reservoirs could not be determined from available data.

The initial inputs were developed using the distribution of inflow as estimated using the USGS StreamStats tool, which resulted in 49% of the inflow to the Kannah Creek Basin above Grand Junction's diversions simulated as inflow to the Upper Reservoirs and 51% simulated as gains below the Upper Reservoirs, but above the Kannah Creek Flowline diversion point. To evaluate the sensitivity of this distribution of inflows, we shifted a portion of the total Kannah Creek flow - as measured above Kannah Creek Flowline

diversion point - above or below the Upper Reservoirs. Several runs were performed with various proportions of flow entering the system below and above the Upper Reservoirs **(Table 7)**.

Shifting the inflows so that 75% of the total Kannah Creek inflow occurs as gains to Kannah Creek below the Upper Reservoirs resulted in firm yield decreasing by 100 AF, or approximately 1.6% versus the baseline model run. On the other hand, shifting the flows so that 75% of the total Kannah Creek inflow occurs above the upper reservoirs, the firm yield showed a smaller decrease, only 25 AF. Because the firm yield criteria rely on both storage in Juniata Reservoir and storage in the Upper Reservoirs, and because model operations fill a portion of Juniata Reservoir with releases from the Upper Reservoirs, where inflows enter the reach above Grand Junction's diversion points on Kannah Creek has little impact on the firm yield, with the distribution that maximizes firm yield being approximately 50% above and 50% below the Upper Reservoirs. Therefore, the distribution of flow above and below the Upper Reservoirs is an insensitive input.

Table 7. Sensitivity to distribution of Kannah Creek inflows

Total Kannah Creek Flow Below GM Reservoirs	Total Kannah Creek Flow Above GM Reservoirs	Firm Yield (AF)	Change in Firm Yield (AF)	Failure Criteria
75%	25%	6,175	-100	Juniata 90% full summer 1978
60%	40%	6,200	-75	Juniata 90% full summer 1978
49%	51%	6,275	0	Juniata 90% full spring 2003
40%	60%	6,250	-25	Juniata 90% full spring 2003
25%	75%	6,250	-25	Juniata 90% full spring 2003

In addition to the distribution of inflow, the total inflow above the Grand Junction Flowline diversion was also tested for sensitivity in the firm yield analysis. In this analysis, we reduced the baseline inflow in all months by a specified percentage. The same reduction was applied to dry years and wet years. In contrast to the distribution of flows above and below the reservoirs, the total inflow to Kannah Creek is a sensitive input. As shown on **Table 8** and **Figure 11**, Firm yield is reduced by approximately 60% to 80% of the reduction to inflow to Kannah Creek. The model is less sensitive to smaller changes in Kannah Creek inflow than to more severe reductions, as indicated by the lower slope in Figure 10 from 2% to 15% flow reduction. In all model scenarios, the June 1978 historical month and Juniata filling to 90% criterion was the driving factor for firm yield determination.

Table 8. Sensitivity to Kannah Creek inflow reduction

Total Flow Reduction	Firm Yield (AF)	Change in Firm Yield (AF)	Change in Firm Yield (%)	Failure Criteria
2%	6,150	-125	-2%	Juniata 90% full spring 1978
5%	6,000	-275	-4%	Juniata 90% full spring 1978
10%	5,875	-400	-6%	Juniata 90% full spring 1978
15%	5,725	-550	-9%	Juniata 90% full spring 1978
25%	5,075	-1,200	-19%	Juniata 90% full spring 1978
50%	3,900	-2,375	-38%	Juniata 90% full spring 1978

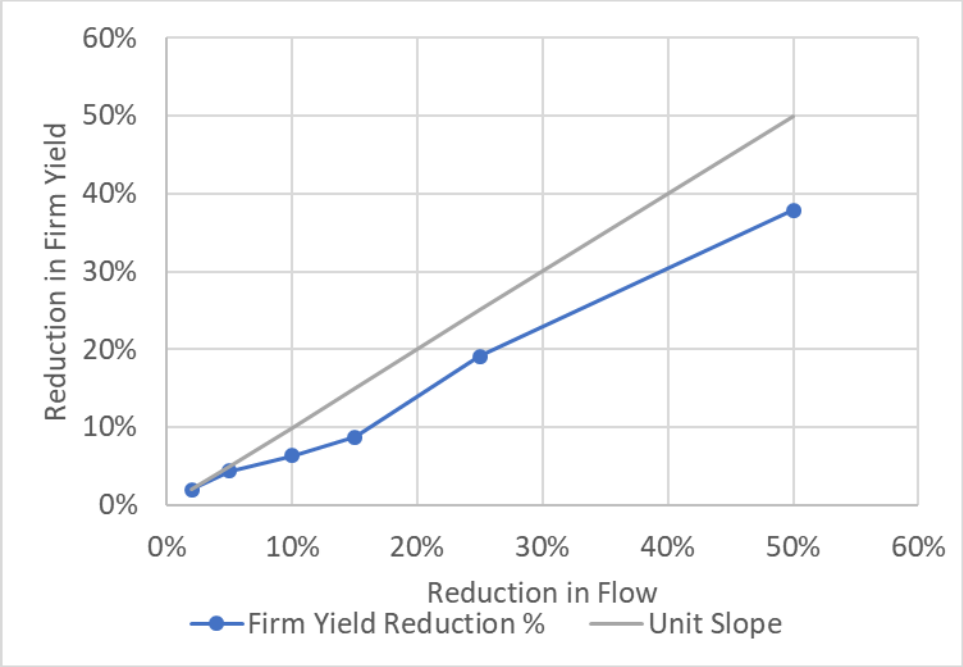

Figure 11. Percent reduction in firm yield relative to percent reduction in Kannah Creek inflow

6.2 Reservoir Evaporation Sensitivity

Based on conversations with Grand Junction staff, losses from the Upper Reservoirs average around 500 AFY and may be as much as 1,000 AFY in dry years. This variability is beyond the range seen at the Grand Junction 6 ESE weather station, which shows a maximum deviation of 14% above the average throughout the model period (see Section 3.3 and Figure 6). Additional losses to seepage in dry years or other climatic factors not seen at the Grand Junction 6 ESE station may account for some this difference.

To evaluate the effects of increased evaporation on modeled firm yield, we incrementally increased the modeled evaporation rate and variability by adjusting the parameters used to develop evaporation inputs as described in Section 3.3. This process resulted in five model runs with average annual total system evaporation ranging from approximately 1080 AF in the baseline (Upper Reservoirs and Juniata Reservoir) to 2,160 AF average annual evaporation. This process evaluated the effect on firm yield up to an approximately 100% increase from the baseline evaporation and quantified the effects on the modeled firm yield while keeping all other inputs static.

With the model targeting 2,000 AF of carry-over storage each year in the Upper Reservoirs, once the evaporation variability reaches somewhere between 30-50% over the baseline run, evaporation from the Upper Reservoirs causes them to fall below the 1,800 AF carry over criteria. This occurs due to a lack of water physically or legally available for diversion to fill the reservoirs in the preceding winter months of dry years. When this occurs, the only way to maintain 1,800 AF in the Upper Reservoirs is to go into the winter with more than the target 2,000 AF. Pursuant to the model logic, this can only occur if Juniata Reservoir is so full that there is not enough capacity to accept all the water from the Upper Reservoirs in excess of the target carryover of 2,000 AF in October, thereby keeping more than 2,000 AF in the Upper Reservoirs at the end of October. This is not a realistic scenario and is a result of strict adherence to the model logic. In addition, the parameters used to increase evaporation increase the evaporation rates in all months of the year. If evaporation rates in actuality are more consistent during the winter and the variability can be attributed to summertime evaporation rates, the increase in winter drawdown would not occur.

Therefore, we evaluated the firm yield enforcing only the Juniata fill criteria, and by not strictly enforcing the 1,800 AF Upper Reservoir carry over storage criteria. Results are shown in **Table 9** and **Figure 12.** Table 9 includes a row that shows how far below the 1,800 AF target the Upper Reservoirs fall. Increased evaporation causes a reduction in firm yield in a linear relationship at a rate of about 1 AF of firm yield per 2.3 AF of additional evaporation. **Figure 13** shows this relationship in terms of the percentage increase in evaporation compared to the percentage decrease in firm yield. This figure shows that although the firm yield decreases by 475 AF, this is a relatively small percentage reduction in comparison to the large percentage increase in evaporation needed to bring about such a reduction.

Given that Grand Junction staff have observed losses in the Upper Reservoir near 1,000 AF, it is prudent to consider this as a realistic hydrologic scenario even though observed pan evaporation rates located at the Grand Junction 6 ESE station do not suggest evaporation alone would cause this type of reservoir loss. Therefore, we consider 5,800 AF firm yield to be a reasonable lower end of the range of firm yield as described in Section 5.

Table 9. Evaporation sensitivity results

	Baseline	15% Increase over Baseline	45% Increase over Baseline	70% Increase over Baseline	90% Increase over Baseline	100% Increase over Baseline
Upper Reservoirs Average Annual Evaporation (AF)	599	696	895	1,035	1,163	1,231
Juniata Reservoir Average Annual Evaporation (AF)	481	560	686	787	886	936
Total System Average Annual Evaporation (AF)	1,080	1,256	1,581	1,822	2,049	2,167
Change in Total System Evaporation from Baseline (AF)	0	176	501	742	969	1,087
Firm Yield (AF)	6,275	6,175	6,075	5,975	5,850	5,800
Upper Reservoir minimum storage (AF)	>1,800	>1,800	1,791	1,740	1,691	1,668
Reduction in Firm Yield Relative to Baseline (AF)	0	(100)	(200)	(300)	(425)	(475)
Reduction in Firm Yield Relative to Baseline (%)	0%	-2%	-3%	-5%	-7%	-8%

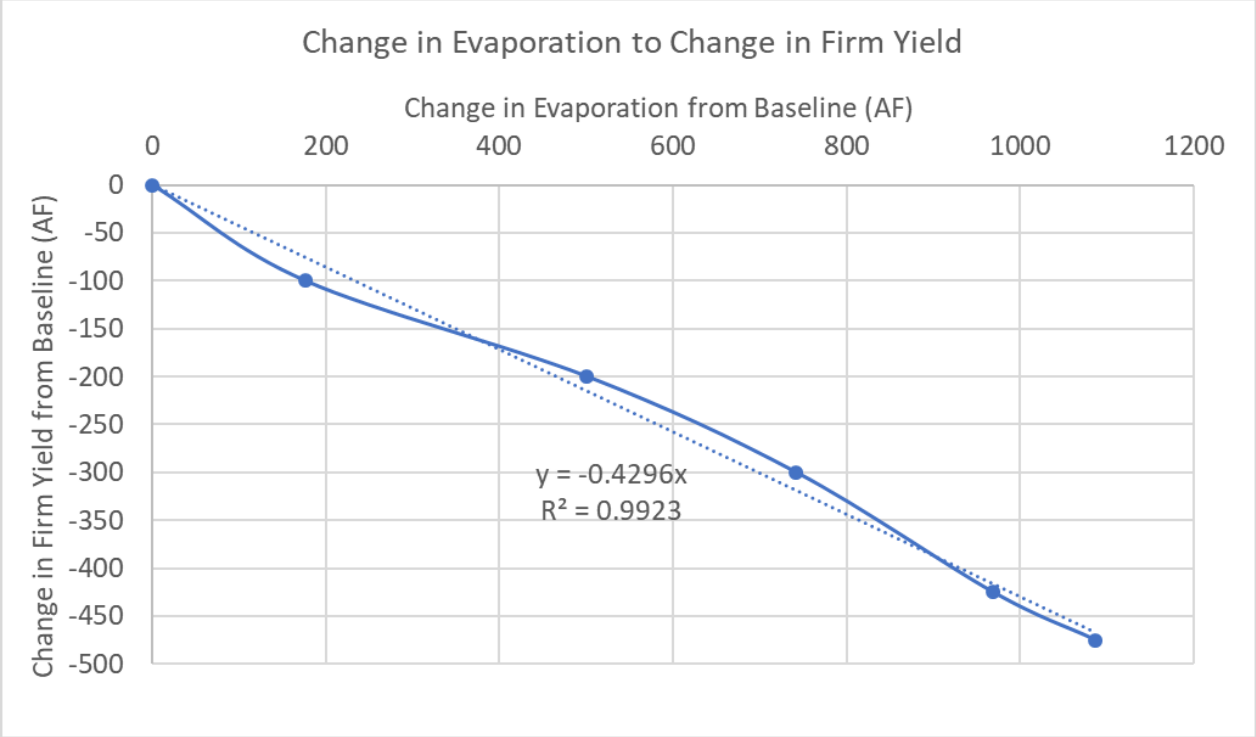

Figure 12. Change in volume of evaporation compared to change in firm yield

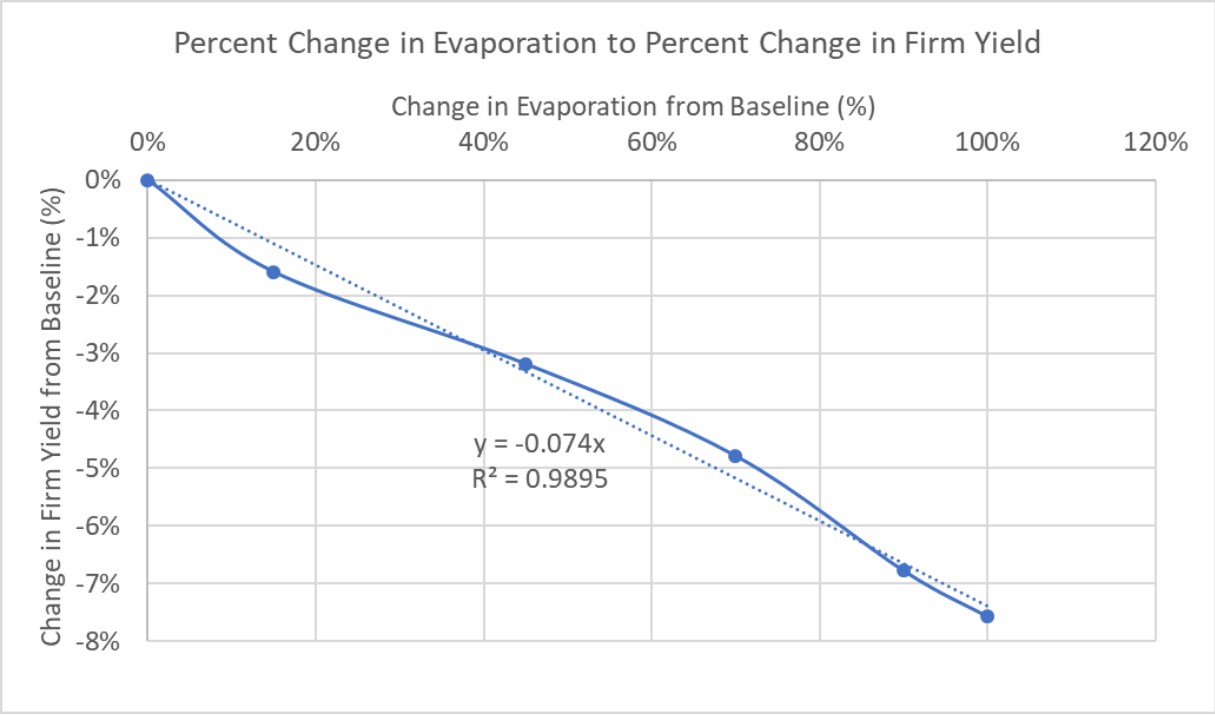

Figure 13. Percent change evaporation compared to percent change in firm yield

7. MODEL LIMITATIONS AND RECOMMENDATIONS

Natural hydrologic systems are complex and dynamic, dependent on a host of variables that cannot be fully captured in a model. The measure of the quality of a model is how useful it can be in illuminating reliability, system vulnerabilities, and testing various operational scenarios and potential changing hydrologic conditions. No matter how useful it is, every model has limitations, and users of the model should be well-versed in such limitations so that future analysis and results obtained from the model can be considered in the proper context. The following are key limitations to the current version of the RiverWare model developed for this project. For each model limitation discussed below, we provided a recommendation (denoted with a letter heading) for Grand Junction to consider for future water supply planning efforts. After the discussion on limitations, additional recommendations are provided.

1) The firm yield model was developed with monthly historical hydrology

Historical hydrology is the basis for many firm yield models for water providers throughout the nation and world. For example, in Texas, water rights are only granted if the firm yield can be demonstrated through the "drought of record." Historical observations are the best predictor of future hydrological conditions. Nonetheless, the worst drought in the historical period will likely be exceeded at some point in the future. Historical gage records are rarely more than 100 years old with most records being only a few decades old. This period is relatively short when considering the length of time over which climatic events such as the Little Ice Age (ca 1400 CE), the Medieval Warm Period (ca 1000 CE) and the Roman Warm Period (ca 200 CE) have occurred.

Use of historical hydrology means that if a more severe drought occurs than seen historically, the water supply system will not be able to deliver the firm yield and still satisfy the reliability criteria. This occurred recently in Cape Town, South Africa where an unprecedented drought began in 2015 and continues on as of the date of this report. In early 2018, Cape Town declared "Day Zero," the day on which water taps would be shut off due to lack of water. "Day Zero" was initially predicted for early April 2018. Drastic and severe water conservation measures pushed "Day Zero" out several months from the initial predicted April date. Rainfall in the winter (July – September) of 2018 appears to have alleviated the immediate threat of "Day Zero."

The RiverWare model can be used to test a variety of different hydrologic conditions. Hydrology inputs can be altered in numerous ways to test the

robustness of the firm yield computed with historical hydrology. The following are some examples:

- Rearrange historical inputs, including intentionally putting two or more known drought years in series to test reliability over a longer drought period.
- Adjust for potential climate change scenarios. Considering climate change can be accomplished from a simple percentage adjustment of relevant inputs (as was done in Section 6.1) to sophisticated methods that use down-scaled climate change global circulation model (GCM) predictions to estimate changes to historical flows.
- Stochastic methods can be used to develop hydrologic data with defined return intervals (e.g. a 1-in-100 year drought).

A) Grand Junction should consider testing variations on sequence and method of hydrologic input development. This will further its understanding of the system reliability when tested against hypothetical drought conditions that are potentially more severe than historical conditions. Additionally, as discussed above the use of monthly hydrology may have the effect of masking shortages during portions of a month with excess flow in other portions. Grand Junction should consider evaluating if the availability of water on a daily basis coincides well with monthly availability, or if adjustments to the monthly hydrology are warranted.

2) System Reliability Criteria

Grand Junction staff provided system reliability criteria primarily based on historical operating protocol and institutional knowledge. This is not necessarily a limitation because it based on years of experience operating the system. However, establishing defined system reliability criteria based on thorough system analysis can assist in providing additional technical support for the experience-based criteria or provide opportunities to modify existing criteria if appropriate.

As part of this project, we contacted several Grand Junction area water providers to inquire about reliability criteria used by other regional water providers. We received limited feedback from Ute Water Conservancy District (Ute Water) and the City of Glenwood Springs. Ute Water uses a 20% demand factor when developing its firm yield. That is, it develops a system that is able to deliver water to 120% of its anticipated demand. Ute Water did not provide other reliability criteria needed to meet that demand, such as any required storage levels. Glenwood Springs relies on two diversions points from tributaries to the Colorado River and has an emergency intake on the Roaring Fork River. It was our understanding that Glenwood Springs has not determined its system firm yield.

As a point of comparison with the Ute Water system, we simulated the Grand Junction system with demands increased by 20%. In that model run, Juniata Reservoir was nearly depleted, but water was still available in the Upper Reservoirs. Although not a perfect comparison with Ute Water, this indicates that the Grand Junction system has similar reliability characteristics as Ute Water uses.

B) Grand Junction should consider attempting additional outreach to regional water providers to understand other water provider system reliability criteria and assess whether such criteria would be appropriate for Grand Junction's system. This outreach may include water providers in other areas of Colorado or nearby states that have similar water supply system characteristics. The RiverWare model can be used to evaluate the effectiveness of any other reliability criteria.

C) Grand Junction should consider evaluating the effect of each of its reliability criteria on firm yield. Each of the reliability criteria directly affects the firm yield quantification. This recommendation was carried out in part as described in Section 6.1 when the Upper Reservoir criterion was relaxed for certain model runs, but may be useful for other of the reliability criteria. Sensitivity testing of different criteria will allow Grand Junction to weigh potential increases in risk associated with relaxing such criteria against gains in firm yield (and conversely any reduction in risk against reduction in firm yield).

Other Recommendations:

Gunnison River and Colorado River

In addition, decreed water diversions from the Colorado River and the Gunnison River were not included in the firm yield modeling. Water from these sources is vastly more plentiful than Kannah Creek but both rivers have degraded water quality especially in comparison to Kannah Creek sources. In the future, these sources could potentially be used to offset a portion of the demand from Kannah Creek sources. For example, potential opportunities for non-potable use of Gunnison River or Colorado River supplies could be evaluated and would have result in a higher firm yield for potable use from the Kannah Creek system.

D) Grand Junction should consider evaluating potential potable and non-potable water uses for Gunnison River or Colorado River supplies. This may include a water quality evaluation and/or consideration of different water treatment technologies that could best serve Grand Junction.

Colorado River Compact

The State of Colorado along with other Colorado River basin states (California, Arizona, Nevada, Utah, New Mexico, and Wyoming) have spent considerable effort evaluating the effect of a potential Colorado River Compact Call. As we understand it, water rights decreed prior to the signing of the Compact would not be subject to a call for water from downstream states, and therefore many of Grand Junction's rights would not be affected. However, Grand Junction uses junior 1993 and 1994 water right to fill many of its Upper Reservoirs.

E) *Grand Junction should consider evaluating the potential effect of the Colorado River Compact on its operation of junior water rights and develop a plan for operation under and maintenance of its more senior rights. This could include use of Aspinall Unit water as a substitute supply in the event that junior water rights are called out.*

Evaluation of Internal Operations

The model is also useful for evaluating the impacts of operational changes on the system yield. This may also be done in conjunction with modified hydrology as discussed above to evaluate how these changes may impact the system under future conditions.

F) *Grand Junction should consider evaluating operational changes that may result in an increased firm yield. These changes could include evaluating the timing of upper reservoir releases to Juniata Reservoir and forgoing the diversion of irrigation water in times of greater municipal demand.*

8. REFERENCES

Colorado Division of Water Resources. (2016, February). General Administration Guidelines for Reservoirs.

Spronk Water Engineers, Inc. (2018, April). Summary of Water Supply System, City of Grand Junction.

APPENDIX A

Note: RiverWare simulates beginning with Rule #59 first and moves to Rule #1 last.

8.1 Model Ruleset

Priority	Description
1	Sets the reservoir storage on the physical system equal to the sum of the storage in all accounts in the reservoir, allowing the object to solve
2	Sets the reservoir gain/loss on the physical system equal to the sum of the gain/loss in all accounts in the reservoir, allowing the object to solve
3	Releases a percentage of water in irrigation storage for delivery to Grand Junction Ranches
4	Diverts water from Purdy Mesa reservoir to meet the irrigation lease
5	Recalculates the amount in rule 13
6	Diverts leased irrigation water out of Grand Mesa Reservoir No. 1
7	Recalculates the amount in rule 13
8	Diverts leased irrigation water out of Deep Creek Reservoir
9	Recalculates the amount in rule 13
10	Diverts leased irrigation water out of Dry Creek Reservoir
11	Recalculates the amount in rule 13
12	Diverts leased irrigation water out of Grand Mesa and Scales Reservoirs
13	Calculates the total amount to release from Upper Reservoirs to Irrigation Leases based on user input in the "Irrigation Demand Input" data object
14	Decides whether to lease irrigation water from Purdy Mesa Reservoir if the reservoir is at least 75 percent full going into irrigation season, and lease from upper reservoirs if SWE is greater than 90%
15	Diverts water from Upper Reservoirs with partial ownership for use by non Grand Junction users
16	Diverts Upper Reservoir releases at the City Ditch
17	Diverts Upper Reservoir releases at the Juniata Enlargement Ditch
18	Sets the shrink on Upper Reservoir releases down to the City Ditch
19	Sets the shrink on Upper Reservoir releases down to the Juniata Enlargement Ditch
20	Sets the shrink on Upper Reservoir releases down to the Kannah Creek Flowline
21	Releases water from Bolen and BA&J Reservoirs per rule 33
22	Re-calculates the amount from rule 33
23	Releases water from Anderson Reservoir No 6 per rule 33
24	Re-calculates the amount from rule 33
25	Releases water from Anderson Reservoirs 1 and 2 per rule 33
26	Re-calculates the amount from rule 33

27	Releases water from Raber Click Reservoir per rule 33
28	Re-calculates the amount from rule 33
29	Releases water from Flowing Park Reservoir per rule 33
30	Re-calculates the amount from rule 33
31	Releases water from Carson Lake per rule 33
32	Sets the total release from the Upper Reservoirs to Juniata equal to the minimum of the remaining storage in Juniata and the amount in excess of the target carryover storage, taking into account reach and ditch losses
33	Calculates the amount of municipal and irrigation storage in the Upper Reservoirs
34	Divers water released from Somerville Reservoir at the Somerville Pipeline
35	Releases water from Somerville Reservoir to meet shortage at Somerville Pipeline
36	Sets the ditch losses on diversion objects based on user input in the "Reservoir and Reach Loss Input" data object
37	Recalls the RiverWare water rights solver
38	Sets the initial request at the Somerville Pipeline equal to the remaining WTP demand if Juniata storage is below 70 percent during the winter or if Juniata storage is below 25 percent during the irrigation season
39	Releases water from Juniata Reservoir to meet the remaining demands at the WTPs
40	Transfers water from all accounts in Purdy Mesa Reservoir into the irrigation account
41	Transfers water from all accounts in Juniata Reservoir into the municipal account
42	Transfers Grand Junctions pro-rata portion of water in reservoirs with shared ownership into their account
43	Sets the demand at the Kannah Creek/Purdy Mesa WTP
44	Sets the initial request at the City Ditch for delivery to Juniata Reservoir equal to the minimum of the remaining storage capacity and the input water right amount, taking into account ditch loss
45	Sets the initial request at the Juniata Enlargement Ditch for delivery to Juniata Reservoir equal to the minimum of the remaining storage capacity and the input water right amount, taking into account ditch loss
46	Calls the RiverWare water rights solver
47	Sets the initial request for the 3.91 Kannah Creek Flowline right diversion to Purdy Mesa Reservoir to the minimum of the remaining storage capacity and the amount not used for direct diversion or diversion to Juniata
48	Sets the initial request for the 3.91 Kannah Creek Flowline right diversion to Juniata Reservoir to the minimum of the remaining storage capacity and the amount not used for direct diversion
49	Sets the initial request for the 3.91 Kannah Creek Flowline right direct diversion to the WTP to the lesser of the water right input and the plant demand
50	Sets the initial request for the Paramount right diversion to Purdy Mesa Reservoir to the minimum of the remaining storage capacity and the amount not used for direct diversion or diversion to Juniata

51	Sets the initial request for the Paramount right diversion to Juniata Reservoir to the minimum of the remaining storage capacity and the amount not used for direct diversion
52	Sets the initial request for the Paramount right direct diversion to the WTP to the lesser of the water right input and the plant demand
53	Sets the gain/loss slot on each reservoir account based on the user input in the "Reservoir and Reach Loss Input" data object
54	Sets the initial diversion request at each Upper Reservoir in which Grand Junction is a partial owner from November to June equal to amount needed to fill the reservoir
55	Sets the initial diversion request at each Upper Reservoir used for irrigation storage from November to June equal to amount needed to fill the reservoir
56	Sets the initial diversion request at each Upper Reservoir used for municipal storage from November to June equal to amount needed to fill the reservoir
57	Diverts the inflow to the Grand Junction WTP to meet non-potable demand at the "Nonpotable" diversion account
58	Diverts the inflow to the Grand Junction WTP to meet potable demand at the "Potable" diversion account
59	Sets the inflow to the Grand Junction WTP reach (including non-potable use) to the sum of the diversions to the plant

8.2 Initialization Rules:

Index	Description
1	Sets the demand at the Grand Junction WTP based on user input in the "WTP Demand Input" data object
2	Sets the demand at the Kannah Creek/Purdy Mesa WTP based on user input in the "WTP Demand Input" data object
3	Sets initial values on the physical system that are required for the model to run
4	Sets initial values for reservoir storage based on user input in the "Reservoir Storage Input" data object
5	Sets the initial request for all water rights based on the user input in the "Non GJ Water Rights Input" and "GJ Water Rights Input" data objects

DiNatale WATER CONSULTANTS

MEMORANDUM

TO: Randi Kim, Mark Ritterbush, Jamie Beard (City of Grand Junction)

FROM: Stephen Buechner, PE and Matt Bliss, PE (DiNatale Water Consultants)

SUBJECT: Water Supply Analysis in support of a finding of diligence for the Gunnison River Pipeline Water Right

DATE: July 9, 2019

Grand Junction will file an application seeking a diligence finding for its conditional water right on the Gunnison River in September 2019. The City of Grand Junction contracted DiNatale Water Consultants (DiNatale Water) to prepare a water supply analysis to support the application. The analysis evaluates Grand Junction's water demands on a 50-year planning horizon, the water supply generated by the conditional Gunnison River right and demonstrates that Grand Junction can and will use the conditional Gunnison River right.

1. GUNNISON RIVER CONDITIONAL RIGHT BACKGROUND

In July of 1959, Grand Junction obtained a conditional water right for the Grand Junction-Gunnison River Pipeline in Civil Action 8303 of the Mesa County District Court (CA8303) with an appropriation date of January 22, 1957. This water right was decreed for domestic, municipal and industrial uses in the amount of 120 cubic feet per second (cfs) of water. CA8303 granted a conditional priority to this Gunnison River Pipeline right, which means that Grand Junction must demonstrate through periodic findings of diligence that they have put this water right to a beneficial use or are working towards doing so. In the last 60 years since this adjudication, numerous diligence proceedings have been held and a total of 18.6 cfs of this 120 cfs water right has been made absolute (i.e. no longer conditional) while the remaining 101.4 cfs remains conditional.

In the most recent diligence proceeding represented by Case No. 13CW3004, the Water Division 4 Engineer's Office (Division 4) issued a letter recommending a finding of reasonable diligence for the Gunnison River Pipeline right. However, the letter contains the following statement:

> *The applicant should be aware that as this right is 54 years old and we have no record in our files of a water supply analysis addressing the elements required for a governmental entity to make a non-speculative conditional appropriation,*

> *as stated in* Pagosa Area Water and Sanitation District v. Trout Unlimited*, that this office will require such an analysis prior to recommending continued diligence in 2019. This study can include projected demand within the City of Grand Junction service area for up to a 50 year planning period pursuant to the ruling in* Pagosa Area Water and Sanitation District v. Trout Unlimited*.*

The Pagosa ruling cited in the Division Engineer's 2013 letter deals with the elements necessary for a governmental entity to make a non-speculative conditional appropriation. In that case, the Pagosa water districts were attempting to obtain a conditional water right. That case differs from the Grand Junction Gunnison River conditional water right at issue in this case because Grand Junction is not applying for a new conditional water right. Grand Junction seeks only to demonstrate diligence on an already-decreed conditional water right. Therefore, it is not clear that Grand Junction must meet the requirements laid out in the Pagosa ruling as indicated by the Division Engineer's 2013 letter, and instead must only demonstrate diligence towards completing the decreed appropriation.

The Pagosa decision discusses several "reality checks" that were built into the proposed decree for the conditional rights sought in that case. No such "reality checks" or other terms and conditions were included in the original Gunnison conditional water right decree from CA8303. A recent ruling in Water Division 1 clarified that terms and conditions cannot be added to a conditional water right decree through diligence proceedings (ruling in Case No. 15CW3065, Division 1). Therefore, addition of terms and conditions to the Gunnison decree would not be appropriate, and Grand Junction must only demonstrate diligence towards perfecting the water right and that it can and will perfect the water right. To that end, this report demonstrates the ongoing need for the water right and Grand Junction's ability to use it. In addition, the application for diligence lists several other factors that support a finding of diligence.

2. EXISTING FACILITIES

Grand Junction operates an integrated water supply system that serves a portion of the entire City of Grand Junction, primarily in the City Center area. The Gunnison River Pipeline water right can be integrated into the system and has been used in the past in the Grand Junction system. Grand Junction derives its primary water supply from the Kannah Creek watershed. Kannah Creek is a tributary to the Gunnison River approximately 20 miles southeast of the city. Water from Kannah Creek is a higher water quality than the Gunnison River, and therefore is the preferred water source for Grand Junction. Grand Junction recently completed modeling of the firm yield of its Kannah Creek water supply system.

The modeling determined that the Kannah Creek supplies can reliably deliver between 5,800 and 6,275 AF of water per year, depending on assumptions related to Grand Mesa reservoir evaporation and inflows. Of this amount, approximately 350 AF is dedicated to the Kannah Creek water treatment plant and other non-potable uses, resulting in delivery of approximately 5,450 to 5,925 AF to the existing water treatment plant through two existing pipelines, also known as flowlines. Grand Junction also has water rights on the Colorado River that are used primarily to meet some non-potable water demands.

In the past, Grand Junction has used water from the Gunnison River to meet peak summer demands and blended this water into the potable supply from the Kannah Creek flowlines. In recent years, water demand has decreased due primarily to increased water conservation efforts and Gunnison River supplies have not been required. In addition, more recent water quality standards related to turbidity make this practice more challenging with the current direct filtration water treatment process. The city is currently undertaking a water filtration study to evaluate its water treatment options for treating the Gunnison River water supply.

The Gunnison River Pipeline diversion point is constructed on the east bank of the Gunnison River at the Redlands Power Canal river check structure and diversion facility. Water is delivered from the diversion point into a wet well beneath the existing pump station. The pump station has three pump skids. On a site visit in July 2018, we observed two pumps on-site and the third pump was being repaired. The pumps currently installed have a combined capacity of 4.9 cfs and can deliver water to the Grand Junction water treatment plant through an existing 18-inch pipeline. Capacity is limited by the current installed pump sizes and in the past, larger pumps have been used to obtain the amount made absolute in previous cases.

3. FUTURE WATER DEMAND

This water supply analysis for the City includes a 50-year timeframe for evaluation of future water demands in Grand Junction.

Current Water Demand

To properly evaluate future water demands for Grand Junction, DiNatale Water first identified the City's current water demands and the prospective changes to this demand that will occur in the coming 50 years. To quantify current water demands, DiNatale Water coordinated with City personnel to evaluate the City's water service area and water consumption data in recent years. Grand Junction provided water usage for potable and non-potable water users located within their service area for every year from 2010-2018.

The Grand Junction Utilities Department serves a portion of the entire City of Grand Junction. Other portions of the City are served by Ute Water District and Clifton Water District. The service area for Grand Junction Utilities is shown on **Figure 1**.

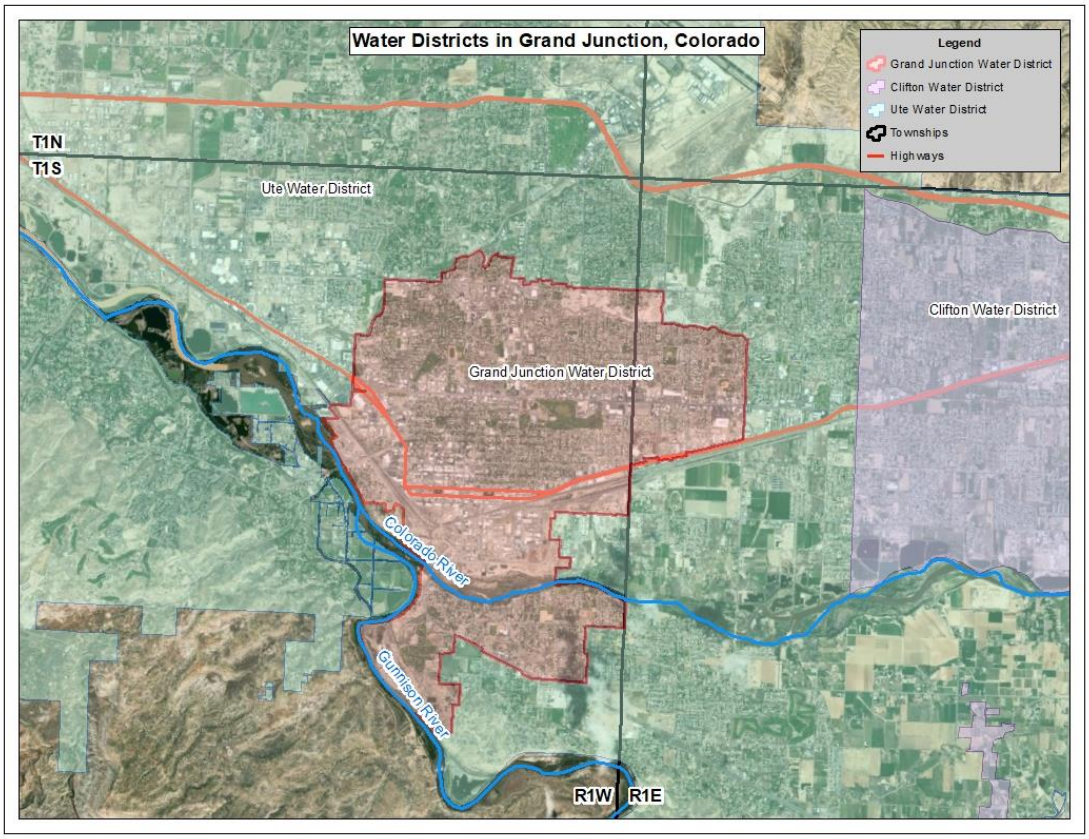

Figure 1. Water Utilities in Grand Junction, CO

The water usage data provided by the City was broken down into metered water use, raw water deliveries to a local cemetery, raw water sales to customers off the water service lines, water leased to City ranch properties, and supplemental irrigation water occasionally leased to irrigators by auction. The metered water use represents a total of all of the City's domestic water customers, all customers located off of Kannah Creek, any water the Grand Junction Parks Department uses for repayment to Ute Water District and any bulk water sales from the fill stations in the distribution system. Grand Junction also provided estimates of system loss within their distribution system. DiNatale Water totaled all of the potable and non-potable uses and applied the system losses to the appropriate metered water deliveries to identify the current annual raw water demand for the City in **Table 1** from 2010-2018.

Table 1. Grand Junction Utilities Annual Water Demands

Year	Metered Water Deliveries (AF)	System Losses (AF)	Water Treatment Plant Deliveries (AF)	Kannah Creek Deliveries* (AF)	Raw Water Deliveries** (AF)	Total Water Demand (AF)
2018	4,881	422	5,303	45	2,852	8,200
2017	4,966	425	5,391	45	5,779	11,216
2016	4,789	288	5,076	45	5,736	10,857
2015	4,534	339	4,873	45	4,991	9,910
2014	4,351	497	4,848	45	5,367	10,260
2013	4,474	583	5,057	45	4,671	9,773
2012	5,074	660	5,734	45	3,499	9,278
2011	4,690	607	5,297	45	6,857	12,199
2010	4,994	662	5,656	45	5,619	11,320
Average	4,750	498	5,248	45	5,041	10,335

**City personnel estimate 45 ac-ft/yr delivery to Kannah Creek Watershed Municipal Users*

***Includes raw water sales, supplemental irrigation leases, deliveries to cemetary and deliveries to City ranches*

Population Growth

DiNatale Water discussed future growth estimates with Grand Junction Planning Department personnel to estimate future potable water use for the City. Grand Junction's Planning Department uses a 1.4% growth rate for the City based on recent measured population growth. We applied this growth rate to the population within the Grand Junction Utility water service area using the 2010 US Census data and also to an estimate of 2017 population in the service area.

The population according to the 2010 US Census is considered to be the most accurate measurement of population within the Grand Junction service area because the census counts population at the parcel level. No census-level population counts are available for more recent years. However, Grand Junction planning staff have made population estimates through 2017 on the census tract level, which are larger than the more detailed census data. The census tracts do not exactly align with the Grand Junction water service area boundaries, so Grand Junction GIS professionals assisted DiNatale Water with estimating the population within the service areas in 2017 by scaling the tract populations based on the area of each tract within the City's Utility service area, resulting in an estimated 2017 population of approximately 29,500.

We used both the 2010 census-based population and the 2017 estimated population and projected population in 2069 using the 1.4% growth rate. Beginning with the 2010 population, the projected future population is approximately 63,000 people. Beginning with the 2017 population estimate, the future projected population is approximately 61,000 people. As a conservative measure, DiNatale Water chose to use the smaller of the two projections for estimating future demand.

Additionally, DiNatale Water opted to reduce this projected population metric as future growth within the City's water service area will be limited by the space available surrounding the current service area. The 1.4% growth rate was developed city-wide and was not limited to the water utility service area. Within the current water service area, population growth will result primarily from infill development and increasing density of land use, rather than development or new lands within the current service area. Therefore, DiNatale Water reduced the future population estimate by 20% within the current water service area in the year 2069 to be approximately 49,000.

The City Center of Grand Junction is experiencing an increase in the amount of infill development within the City's service area. Land use within the service area has become denser as parcels that historically served single family homes or were unoccupied have been developed into apartment buildings and hotels. Grand Junction Planning Department personnel provided several examples of this type of infill development where an increase in water demand is expected due to a change to the land use of the same area. DiNatale Water mapped these examples on **Figure 2**.

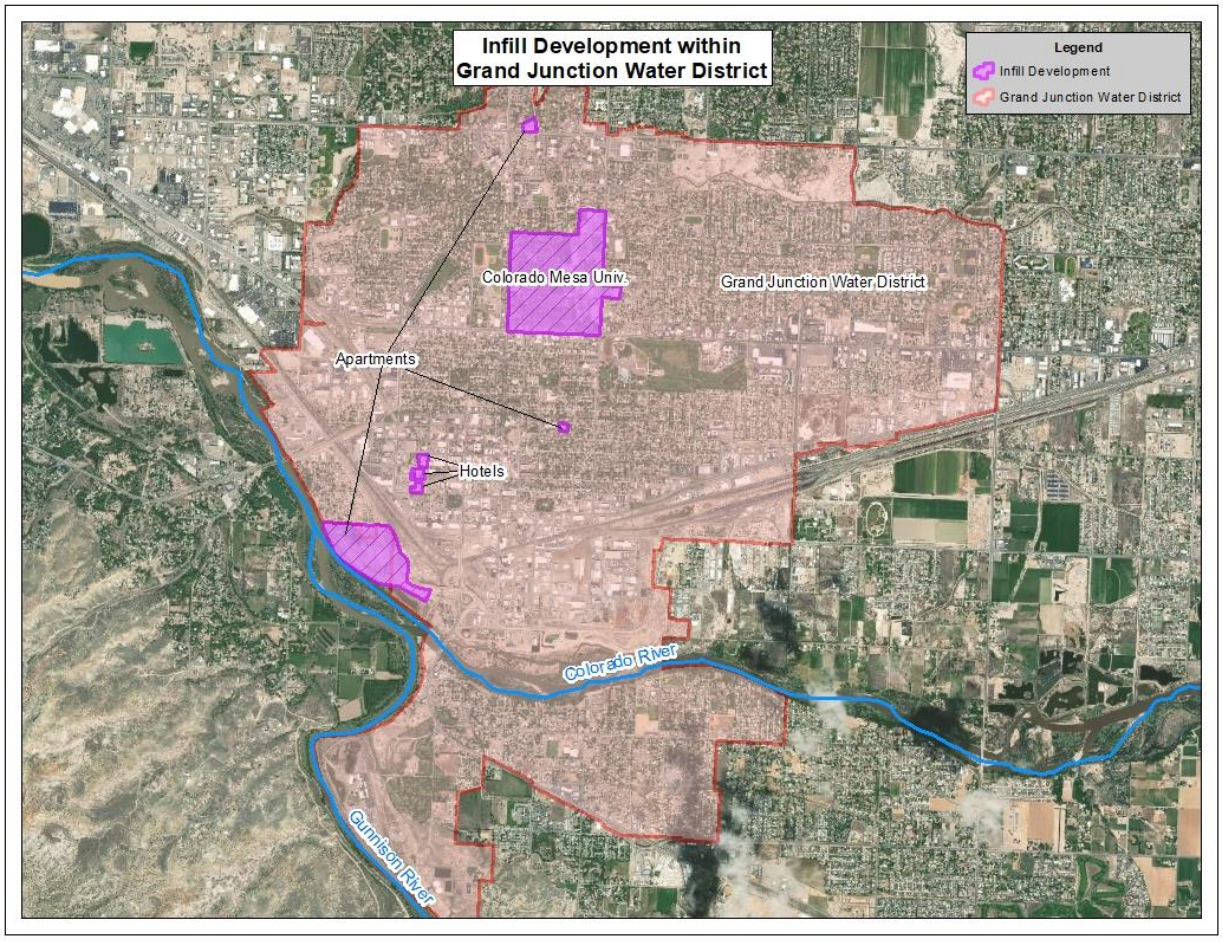

Figure 2. Examples of Infill Development Within Grand Junction Utilities Service Area

The examples provided by the City indicate that infill development is occurring and will results in higher water use within the current service area, even without an expansion of the land area of the City's water service area.

Using the current per capita potable water demand and the projected population for 2069, DiNatale Water estimates an annual treated water demand of 8,760 acre-feet (AF) as measured as production at the water treatment plant. This is 3,460 AF more than the current potable water treatment plant production demand of 5,300 acre-feet in 2018. An average annual direct flow rate of 4.77 cfs could satisfy this increased annual demand if there were no system losses and water was delivered consistently throughout the year. However, there are many other considerations one must make when delivering treated water. In order to deliver treated water to customers, additional raw water must be diverted from the stream system to account for treatment losses, distribution system losses and additional distribution considerations. In addition, water can be stored in reservoirs at higher rates when available and released at lower rates when needed. Therefore, a diversion rate from the stream system in excess of the treated water delivery rate is needed to support the water storage, treatment, and delivery processes. Further, the treated water demand varies throughout the year, with summer months requiring more water delivered to the system than winter months. This monthly variability in water use by customer class is demonstrated in **Figure 3** below, which was taken from the 2018 Water Supply Inventory.

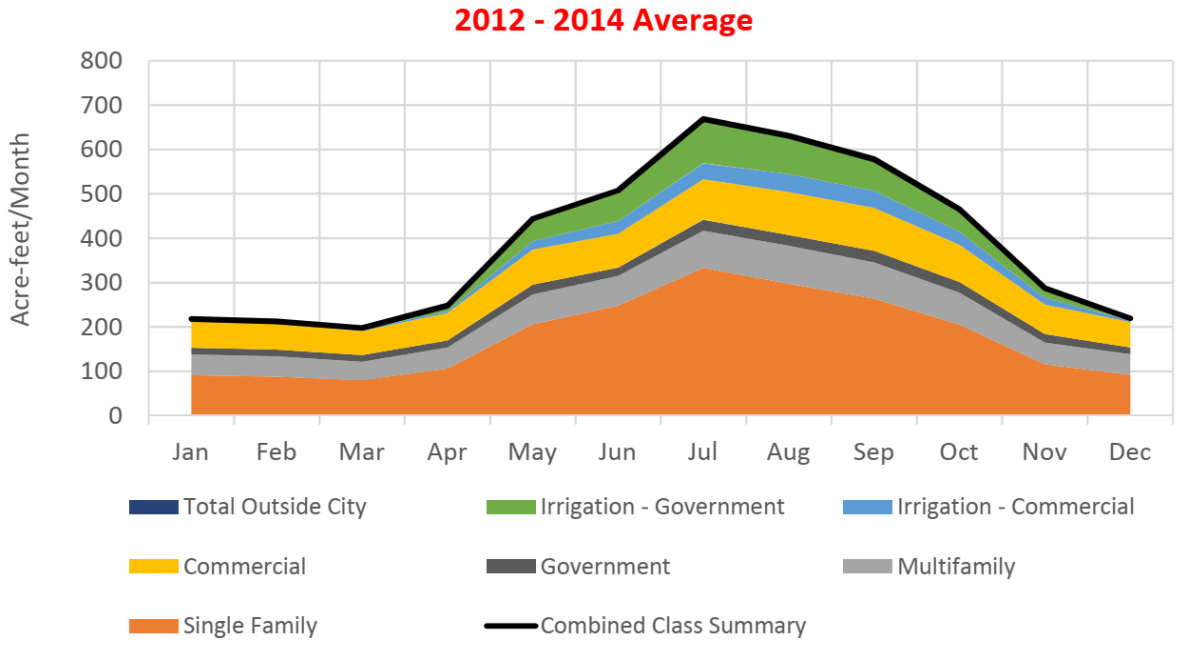

Figure 3. City of Grand Junction Water Use by Customer Class

DiNatale Water reviewed the data from the Water Supply System Summary for the City of Grand Junction and found that the month of July accounted for approximately 14% of the annual water use in recent years (2010-2017). To deliver 14% of the increased annual water demand in one month, an average monthly flow rate of 7.88 cfs would be needed.

Finally, a water treatment plant must account for daily variations in water demand. Water demands from customers can vary from day to day, and even hourly as there are greater demands in the evening hours than in the middle of the night. To account for these daily and hourly variations, DiNatale Water applied a peaking factor of 2.0. Using this peaking factor and the maximum water demand in any one month and the projected population increases expected within the Grand Junction Utilities service area, DiNatale Water estimates that potable water demands in 2069 could increase by 15.76 cfs during peak water treatment plant production. This 15.76 cfs is an estimate of the increase in water demand above and beyond the current 2018 water demands. Recent peak demand at the Grand Junction water treatment plant reached 15.11 cfs in June 2017.

Non-Potable Use

In addition to increased potable water demands for the City of Grand Junction, there are numerous opportunities for the Gunnison River Pipeline right to serve non-potable demands for the City. Non-potable use presents an opportunity for using the Gunnison River Pipeline water right because water diverted from the Gunnison River is typically lower quality than the Kannah Creek water, and may be more suitable for non-potable uses than to treat the water to potable standards. **Figure 4** shows that there are numerous parks and potential uses of non-potable water located within and near the Grand Junction Water District service area. At this time, the City has sufficient water supply from the Kannah Creek watershed and its Colorado River sources for the parks within the service area. However, as population within the service area increases, there will be additional demand for the higher quality Kannah Creek water for potable delivery, and the Gunnison River water will become an increasingly viable option for non-potable use.

The Gunnison River has relatively high levels of turbidity which can cause degradation of irrigation systems used in City parks. Grand Junction is currently exploring water treatment options for the Gunnison River. However, one method that would reduce turbidity is to store the water and allow particulates to settle out of the water. Storing the Gunnison River conditional water right prior to delivery into a non-potable irrigation season may be one of the most cost-effective means of using this water right for non-potable uses. If such a method were implemented, the high flow rate of the claimed water right would be useful to fill storage capacity quickly, but also to periodically flush the storage vessel of accumulated particulates.

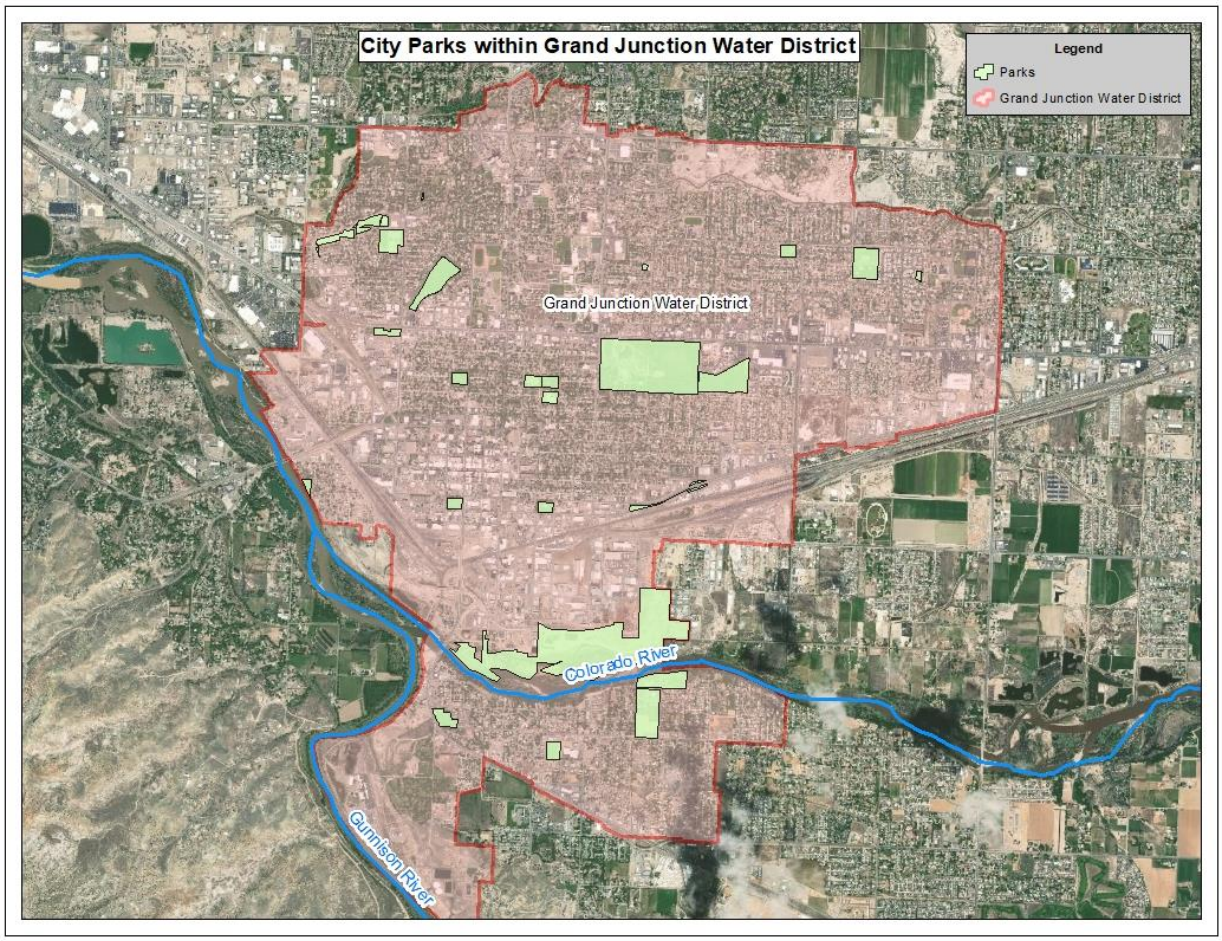

Figure 4. Parks within Grand Junction Utilities Service Area

Kannah Creek Watershed

In addition to the primary water service area within Grand Junction, the City also serves some residential users within the Kannah Creek watershed. Kannah Creek is a tributary to the Gunnison River located upstream from the Gunnison River Pipeline right diversion point and is the source of the two flow lines that serve the City's water treatment plant (Kannah Creek Flow Line and Purdy Mesa Flow Line). Therefore, additional demand within this service area will reduce the water supply from Kannah Creek available to the primary service area, increasing the potential demand on the Gunnison River water right for water within the primary service area. The current water demand for the Kannah Creek water users is relatively small (45 AF per year). Assuming a similar growth rate in this region as for Grand Junction results in a projected future demand of approximately 90 AF.

Interconnects to Other Water Utilities

Grand Junction Utilities has interconnects with both the Ute Water District and Clifton Water District for potential use in the event of drought or an emergency such as infrastructure failure. By connecting these utilities' distribution networks, the utilities provided redundancy to ensure a sufficient water supply in such conditions. This interconnectivity represents a potential demand for potable water on the Grand Junction system that exceeds demands within its service area discussed above. The ability to divert and potentially store additional water supply from the Gunnison River is important to maintain Grand Junction's ability to deliver water to neighboring districts if needed by those districts. Water stored in Grand Junction's Grand Mesa Reservoirs are delivered through the existing flowlines to the City. During peak summer months, the flowline capacity is needed for demands with the current service area. Additional water to deliver to neighboring districts therefore, could not use the flowlines from Kannah Creek. The Gunnison River pipeline is situated near the water treatment plant and could deliver such a supply.

The City entered into an agreement with the Clifton Water District that allows Grand Junction to take delivery of Clifton water, and to deliver water to Clifton through an existing pipeline that connects the two entities. The current agreement allows for a water supply of up to 4.5 million gallons per day (MGD) which is equivalent to 6.96 cfs, although additional water could be delivered in an emergency situation. The City has a verbal agreement with the Ute Water District for an emergency water supply which can be delivered through the 8 points of interconnection between the Grand Junction and Ute Water systems. Grand Junction staff report that the largest of these interconnects has a capacity of over 10 MGD, which is approximately 15 cfs.

Use within Grand Junction City Limits

In addition to emergency use through the interconnect agreements, the Gunnison River conditional right was decreed for use within the City of Grand Junction. Therefore, the water right could be used in areas outside the City water service area and used within the city limits of Grand Junction, including in areas currently served by Ute Water. While no formal discussions with Ute Water have taken place, this water source is available to supply approximately an additional 50% of the current and future projected population of the current Grand Junction Utilities water service area discussed above, which is approximately an additional population within Grand Junction city limits of 54,000 people.

Storage

Grand Junction may be able to store water under the Gunnison River Pipeline water right. Although not specifically named as a use in the original decree, storage is at times an understood use in a municipal system, such as was confirmed by the Supreme Court for the

City's Paramount Right in Kannah Creek. In addition, several of the summary of consultation documents from previous diligence proceedings indicate storage as a contemplated use for the Gunnison conditional right (e.g. Case Nos. 87CW84 and 93CW182). As discussed above, storage for non-potable uses with the current service area and within the city limits would relieve demand pressure from the potable water system as population increases. Further, the City is in the early planning stages of a potential augmentation plan to protect against potential future Colorado River compact calls, as described below that would use the Gunnison conditional water right in a local storage facility.

Colorado River Compact Protection

The City of Grand Junction is uniquely located at the mouth of the Gunnison River as well as near the Colorado River near the Colorado state boundary. Having water rights tributary to the Colorado River that are likely junior to the Colorado River Compact necessitates that the City be aware of the potential impact of a call associated with the Colorado River Compact. The possibility of a compact call under the 1922 priority of the Colorado River Compact would likely disallow use of the 1957 Gunnison River Pipeline right as well as a number of the City's additional water rights in the Kannah Creek watershed. Therefore, Grand Junction is in the initial stages of considering a plan for augmentation on the Colorado River that would involve storing flows from the Gunnison River Pipeline right when there is no compact call, and, during periods of a compact call, releasing the stored water to augment any out-of-priority depletions from other City water usage, including use of its Kannah Creek water rights. If pursued further, such an augmentation plan would need to be adjudicated in Water Court before implementation, but remains a valid and beneficial consideration for the City to use its Gunnison River Pipeline right to anticipate future Colorado River call conditions.

4. WATER SUPPLY ANALYSIS

The Gunnison River Pipeline water right was originally decreed for 120 cfs and 18.6 cfs of this right has already been made absolute. The intended infrastructure for this water right involved two parallel pipelines delivering water from the Gunnison River to the City of Grand Junction directly for use in the City's potable and non-potable water systems. DiNatale Water evaluated flows in the Gunnison River along with call records for Division 4. Since the beginning of the diligence period through the present (September 2013

through May 2019), there has not been a call in effect at the Gunnison River Pipeline diversion point and flows below the diversion point regularly exceed the claimed 120 cfs (Colorado DWR gage station GUNREDCO). Therefore, there continues to be sufficient water physically and legally available at the point of diversion.

In 2018 the City of Grand Junction developed a water supply model to determine the firm yield of its Kannah Creek water supply. The model determined the firm yield to be between 5,800 AF and 6,275 AF depending on various assumptions related to Grand Mesa reservoir evaporation and inflows. Once reduced for non-potable deliveries, and treatment and distribution system losses, this results in approximately 5,450 to 5,925 AF delivered to customer taps within the service area. When compared to Table 1, it is clear the Kannah Creek supplies are sufficient for the current potable water demand. However, as discussed in Section 3, population increases within the Grand Junction service area are projected to cause an increase in demand that will exceed the Kannah Creek firm yield, making the Gunnison River pipeline an important component in the Grand Junction system.

5. CONCLUSIONS

Based on our review of available information, DiNatale Water Consultants finds that the City of Grand Junction can and will put to beneficial use the entire 120 cfs of the Gunnison River Pipeline Right originally decreed in CA8303 based on the following:

- Future population increase projected through 2069 will approximately double within the Grand Junction Utility water service area resulting in increased water demands. Population increases will occur primarily through ongoing infill development and higher density development within the service area.
- As potable demands increase, use of the Gunnison River Pipeline water right for non-potable water will become an increasingly viable option.
- Demands in the Kannah Creek water service area will increase resulting in less Kannah Creek water available to the primary service area.
- Interconnect agreements with Clifton and Ute Water may place high demands on the Grand Junction system in the event of an emergency.
- The Gunnison River Pipeline water right is decreed for use within the entire City of Grand Junction and is not limited to the Grand Junction Utility water service area.
- The city is evaluating options to use stored Gunnison River Pipeline right water to meet non-potable uses or as a means to protect the city from potential future Colorado River Compact calls.

In addition to these reasons that show Grand Junction can and will use the Gunnison River Pipeline right, during the diligence period the city has diligently pursued completion of the appropriation through the following:

- Multiple investments in the integrated water system into which the Gunnison River Pipeline right can be delivered
- Studies and modeling regarding the city's water resources and firm yield of water rights from the Kannah Creek watershed
- This water supply analysis
- Participation in a USBR water marketing grant program
- Initial evaluation of potential uses of storage of the Gunnison River Pipeline right

Therefore, DiNatale Water finds that Grand Junction has met its burden to demonstrate it can and will develop the Gunnison River Pipeline water right and that it has been diligent in its efforts to complete the appropriation.

Options Assessment for the City of Grand Junction Water Supply

City of Grand Junction, CO

July 7, 2020

Project No. 117086

Revision 6

Options Assessment for the City of Grand Junction Water Supply

Prepared for

City of Grand Junction

Grand Junction, CO

Project No. 117086

Revision 6

7/7/2020

Prepared by

Burns & McDonnell Engineering Company, Inc.

Centennial, Colorado

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ABBREVIATIONS

Abbreviation	Term/Phrase/Name
AACE	Association of Advancement of Cost Engineering
AF	Acre Feet
BMcD	Burns & McDonnell Engineering Company, Inc.
CDPHE	Colorado Department of Public Health and Environment
cfs	Cubic Feet Per Second
CCS	Corrosion Control Study
CCT	Corrosion Control Treatment
City	City of Grand Junction
Clifton	Clifton Water District
EOPCC	Engineer's Opinion of Probable Construction Cost
gpcd	Gallons Per Capita Per Day
gpm	Gallons Per Minute
GRPS	Gunnison River Pump Station
HGL	Hydraulic Grade Line
IFC	International Fire Code
KCFL	Kannah Creek Flow Line
kWH	Kilowatt Hour
MCL	Maximum Contaminant Level
MF	Microfiltration, Membrane Filtration
mgd	Million Gallons Per Day
mg/L	Milligrams Per Liter
NF	Nanofiltration
NTU	Nephelometric Turbidity Unit
PS3	Reservoir 3 Pump Station
PMFL	Purdy Mesa Flow Line
PRV	Pressure Reducing Valve
RO	Reverse Osmosis
TDS	Total Dissolved Solids
Ute	Ute Water Conservancy District
WTP	Water Treatment Plant
ZOP	Zinc Orthophosphate

1 EXECUTIVE SUMMARY

The City of Grand Junction (City) provides potable water to its customers from its existing water treatment facility (WTP) at 244 26 1/4 Road, Grand Junction, Colorado. The primary source of raw water for the WTP is the Juniata Reservoir on the Grand Mesa through the Purdy Mesa flow line (PMFL). The Kannah Creek flow line (KCFL) runs parallel to the PMFL as a secondary supply from the Kannah Creek, also on the Grand Mesa. The KCFL experienced a series of several breaks in 2019 and is not capable of providing peak day demands.

The City contracted with Burns & McDonnell Engineering Company, Inc. (BMcD) to investigate the feasibility of alternative water supplies in the event that the PMFL is not available. The PMFL and KCFL both draw from mountain sources on the Grand Mesa. The City also has water rights to the Colorado and Gunnison Rivers, as well as an interconnection agreement with Clifton Water District. The Ute Water Conservancy District (Ute) distribution system surrounds the City with several interconnections, but there is no formal agreement.

Fourteen options were identified by the Project Team:

1. Treat Gunnison River by Lime Softening
2. Treat Gunnison River by Reverse Osmosis
3. Settle Gunnison River in the Existing Raw Water Reservoirs and Blend with Clifton
4. Settle Gunnison River in the Existing Raw Water Reservoirs and Use for Raw Water
5. Replace KCFL (24 inch)
6. Replace KCFL (20 inch)
7. Replace KCFL (24 inch) and Add Turbine
8. New WTP in Kannah Creek Watershed and Replace KCFL
9. Clifton Water Emergency Interconnect
10. Transfer Colorado River Rights to Clifton for Treatment (Full Expansion, 24 inch pipeline)
11. Transfer Colorado River Rights to Clifton for Treatment (Partial Expansion, 20 inch pipeline)
12. Route Gunnison to Clifton WTP from Current Intake
13. Purchase Treated Water from Ute (Breakpoint Chlorination)
14. Purchase Treated Water from Ute (Chloramine Conversion)

Conceptual designs were developed for each of the options to create planning-level engineer's opinion of probable construction cost (EOPCC). Estimates of operating costs were compared to purchase costs for each of the identified Options.

The analysis identified that an interconnection between the PMFL and KCFL at the Juniata Reservoir would improve redundancy by directing flow from the Juniata Reservoir and the Kannah Creek watersheds into either flowline.

The Project Team developed and evaluated the Options through a series of meetings, culminating in a Selection Workshop in January 2020. Three additional Options were added in April 2020 following a meeting with key stakeholders from the City. The Options were then re-ranked. Qualitative, non-monetary selection criteria were used to score each option, weight the criteria, rank and calculate the cost/benefit of each Option.

The Options receiving the highest weighted scores were:

1. Option 5 – Replace KCFL (24-inch)
2. Option 6 – Replace KCFL (20-inch)
3. Option 14 – Purchase Treated Water from Ute (Chloramine Conversion)
4. Option 13 – Purchase Treated Water from Ute (Breakpoint Chlorination)

The scoring indicates two types of projects will provide benefit to the City, but the nature of their benefit varies. The KCFL options provide multiple ways to access the full water rights from the Purdy Mesa. This prioritizes operational redundancy. However, the KCFL options do not provide long term resiliency for the City as a source interruption would leave the City without a water supply. In this case, the City has the option to pursue either interconnects with Clifton or Ute. The two Ute options scored higher as a mountain source with minimal capital improvements required.

2 BACKGROUND

2.1 Project Objective

The City provides potable water to its customers from its existing WTP at 244 26 1/4 Road, Grand Junction, Colorado. The primary source of raw water for the WTP is the Juniata Reservoir on Purdy Mesa through the PMFL. The KCFL runs parallel to the PMFL as a secondary supply. The KCFL experienced a series of several breaks in 2019 and is not capable of providing peak day demands.

The City contracted with BMcD to investigate the feasibility of alternative water supplies in the event that the PMFL is not available. The PMFL and KCFL both draw from the same mountain sources on the Grand Mesa. The City also has water rights to the Colorado and Gunnison Rivers, as well as an interconnection agreement with Clifton. The Ute Water Conservancy District surrounds the City and is an additional source, however, the City does not have an interconnection with Ute.

This study identifies the available water sources for the City and evaluates the associated infrastructure required to supply future peak day demands as an alternate supply to the PMFL. This study considers both redundancy (ability to provide peak day flow) and resiliency (ability to draw from alternative source waters). Monetary and non-monetary factors were used to score and rank the identified Options.

The conceptual design of the preferred option is not included in this study.

2.2 Water Sources

The following water sources are available to the City:

1. **Purdy Mesa –** The PMFL draws raw water from the Juniata Reservoir on the Grand Mesa. This high quality mountain source is the primary raw water supply for the City. The PMFL consists of approximately 18.2 miles of 18-inch steel, 20-inch steel and PVC and 24-inch PVC diameter gravity transmission main. Upgrades are proposed to replace sections that were at the end of their useful life as well as upsizing segments to 20-inch diameter to reduce air entrainment. Water rights for the PMFL are 7,459 acre-feet (AF). The 20-inch gravity transmission main has a hydraulic capacity of 9.8 mgd [1]. The existing Kannah Creek WTP draws water from both the Juniata and Hallenbeck Reservoirs to serve customers on the Kannah Creek basin. The Kannah Creek WTP has an approximate capacity of 200 gallons per minute (0.3 million gallons per day, mgd) and does not send water to the City's WTP.

2. **Kannah Creek –** The KCFL draws raw water from Kannah Creek at the City Intake, approximately 4-miles upstream from the Juniata Reservoir. The KCFL provides additional raw water to the City during the peak summer season and acts as a backup pipeline to the PMFL. During winter, the KCFL is only used to transfer water from the Kannah Creek watershed into the Juniata Reservoir. The City has 7.81 cubic feet per second (cfs) (5 mgd) of paramount water rights from Kannah Creek. The City may access an additional 3.91 cfs (2.5 mgd) of winter water rights when available. The Kannah Creek watershed can deliver up to 6,275 AF[2]. The KCFL is approximately 20-miles of 18-inch cast iron and 20-inch steel gravity transmission main. City operations limit the flow to less than 2 mgd to minimize stress on the pipeline. Extensive repairs are required on the KCFL to provide critical redundancy.

[1] Black & Veatch, Project 197600, February 2018, Draft Purdy Mesa Flow Line Hydraulic Evaluation
[2] DiNatale Water Consultants, July 9, 2019, Memorandum, Water Supply Analysis in support of a finding of diligence for the Gunnison River Pipeline Water Right

3. **Gunnison River –** The City has 120 cfs of water rights to the Gunnison River that are not being utilized (18.6 cfs absolute and 101.4 cfs conditional). The Gunnison River is a river source of variable quality, subject to swings in turbidity and has high levels of total dissolved solids (TDS). The existing water treatment plant (WTP) is not capable of treating the Gunnison River without modifications to their treatment process. The City used the Gunnison River source in the past to augment peak summer demands by blending with the Grand Mesa sources in the existing Reservoirs 3 and 4. Recent peak day demands have been met by the PMFL, making it unnecessary to use the Gunnison River source. The existing Gunnison River Pump Station (GRPS) is in poor condition with only one pump operational and is located in the flood plain. The GRPS is now only exercised periodically, with raw water blended in Reservoirs 3 and 4. The GRPS pumping capacity is approximately 6 mgd.

4. **Colorado River** – The City owns 80 cfs of water rights to the Colorado River that are not being utilized. This right was originally 120 cfs, but subsequent diligence proceedings have reduced the City's right to 80 cfs, with 20 cfs going to the Clifton and 20 cfs to the Water Development Group. The City does not have any active infrastructure to use the Colorado River source.

5. **Clifton Water District –** The City has an agreement with Clifton for seasonal water exchange. The 1998 amendment allows Clifton to supply the City with up to 250 million gallons between April and September each year (1.4 mgd average). The amendment states that the City will supply Clifton with up to 250 million gallons per day between October and March. The agreement has informally expanded over the years to allow the City to take up to 4.5 mgd of treated water from Clifton in emergency situations. Clifton treats a mix of Grand Mesa and Colorado River at its 12 mgd capacity WTP. The interconnection with Clifton is located on 29 Road, north of D Road. Water main breaks in 2019 required the City to use the Clifton interconnection. Maximum day flows up to 5.5 mgd were sustainable through the existing interconnection.

6. **Ute Water Conservancy District** – The Ute water distribution system surrounds the City's distribution system to the west, north and east, with eight points of interconnection. Ute supplies water to some customers in the municipal boundary of the City. There is no formal agreement between the City and Ute for water supply. However, there is a verbal agreement for supply in emergency conditions. The raw water source for Ute is the Plateau Creek, which is considered a high quality mountain source. Ute uses chloramines for disinfection, which are not compatible with the City's use of free chlorine. Blending of the two waters would require additional treatment.

The locations of the water sources are illustrated in Figure 1.

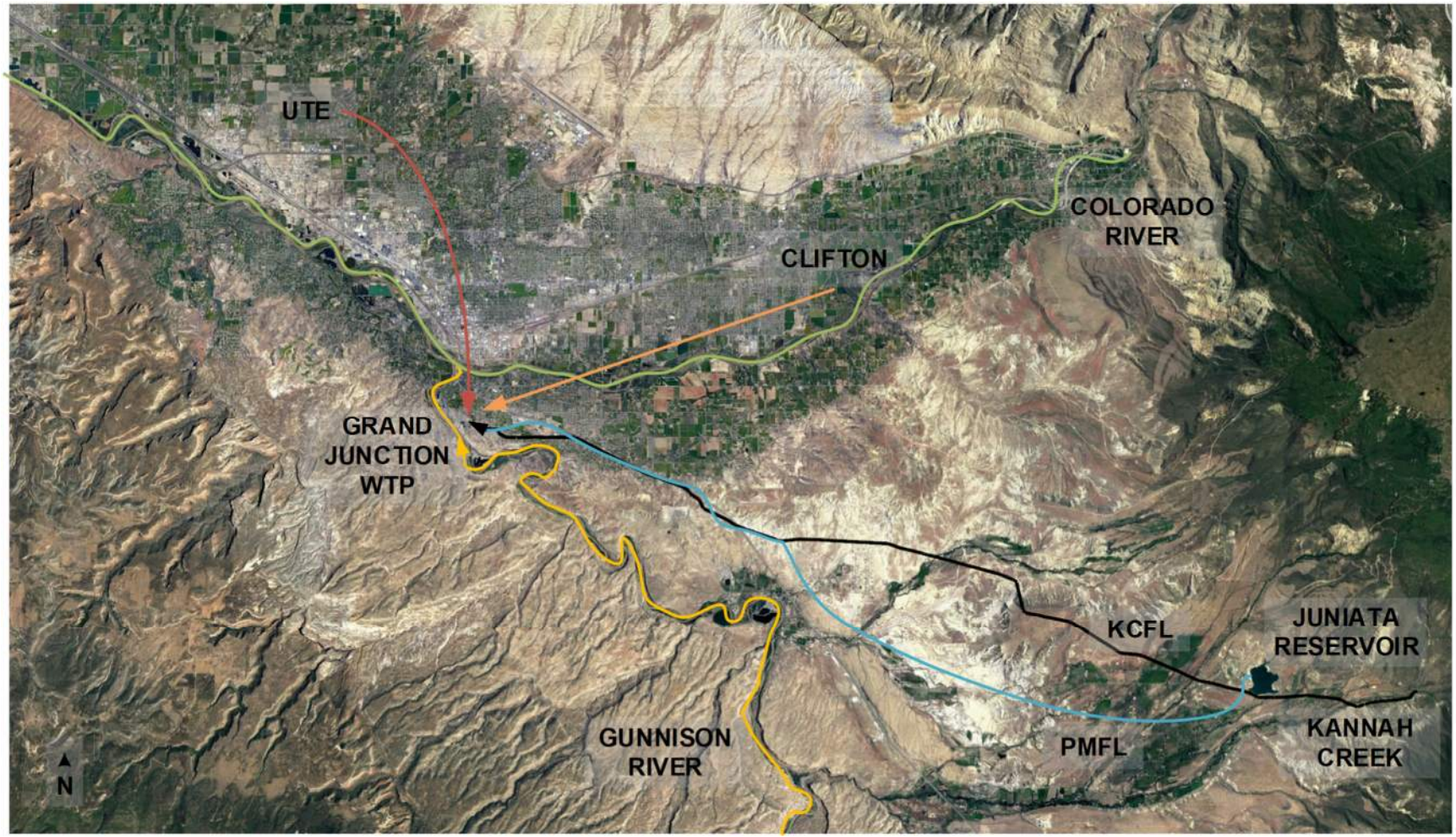

Figure 1: Map of Potential Sources for All Options

The City's available water sources are summarized in Table 1.

Table 1: Raw Water Source Summary

Source	Type	Water Rights	Current Capacity
Juniata Reservoir	Raw	7,459 AF	9.7 mgd (PMFL at 20-inch)
Kannah Creek	Raw	7.81 cfs (5 mgd) summer 11.72 cfs (7.5 mgd) winter	2 mgd[1]
Gunnison River	Raw	18.6 cfs[2] (12 MGD)	6 mgd[3]
Colorado River	Raw	80 cfs[4]	N/A
Clifton Water District[5]	Treated	4.5 mgd	5.5 mgd
Ute Water Conservancy District[6]	Treated	---	---

[1] KCFL capacity restricted by City's operations staff due to history of recent breaks, air entrainment
[2] 18.6 cfs absolute and 101.4 cfs conditional on availability (120 cfs total)
[3] Gunnison River capacity is limited by the condition and size of the existing pumps and electrical systems at the Gunnison River Pump Station
[4] Originally 120 cfs, transferred 20 cfs to Clifton and 20 cfs to Rifle
[5] The City and Clifton have an emergency interconnection agreement allowing 250 million gallons between April and September at no cost to City. Water rights are based on current agreement. Current capacity is based on the max peak daily flow through the interconnect in the summer of 2019.
[6] The City has eight emergency interconnects with the Ute but no formal interconnection agreement.

Table 2 compares the water quality of the raw water sources considered in this study.

Table 2: Raw Water Quality Comparison for Average and Maximum

Parameter	Juniata Reservoir[7] (Avg./Max.)	Kannah Creek[8] (Avg./Max.)	Gunnison River[9] (Avg./Max.)	Colorado River (Avg./Max.)
pH	7.9/8.0	8.2/8.6	8.4/8.8	8.01/8.53
Alkalinity (mg/L as $CaCO_3$)	81/83	64/91	137/188	143/260
Hardness (mg/L as $CaCO_3$)	92/95	66/90	339/492	218/316
TDS (mg/L)	86/119	62/122	530/778	517/865
Turbidity (NTU)	2.5/2.7	3.8/11.6	66/560	Unavailable
TOC (mg/L)	Unavailable	2.0/2.3	3.4/5.1	2.86/10
Fluoride (mg/L)	0.13/0.14	0.11/0.18	0.4/0.5	0.25/0.42
Chloride (mg/L)	1.0/1.1	0.42/0.75	6.5/10.6	170/408
Calcium (mg/L)	Unavailable	Unavailable	90.6/135	161/246
Sulfate (mg/L)	18.8/20.0	3.0/6.6	256/401	125/243
Selenium (mg/L)	Unavailable	Unavailable	3.4/6.5	Unavailable

[7] Source - City (based on 2016-2018 averages, unknown number of data points)
[8] Source - City (10-15 data points)
[9] Source - USGS 09152500 Gunnison River near Grand Junction, CO (38-44 data points)

2.3 Existing Water Treatment Plant

The City provides up to 9.8 mgd (peak day demand) of treated water to its and customers from its existing WTP. The rated capacity of the WTP is 16 mgd.

The WTP uses a conventional direct filtration process as shown in Figure 2. Raw water from the PMFL and KCFL enters at the Raw Water Control Vault, where it can be sent to either the contact basin or Reservoir 4. PMFL and KCFL raw water is sent to Reservoir 4 and/or Reservoir 3 during periods of poor water quality for pre-sedimentation. Water from Reservoirs 3 and 4 is recycled back to the Raw Water Control Vault from the existing Reservoir 3 Pump Station (PS3).

Raw water flows through the baffled contact basin before the gravity media filters. Filtered water flows by gravity to two 4 million gallon ground storage tanks and onto the distriubtion system. On-site sodium hypochlorite generation is used for disinfection. Backwash waste is sent to Reservoir 4 for settling before being recycled back to the Raw Water Control Vault. Residuals are disposed in a monofill on site.

Raw water from the Gunnison River is pumped from an existing intake and pump station to the 8 mg Reservoir 4. Reservoir 4 supplies raw water to the Spy Glass subdivision for irrigation from a dedicated pump station. Reservoir 4 overflows into the 15 mg Reservoir 3 and is pumped back to the Raw Water Control vault from an existing PS3. Reservoir 3 is also used to direct raw water to the nearby cemetery and Las Colonias development for irrigation purposes.

The average finished water quality can be found in Table 3.

Table 3: WTP Finished Water Quality

Parameter	Average Value
pH	8
Alkalinity	80 mg/L (as $CaCO_3$)
Hardness	88 mg/L (as $CaCO_3$)
Turbidity	0.07 NTU
Total Dissolved Solids	110 mg/L
Fluoride	0.58 mg/L
Chloride	5.8 mg/L

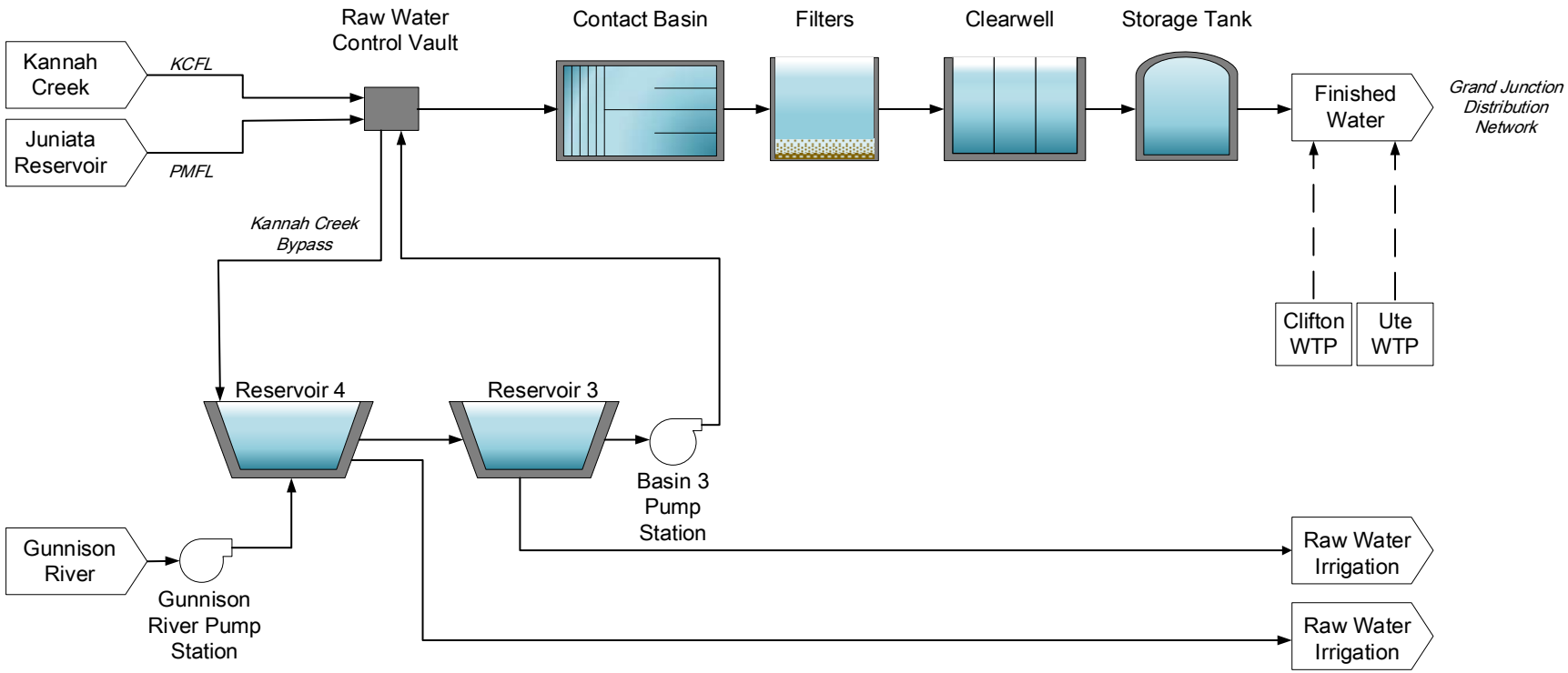

Figure 2: Existing WTP Process Flow Diagram

The City's raw water customers include the Spy Glass subdivision, the adjacent cemetery, and the City's Public Works Department for irrigation. The City has an agreement to supply the proposed and Las Colonias business park with raw water for its customers for irrigation, including a recreational amenity lake. Allocations for raw water customers are summarized in Table 4.

Table 4: Raw Water Irrigation Customer Summary

Customer	Average Flow (mgd)
Spy Glass Subdivision	0.4
Irrigation	1.0
Las Colonias	0.6
TOTAL	**2.0**

2.4 Future Water Demand

Future water demands were studied separately[3]. The future capacity of infrastructure for the purposes of this study is calculated as follows:

- Current conditions (2019):
  - Population of 29,500.
  - WTP annual production of 5,300 AF.
  - Average day demand 4.7 mgd.
  - Peak day demand 9.8 mgd.
  - Peaking factor of 2.07 (ratio of peak day to average day demand).
  - Residential demand of 88 gallons per capita per day (gpcd).

- Future conditions (2069):
  - Population of 49,000.
    - This City's Planning Department estimates an annual growth rate of 1.4%. However, the growth in the City's water service area is expected to be infill by nature, which is anticipated to result in a lower overall increase in population.
  - Population change of 19,400 .
  - Additional average day demand of 1.8 mgd (88 gpcd for new population of 19,400)
  - Future average day demand of 6.5 mgd (4.7 mgd current average day plus 1.8 mgd future average day)
  - Future peaking factor of 2.0.
    - The ratio of future peak to average day demand will be lower due to the infill nature, with less outdoor irrigation, fewer new parks, commercial or industrial users.
  - Peak day demand of 13.0 mgd.

Options considered in this study will be sized for a peak day demand of 13.0 mgd.

[3] Source – DiNatale Water Consultants, July 9, 2019, Memorandum, Water Supply Analysis in support of a finding of diligence for the Gunnison River Pipeline Water Right

2.5 Planning Goals

The options presented in the study are evaluated with their respect to their ability to provide operational redundancy, long term resiliency or both. For the purposes of discussion, the terms are defined as follows:

- **Operational Redundancy** – The ability to provide redundancy to the hydraulic capacity of the Purdy Mesa Flow Line, up to future peak day demands of 13 mgd.

- **Long Term Resiliency** – The ability to supply raw water from an alternative source in the event of a long term interruption to the City's primary source (Kannah Creek watershed and the Juniata Reservoir).

2.5.1 Operational Redundancy

This study considers which available water source has the ability to provide operational redundancy to the PMFL. The options are sized for 13 mgd future peak day demands if the PMFL is offline. PMFL outages are defined as short term events due to line breaks or periodic maintenance. Short term outages are expected to be corrected within five days.

It is anticipated that the City staff is able to repair line breaks on the PMFL within five days. The existing raw water Reservoirs 3 and 4 have up to 23 mg of storage that is available to the WTP from PS3 during short term outages (approximately 5 days of storage at current average day demands). The raw water stored in Reservoirs 3 and 4 is also available to augment flows to the WTP for Options that do not provide the future peak day demand of 13 mgd.

The KCFL provides redundancy to the PMFL from the upper Kannah Creek watershed. However, the existing KCFL is limited to only 2 mgd to limit stress on the pipeline and air entrainment. An Option considering the replacement of the KCFL will need to be sized for 13 mgd if a truly redundant pipeline is desired. However, this will require a new connection from Juniata Reservoir to the KCFL to augment KCFL flows due to the seasonal water rights from Kannah Creek (5 mgd summer and up to 7.5 mgd in the winter, when available). The redundancy provided by a replaced KCFL is only available if the Juniata Reservoir and the Kannah Creek watershed are not impacted by the same event preventing the use of the PMFL.

The City may use their existing Clifton interconnection (5.5 mgd capacity) to augment any treated water flows that the WTP is not able to produce. The use of Clifton treated water also allows the City to reserve its Grand Mesa water allocation (Juniata Reservoir and Kannah Creek), while utilizing their Colorado River rights through a water rights transfer. This is discussed in more detail in Option 10.

2.5.2 Long Term Resiliency

Long term resiliency is necessary for outages that impact the source availability of the Juniata Reservoir and the Kannah Creek watershed. A redundant pipeline to the Grand Mesa will not resolve water supply issues if the Juniata Reservoir and Kannah Creek watershed are impacted as a whole.

Events that may impact the availability of the KC watershed include runoff from wildfire, algae blooms, or drought. These events are expected to be longer term in nature and could last for a period of a few

weeks to several months. Resiliency options including those drawing from alternate sources than the Grand Mesa – Gunnison River, Colorado River. or the Plateau Creek watershed (Ute).

2.6 Corrosion Control Study

Corrosion control studies (CCS) are required by both the Colorado Department of Public Health and Environment (CDPHE) and the Environmental Protection Agency's Lead and Copper Rule to evaluate and determine the optimal corrosion control treatment (CCT) for a water system. Usually a CCS is required to obtain an "optimized" designation for either an action level exceedance of lead or copper or treatment changes expected to affect corrosivity.

The City has had no action level exceedances that would normally trigger a CCS. However, a CCS is required if there is a change of the raw water source. A CCS would review the current treatment process and review other potential CCT's to comply with CDPHE and EPA requirements.

Lead and Copper Rule requirements state that a single CCT must be used at all treatment sites. Therefore, the optimal CCT for the City's entire water system must be identified from a holistic view of the City's distribution system, The optimal CCT is not for individual treatment sites and must include other finished water entry points (e.g. Clifton or Ute interconnections, if used).

Potential CCT for the City may include zinc orthophosphate (ZOP) addition, alkalinity adjustment, pH adjustment or calcium hardness adjustment. The effectiveness of CCT options must be studied over a range of conditions and water quality parameters.

This study assumes the implementation of a ZOP as the optimal CCT, which requires the City to add the corrosion control chemical at the WTP or other finished water entry points. Implementing ZOP would require the addition of chemical feed and storage equipment in a new building. Additionally, the City must consider the potential impacts ZOP will have on the Persigo Wastewater Treatment Plant, which will be subject to low phosphorous limits in the future. The implementation of ZOP could result in a significant rise in treatment costs for the Wastewater Treatment Plant.

A CCS is not part of this study but is recommended if there is a change to the City's raw water source.

3 OPTION DESCRIPTIONS

The Project Team identified the following options for providing redundancy to the PMFL, as well as resiliency to the Purdy raw water source. Table 5 lists the options that were developed as part of this study.

Table 5: Summary of Options

#	Option
1	Treat Gunnison River by Lime Softening
2	Treat Gunnison River by Reverse Osmosis
3	Settle Gunnison River in Existing Reservoirs and Blend with Clifton
4	Settle Gunnison River in Existing Reservoirs and Use for Raw Water
5	Replace Kannah Creek Flow Line (24 inch)
6	Replace Kannah Creek Flow Line (20 inch)
7	Replace Kannah Creek Flow Line (24 inch) and Add Turbine
8	New WTP in Kannah Creek Watershed
9	Clifton Water Emergency Interconnect
10	Transfer Colorado River Rights to Clifton for Treatment (Full Expansion, 24 inch pipeline)
11	Transfer Colorado River Rights to Clifton for Treatment (Partial Expansion, 20 inch pipeline)
12	Route Gunnison to Clifton WTP from Current Intake
13	Purchase Treated Water from Ute (Breakpoint Chlorination)
14	Purchase Treated Water from Ute (Chloramine Conversion)

The following sections provide a narrative of each option, list the assumptions made and present a process flow diagram.

Appendix A includes the detailed scope used to develop the EOPCC for each option.

Appendix B presents the EOPCC.

3.1 Option 1: Treat Gunnison River by Lime Softening

The City owns water rights to the Gunnison River that are not currently being utilized. The existing intake and Gunnison River Pump Station (GRPS) are only exercised periodically when raw water is sent to the WTP to blend with water in Reservoirs 3 and 4. Total dissolved solids (TDS) levels in the Gunnison River are above the secondary maximum contaminant level (MCL) of 500 mg/L. High TDS make the Gunnison River an undesirable water source, which necessitates additional treatment if used as a raw water source.

The existing intake will remain in service at its current location. The GRPS will be upgraded with new pumps, electrical and superstructure. Raw water from the Gunnison River will be pumped to Reservoir 4 to settle by gravity before it is sent to new lime softening clarifiers.

Lime softening by lime and/or soda ash addition will remove hardness by precipitation. Lime softening is assumed to the effective at reducing TDS because the Gunnison River TDS is dominated by calcium sulfate. A softened TDS goal of 200 mg/L was selected to produce water quality similar to that of Purdy Mesa. Lime silos and feed equipment, soda ash feed equipment, carbon dioxide feed equipment, solids handling and dewater systems will be included within the main building. Lime clarifiers and the chemical facilities will be located on City land to the north of Reservoir 3.

The existing Reservoir 3 Pump Station will be replaced with a new Filter Feed Pump Station to pump softened water to the existing WTP for filtration. All irrigation flows will also be routed from this pump station.

The softened Gunnison River source is significantly different in character from the current Purdy Mesa source. Therefore, a ZOP storage and dosing facility will be required on the finished at the WTP for corrosion control.

The following assumptions were used for this Option:

- Raw water source: Gunnison River via GRPS
- 13 mgd peak day demand
- KCFL will remain at current capacity as a partial backup for PMFL
- Reuse the existing intake and wet well for GRPS
- Reuse the existing pipeline from GRPS to Reservoir 3
- Lime softening process is able to reduce TDS to 200 mg/L, based on water dominated by calcium sulfate
- Lime softening effective at removing selenium present in Gunnison River
- Locate lime softening on City land north of Reservoir 3
- Treated water target to match that of Purdy Mesa (100 to 200 mg/L TDS)
- Turbidity: < 2 NTU

Figure 3 illustrates a conceptual process flow diagram for Option 1.

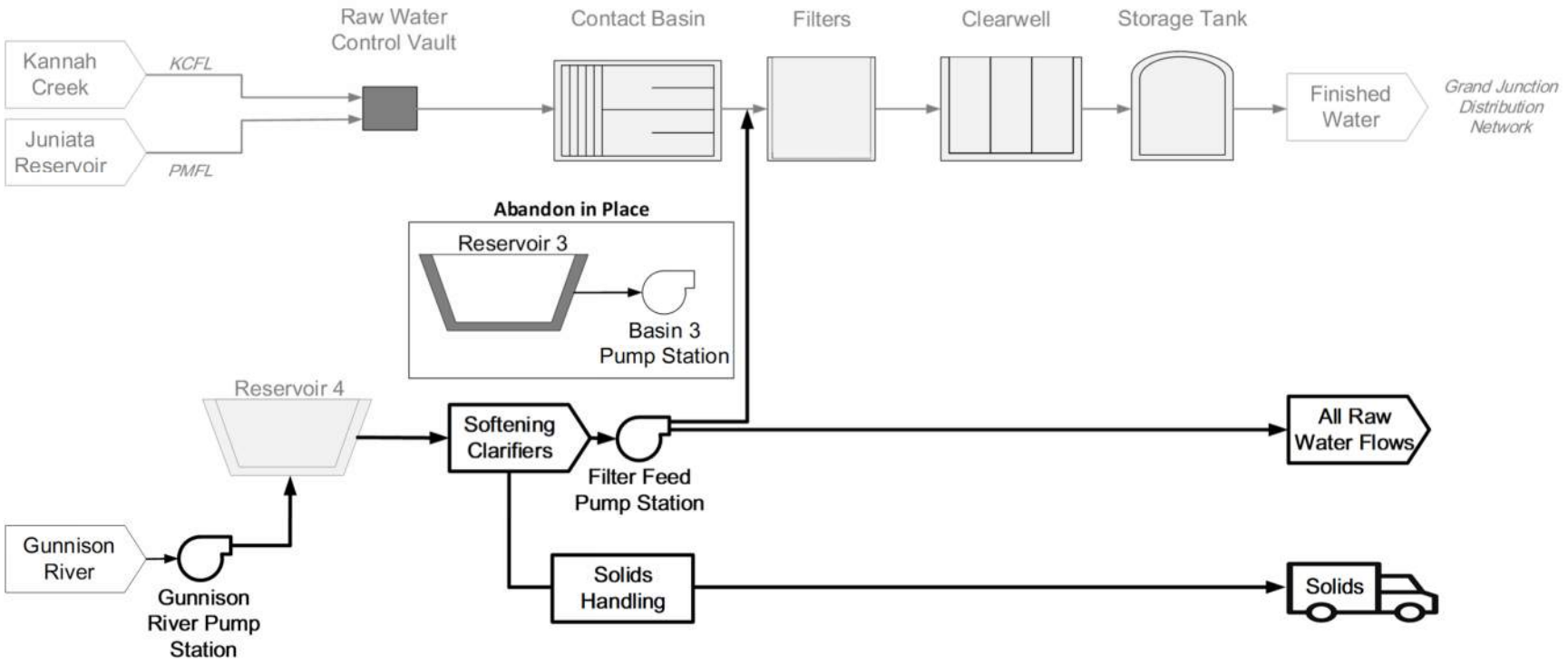

Figure 3: Process Flow Diagram for Option 1

3.2 Option 2: Treat Gunnison River by Reverse Osmosis

The high TDS of the Gunnison River may also be treated using nanofiltration (NF) or reverse osmosis (RO). A treatment goal of 100 to 200 mg/L TDS was selected to match the existing water quality supplied by the City from Purdy Mesa. This NF/RO process is similar to that used by Clifton on their Colorado River source.

The proposed treatment train consists of high pressure feed pumps, cartridge filters, RO skids, cleaning system, and chemical systems.

The existing intake will remain in service at its current location. The GRPS will be upgraded with new pumps, electrical and superstructure. Raw water from the Gunnison River will be pumped to Reservoir 4 to settle by gravity before it is sent to Reservoir 3. Reservoir 3 Pump Station pumps and electrical system will be upgraded. The settled Gunnison River water will be blended with the PMFL at the WTP contact basins and sent to filtration. A side stream flow of approximately 50% will be sent to NF/RO to remove TDS. NF/RO filtrate will be blended into the WTP filtered water to meet the TDS treatment goal.

The treated Gunnison River source is significantly different in character from the current Purdy Mesa source. Therefore, a ZOP storage and dosing facility will be required on the finished at the WTP for corrosion control.

Brine disposal is a challenge for RO facilities and will require negotiation with the CDPHE Water Quality Control Division. Disposal options include evaporation ponds, deep well injection, discharge to a wastewater treatment plant or discharge to surface water. Disposal by evaporation ponds will require a significant footprint larger than the City's existing WTP property. Therefore, deep well injection was assumed for this study because of the proximity of abandoned oil and gas wells and likelihood of CDPHE approval.

The following assumptions were used for this Option:

- Raw water source: Gunnison River via GRPS
- 13 mgd peak day demand
- KCFL will remain at current capacity as a potential backup for PMFL
- Reuse the existing intake and wet well for GRPS and PS3
- Reuse the existing pipeline from GRPS to Reservoir 3
- Locate the proposed RO system on open land to the south of the existing WTP
- Pretreatment turbidity goal: < 10 NTU
- Treated water target: < 100 mg/L TDS (to match existing source).
- Brine disposal using a high-pressure pump station and injected to four deep injection wells (10,000 to 15,000 feet).
- Suitable nearby candidates to locate and permit RO brine disposal by deep well injection

Figure 4 illustrates a conceptual process flow diagram for Option 2.

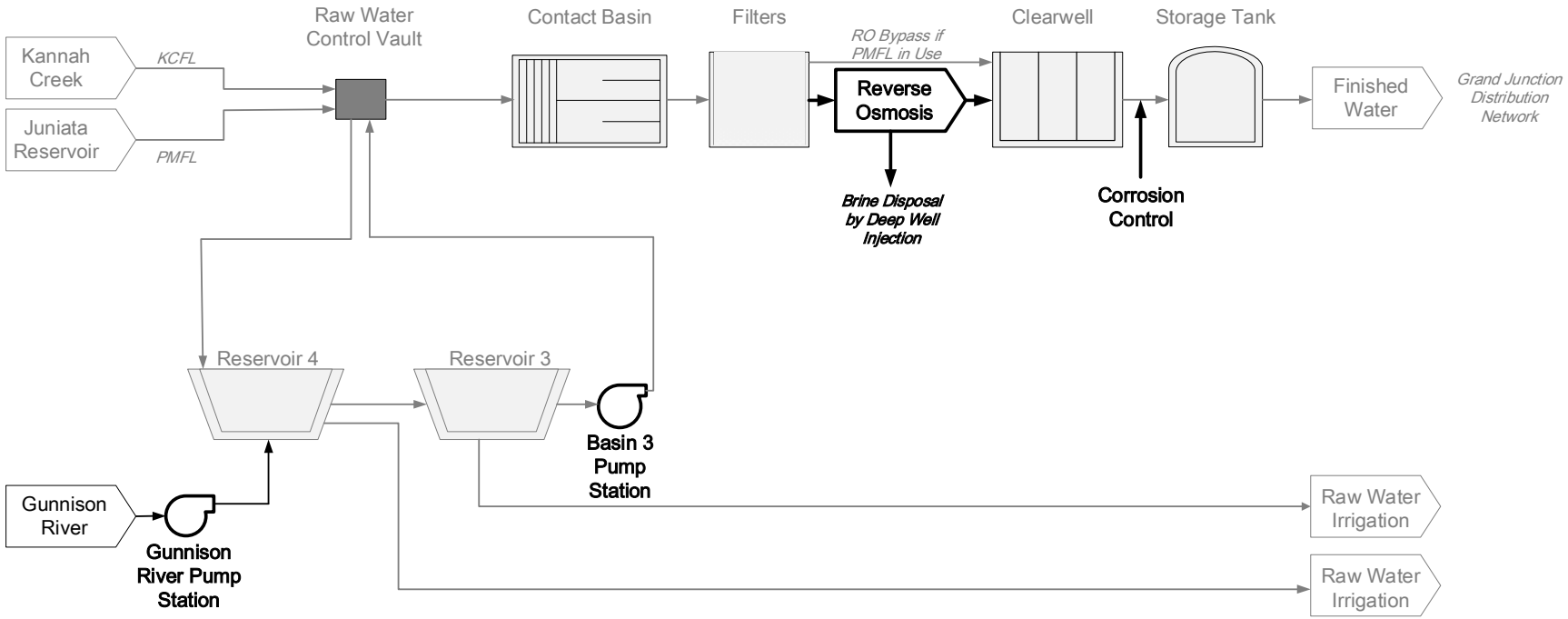

Figure 4: Process Flow Diagram for Option 2

3.3 Option 3: Settle Gunnison River in Existing Reservoirs and Blend with Clifton

This Option utilizes Gunnison River water rights by pumping to Reservoir 4 where major turbidity will be settled to less than 10 NTU. Settling in Reservoir 4 will be achieved by gravity with no mechanical modifications. Settled Gunnison River water will be pumped to the Raw Water Control Vault by a new PS3 and treated through the existing WTP.

This treatment will not impact the salinity or TDS of the water which is above the secondary maximum contaminant level (MCL) of 500 mg/L. Thus, settled water from Gunnison River will be blended with treated water from Clifton at the Raw Water Control Vault to meet the City's existing distribution system TDS. The blending of Clifton water to the Gunnison River is assumed at a 4:1 ratio to meet the finished water TDS goal.

The existing interconnection with Clifton is located on 29 Road, north of D Road. Maximum daily flows of up to 5.5 mgd were sustainable through the existing interconnection during emergency conditions in 2019. Clifton flows of 10.4 mgd are required to achieve peak day flows of 13 mgd at a 4:1 ratio with Gunnison River (2.6 mgd). The required Clifton flows of 10.4 mgd exceed the capacity of the existing interconnection. Therefore, a new pipeline will be required to bring from the Clifton WTP to the City's WTP.

The existing intake will remain in service at its current location. The GRPS will be upgraded with new pumps, electrical and superstructure . Raw water from the Gunnison River will be pumped to Reservoir 4 to settle by gravity before it is sent to the WTP from a new PS3. PS3 will be replaced due to its current condition, age, and lack of redundancy.

The treated Gunnison River source is significantly different in character from the current Purdy Mesa source. Therefore, a ZOP storage and dosing facility will be required on the finished at the WTP for corrosion control.

The following assumptions were used for this Option:

- Raw water source: Gunnison River via GRPS
- Blend with treated water from Clifton
- 13 mgd day demand
    - 2.6 mgd from Gunnison River
    - 10.4 mgd from Clifton
- KCFL will remain at current capacity as a potential backup for PMFL
- New 20-inch pipeline from Clifton to WTP (10.3 miles)
- Reuse intake and wet well for GRPS
- Reuse pipeline from GRPS to Reservoir 3
- Route GR flow to Reservoir 4 to settle by gravity
- Upgraded PS3
- Blend water 4:1
- Blending must occur before filters due to compliance point
- Turbidity: <10 NTU
- Total Dissolved Solids: 150-200 mg/L

Figure 5 below illustrates a conceptual process flow diagram for Option 3. Figure 6 shows a preliminary alignment of the pipeline from the Clifton WTP to the City's WTP.

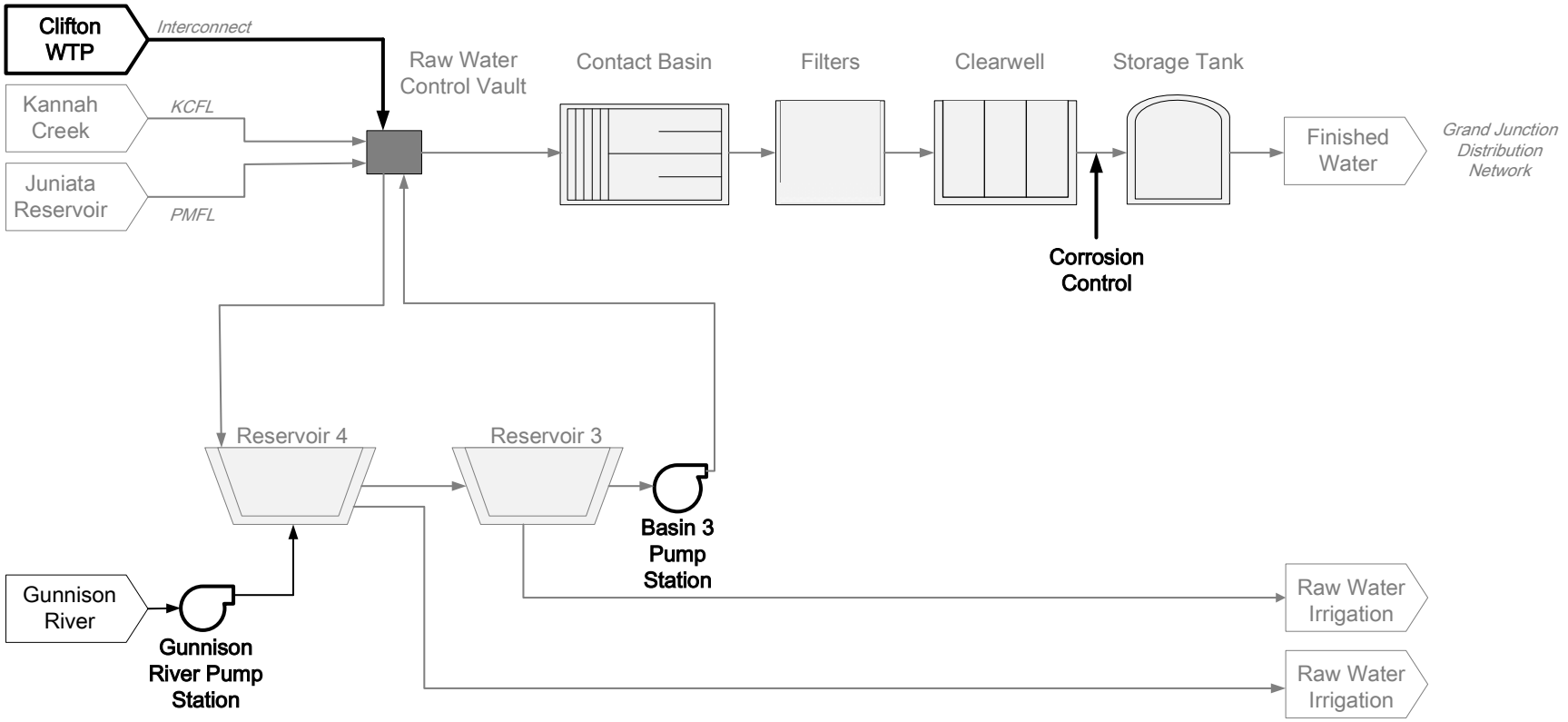

Figure 5: Process Flow Diagram for Option 3

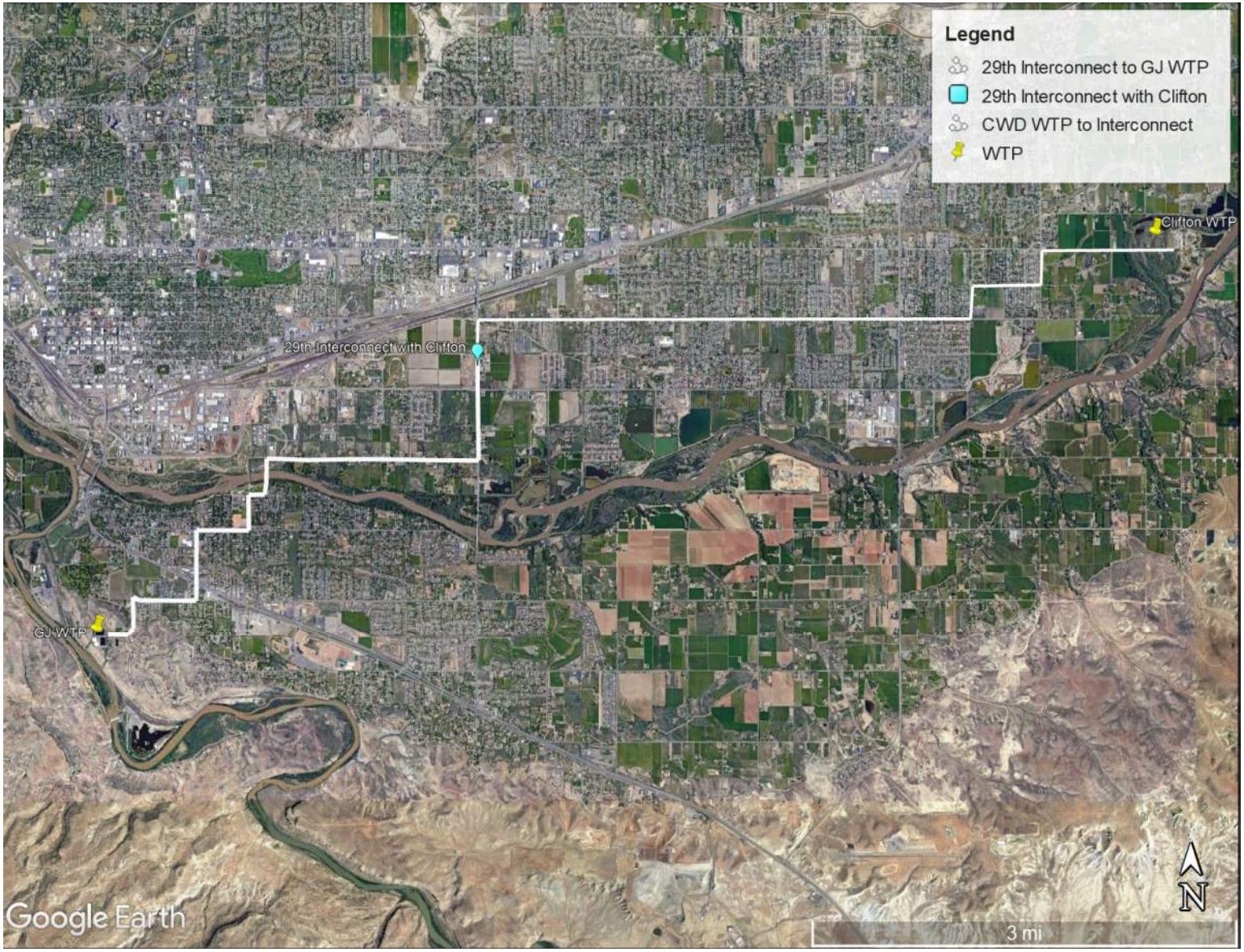

Figure 6: Preliminary Alignment for Pipeline from Clifton WTP to the City WTP

3.4 Option 4: Settle Gunnison River in Existing Reservoirs and Use for Raw Water Irrigation

This Option uses Gunnison River water rights by pumping to Reservoir 4 where major turbidity will be settled to less than 10 NTU. The Gunnison River will be used for all irrigation customers (Spy Glass Development, Las Colonias Industrial Park, and the cemetery). This reduces the total demand from the Grand Mesa source in the KCFL by dedicating all of the Kannah Creek flows for treatment at the WTP. The KCFL will be replaced but at a smaller diameter due to the 2 mgd of irrigation flows being supplied from the Gunnison River. KCFL replacement options are discussed in more detail in Option 6.

The existing intake will remain in service at its current location. The GRPS will be upgraded with new pumps, electrical and superstructure . Raw water from the Gunnison River will be pumped to Reservoir 4 to settle by gravity before it is sent to the irrigation customers. Reservoir 3 will remain as storage and settling reservoir for high turbidity events in both Grand Mesa sources.

Based on discussions with the City, this Option is not likely because the quality of settled Gunnison River water will not meet the water quality standards for the existing irrigation customers (high TDS).

The following assumptions were used for this Option:

- Raw water sources:
  - Gunnison River via GRPS
  - Kannah Creek via KCFL
- 11.7 mgd peak day flow
  - Gunnison River raw water at 2.0 mgd
  - Kannah Creek raw water of 9.7 mgd (20-inch KCFL replacement per Option 6)
- Reuse the existing intake and wet well for GRPS
- Reuse the existing pipeline from GRPS to Reservoir 3
- Route Gunnison River through Reservoir 4, settle by gravity to < 10 NTU
- Gunnison River only through Reservoirs 3 and 4 to raw water customers
- Customers do not require a higher level of treatment beyond removal of major turbidity

Figure 7 below illustrates a conceptual process flow diagram for Option 4. Figure 8 shows a preliminary alignment of the KCFL replacement.

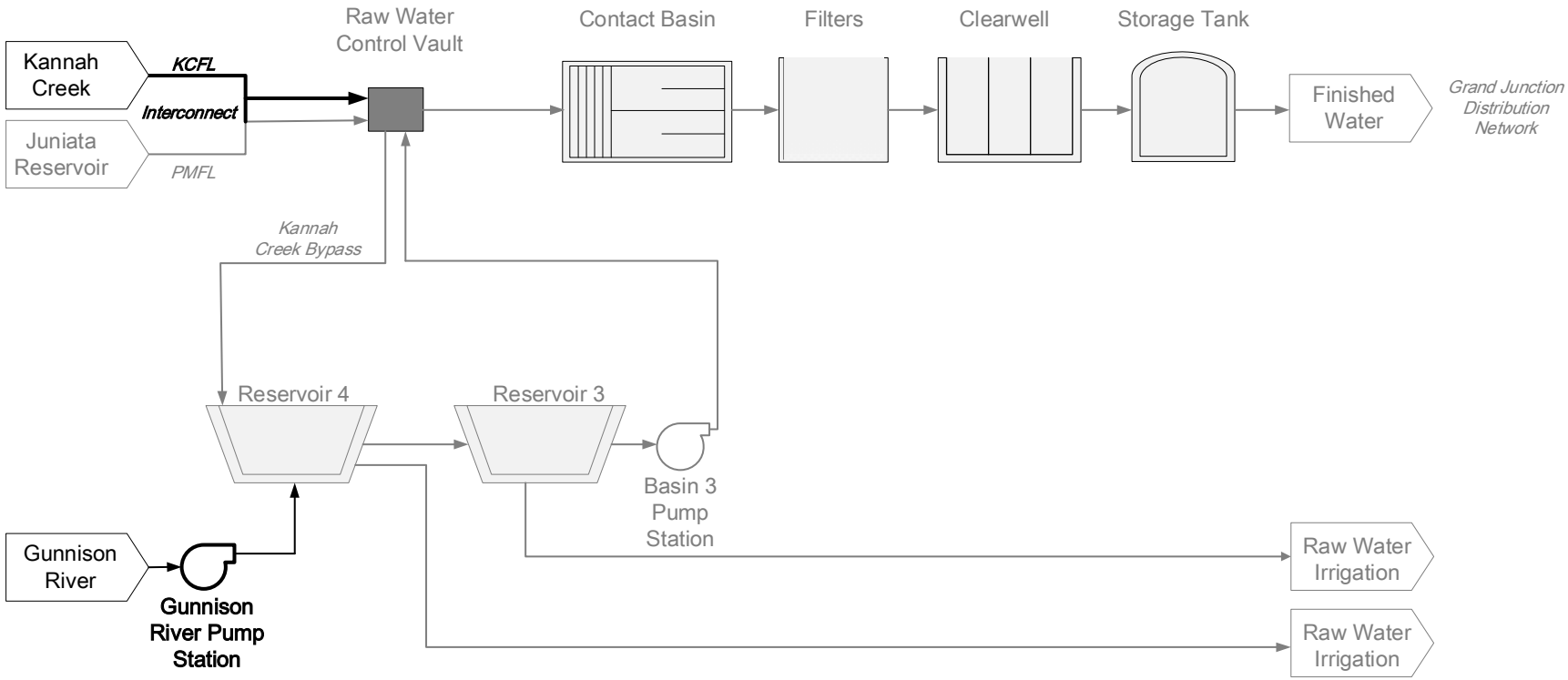

Figure 7: Process Flow Diagram for Option 4

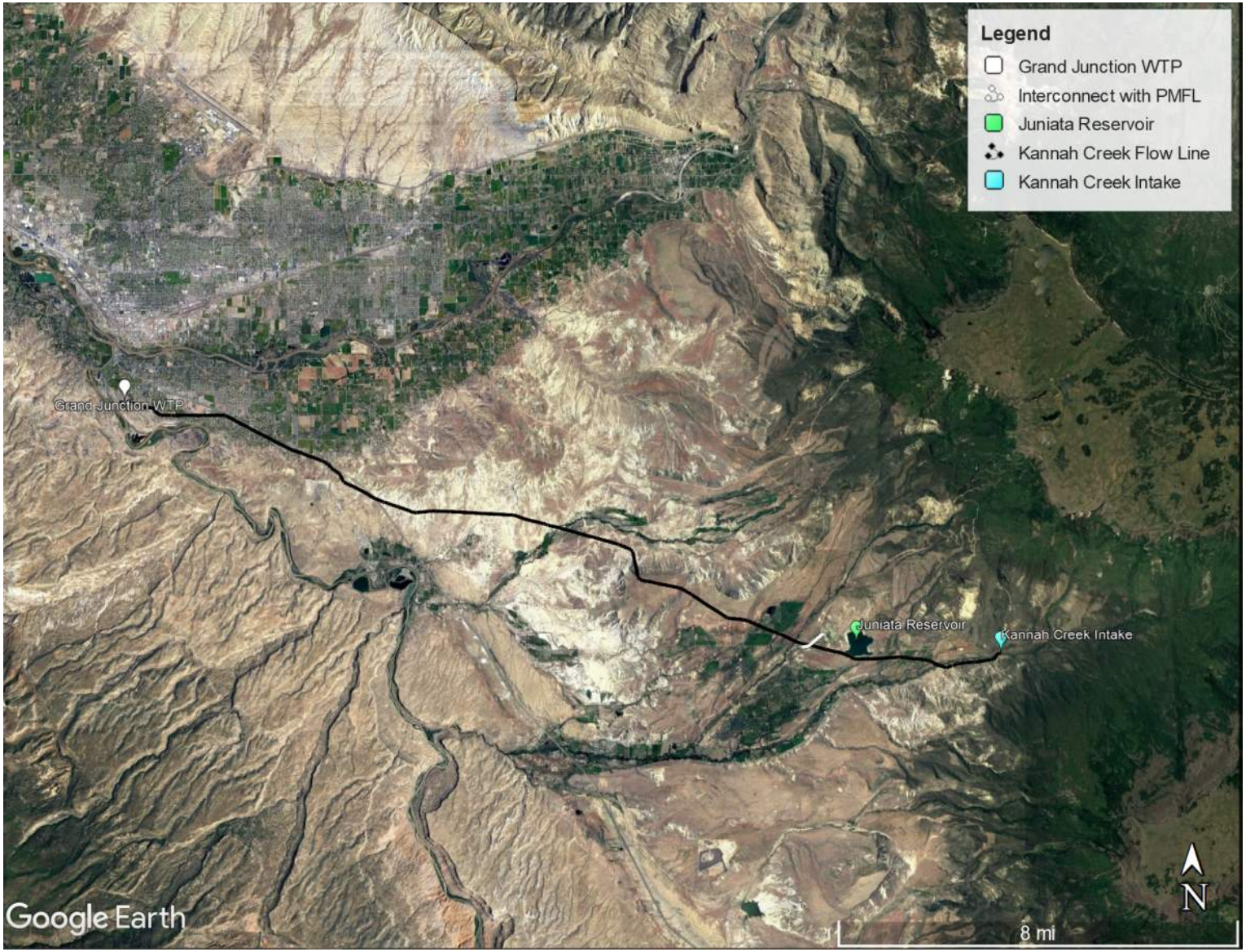

Figure 8: Preliminary Alignment for KCFL Replacement

3.5 Option 5: Replace Kannah Creek Flow Line (24 inch)

The KCFL draws raw water from Kannah Creek at the City intake, approximately 4-miles upstream from the Juniata Reservoir. The KCFL provides additional raw water to the City during the peak summer season and acts as a backup pipeline to the PMFL. During winter, the KCFL is only used to transfer water from the Kannah Creek watershed into the Juniata Reservoir.

The KCFL is approximately 20-miles of 18-inch cast iron and 20-inch steel gravity transmission main. Current City operations limit the flow to less than 2 mgd to minimize stress on the pipeline. Extensive repairs to the KCFL or a full replacement are required to provide critical redundancy.

The City has 7.81 cfs (5 mgd) of paramount water rights from Kannah Creek. The City may access an additional 3.91 cfs (2.5 mgd) of winter water rights when available. Modelling results indicate that the Kannah Creek watershed can deliver up to 6,275 AF annually, with approximately 350 AF dedicated to the Kannah Creek WTP and other non-potable uses.

An interconnect to the Juniata Reservoir is required to achieve fully redundant peak day flows to the KCFL. Juniata Reservoir water rights will augment the flow from Kannah Creek to provide peak day flow. The interconnection will allow flow from both Kannah Creek and Juniata Reservoir into either the PMFL or KCFL. The scope of the interconnection is discussed below (Section 3.5.1).

The City is planning on replacing the 4-miles of pipeline between Kannah Creek and Juniata Reservoir. Therefore, the scope of all KCFL options in this study is limited to the approximately 16-miles between Juniata Reservoir and the WTP.

Figure 9 shows the approximate pipeline elevation (blue), hydraulic grade line (red), static pressure (purple) and pipe pressure class (green). The hydraulic grade line must remain below the green line, representing the pipe pressure rating. The vertical drop in the red and purple lines represents the pressure drop at the proposed pressure reducing valve (PRV) chamber. The pipe pressure class, PRV setting, PRV location and diameter are optimized to prevent operating and static pressures from exceeding the pipe pressure class. Further optimization of pipe pressure class will occur during the concept design.

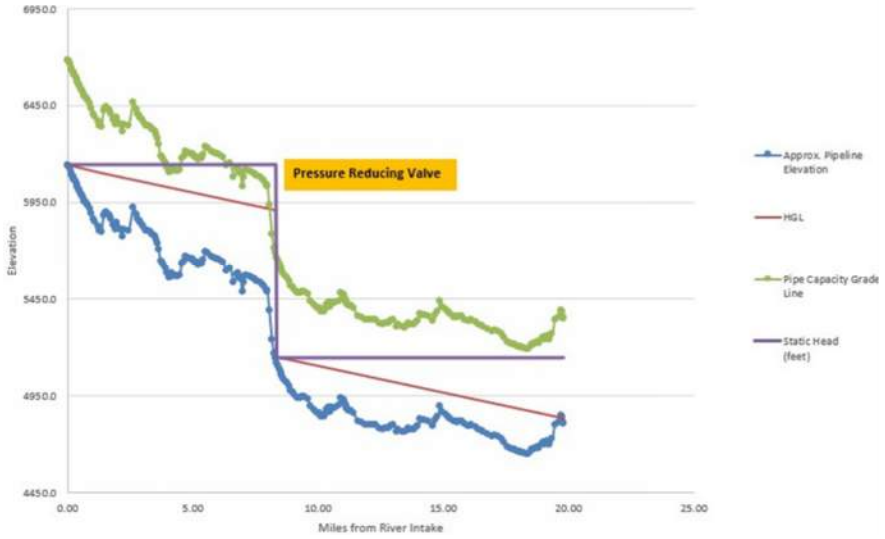

Figure 9: Hydraulic Profile of 24 inch KCFL Replacement (Option 5)

Option 5 at 24-inch diameter will convey up to 12.5 mgd. One pressure control valve is required (Figure 9). A new PRV chamber at the mesa will reduce pressures to less than the pipeline rating (235 psi). KCFL flow control will be relocated to the WTP with modulating a valve and flowmeter. KCFL flow control at Kannah Creek will be abandoned.

This Option does not change the WTP treatment processes. Kannah Creek will remain as the secondary raw water source to Purdy Mesa flow line. The Gunnison River will not be used.

The following assumptions were used for this Option:

- Raw water source:
  - Kannah Creek via KCFL
  - Augmented by Juniata Reservoir interconnection
- Capacity:
  - 12.5 mgd hydraulic capacity
    - Summer: 5 mgd from Kannah Creek plus 7.5 mgd from Juniata Reservoir
    - Winter: 7.5 mgd from Kannah Creek plus 5 mgd from Juniata Reservoir
- Add one pressure control chamber along KCFL
- Uppermost 4 miles of KCFL replacement outside scope of this project

This Option does not provide the future peak day flows of 13 mgd. Therefore, WTP flows must be augmented on peak demand days by raw water storage in Reservoirs 3 or 4 or existing distribution system storage. The interconnection with Clifton may also be used to meet peak daily flows greater than 12.5 mgd.

This Option does not provide access to an alternate water source than the PMFL.

Figure 10 below illustrates a conceptual process flow diagram for this Option. Figure 11 shows a preliminary alignment of the KCFL replacement.

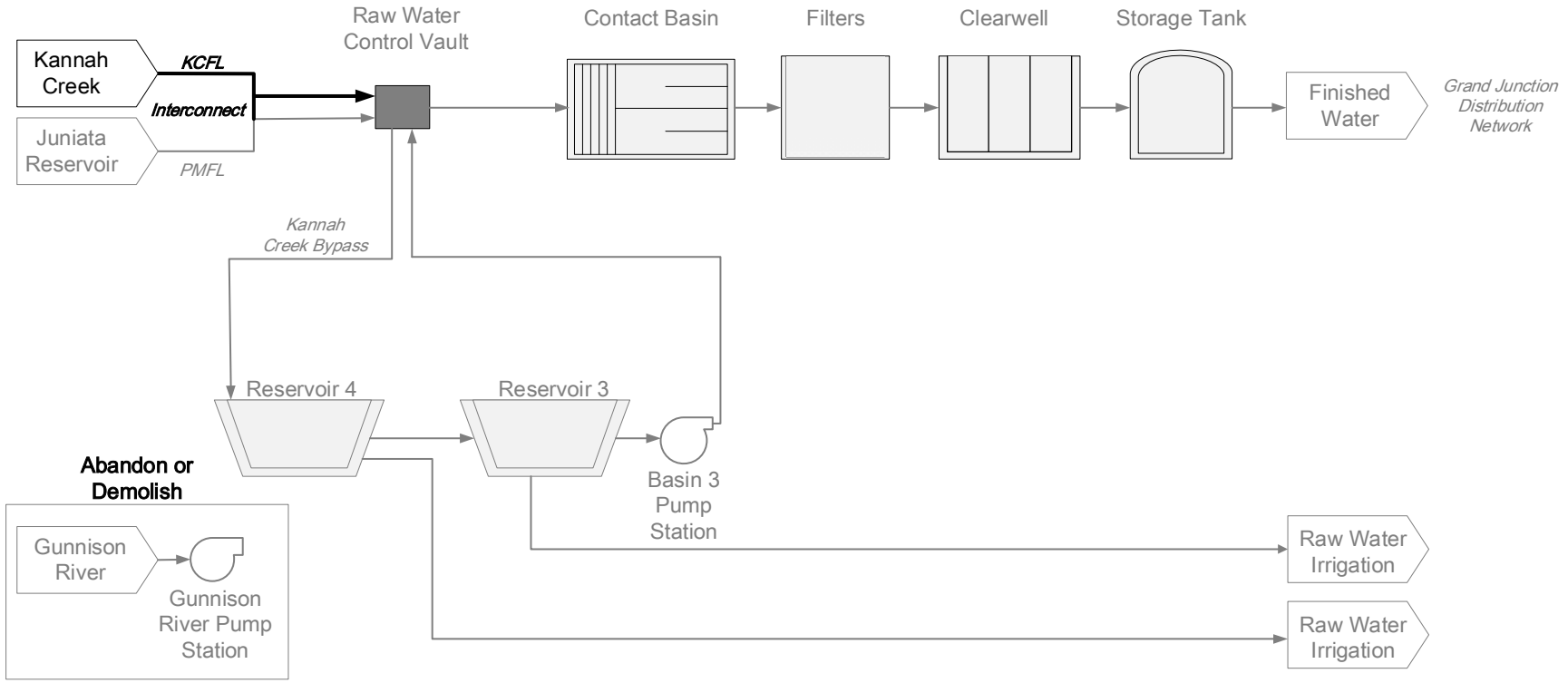

Figure 10: Process Flow Diagram for Option 5

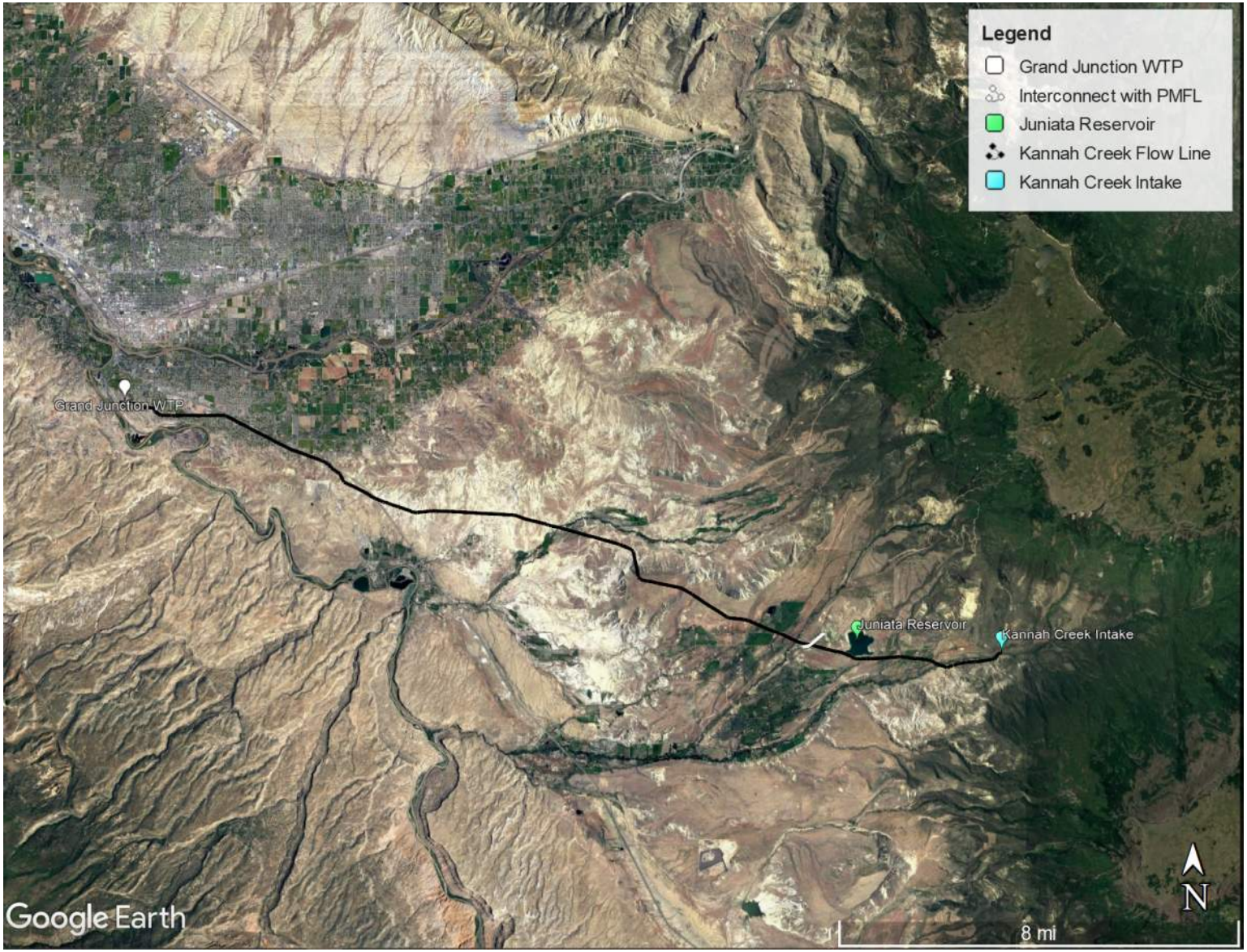

Figure 11: Preliminary Alignment for KCFL Replacement

3.5.1 Juniata Reservoir Interconnection

An interconnect to the Juniata Reservoir will be required to achieve fully redundant peak day flows to the KCFL. Juniata Reservoir water rights will augment the flow-limited, seasonal water rights from Kannah Creek to provide peak day flow. The interconnection will allow flows from both Kannah Creek and Juniata Reservoir into either the PMFL or KCFL. This improves the overall water system resiliency by allowing access to either the Juniata Reservoir or Kannah Creek watershed in either pipeline during periods of poor water quality, wildfire or algae blooms.

Control valves on the KCFL will direct flow from Kannah Creek water into the Juniata Reservoir. The existing outlet piping from Juniata Reservoir will then be sent to either the PMFL or the PMFL. Kannah Creek is at a higher elevation (approximately 6,130 feet) than Juniata Reservoir (approximately 5,760 feet). Therefore, flow control valves will isolate the portion of the KCFL upstream of the Juniata Reservoir. The interconnection will be sized to deliver the difference between the maximum hydraulic capacity of the KCFL and the seasonal water flows from Kannah Creek. The KCFL has a hydraulic capacity of 12.5 mgd at 24-inch diameter, resulting in an interconnection capacity of 7.5 mgd (5,200 gpm).

The proposed location of the Junita Reservoir Interconnection is shown in Figure 12.

Figure 12: Proposed Location of Juniata Reservoir Interconnection

Figure 13 shows a preliminary process flow diagram for the interconnection facility. The interconnection improvement is recommended regardless of which Option is selected. The interconnection will allow flows from both the Juniata Reservoir and Kannah Creek water sources through either pipeline.

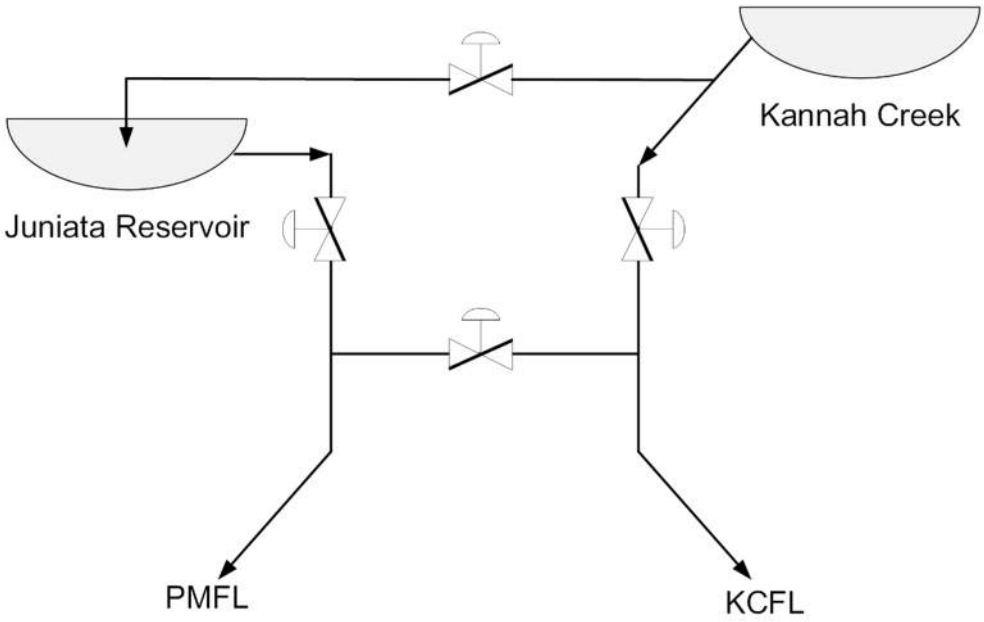

Figure 13: Process Flow Diagram for Juniata Reservoir Interconnection

3.6 Option 6: Replace Kannah Creek Flow Line (20 inch)

This Option includes the replacement of the KCFL at 20-inch diameter. Raw water is sourced from Kannah Creek, as described in Option 5. The Juniata Reservoir Interconnection (Section 3.5.1) will be required to achieve fully redundant raw water flows in either pipeline to the WTP from the Grand Mesa.

Reducing to 20-inch diameter will reduce the hydraulic capacity to 9.7 mgd. Two pressure control stations will be required. The operating pressure in the KCFL will be higher at 20-inch diameter, resulting in a higher pressure class pipe. The Option cost will be reduced at the smaller diameter KCFL.

Figure 14 shows the approximate pipeline elevation (blue), hydraulic grade line (red), static pressure (purple) and pipe pressure class (green) for both pipeline options. The hydraulic grade line must remain below the green line, representing the pipe pressure rating. The vertical drop in the red and purple lines represents the pressure drop at the proposed PRV. The pipe pressure class, PRV setting, PRV location and diameter are optimized to prevent operating and static pressures from exceeding the pipe pressure class. Further optimization of pipe pressure class will occur during the concept design.

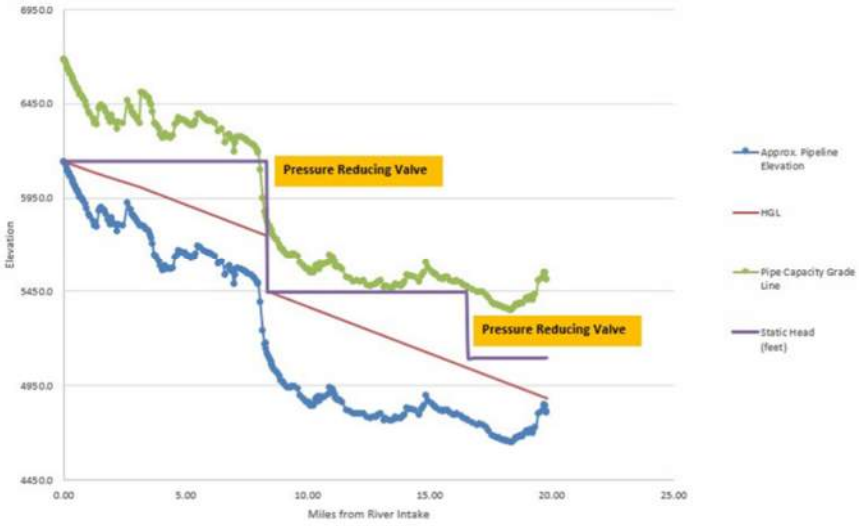

Figure 14: Hydraulic Profile of 20 inch KCFL Replacement (Option 6)

Two new PRV chambers will manage the operating pressures to the pipe rating. PVC pipe pressure class will vary along KCFL, limited either to 235 psi or 300 psi. KCFL flow control will be relocated to the WTP with modulating a valve and flowmeter. KCFL flow control at Kannah Creek will be abandoned. This option does not change the WTP treatment processes. Kannah Creek will remain as the secondary raw water source to Purdy Mesa. The Gunnison River will not be used.

The following assumptions were used for this Option:

- Raw water source:
  - Kannah Creek via KCFL
  - Augmented by Juniata Reservoir interconnection
- Capacity:
  - 9.7 mgd hydraulic capacity
    - Summer: 5 mgd from Kannah Creek plus 4.7 mgd from Juniata Reservoir
    - Winter: 7.5 mgd from Kannah Creek plus 1.2 mgd from Juniata Reservoir
- Two PRV chambers along KCFL

- Uppermost 4 miles of KCFL replacement outside scope of this project

This Option does not provide the future peak day flows of 13 mgd. Therefore, WTP flows must be augmented on peak demand days by raw water storage in Reservoirs 3 or 4 or existing distribution system storage. The interconnection with Clifton may also be used to meet peak daily flows greater than 9.7 mgd.

This Option does not provide access to an alternate water source than the PMFL.

Figure 15 below illustrates a conceptual process flow diagram for this Option. Preliminary alignment is identical to Option 5 above.

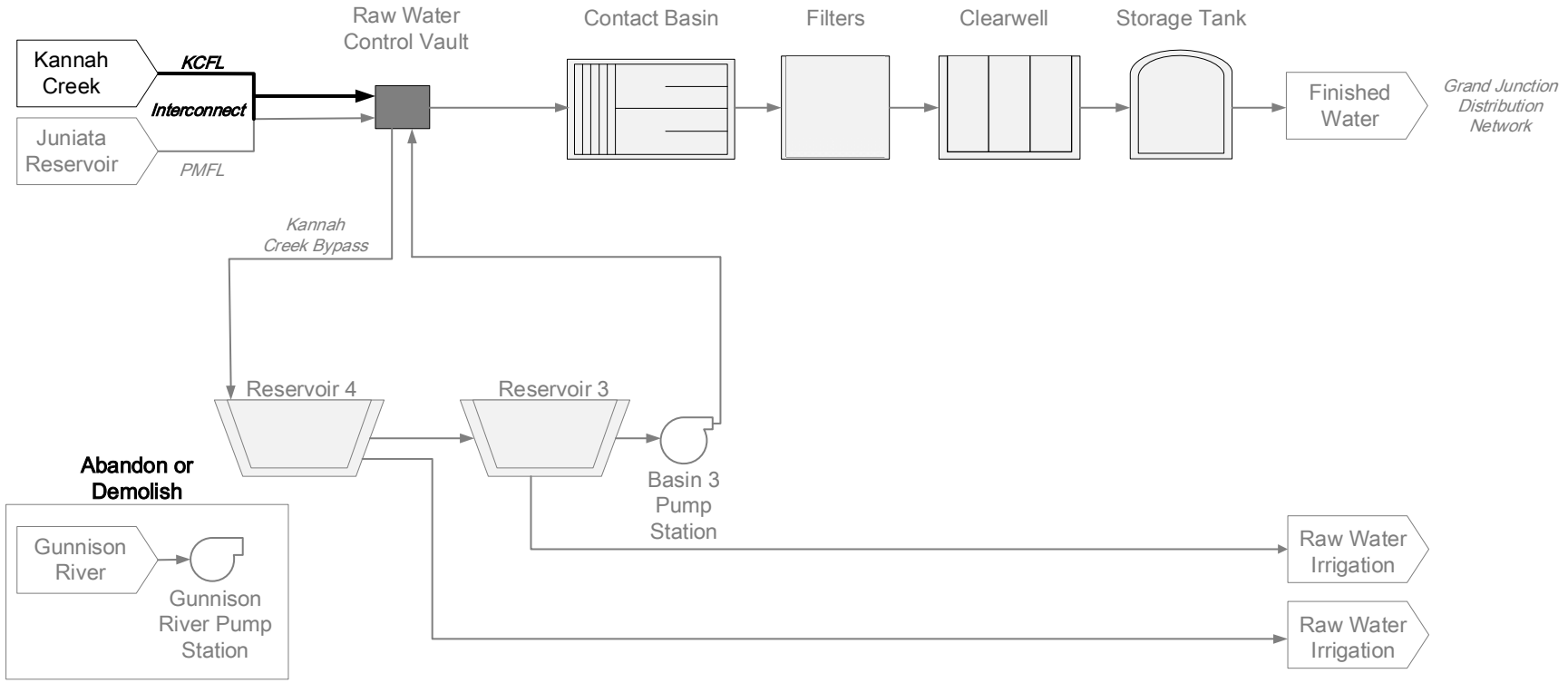

Figure 15: Process Flow Diagram for Option 6

3.7 Option 7: Replace Kannah Creek Flow Line (24 inch) and Add Turbine

This Option includes the replacement of the KCFL at 24-inch diameter. Raw water is sourced from Kannah Creek, as described in Option 5. The Juniata Reservoir Interconnection (Section 3.5.1) will be required to achieve fully redundant raw water flow to the WTP.

A new PRV chamber at the mesa will limit the pipeline pressures to less than 235 psi. A hydroelectric turbine will be installed in parallel with PRV to capture the potential energy of the high-pressure raw water. Electricity generated at the hydroelectric turbine will be transmitted overhead approximately 6 miles to the Grand Valley Power substation. Conceptual calculations indicate the potential to generate up to 3,000,000 kilowatt hours (kWH) per year (700 kW turbine), based on assumed monthly flows and available pressure.

KCFL flow control will be relocated to the WTP with modulating a valve and flowmeter. KCFL flow control at Kannah Creek will be abandoned. This Option does not change the WTP treatment processes. Kannah Creek will remain as the secondary raw water source to Purdy Mesa. The Gunnison River will not be used.

The following assumptions were used for this Option:

- Raw water source:
  - Kannah Creek via KCFL
  - Augmented by Juniata Reservoir interconnection
- Capacity:
  - 12.5 mgd hydraulic capacity
    - Summer: 5 mgd from Kannah Creek plus 7.5 mgd from Juniata Reservoir
    - Winter: 7.5 mgd from Kannah Creek plus 5 mgd from Juniata Reservoir
- Add one pressure control chamber along KCFL
- Uppermost 4 miles of KCFL replacement outside scope of this project
- Elevation change requires control valves to reduce pressure
- Transmit generated electricity to Grand Valley Power's Substation near Highway 50 and 32 Road. The capacity of this substation to receive the generated electricity must be confirmed.

This Option does not provide the future peak day flows of 13 mgd. Therefore, WTP flows must be augmented on peak demand days by raw water storage in Reservoirs 3 or 4 or existing distribution system storage. The interconnection with Clifton may also be used to meet peak daily flows greater than 12.5 mgd.

This Option does not provide access to an alternate water source than the PMFL.

Figure 16 below illustrates a conceptual process flow diagram for this Option. Figure 17 shows a preliminary alignment for the KCFL as well as preliminary turbine placement.

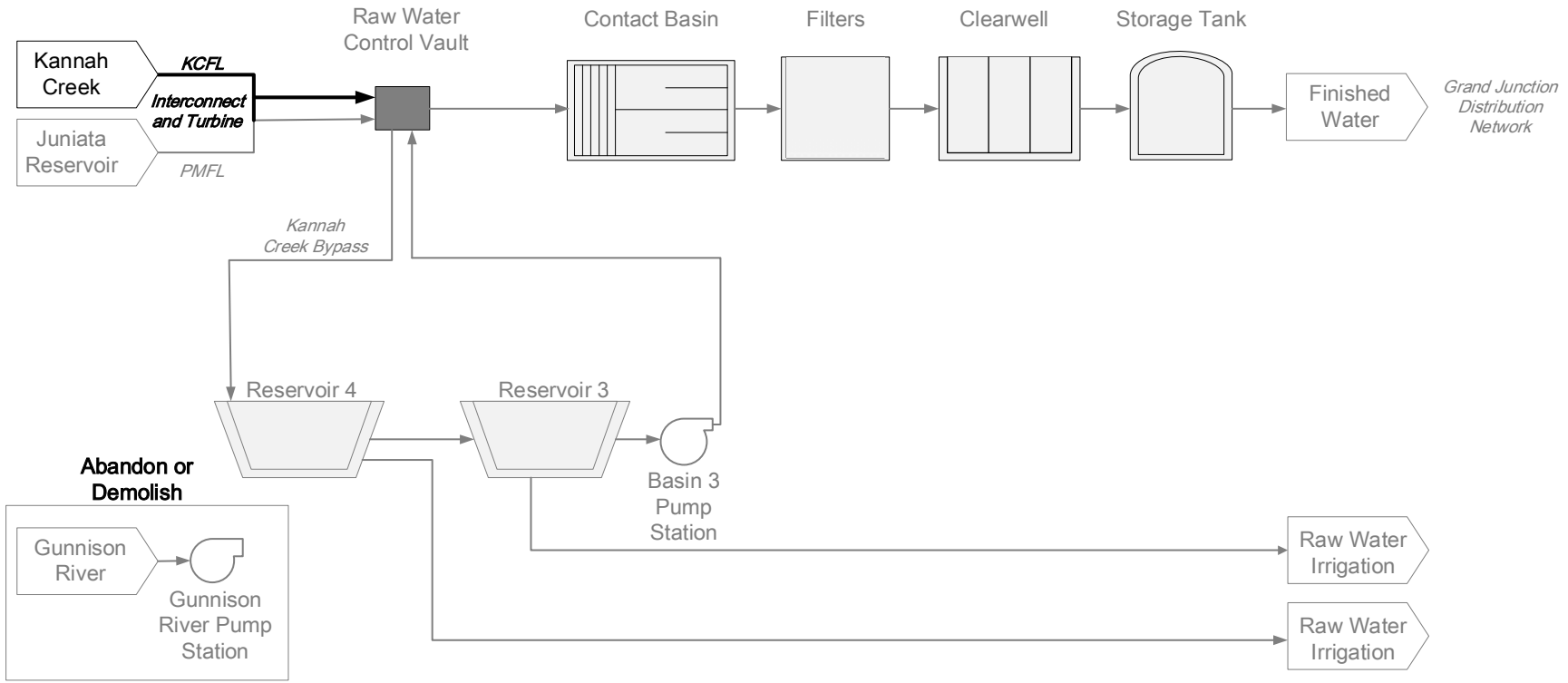

Figure 16: Process Flow Diagram for Option 7

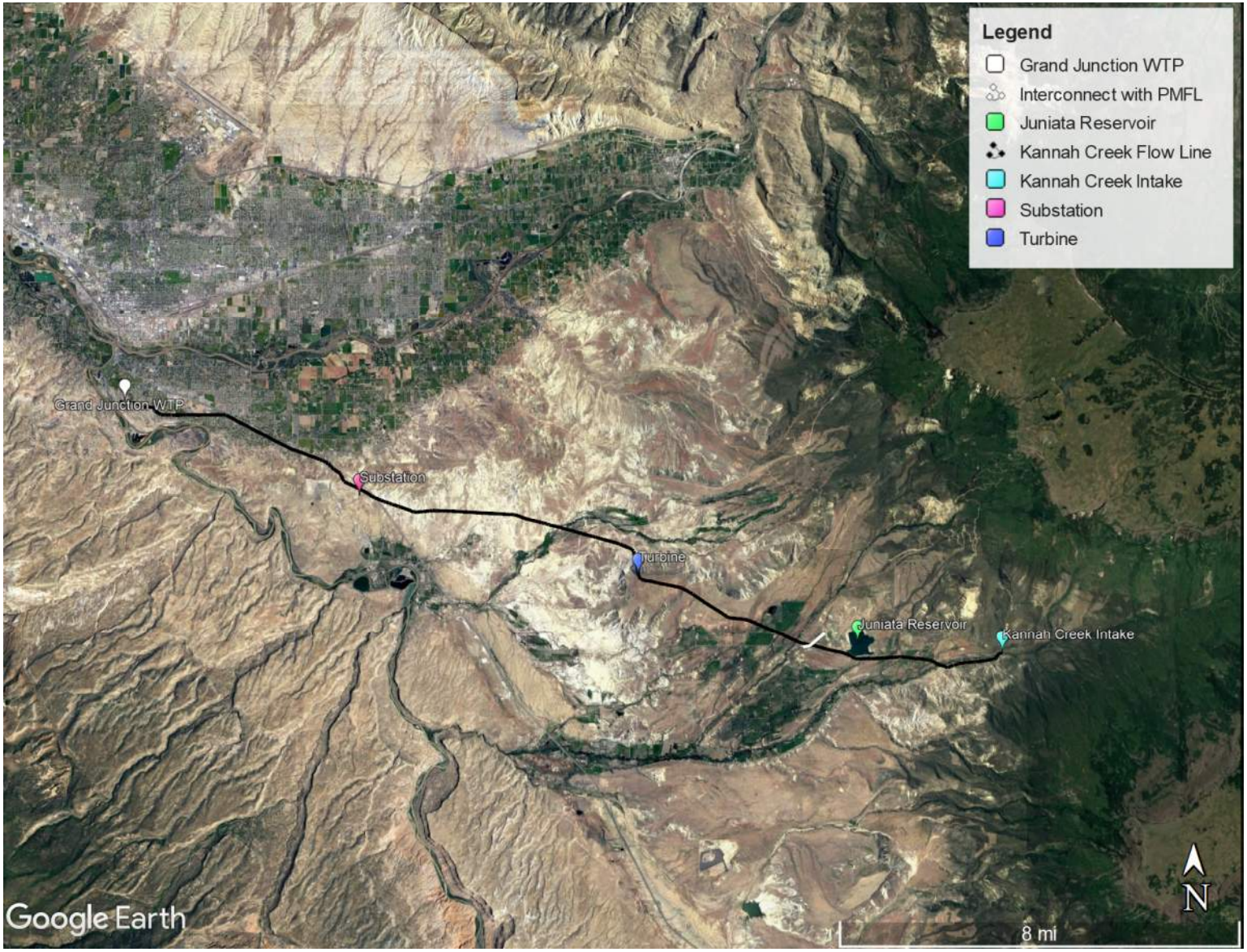

Figure 17: Preliminary Alignment for KCFL Replacement and Preliminary Turbine Placement

3.8 Option 8: New WTP in Kannah Creek Watershed

This Option includes a new WTP sized for peak day flows constructed in the Kannah Creek watershed. This new Kannah Creek WTP will utilize both Kannah Creek and Juniata Reservoir water rights. The Juniata Reservoir Interconnection (Section 3.5.1) will be required to achieve fully redundant raw water flow to the new Kannah Creek WTP.

A new Low Lift Pump Station will be constructed deliver water from either Kannah Creek or Juniata Reservoir to the new WTP. The new WTP will include conventional pretreatment, filtration, and chemical systems. Treated water will be conveyed to the distribution system via gravity through either PMFL or KCFL. The KCFL will be completely replaced with a new 24 inch pipeline (Option 5).

The new 13 mgd Kannah Creek WTP will provide treated water to the local Kannah Creek area customers and make the existing 0.3 mgd WTP redundant.

The Gunnison River will not be used but may remain operational to supply irrigation customers.

The following assumptions were used for this Option:

- Raw water source:
  - Kannah Creek via KCFL
  - Augmented by Juniata Reservoir interconnection
- Capacity:
  - 12.5 mgd (limited to hydraulic capacity of KCFL at 24-inch)
    - Summer: 5 mgd from Kannah Creek plus 7.5 mgd from Juniata Reservoir
    - Winter: 7.5 mgd from Kannah Creek plus 5 mgd from Juniata Reservoir
- Kannah Creek via interconnection and low lift pump station will be treated at new WTP
- Juniata Reservoir via low lift pump station will be treated at new WTP
- Residual pressure from the new WTP will be used to supply water directly to distribution system
- KCFL or PMFL available to convey either raw or treated water to the existing WTP for treatment or distribution
- Abandon existing 0.3 mgd WTP in place
- Add one pressure control chamber along KCFL
- Uppermost 4 miles of KCFL replacement outside scope of this project

This Option does not provide the future peak day flows of 13 mgd. Therefore, WTP flows must be augmented on peak demand days by raw water storage in Reservoirs 3 or 4 or existing distribution system storage. The interconnection with Clifton may also be used to meet peak daily flows greater than 12.5 mgd.

This Option does not provide access to an alternate water source than the PMFL.

Figure 18 below illustrates a conceptual process flow diagram for this Option. Figure 19 shows a preliminary alignment for the KCFL as well as preliminary Kannah Creek WTP location.

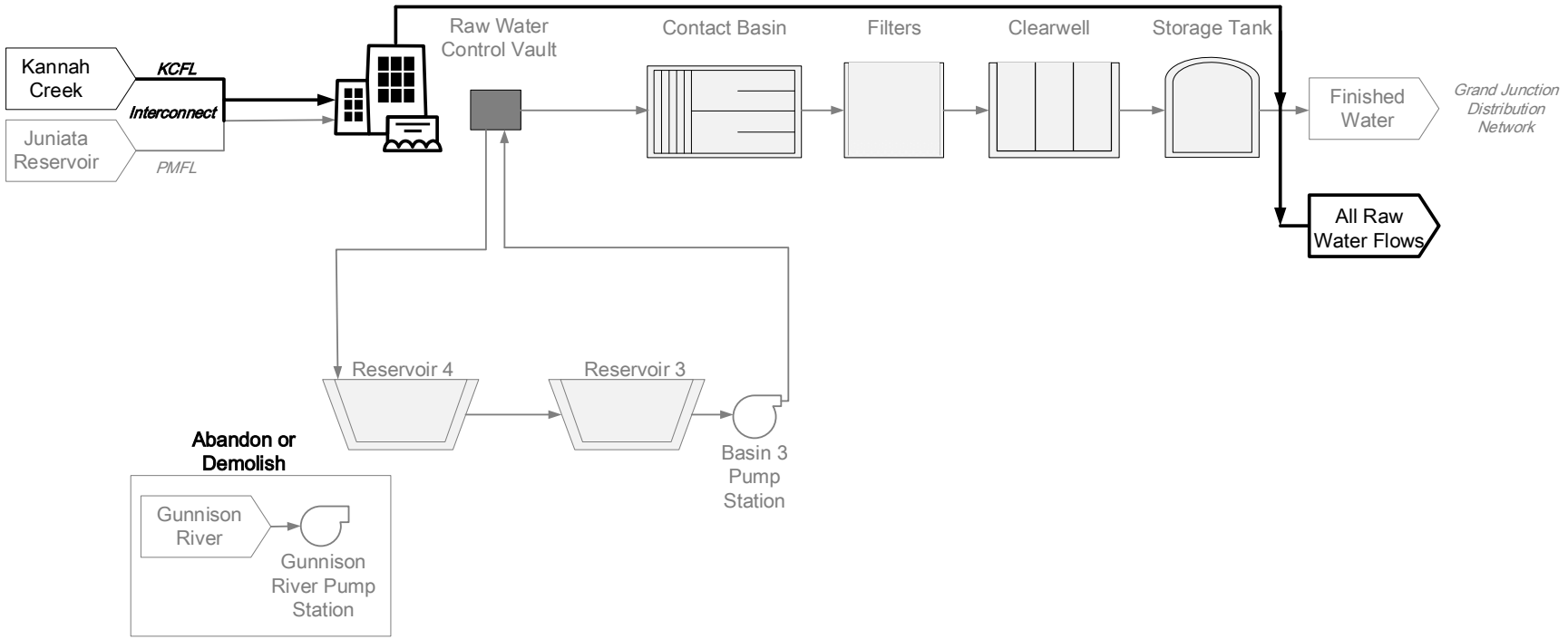

Figure 18: Process Flow Diagram for Option 8

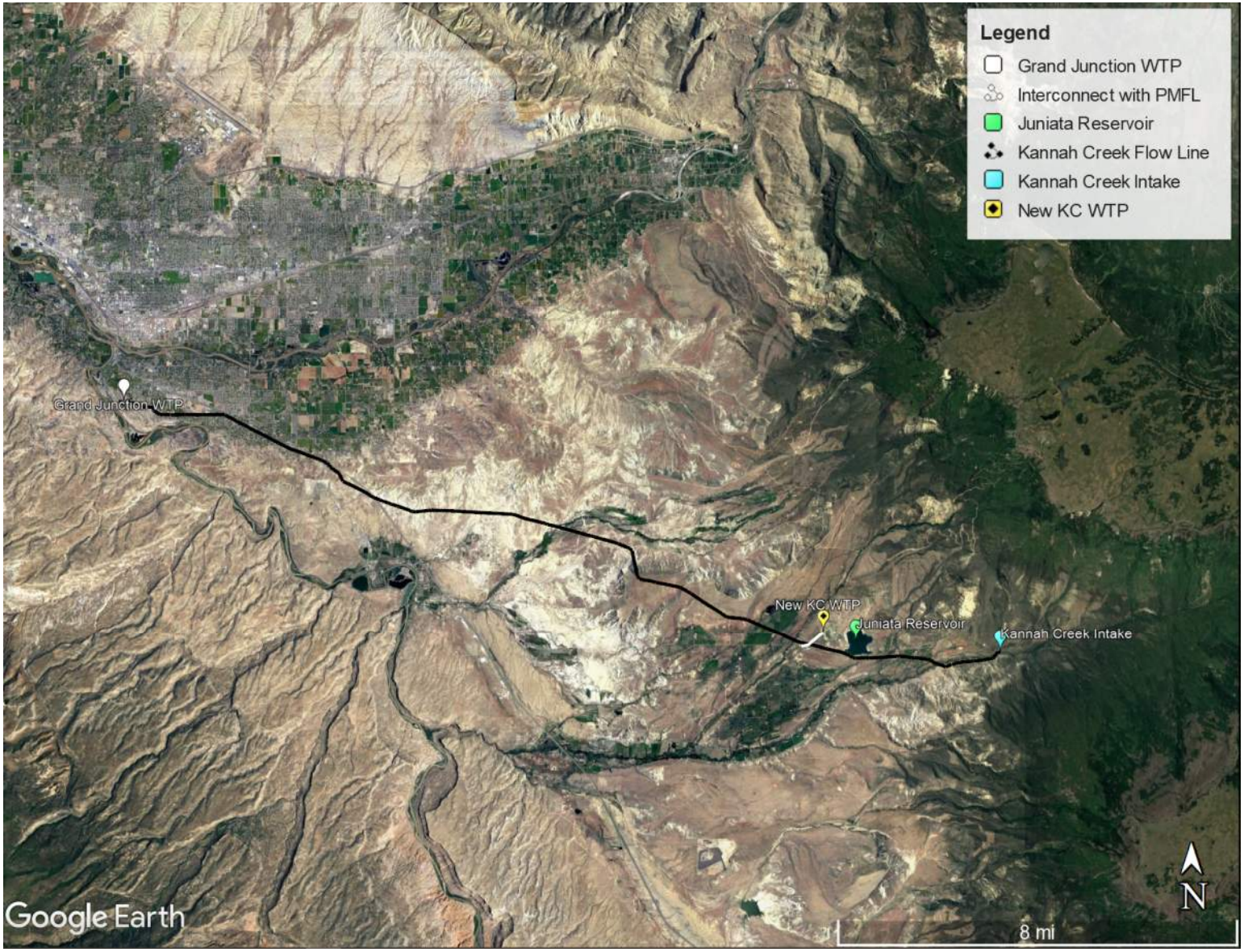

Figure 19: Preliminary Alignment for KCFL Replacement and Preliminary KC WTP Placement

3.9 Option 9: Clifton Water Emergency Interconnect

This Option is based on using the existing interconnection agreement with Clifton. The 1998 amendment allows Clifton to supply the City with up to 250 million gallons between April and September each year (1.4 mgd average). The amendment states that the City will supply Clifton with up to 250 million gallons per day between October and March. The agreement has informally expanded over the years to allow the City to take up to 4.5 mgd of treated water from Clifton in emergency situations. The Clifton interconnection on 29 Road is able to sustain flows up to 5.5 mgd.

The City will use the interconnection with Clifton in the event of a failure of the PMFL. This water would supplement the KCFL at its current capacity until complete failure of the KCFL.

The following assumptions were used for this Option:

- Raw water source: Kannah Creek via KCFL
- Treated water source: Grand Mesa and Colorado River via Clifton
- Capacity: 7.5 mgd
    - 5.5 mgd raw water from Clifton
    - 2 mgd raw water from KCFL in current condition
- KCFL will be utilized at current capacity until complete pipe failure
- Negotiate an updated agreement with Clifton
- Finished water from Clifton will be sent to the City through the existing interconnect
- Reservoirs 3 and 4 will be used to supply existing raw water irrigation customers while the PMFL is offline for repairs lasting a maximum of one week

This Option does not provide the future peak day flows of 13 mgd. Therefore, WTP flows must be augmented on peak demand days by raw water storage in Reservoirs 3 or 4 or existing distribution system storage.

The City may also consider using the Clifton interconnection agreement to preserve its water allocation on the Purdy Mesa. Clifton water may be used in non-emergency situations under the existing agreement. This approach may trigger a renegotiation of the agreement if used as a permanent, non-emergency source. Investigation of transfer, exchange, or credit of water rights to either Gunnison River or Colorado River should be explored by City but is not included in this study.

Figure 20 below illustrates a conceptual process flow diagram for this Option. This Option does not involve any capital costs, so it has been purposefully excluded from Appendices A and B.

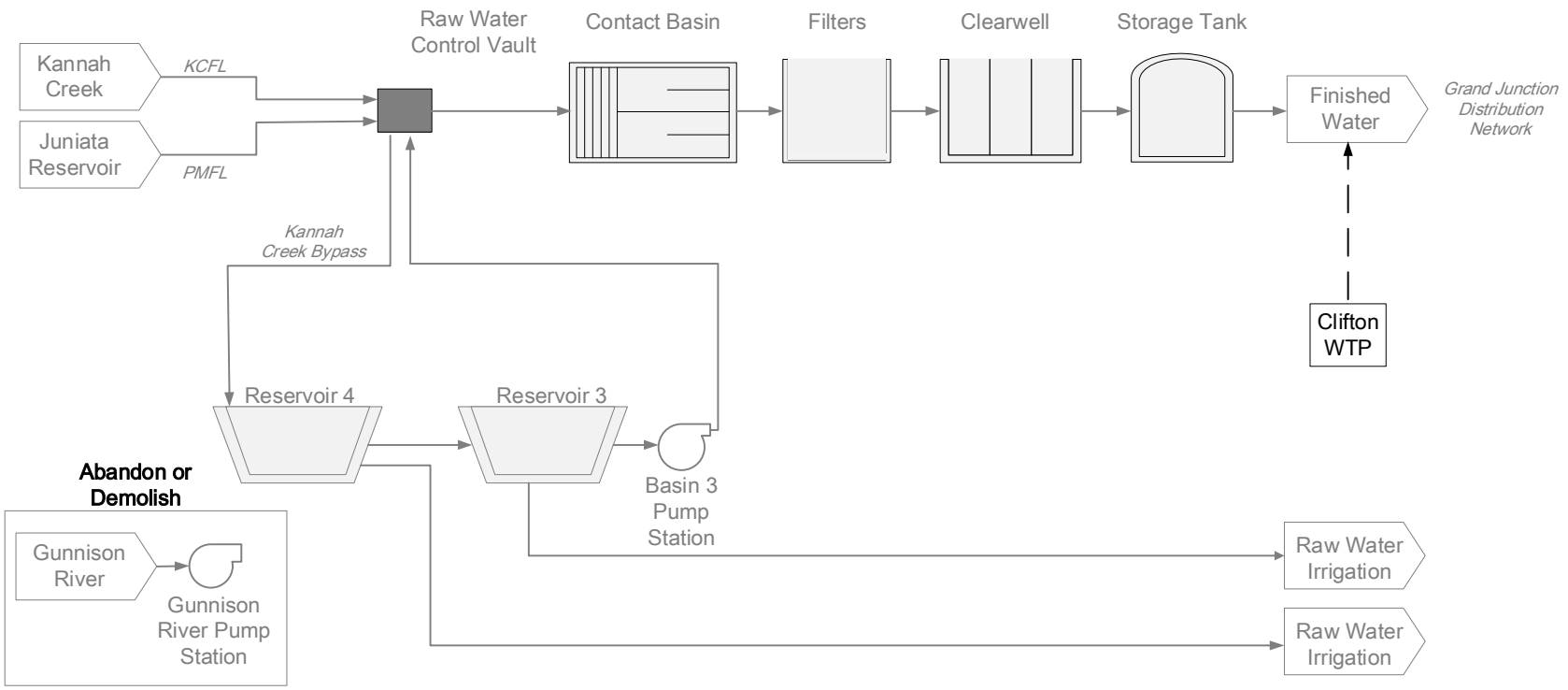

Figure 20: Process Flow Diagram for Option 9

3.10 Option 10: Transfer Colorado River Rights to Clifton for Treatment (Full Expansion, 24 inch pipeline)

The City owns 80 cfs of additional water rights to the Colorado River that are not being utilized. There is no active infrastructure that will allow the City to access its Colorado River source. This Option includes the transfer of Colorado water rights to Clifton for treatment and distribution back to the City. The Clifton WTP will be expanded to provide a fully redundant supply of 13 mgd to the City. It is anticipated that the City will contribute to the construction, operation, and maintenance of the expanded Clifton WTP.

The Clifton WTP combines membrane filtration with reverse osmosis. The treatment train is pre-sedimentation, flocculation, sedimentation and MF/UF. A portion of flow is treated by NF/RO to address high TDS in the Colorado River. The NF/RO bypass stream is blended back into the MF/UF stream.

The existing Clifton WTP has a capacity of 12 mgd, with a peak day flow of 6.3 mgd. The Clifton WTP has available space on the MF/UF and NF/RO racks for additional modules, as well as floor space in the existing buildings for additional membrane trains.

This Option is based on the expansion of the Clifton WTP to 21 mgd accommodate future peak day demands in Clifton and the City. This assumes future Clifton peak day demand of 8 mgd (30% increase), plus 13 mgd peak day demand from Grand Junction.

A new water transmission main will route treated water from the Clifton WTP to 30th Rd where existing pipe will be utilized to connect to the City's distribution network (24-inch diameter for 4 miles). This new treated water pipeline will provide flows above the 5.5 mgd capacity of the existing Clifton interconnection.

The following assumptions were used for this Option:

- Raw water source: Colorado River via Clifton WTP
- 13 mgd peak day flow
- KCFL will be abandoned in place
- Clifton will provide treatment
- Expand Clifton WTP from 12 to 21 mgd
    - 8 mgd for Clifton
    - 13 mgd for Grand Junction
- Adequate space available for Clifton WTP expansion
- CDPHE permits the expansion of the existing Clifton brine disposal ponds
- New 24-inch pipeline from Clifton to the City's distribution (4 miles)
- Reservoirs 3 and 4 will be used to supply existing raw water customers while PMFL is offline for up to one week

This Option uses the City's existing Colorado River water rights and provides access to an alternate water source than the Purdy Mesa.

Figure 21 below illustrates a conceptual process flow diagram for this Option. Figure 22 shows a preliminary alignment for the finished water pipeline from the Clifton WTP to the City's distribution system.

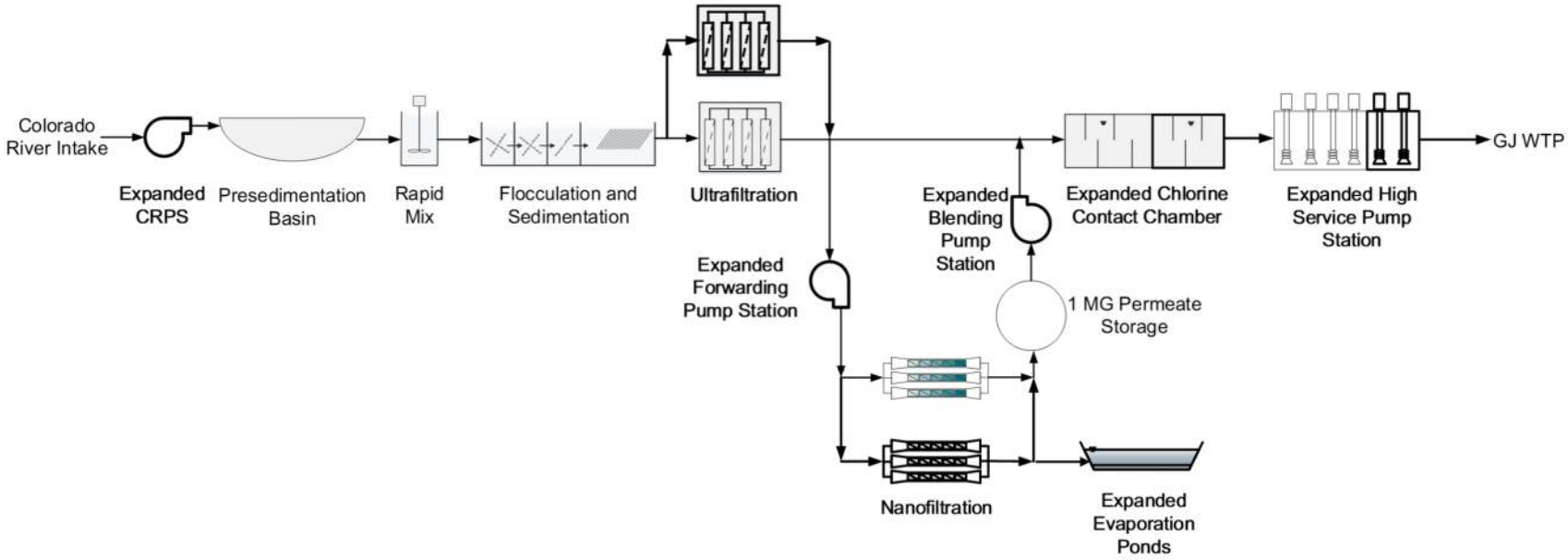

Figure 21: Process Flow Diagram for Option 10

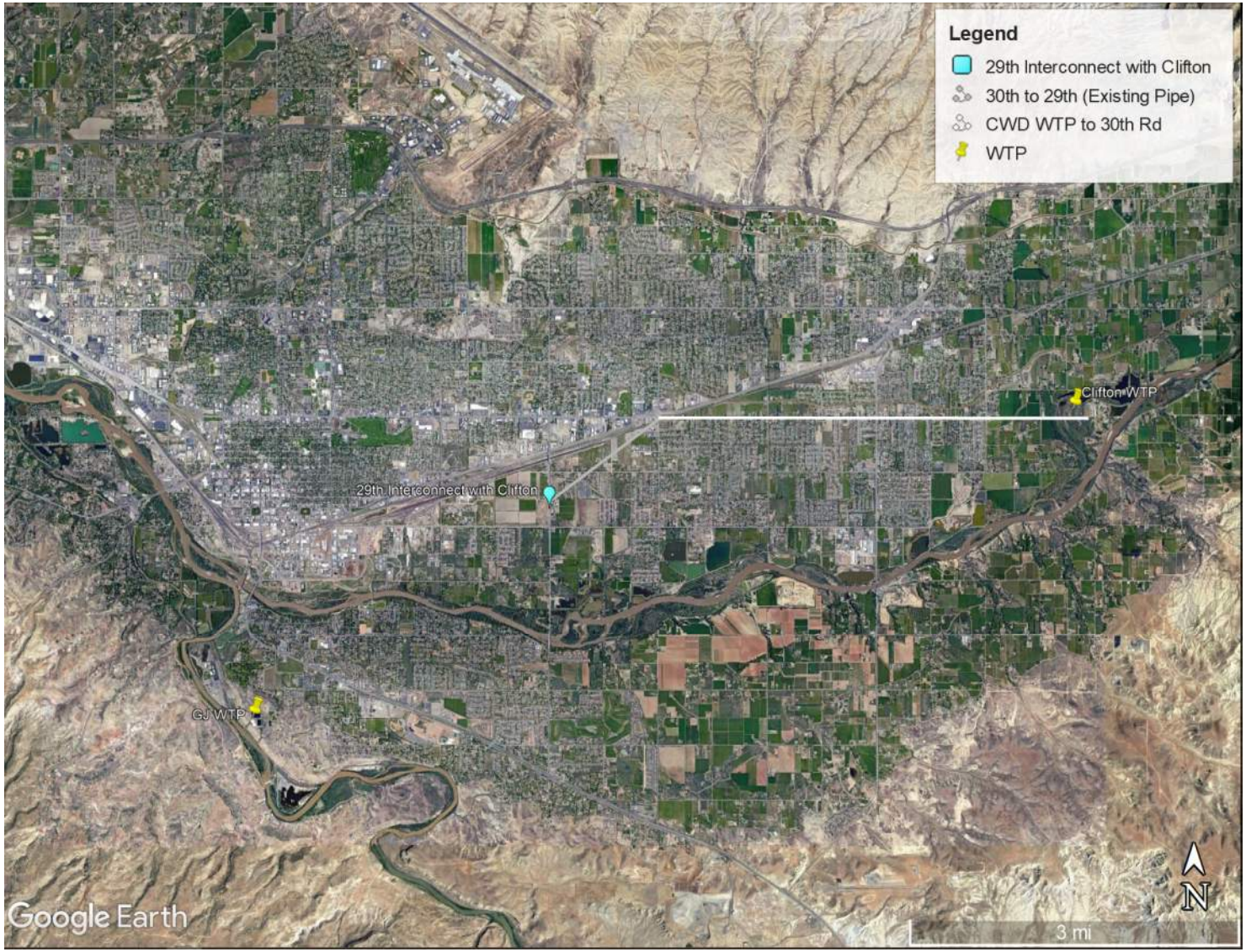

Figure 22: Preliminary Alignment for FW Transmission from CWD WTP to Grand Junction Distribution System

3.11 Option 11: Transfer Colorado River Rights to Clifton for Treatment (Partial Expansion, 20 inch pipeline)

This Option is based on an expansion of the Clifton WTP, similar to Option 10, but to a capacity of 16 mgd. This does not provide full future redundancy to the City but is a less complex and expensive expansion than the Clifton WTP expansion to 21 mgd. Clifton's pretreatment is already sized for 16 mgd, reducing the number of processes that need to be expanded. The MF/UF system will be expanded through a combination of populating existing skids with additional membrane modules, as well as adding a new MF/UF skid in the existing building space.

This Option assumes a future peak day demand of 8 mgd in Clifton (30% increase), leaving 8 mgd available for the City.

A new water transmission main will route treated water from the Clifton WTP to 30th Rd where existing pipe will be utilized to connect to the City's distribution network (20-inch diameter for 4 miles). This new treated water pipeline will provide flows above the 5.5 mgd capacity of the existing Clifton interconnection.

The following assumptions were used for this Option:

- Raw water source: Colorado River via Clifton WTP
- KCFL will be abandoned in place
- Clifton will provide treatment
- Expand Clifton WTP from 12 to 16 mgd
    - 8 mgd for Clifton
    - 8 mgd for Grand Junction
- Adequate space available for Clifton WTP expansion
- CDPHE permits the expansion of the existing Clifton brine disposal ponds
- New 20-inch pipeline from Clifton to the City's distribution (4 miles)
- Reservoirs 3 and 4 will be used to supply existing raw water customers while PMFL is offline for up to one week

This Option uses the City's existing Colorado River water rights and provides access to an alternate water source than the Purdy Mesa.

Refer to Figure 21 and Figure 22 under Option 10 for a conceptual process flow diagram and a preliminary alignment for the finished water pipeline from the Clifton WTP to the City's distribution system.

3.12 Option 12: Route Gunnison River to Clifton WTP

The City owns 120 cfs of additional water rights to the Gunnison River that are not being utilized. These rights could be transferred to Clifton for treatment at their WTP. This will require upgrades to the GRPS and a new raw water pipeline from the existing Gunnison River Intake to the Clifton WTP.

There are no significant water allocations between Clifton's Colorado River intake and the confluence of the Gunnison River. Therefore, the City could transfer part of its Colorado River rights to Clifton for treatment and replace those flows with its Gunnison River rights downstream. This avoids significant upgrades at the existing or a new Gunnison River intake, modifications to the GRPS and a raw water pipeline to the Clifton WTP.

The required upgrades after the transfer of water rights become the same as those proposed in Option 10. Options 10 and 12 result in the same scope of work (Clifton WTP expansion and finished water piping from Clifton to the City).

3.13 Blending of Free Chlorine and Chloraminated Sources

Options 13 and 14 are based utilizing the existing interconnections between the City and Ute. Ute uses chloramines for disinfection, which are not compatible with the City's use of free chlorine. Blending of the two waters would require additional treatment.

Blending of chlorinated and chloraminated water is generally not recommended due to the potential to lose chlorine residual. The ratio of chlorine to ammonia (Cl_2:NH_4-N) changes in an uncontrolled manner when free chlorine sources are blended with chloraminated sources. This can lead to a lowering of the disinfectant residuals to unsafe levels and create aesthetically unpleasing water.

Options for blending free chlorine and chloraminated sources include:

- Breakpoint Chlorination. Convert chloraminated water to free chlorine by adding sodium hypochlorite.
- Ammoniate the Chlorinated Water. Convert all water to chloramines by adding ammonia after free chlorine injection.
- Isolate Disinfectants. Separate or partition portions or zones of the distribution system to accommodate Ute's chloraminated water while some zones continue with the City's treated water from the KCFL source.
- Controlled Blending. Blend sources directly at each interconnect with the injection of chorine to convert to free chlorine residual. This option must include extensive controls to verify that free and total chlorine residuals will remain at acceptable levels. This may cause taste and odor issues if dichloramines form in the system. This option assumes use of some treated water from the City is available in the distribution system.
- Emergency Utilization. Utilize interconnects to blend Ute water as-is only in the event of emergency. This option is not recommended due to the inherent water quality risks.

Breakpoint chlorination (Option 13) and ammoniating of chlorinated water (Option 14) are discussed in the following sections.

3.14 Option 13: Purchase Treated Water from Ute (Breakpoint Chlorination)

The City has eight emergency interconnects in their water distribution network with Ute. Currently, the interconnects are not used due to the differing disinfection regimes (free chlorine at the City, chloramines at Ute).

The Linden Vault at Highway 50 and Linden Avenue is the closest Ute interconnect to the WTP at less than one mile away. Ute water enters the Linden Vault in an 18-inch pipe at approximately 200 psi. This is adequate pressure to deliver treated Ute water to the WTP in a new 24-inch pipeline from the Linden Vault.

A breakpoint chlorination station will be installed at the WTP to receive Ute treated water and convert chloramines to free chlorine. below. The City's existing sodium hypochlorite system will be expanded to accommodate the Ute flows and the higher free chlorine dose needed to destroy the chloramines. Sodium hypochlorite will be dosed in-line via a mixer past breakpoint concentrations to match the free chlorine residual required by the City.

Breakpoint chlorination (Figure 23) will remove the chloramines from the Ute treated water and convert to a free chlorine residual that matches the treated water in the City's distribution system. Breakpoint adjusted Ute water will be blended with the City's treated water in the existing storage tanks.

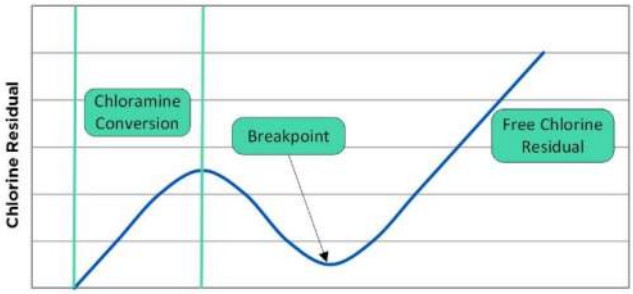

Figure 23: Breakpoint Chlorination Curve

Extensive pilot testing on the two source waters will be required to determine feasibility of blending Ute treated water with the City's water. A corrosion control/blending study is also recommended to determine the outcomes of the proposed break point chlorination design parameters across the City's distribution system.

A monitoring program must be implemented during episodes of blending Ute water. A monitoring program must monitor total chlorine, monochloramine, free ammonia, and free chlorine in the blended water to prevent issues with maintaining the chlorine residual and avoiding nitrification in the distribution network. This monitoring program will help the City verify that the water has reached and exceeded breakpoint chlorination, and that the ammonia has been removed. Nitrification action plans are also required for systems blending free and chloraminated water.

Note that the City's distribution system may encounter elevated concentrations of disinfection byproducts (DBPs) due to the additional chlorine required for breakpoint chlorination.

Pilot testing, blending studies, monitoring programs and nitrification action plans are not included in the scope of this study.

The following assumptions were used for this Option:

- Raw water source: Plateau Creek via Ute
- Adequate water rights and capacity in Ute raw water source to supply both Ute and the City's future needs
- 13 mgd peak day flow

- Single interconnection with Ute at Linden Vault
- Adequate pressure (200 psi) at Linden Vault to avoid re-pumping to the City's WTP
- Expand City's on-site sodium hypochlorite system for breakpoint chlorine doses
- Sufficient space for sodium hypochlorite tanks and pumps in existing chemical rooms (no building expansion)
- Must conduct CCS to understand the impact of using Ute water in the City's distribution system

This Option provides access to an alternate water source than the Purdy Mesa.

Figure 24 below illustrates a conceptual process flow diagram for this Option. Figure 25 shows a preliminary alignment for the raw water pipeline from the Linden Vault to the WTP.

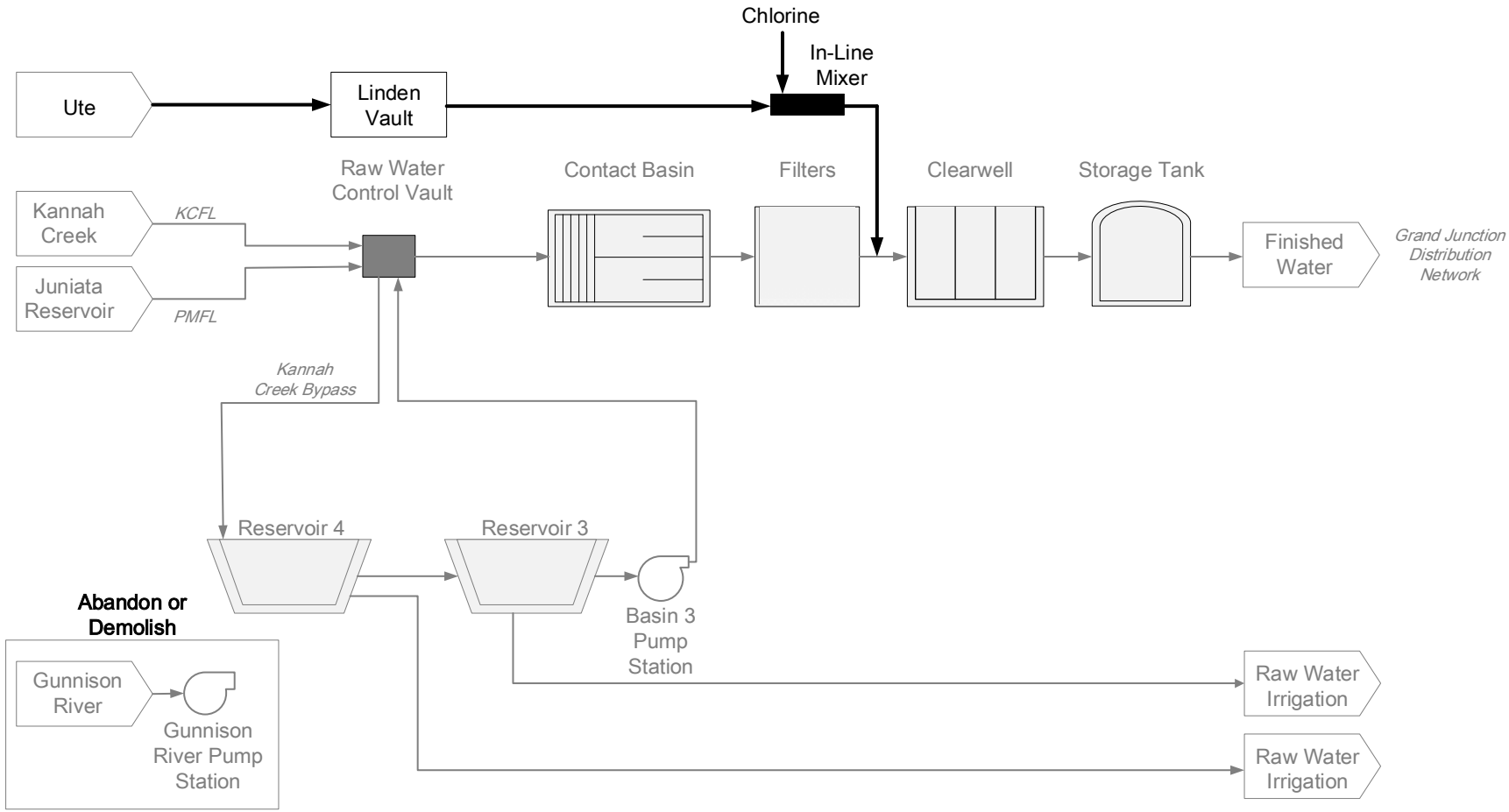

Figure 24: Process Flow Diagram for Option 14

Figure 25: Preliminary Alignment of Pipeline from Linden Vault to GJ WT

3.15 Option 14: Purchase Treated Water from Ute (Chloramine Conversion)

This Option includes the conversion of City water to chloramines instead of free chlorine. This allows the City to directly utilize any of the eight interconnects with Ute without needing to pump the water to the plant for breakpoint chlorination. It is assumed that the City will utilize the Linden and Riverside Vaults with modifications for flow control. Unlike breakpoint chlorination, this would be a permanent change to WTP operations, not just utilized when utilizing Ute water.

A liquid ammonia sulfate dosing system will be added to the WTP to convert free chlorine into chloramines. This will require a building expansion.

The use of chloramines will result with lower free chlorine levels in the distribution system, which will contribute to lower levels of DBP.

The following assumptions were used for this Option:

- Raw water source: Plateau Creek via Ute
- Adequate water rights and capacity in Ute raw water source to supply both Ute and the City's future needs
- 13 mgd peak day flow
- Two interconnects with Ute at the Linden and Riverside Vaults
- New 700 square foot liquid ammonia sulfate building at WTP
- Adequate pressure to avoid re-pumping to the City's distribution network
- Must conduct CCS to understand the impact of using Ute water in the City's distribution system

This Option provides access to an alternate water source than the Purdy Mesa.

Converting the City to chloramines will make the disinfection regime incompatible with Clifton, who use free chlorine. This may require renegotiation with Clifton on the interconnection agreement that is based on seasonal flow swapping between the City and Clifton.

Figure 26 shows a map of the top six interconnects the City has with Ute.

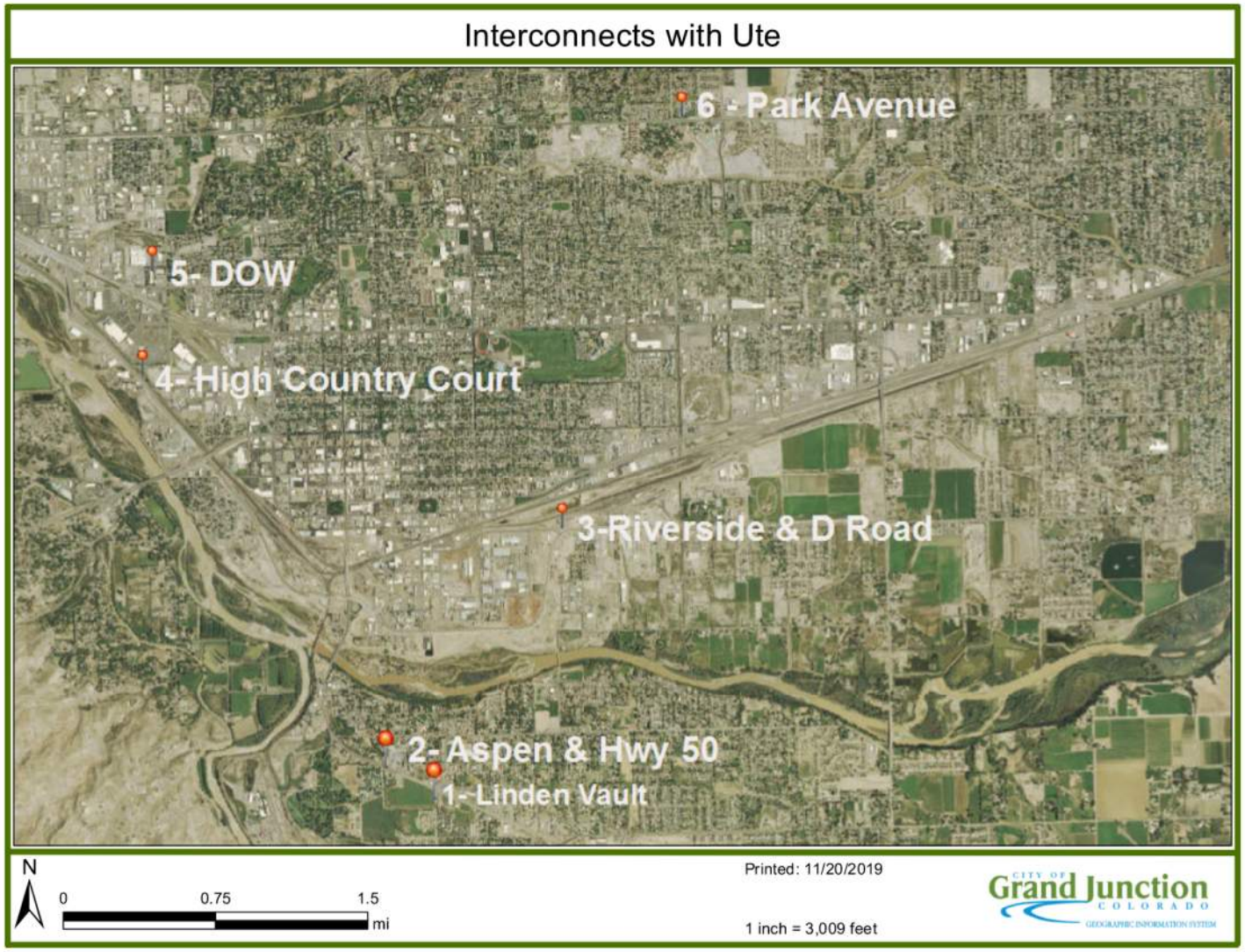

Figure 26: Map of Top Six Interconnects with Ute

4 OPTIONS SUMMARY

4.1 Hydraulic Capacity

Not all Options considered provide a fully redundant supply of 13 mgd flow. Therefore, combinations of sources were used within specific Options to achieve the 13 mgd future peak day flows. Option 9 (Clifton Emergency Interconnect) does not provide full redundancy but is included as an emergency option only. Table 6 summarizes the source, conveyance, and maximum flow of each option.

Table 6: Option Flow Composition

	Option	Source	Conveyance	Flow (mgd)
1	Treat Gunnison by Lime Softening	Gunnison River	GRPS	13.0
2	Treat Gunnison by Reverse Osmosis	Gunnison River	GRPS	13.0
3	Settle Gunnison in Existing Reservoirs and Blend with Clifton	Gunnison River Colorado River	GRPS Clifton	13.0
4	Settle Gunnison in Existing Reservoirs and Use for Raw Water	Gunnison River Kannah Creek	GRPS KCFL	11.7
5	Replace KCFL (24 inch)	Kannah Creek	KCFL	12.5
6	Replace KCFL (20 inch)	Kannah Creek	KCFL	9.7
7	Replace KCFL (24 inch) and Add Turbine	Kannah Creek	KCFL	12.5
8	New WTP in Kannah Creek Watershed	Kannah Creek	KCFL	12.5
9	Clifton Water Emergency Interconnect	Colorado River Kannah Creek	Clifton KCFL	7.5
10	Transfer Colorado Water Rights to Clifton for Treatment (Full Expansion, 24 inch)	Colorado River	Clifton	13.0
11	Transfer Colorado Water Rights to Clifton for Treatment (Partial Expansion, 20 inch)	Colorado River	Clifton	8.0
12	Route Gunnison to Clifton WTP	Colorado River (Same as Option 10)	Clifton	13.0
13	Purchase Treated Water from Ute (Breakpoint Chlorination)	Grand Mesa	Ute	13.0
14	Purchase Treated Water from Ute (Chloramine Conversion)	Grand Mesa	Ute	13.0

Figure 27 illustrates the combination of sources for each Option and their respective hydraulic capacities. Flows must be augmented on peak demand days by either raw water storage in Reservoirs 3 or 4 or the City's existing treated water storage reservoirs. The 5.5 mgd capacity interconnection with Clifton may also be used to augment Options which do not provide 13 mgd.

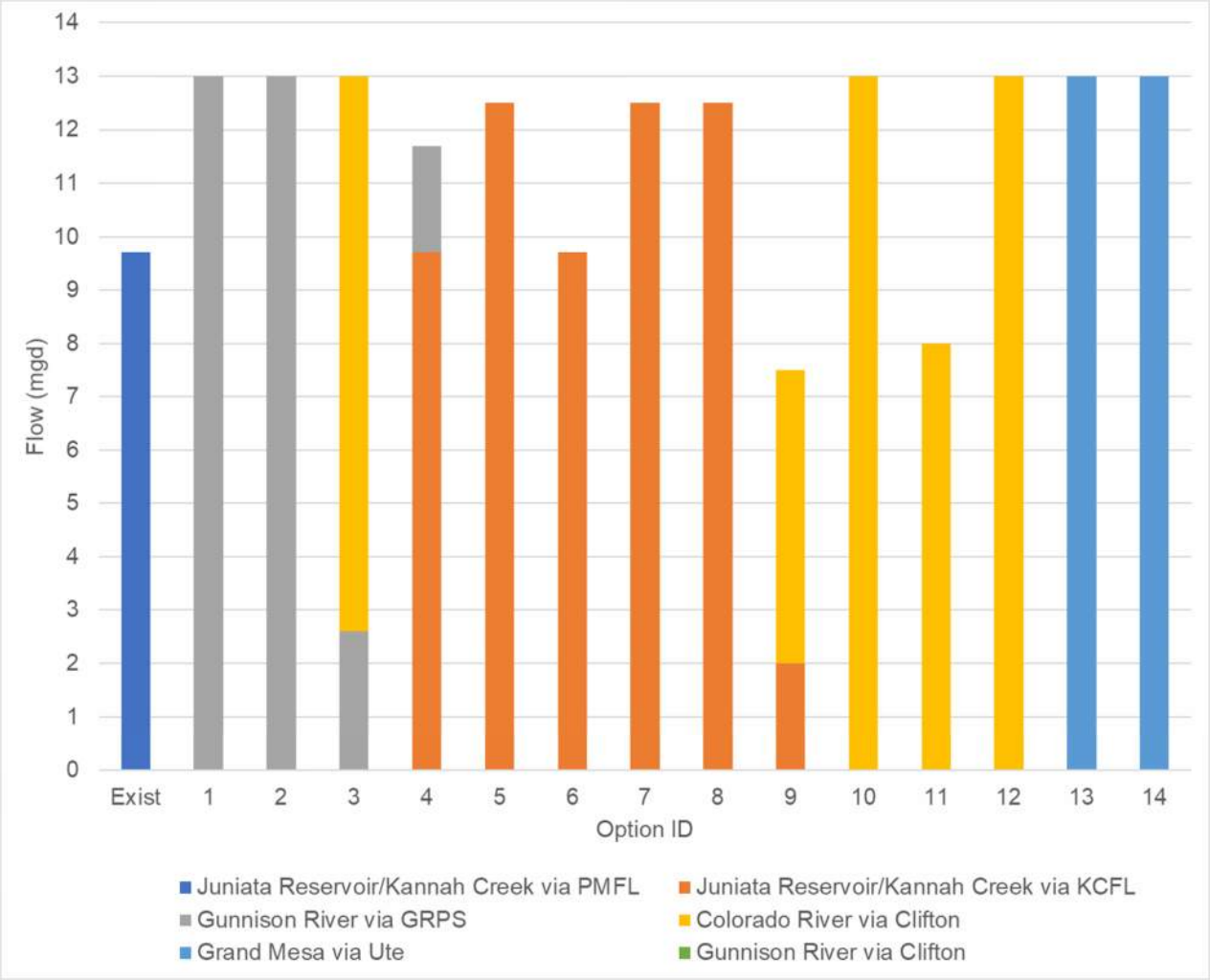

Figure 27: Hydraulic Capacity by Option

4.1.1 Treated Water Storage

The City has two 4 mg ground storage tanks at the WTP site (8 mg total). There is no treated water storage in the distribution system. Treated water storage capacity is determined through engineering studies to assess domestic demands and fire flows. Generally, water storage tanks provide:

- Peak balancing storage for instantaneous demands greater than the WTP production rate,
- Fire flows, and
- Emergency storage.

Current and future peak day demands are discussed in Section 2.4.

Fire flows in Grand Junction are based on the 2000 edition of the International Fire Code (IFC). Fire flow rates are determined by the size of the building, its use, and type of construction. Fire flows range from a minimum of 1,500 gpm for single family dwellings to 8,000 gpm for large buildings per Table B105.1 of the IFC. An assumed fire flow of 6,000 gpm is used in this study, which represents a Type 1A building of over 300,000 square feet. A duration of 4 hours required for fire flows of 6,000 gpm.

Emergency storage is available to serve customers in the event of a watermain break or service interruption at the WTP. Emergency storage may be reduced if there is sufficient capacity in the source water supply and the WTP with standby power to meet peak demands. Excess capacity may lead to water quality deterioration.

Table 7: Grand Junction Treated Water Storage

Component	Design Criteria	Flow / Volume	Volume
Peak balancing	25% of maximum day demand	13 mgd	3.3 mg
Fire flow	Table B105.1 IFC, 2000	6,000 gpm for 4 hours	1.4 mg
Emergency storage	15% of average day flow	6.5 mgd	1.0 mg
		Recommended treated water storage (future)	5.7 mg
		Actual treated water storage	8.0 mg
		Spare treated water storage (future)	2.3 mg

Table 7 indicates the City has spare storage available in the existing treated water storage tanks. This volume is available for short term operational issues, such as line breaks in the PMFL or KCFL or periodic maintenance at the WTP. The contributes to the City's goal of operational redundancy. This equates to approximately 30 hours of treated water supply at the current average day demand of 4.7 mgd, while maintaining the recommended fire flow and emergency storage volumes in the tanks. The available treated water storage is augmented by the up to 23 mg of raw water storage in Reservoirs 3 and 4 (approximately 5 days of storage at current average day demands).

Further engineering analysis and modeling is recommended to assess the benefit of additional treated water storage in the distribution system, its potential volume and location. Potential sites may require land acquisition and may modify the operating pressures due to the tank elevation. Additional water storage may impact water quality due to a longer water age.

4.2 Cost Comparison

4.2.1 Engineer's Opinion of Probable Construction Costs

EOPCC were completed in accordance with the Association for the Advancement of Cost Engineering (AACE) Class 4 definition. Class 4 EOPCC are prepared to evaluate and compare the options presented in Section 2. Class 4 EOPCC are generally developed with limited information and subsequently vary in their accuracy. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval.

Class 4 EOPCC are typically based on 1% to 15% complete design development, comprising at a minimum of:

- Plant capacity,
- Block schematics,
- Process flow diagrams (PFDs) for main process systems,
- Preliminary equipment lists, and
- Pipeline diameter and initial routing.

The expected accuracy range is -15% to -30% below and +20% to +50% above. Vendor quotes were sought and gross unit costs/ratios from past projects were used to develop the estimates in this study.

Contingency values range from 10 to 30% based on the level of detail known for each option. Major scope items and EOPCC for each option are presented in Appendices A and B, respectively. A summary of each option including EOPCC and construction cost per gallon of capacity can be found in Table 8.

The estimates, analyses, and recommendations contained in this analysis are based on professional experience, qualifications, and judgment. BMcD has no control over weather; cost and availability of labor, material, and equipment; labor productivity; energy or commodity pricing; demand or usage; population demographics; market conditions; changes in technology; and other economic or political factors affecting such estimates, analyses, and recommendations. Therefore, BMcD makes no guarantee or warranty (actual, expressed, or implied) that actual results will not vary, perhaps significantly, from the estimates, analyses, and recommendations contained herein.

4.2.2 Escalation

The EOPCC presented in this study are based on 2020 dollars at the time of issue. The use of the costs presented in this study should be escalated if used for future purposes to reflect changes in labor, material, and equipment. Local cost data or published cost indices should be consulted to determine an appropriate cost escalation factor.

Table 8: Summary of EOPCC

	Option	EOPCC	Capital Cost/Gal	Notes
1	Treat Gunnison by Lime Softening	$41,900,000	$3.22/gal	$15,300,000 Lime Softening $10,600,000 Solids Handling
2	Treat Gunnison by Reverse Osmosis	$70,900,000	$5.45/gal	$28,800,000 RO Treatment $42,100,000 Brine Disposal
3	Settle Gunnison in Existing Reservoirs and Blend with Clifton	$18,100,000	$1.39/gal	
4	Settle Gunnison in Existing Reservoirs and Use for Raw Water	$23,300,000	$1.99/gal	11.7 mgd
5	Replace KCFL (24 inch)	$27,900,000	$2.23/gal	12.5 mgd
6	Replace KCFL (20 inch)	$23,000,000	$2.32/gal	9.7 mgd
7	Replace KCFL (24 inch) and Add Turbine	$39,200,000	$3.14/gal	$28,000,000 Pipeline $1,500,000 Turbine plus $7,300,000 Electrical Transmission
8	New WTP in Kannah Creek Watershed	$59,400,000	$4.75/gal	$20,300,000 WTP $28,200,000 Pipeline
9	Clifton Water Emergency Interconnect	N/A	N/A	7.5 mgd
10	Transfer Colorado Water Rights to Clifton for Treatment (Full Expansion, 24 inch)	$44,600,000	$3.43/gal	$37,300,000 Clifton WTP expansion with evap. ponds $7,300,000 Pipeline
11	Transfer Colorado Water Rights to Clifton for Treatment (Partial Expansion, 20 inch)	$25,300,000	$3.16/gal	$19,400,000 Clifton WTP expansion with evap. ponds $5,900,000 Pipeline
12	Route Gunnison to Clifton WTP	$44,600,000	$4.31/gal	Same as Option 10
13	Purchase Treated Water from Ute (Breakpoint Chlorination)	$3,300,000	$0.25/gal	Excluding CCS, blending study, monitoring costs
14	Purchase Treated Water from Ute (Chloramine Conversion)	$3,500,000	$0.27/gal	Excluding CCS, blending study, monitoring costs

4.2.3 Operating Costs

Operations and maintenance (O&M) costs were developed under the following assumptions:

- Operating costs are based on one month use of the alternate source at current peak day flow (9.8 mgd). This value was chosen to compare to current baseline O&M costs. If option provides less than 9.8 mgd, cost is based on the lower value.
- O&M costs include chemical and electricity usage
- O&M costs exclude consumables and labor
- Treatment costs based on typical cost per 1,000 gallon (kgal) from white paper research:
    - $0.50/kgal for lime softening
    - $1.00/kgal for reverse osmosis
- Gunnison River Options
    - $35,000 pumping cost for 9.8 mgd
    - $5,000 pumping cost for 2 mgd (Option 4)
- O&M cost equivalent for KCFL is equivalent to the existing PMFL ($88,000/month)
- O&M cost for new Kannah Creek WTP (Option 8) equivalent to existing WTP
- Hydro-turbine operating costs
    - Power generation estimated 370 psi available head at average flow of 5.3 mgd
    - Turbine efficiency 73%
    - Energy cost savings of $0.034/kWh
    - Electrical demand charge savings vary seasonally between $18 and $23 per kW
- Clifton Interconnect Options
    - Purchase cost of treated water includes O&M cost (e.g. pump costs from CWD)
    - Current agreement of $0.30/kgal treated water between the City and CWD may need to be renegotiated
- Ute Interconnect Options
    - Purchase cost of treated includes O&M cost (e.g. pump costs from Ute)
    - No current agreement for treated water.
    - City and Ute to negotiate bulk purchase agreement.
        - Ute water rates as published on the City's website.
        - Assumed Ute's cost to supply water is their Tier 2 rate of $3.70/kgal
        - Assumed purchase cost of Tier 3 rate of $4.20/kgal for purposes of this study.

A comparison of the O&M costs versus the bulk water purchase costs is shown in Table 9.

Table 9: Summary of Purchase and Operating Costs by Month

	Option	Purchase Cost	O&M Cost	Total Cost
1	Treat Gunnison by Lime Softening	NA	$233,000	$233,000
2	Treat Gunnison by Reverse Osmosis	NA	$379,000	$379,000
3	Settle Gunnison in Existing Reservoirs and Blend with Clifton	$70,000	$93,000	$163,000
4	Settle Gunnison in Existing Reservoirs and Use for Raw Water	NA	$93,000	$93,000
5	Replace KCFL (24 inch)	NA	$88,000	$88,000
6	Replace KCFL (20 inch)	NA	$88,000	$88,000
7	Replace KCFL (24 inch) and Add Turbine	NA	$71,000	$71,000
8	New WTP in Kannah Creek Watershed	NA	$88,000	$88,000
9	Clifton Water Emergency Interconnect	$50,000	$18,000	$68,000
10	Transfer Colorado Water Rights to Clifton for Treatment (Full Expansion, 24 inch)	$88,000	NA	$88,000
11	Transfer Colorado Water Rights to Clifton for Treatment (Partial Expansion, 20 inch)	$72,000	NA	$72,000
12	Route Gunnison to Clifton WTP	$88,000	NA	$88,000
13	Purchase Treated Water from Ute (Breakpoint Chlorination)	$1,222,000	$30,000	$1,252,000
14	Purchase Treated Water from Ute (Chloramine Conversion)	$1,222,000	$30,000	$1,252,000

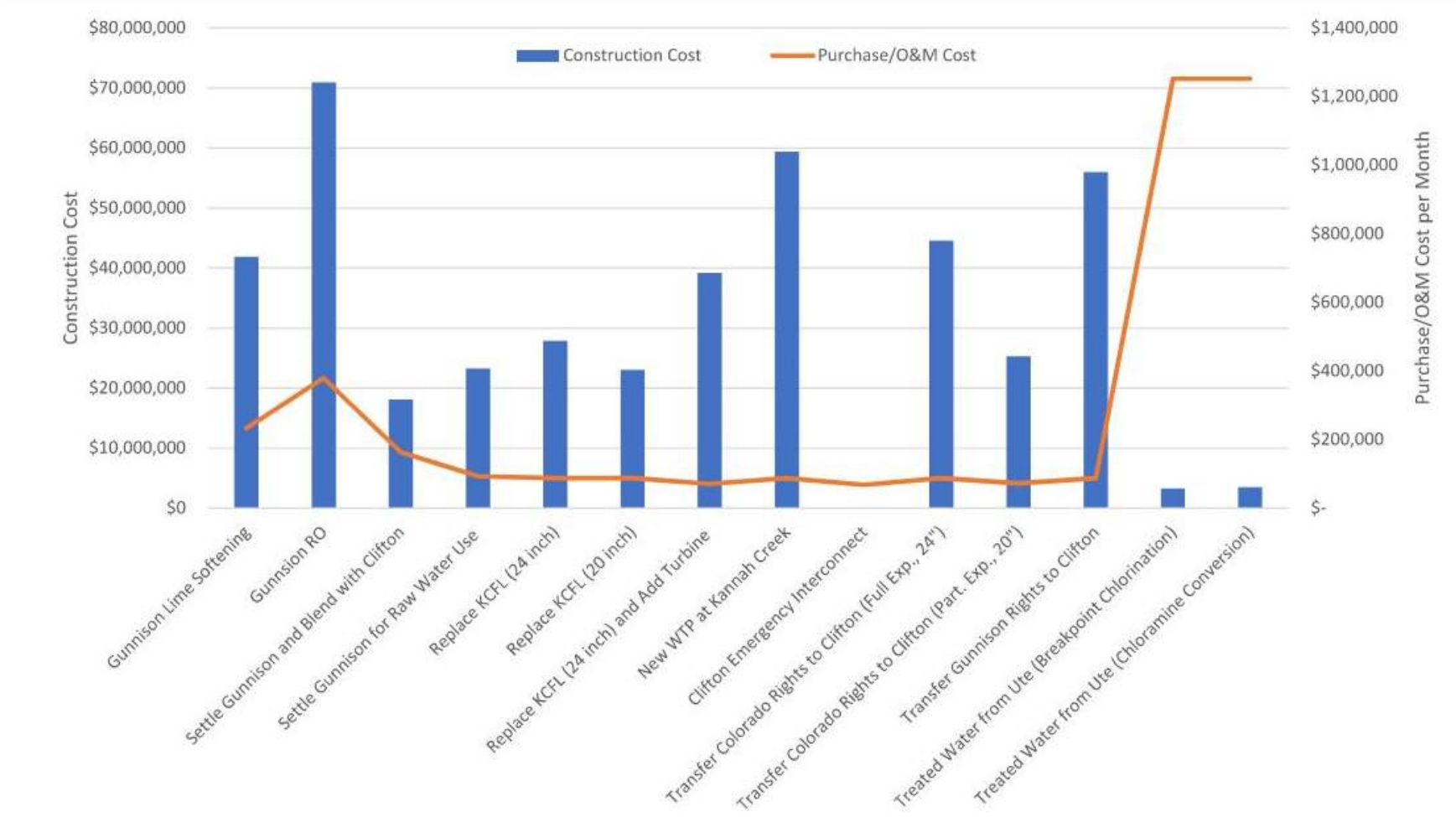

Figure 28: Comparison of Construction and O&M Costs

5 EVALUATION

The Project Team held a series of meetings in order to develop the Options for alternative water supplies. A Selection Workshop was held in January 2020 to evaluate the identified Options and select the preferred Option for conceptual design. The Project Team included the Utilities Director, Water Services Manager, Water Operations, Water Distribution, Asset Management and BMcD. The results of this initial Selection Workshop are document in Appendix C.

Three additional Options were added in April 2020 following a meeting with key stakeholders from the City. The Options were then re-ranked using a qualitative, non-monetary selection criteria. The results of the second evaluation are presented in the following sections.

5.1 Initial Screening

The following options are recommended for disqualification from the evaluation for the reasons presented in Table 9.

Table 10: Disqualified Options

	Option	Reason
2	Treat Gunnison by Reverse Osmosis	High capital cost to treat Gunnison River Option 1 (lime softening) provides lower cost of treatment
4	Settle Gunnison in Existing Reservoirs and Use for Raw Water	Does not provide acceptable water quality for raw water irrigation
7	Replace KCFL (24 inch) and Add Turbine	Feasibility not confirmed with Grand Valley Power. Potential energy production of turbine does not pay for extensive electrical upgrades
8	New WTP in Kannah Creek Watershed	High capital cost for new facility New WTP is redundant to the existing WTP KCFL update required to deliver water to City
9	Clifton Water Emergency Interconnect	Does not provide a fully redundant alternative Capacity well less than future peak day demand of 13 mgd
12	Route Gunnison to Clifton WTP	High infrastructure cost to send Gunnison River to Clifton replaced by water transfer Transfer City's Colorado River rights to Clifton and replace with City's Gunnison River allocation at confluence Becomes same as Option 10

Table 11: Options Evaluated by Project Team

#	Option
1	Treat Gunnison River by Lime Softening
3	Settle Gunnison River in Existing Reservoirs and Blend with Clifton
5	Replace Kannah Creek Flow Line (24 inch)
6	Replace Kannah Creek Flow Line (20 inch)
10	Transfer Colorado River Rights to Clifton for Treatment (Full Expansion, 24 inch)
11	Transfer Colorado River Rights to Clifton for Treatment (Partial Expansion, 20 inch)
13	Purchase Treated Water from Ute (Breakpoint Chlorination)
14	Purchase Treated Water from Ute (Chloramine Conversion)

5.2 Scoring of Options

A multi-step process was used to evaluate the technical, qualitative, and monetary criteria of each option. The first step involved developing the non-monetary criteria and then ranking the criteria in a Workshop with the Project Team. The selected criteria are shown in Table 12.

Table 12: Selection Criteria

Criteria Category	Description
Operational Redundancy	Ability to provide full redundancy of up to 13 mgd to the Purdy Mesa flowline. Options scoring high in this category can provide full redundancy to Purdy Mesa flowline without concern over water rights. Low scoring options do not provide the full capacity of 13 mgd.
Raw Water Quality	Measure of the raw water quality of the source water(s) included within the option. Options scoring high in this category mean the sources have water quality similar to Purdy Mesa. Low scoring options have poor source water quality.
Finished Water Quality	Measure of the anticipated finished water quality as a result of the treatment associated with the option. Options scoring high in this category mean the treatment is expected to produce finished water similar or better than the current WTP. This criteria also considers the satisfaction of raw water customers.
Long Term Resiliency	Ability to supply raw water from an alternative source in the event of a long term interruption to the City's primary source (Juniata Reservoir and Kannah Creek watershed).
Complexity of Sources	Evaluates the number of sources required to provide a fully-redundant capacity and the complexity to operate multiple sources. Options scoring high in this category only require one source to create redundancy.
Ease of Operations	Evaluates the complexity of operations and maintenance, number of treatment process steps and units and chemical dosing systems associated with the option. Options scoring high in this category apply operating procedures similar or less complex than the current WTP.
Public Perception	Evaluates the public perception to the alternate water source. Public opinion prefers elevated sources, considered pristine mountain source. Less favorable view of using river sources.

The second step ranked the non-monetary criteria used a paired comparison to identify the weighting for each criterion (Table 13). Each criteria were paired against the other criteria, with the criteria of higher importance being preferred. The alphanumeric identification of the preferred criteria is recorded in Table 13 (e.g. B). Then the degree to which the criteria was preferred were scored on their relative importance on a scale of 1 to 3, with 3 as a high importance. The numeric score of the preferred criteria is recorded in Table 13 (e.g. 2), resulting in a paired score (e.g. B2).

Table 13: Weighted Criteria

DEVELOP CRITERIA & WEIGHTED MATRIX										
ITEM	CRITERIA	RELATIVE IMPORTANCE							SCORE	NORMALIZED
A	Operational Redundancy	A	A 3	A 3	A 1	A 1	A 2	A 1	11	2.9
B	Raw Water Quality		B	C 3	D 2	B 2	B 1	G 3	3	0.8
C	Finished Water Quality			C	D 2	C 1	C 2	C 1	7	1.8
D	Long Term Resiliency				D	D 1	F 1	G 2	5	1.3
E	Complexity of Sources					E	E 3	G 2	3	0.8
F	Ease of Operations						F	G 1	1	0.3
G	Public Perception							G	8	2.1
Directions: For each pair, select the more important criteria. Then choose a relative importance between 1-3 (3 as high importance).									38	10

Next, the Project Team scored each Option against the criteria on a scale of 1 to 5, with 5 being high (Table 14).

Table 14: Scored Options

SCORE OPTIONS								
Option	Operational Redundancy	Raw Water Quality	Finished Water Quality	Long Term Resiliency	Complexity of Sources	Ease of Operations	Public Perception	Total
Option 1: Treat GR by Lime Softening	5	1	2	5	1	1	1	16
Option 3: Blend GR with Clifton	5	2	1	5	1	2	2	18
Option 5: 24" KCFL	5	5	5	2	5	5	5	32
Option 6: 20" KCFL	5	5	5	2	5	4	5	31
Option 10: Transfer Add. CR to Clifton, Full Ex., 24 in	5	1	3	5	2	3	3	22
Option 11: Transfer Add. CR to Clifton, Part. Ex., 20 in	3	1	3	5	2	3	3	20
Option 13: Purchase Treated Ute Water, Breakpoint Chlor.	5	4	4	4	4	4	4	29
Option 14: Purchase Treated Ute Water, Chloramines	5	4	5	3	4	3	4	28
Directions: Score each option for each criteria between 1-5 (5 is high).								

The weighting criteria was then applied to the scores to establish a weighted score (Table 15).

Table 15: Weighted Scored Options

WEIGHT SCORED OPTIONS								
Option	Operational Redundancy	Raw Water Quality	Finished Water Quality	Long Term Resiliency	Complexity of Sources	Ease of Operations	Public Perception	Total
Option 1: Treat GR by Lime Softening	55	3	14	25	3	1	8	109
Option 3: Blend GR with Clifton	55	6	7	25	3	2	16	114
Option 5: 24" KCFL	55	15	35	10	15	5	40	175
Option 6: 20" KCFL	55	15	35	10	15	4	40	174
Option 10: Transfer Add. CR to Clifton, Full Ex., 24 in	55	3	21	25	6	3	24	137
Option 11: Transfer Add. CR to Clifton, Part. Ex., 20 in	33	3	21	25	6	3	24	115
Option 13: Purchase Treated Ute Water, Breakpoint Chlor.	55	12	28	20	12	4	32	163
Option 14: Purchase Treated Ute Water, Chloramines	55	12	35	15	12	3	32	164
Directions: Table autopopulates based on weight of criteria and scored options.								

High Score	Option 5: 24" KCFL

The Options were then ranked by their weighted score and compared against the EOPCC (Table 16). The cost/benefit for each Option was calculated by dividing the EOPCC by the weighted score. A low cost/benefit indicates a favorable Option, with more benefit achieved at a lower cost investment.

Table 16: Comparison of EOPCC and Weighted Score

Comparison of EOPCC and Weighted Score				
Option		EOPCC	Weighted Score	Cost/Benefit
Option 5: 24" KCFL	$	27,900,000	175	$ 159,000
Option 6: 20" KCFL	$	22,200,000	174	$ 128,000
Option 14: Purchase Treated Ute Water, Chloramines	$	3,500,000	164	$ 21,000
Option 13: Purchase Treated Ute Water, Breakpoint Chlor.	$	3,300,000	163	$ 20,000
Option 10: Transfer Add. CR to Clifton, Full Ex., 24 in	$	44,600,000	137	$ 326,000
Option 11: Transfer Add. CR to Clifton, Part. Ex., 20 in	$	25,300,000	115	$ 220,000
Option 3: Blend GR with Clifton	$	18,100,000	114	$ 159,000
Option 1: Treat GR by Lime Softening	$	41,900,000	109	$ 384,000

Figure 29 presents the relative benefit of the evaluated Options against their EOPCC.

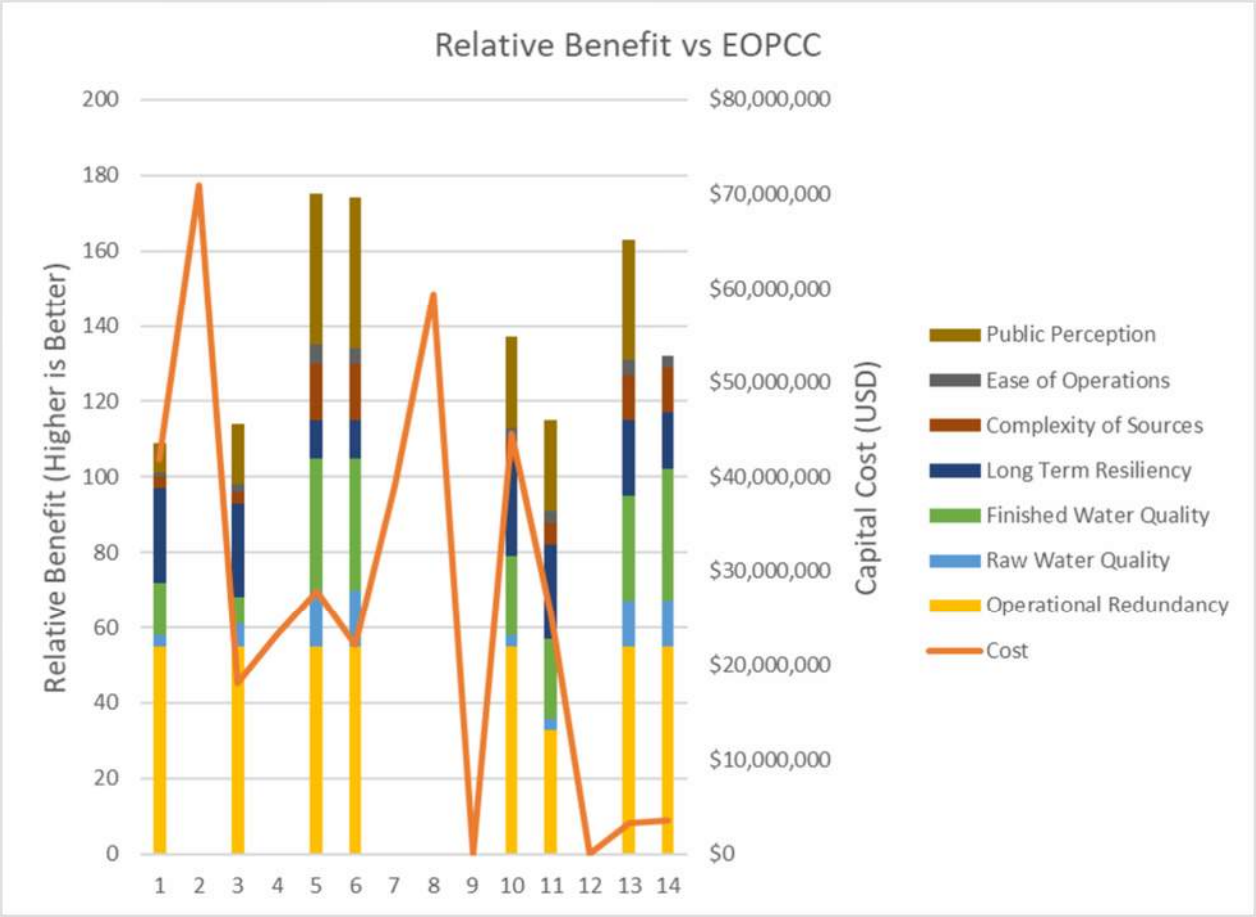

Figure 29: Relative Benefit of Each Option

Figure 30 presents the relative cost/benefit for each Option.

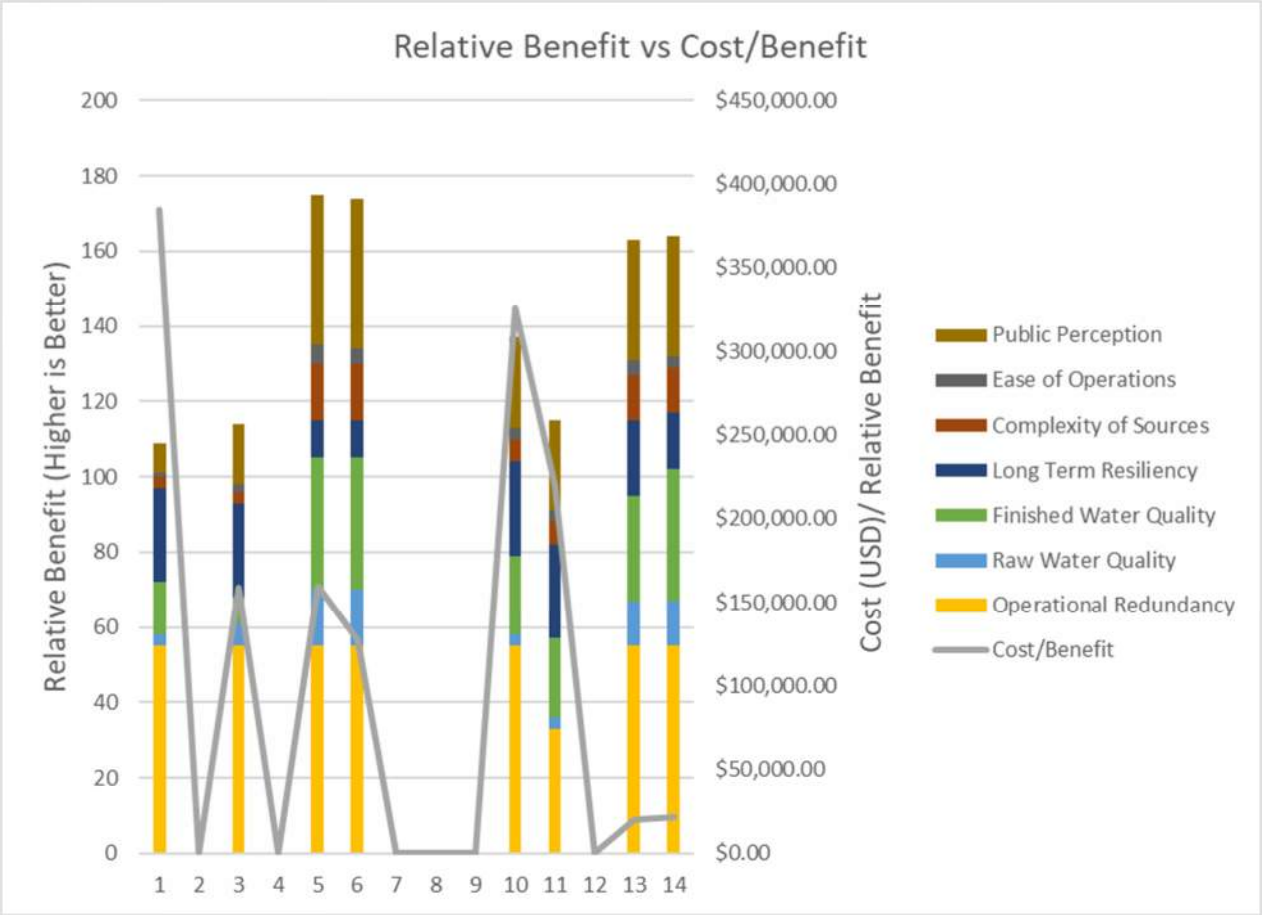

Figure 30: Relative Cost/Benefit of Each Option

The Options were also compared against the operating costs (Table 17). The cost/benefit for each Option was calculated by dividing the EOPCC by the weighted score. A low cost/benefit indicates a favorable Option, with more benefit achieved at a lower cost investment.

Table 17: Comparison of Operating Cost and Weighted Score

Comparison of Monthly Operating Cost and Weighted Score					
Option	Monthly Op. Cost		Weighted Score	Op. Cost/Benefit	
Option 5: 24" KCFL	$	88,000	175	$	500
Option 6: 20" KCFL	$	88,000	174	$	510
Option 14: Purchase Treated Ute Water, Chloramines	$	1,252,000	164	$	7,630
Option 13: Purchase Treated Ute Water, Breakpoint Chlor.	$	1,252,000	163	$	7,680
Option 10: Transfer Add. CR to Clifton, Full Ex., 24 in	$	88,000	137	$	640
Option 11: Transfer Add. CR to Clifton, Part. Ex., 20 in	$	72,000	115	$	630
Option 3: Blend GR with Clifton	$	163,000	114	$	1,430
Option 1: Treat GR by Lime Softening	$	233,000	109	$	2,140

Figure 31 presents the relative benefit of the evaluated Options against their monthly operating cost.

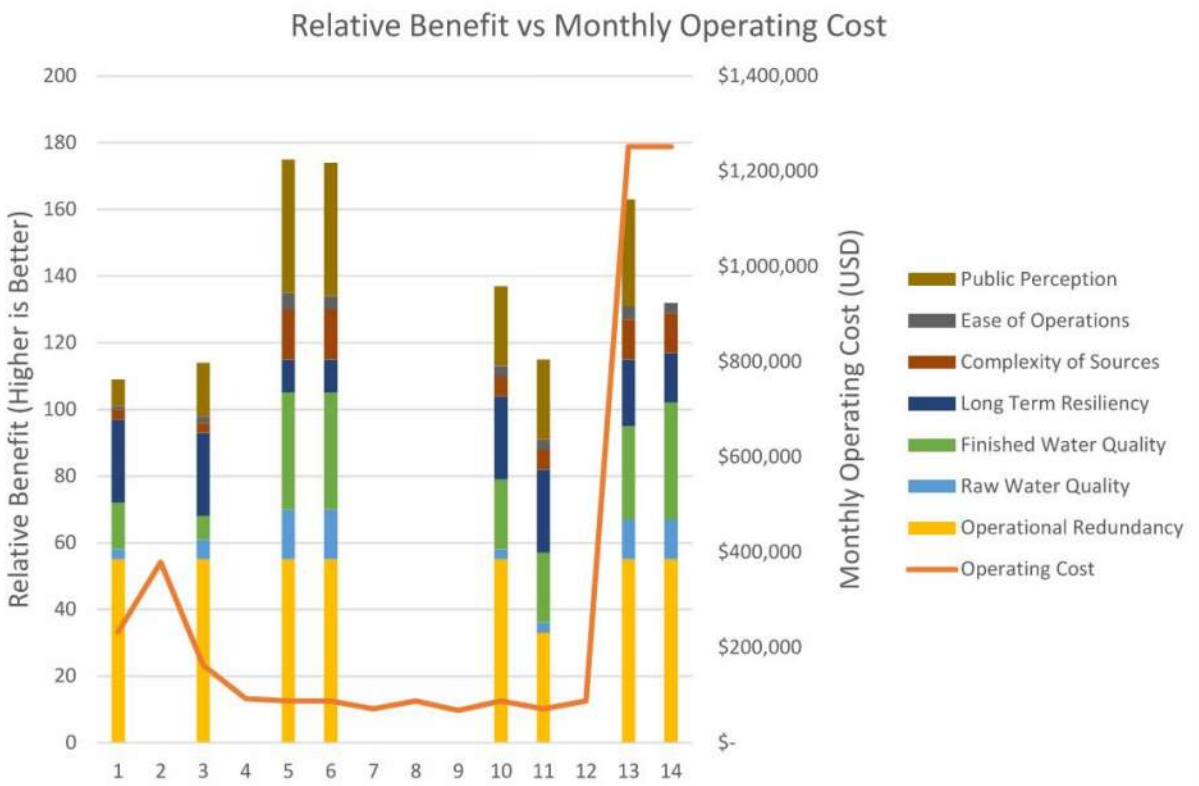

Figure 31: Relative Benefit of Each Option vs Monthly Operating Cost

Figure 32 presents the relative cost/benefit for each Option.

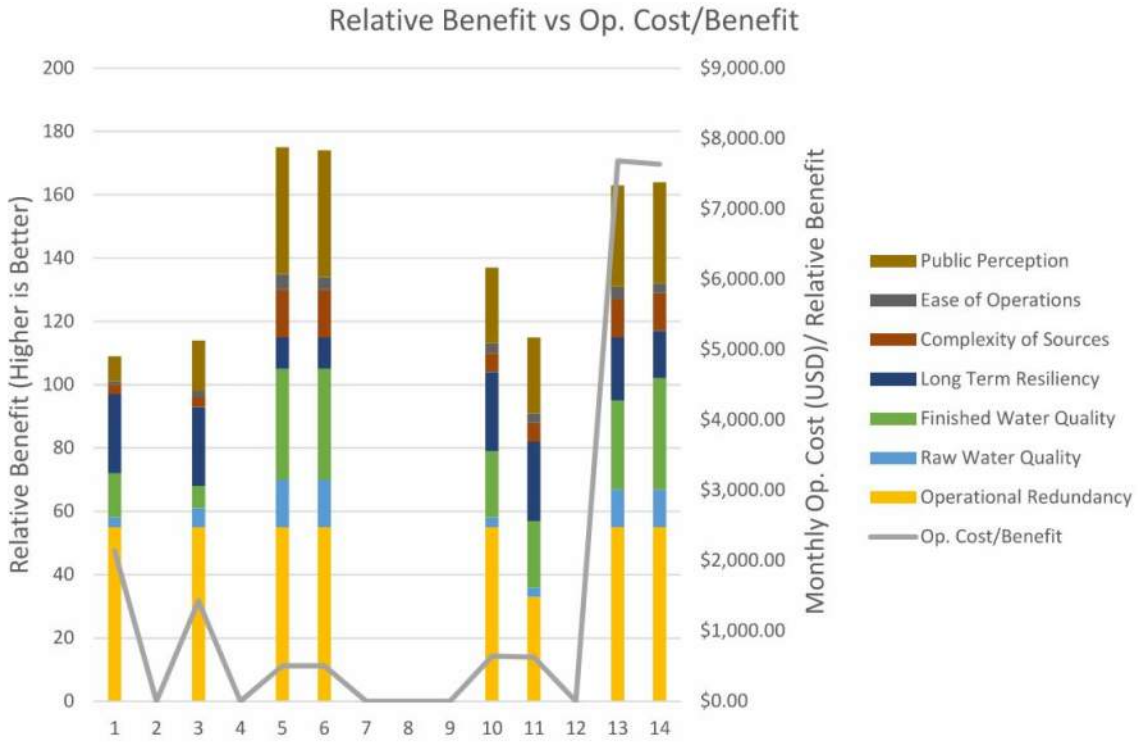

Figure 32: Relative Operating Cost/Benefit of Each Option

Options receiving high weighted scores include the both KCFL replacement Options (Option 5 and 6) and both Ute Options (Option 14 and 15). Option 14 has the lowest cost/benefit ratio for construction cost, while Option 5 has the lowest cost/benefit ratio for operating costs.

6 CONCLUSIONS

6.1 Scoring Results

Table 18 summarizes the Options that received the highest weighted scores.

Table 18: Highest Weighted Scores

#	Option	Weighted Score	Primary Criteria
5	Replace Kannah Creek Flow Line (24 inch)	175	Operational Redundancy
6	Replace Kannah Creek Flow Line (20 inch)	174	Operation Redundancy
13	Purchase Treated Water from Ute (Breakpoint Chlorination)	164	Long Term Resiliency
14	Purchase Treated Water from Ute (Chloramine Conversion)	163	Long Term Resiliency

The scoring indicates two types of projects will provide benefit to the City, but the nature of their benefit differs. The KCFL options provide multiple ways to access the full water rights from the Purdy Mesa. This prioritizes operational redundancy. However, the KCFL options do not provide long term resiliency for the City as a source interruption would leave the City without a water supply. In this case, the City has the option to pursue either interconnects with Clifton or Ute. The two Ute options scored higher as a mountain source with minimal capital improvements required.

6.1.1 Operational Redundancy – KCFL Replacement

The two KCFL Options scored very similarly, with high scores across all criteria. A new KCFL will provide operational redundancy to the PMFL but does not provide long term resiliency. Raw and Finished Water Quality from a replaced KCFL will be similar to the current conditions because it will draw from the same Juniata Reservoir and Kannah Creek sources. This fact contributed to the high score for Complexity of Sources by remaining consistent with current operational practices. Public Perception is expected to remain favorable for continuing with the higher quality mountain sources accessed from the KCFL. Some regulatory challenges are anticipated related to right of way and easement access along the KCFL pipeline route. The 24-inch Option scored higher in Ease of Operation due to only one PRV chamber when compared with two PRV chambers on the 20-inch Option.

The two KCFL Options received high weighted scores, with the 24-inch Option (175 points) slightly higher than the 20-inch Option (174 points) because of the higher complexity of operating two PRV chambers on the 20-inch pipeline. The hydraulic capacity of the 20-inch Option (9.5 mgd) does not supply the future peak day demand of 13 mgd. The 24-inch Option received the highest weighted score and provides a greater hydraulic capacity than the 20-inch Option. The City retains their independence and control of its water supply with both KCFL Options. The cost/benefit of the 24-inch Option was $159,000 per weighted score point for construction cost, while the op. cost/benefit was $500 per weighted score point.

6.1.2 Long Term Resiliency – Ute Interconnection

The two Ute Options also scored high across all criteria, however, operational challenges associated with the blending of the two sources affected the Complexity of Sources and Ease of Operations scores. Further study and a CCS are recommended before the blending of Ute waters into the City's distribution system. This will involve review and approvals by CDPHE before implementation. Public Perception is expected to be favorable with Ute's mountain source in comparison to Clifton's river source. The Ute Options will be implemented at a much lower construction cost when compared with other Options, resulting in a significantly lower cost/benefit ratio.

An interconnection agreement with Ute must be negotiated to confirm bulk water purchase costs before the financial impact of this Option are fully understood. The Ute Option will increase the City's reliance on another government entity for its back-up supply, but it also provides both operational redundancy and long term resiliency where the KCFL options do not. However, Option 14 would result in a loss in the ability to trade water with Clifton easily.

The Ute Options warrant further investigation if the City is interested in pursuing a lower cost Option ($3,300,000/$3,500,000) with a relatively high weighted score (164/163 points) to increase long term resiliency. This Option resulted in a lower cost/benefit score ($21,000/$20,000 per weighted score point) due to its low estimated construction cost. However, these Options also resulted in a significantly higher op. cost/benefit score ($7,630/$7,680 per weighted score point). The Ute Options will require dependence on another government agency and the City will not be providing their own water. The bulk water purchase cost, future Ute water demands, and water quality studies (corrosion control and disinfection by-products) require additional investigation.

6.1.3 Other Options

Treatment Options using the Gunnison River at the City's WTP or the Colorado River at Clifton's WTP did not score well in Finished Water Quality, Complexity of Sources, and Public Perception. Additionally, these Options had comparatively high cost/benefit ratios due to their high construction and operating costs.

6.2 Recommendations

It is recommended to implement the following:

1. Implement either KCFL Option for operational redundancy from the Purdy Mesa source. Consider the benefit of 20 or 24-inch diameter pipeline against the overall project cost.

2. Investigate the feasibility of a Ute interconnection for long term resiliency. Start preliminary discussions with Ute on the terms and bulk purchase cost in a formal interconnection agreement. Determine the City's preference for break-point chlorination of Ute treated water at the WTP or conversion of the City to chlormamines to facilitate multiple Ute interconnection in the distribution system.

3. Start the design and construction of the Juniata Reservoir Interconnect to create access to both the Juniata Reservoir and the Kannah Creek watersheds from either the PMFL or KCFL, regardless of which Option is selected.

APPENDIX A – DETAILED SCOPE BY OPTION

Option 1: Treat Gunnison River by Lime Softening	
Gunnison River Pump Station Improvements	Five vertical turbine pumps (4 duty, 1 standby) • Rated for 2,246 gpm @ 250 foot TDH • Maximum speed of 1800 RPM • 200 HP Motor, VFD • Oil lubricated enclosed line shaft, bowl assembly, inlet strainer • Up to 20 foot setting depth • Fabricated steel discharge head with single mechanical seal • Fitted into existing wet well Pump Station Building • Demolish existing above grade building • Raise floor above floodplain • 20 foot by 20 foot masonry building with steel roof • Replace electrical systems
Lime Softening Clarifiers, Dewatering Systems, and Building	Three softening clarifiers (2 duty, 1 standby) • 3470 gpm/clarifier • 0.75 to 1 gpm/sf • 76 foot diameter • Coated Steel Basins • Lime slurry feed silo • Carbon dioxide feed • Soda ash feed Dewatering Systems • Belt filter presses • Solids feed pumps and conveyors Chemical Feed and Solids Handling Building • 75 foot by 75 foot masonry building with steel roof
Filter Feed Pump Station	Filter Feed Pumps: • Five vertical turbine pumps (4 duty, 1 standby) • Rated for 2,246 gpm @ 30 foot TDH • Maximum speed of 1200 RPM • 30 HP Motor, VFD • Oil lubricated enclosed line shaft, bowl assembly, inlet strainer • Up to 20 foot setting depth • Fabricated steel discharge head with single mechanical seal Pump Station • New concrete wet well • 30 foot by 30 foot masonry building near PS3
Disclaimer: Equipment selections are based on representative projects in Colorado and engineers' experience. The information presented is intended to provide sizing in order to estimate costs.	

Option 2: Treat Gunnison River by Reverse Osmosis	
Gunnison River Pump Station Improvements	Five vertical turbine pumps (4 duty, 1 standby) • Rated for 2,246 gpm @ 250 foot TDH • Maximum speed of 1800 RPM • 200 HP Motor, VFD • Include an oil lubricated enclosed line shaft, bowl assembly, inlet strainer • Up to 20 foot setting depth • Fabricated steel discharge head with single mechanical seal • Fitted into existing wet well Pump Station Building • Demolish existing building • Raise floor above floodplain • 20 foot by 20 foot masonry building with steel roof
Reservoir 3 Pumps	Reservoir 3 Pumps: Five vertical turbine pumps (4 duty, 1 standby) • Rated for 2,778 gpm @ 30 foot TDH • Maximum speed of 1200 RPM • 30 HP Motor, VFD • Include an oil lubricated enclosed line shaft, bowl assembly, inlet strainer • Up to 20 foot setting depth • Fabricated steel discharge head with single mechanical seal • Fitted into existing wet well Pump Station • New concrete wet well • 30 foot by 30 foot masonry building near PS3
Reverse Osmosis System, Brine Disposal System, and Building	13 MGD, Six Train Reverse Osmosis System • 1800 gpm (each train) permeate flow • 85% system design recovery • Includes cartridge filters, RO high pressure pumps, RO skids, interstage booster pumps, system instruments, CIP system, feed tank Brine Disposal System • Four duty, one redundant deep injection wells • Estimated injection rate is 300 to500 gpm, assumed 300 gpm • Pipeline from brine pump station to wells, estimated 14 miles based on minimum distance to reach outside of town limits and minimum of 1 mile between wells Building • Concrete masonry with steel roof • Assumed 75 foot by 100 foot

Option 3: Settle Gunnison River in Existing Reservoirs and Blend with Clifton	
Gunnison River Pump Station Improvements	Three vertical turbine pumps (2 duty, 1 standby) • Rated for 1,042 gpm @ 250 foot TDH • Maximum speed of 1200 RPM • 100 HP Motor, VFD • Include an oil lubricated encased line shaft, bowl assembly, inlet strainer • Up to 10’ setting depth • Fabricated steel discharge head with single mechanical seal • Fitted into existing wet well Pump Station Building • Demolish existing above grade building • Raise floor above floodplain • 20’x20’ masonry building with steel roof • Replace electrical systems
Reservoir 3 Pumps	Reservoir 3 Pumps: Five vertical turbine pumps (4 duty, 1 standby) • Rated for 2,778 gpm @ 30 foot TDH • Maximum speed of 1200 RPM • 30 HP Motor, VFD • Include an oil lubricated enclosed line shaft, bowl assembly, inlet strainer • Up to 20 foot setting depth • Fabricated steel discharge head with single mechanical seal • Fitted into existing wet well Pump Station • New concrete wet well • 30 foot by 30 foot masonry building near PS3
Pipeline	• Alignment from Clifton WTP to City’s WTP • 10.25 mile, 20 inch diameter pipeline • Open-Cut Installation • Utilize existing pedestrian bridge on Colorado River

Option 4: Settle Gunnison River in Existing Reservoirs and Use for Raw Water Irrigation	
Gunnison River Pump Station Improvements	Three vertical turbine pumps (2 duty, 1 standby) • Rated for 1,042 gpm @ 250 foot TDH • Maximum speed of 1200 RPM • 100 HP Motor, VFD • Include an oil lubricated encased line shaft, bowl assembly, inlet strainer • Up to 20 foot setting depth • Fabricated steel discharge head with single mechanical seal • Fitted into existing wet well Pump Station Building • Demolish existing above grade building • Raise floor above floodplain • 20 foot by 20 foot masonry building with steel roof • Replace electrical systems
Pipeline	• KCFL replacement • 16 mile, 24 inch diameter pipeline • Open-Cut Installation • New interconnect with PMFL near Juniata Reservoir

Option 5: Replace Kannah Creek Flow Line (24 inch)	
Pipeline	• KCFL replacement • 16 mile, 24 inch diameter pipeline • DR18 PRV, 235 psi rated • Open-Cut Installation • New Juniata Reservoir Interconnection with PMFL • New PRV chamber near toe of mesa to maintain pressures over Whitewater Hill

Option 6: Replace Kannah Creek Flow Line (20 inch)	
Pipeline	• KCFL replacement • 16 mile, 20 inch diameter pipeline • DR18 PVC, 235 psi rated upstream • DR14 PVC, 300 psi rated upstream • Open-Cut Installation • New Juniata Reservoir Interconnection with PMFL • Two new PRV chamber to control pressures to the pipe pressure rating along the KCFL

Option 7: Replace Kannah Creek Flow Line (24 inch) and Add Turbine	
Turbine	• 700 kW running year round • Locate at 1,000 foot hydraulic grade drop at PRV station • Sell generated electricity back to grid (Grand Valley Power) • Must confirm capacity of substation to receive the generated electricity • Route to nearest substation approximately 6 miles through overhead wire
Pipeline	• KCFL replacement • 16 mile, 24 inch diameter pipeline • DR18 PRV, 235 psi rated • Open-Cut Installation • New Juniata Reservoir Interconnection with PMFL • New PRV chamber near toe of mesa to maintain pressures over Whitewater Hill

Option 8: New WTP in Kannah Creek Watershed	
Water Treatment Plant	• Raw Water Intake • Low Lift Pump Station • Flocculation and Sedimentation • Media Filters • Chemical Systems
Pipeline	• KCFL replacement • 16 mile, 24 inch diameter pipeline • Open-Cut Installation • New interconnect with Purdy Mesa near Juniata Reservoir

Option 9: Purchase Clifton Water (Intentionally Omitted, No Construction Scope)

Option 10: Transfer Colorado River Rights to Clifton for Treatment (Full Expansion, 24 inch)	
Clifton WTP Plant Modifications	• No modifications to the existing Clifton intake on the Colorado River • Two new raw water pumps at 4,250 gpm • No modifications to existing raw water settling pond • One new pretreatment train sized for 8 mgd o New rapid mix o Four stage flocculation o Inclined plate settlers o Solids collection system • Microfiltration system expansion from 12 to 21 mgd o Three new MF feed pumps at 2,380 gpm o One new MF feed strainer o Three new MF racks o Populate spare 15% in existing 8 MF racks o No changes to existing clean in place, blower or air compressor o Fit inside existing building (space available) • Nanofiltration system expansion from 2.4 to 4.2 mgd o Two new NF feed pumps o Five new dual media filters o Four new cartridge filters o Three new NF racks • Expand chlorine contact tank from 68,000 to 120,000 gallons • Two new high service pumps • Expand evaporation ponds by 50 acres
Pipeline from Clifton to 30th Rd	• 4 mile, 24 inch diameter pipeline • Open-Cut Installation • See map of estimated alignment in Figure 22

Option 11: Transfer Colorado River Rights to Clifton for Treatment (Partial Expansion, 20 inch)	
Clifton WTP Plant Modifications	• No modifications to the existing Clifton intake on the Colorado River • One new raw water pumps at 4,250 gpm • No modifications to existing raw water settling pond • No new pretreatment train sized for 8 mgd • Microfiltration system expansion from 12 to 16 mgd o Two new MF feed pumps at 2,380 gpm o One new MF feed strainer o One new MF racks o Populate spare 15% in existing 8 MF racks o No changes to existing clean in place, blower or air compressor o Fit inside existing building (space available) • Nanofiltration system expansion from 2.4 to 3.6 mgd o One new NF feed pumps o Three new dual media filters o Two new cartridge filters o Two new NF racks • Expand chlorine contact tank • One new high service pumps • Expand evaporation ponds by 35 acres

Pipeline from Clifton to 30th Rd	• 4 mile, 20 inch diameter pipeline • Open-Cut Installation • See map of estimated alignment in Figure 22

Option 12: Route Gunnison to Clifton WTP from Current Intake (Same as Option 10)

Option 13: Purchase Treated Water from Ute (Breakpoint Chlorination)	
Pipeline from Linden Vault to WTP	• 1 mile, 24 inch diameter pipeline • Open-Cut Installation
Breakpoint Chlorination Station	• In-line mixer • Injection quill • Chemical feed pumps • FRP storage tanks • Expand existing on-site sodium hypochlorite generation system • Chemical feed and misc. internal piping. • No building expansion

Option 14: Purchase Treated Water from Ute (Chloramine Conversion)	
Vault Modifications	• Modifications for flow control
Chloramine Conversion	• In-line mixer • Injection quill • Chemical feed pumps • FRP storage tanks • LAS system • Chemical feed and misc. internal piping. • 700 sq ft building expansion

APPENDIX B – EOPCC WORKSHEETS

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 03/16/2020
Made by - MAL
Checked by - KK
AACE Class 4 Estimate[1]

Option 1: Treat Gunnison River by Lime Softening

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment and Materials							
Gunnison River Pumps	5	3.3	MGD	$125,000	$625,000	1.3	$812,500
Softening Clarifiers, Dewatering Systems[2]	3	5	MGD	$1/gal	$13,000,000	1.3	$16,900,000
Post-Clarifier Pumps	5	3.3	MGD	$50,000	$250,000	1.3	$325,000
Corrosion Control System	1			$100,000	$100,000	1.3	$130,000
Chemical Systems	3			$100,000	$300,000	1.3	$390,000
TOTAL EQUIPMENT					$14,275,000	IE=	$18,557,500
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
GR Pump Station Building	1	400	sq ft	$ 750	$300,000	1	$300,000
Floor Demolition					$50,000	1	$50,000
New Raised Floor					$100,000	1	$100,000
Filter Feed PS Building	1	900	sq ft	$ 750	$675,000	1	$675,000
							$0
Misc. Civil & Structural (Including Yard Piping)					% of IE	5%	$927,875
Electrical					% of IE	12%	$2,226,900
Instrumentation					% of IE	4%	$742,300
TOTAL UNMARKED UP COST							$23,579,575
GENERAL REQUIREMENTS					% of Above	8%	$1,886,400
CONTRACTOR O&P					% of Above	10%	$2,546,600
TOTAL CONSTRUCTION COST							$28,012,575
DESIGN & CONSTRUCTION PHASE ENG. SERVICES					% of Above	15%	$4,201,900
CONTINGENCY[3]					% of Above	30%	$9,664,300
TOTAL WITH CONTINGENCY							$41,900,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2- Estimate for softening clarifiers and dewatering systems includes price of Dewatering and Chemical Feed Building. One clarifier is redundant, and unit cost is based on gallons of treated water.
3 - Contingency of 30% based on limited design development.

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 03/16/2020
Made by - MAL
Checked by - KK
AACE Class 4 Estimate[1]

Option 2: Treat Gunnison River by Reverse Osmosis

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment and Materials							
Gunnison River Pumps	5	3.3	MGD	$125,000	$625,000	1.3	$812,500
Reservoir 3 Pumps	5	3.3	MGD	$50,000	$250,000	1.3	$325,000
Reverse Osmosis	1	13	MGD	$6,000,000	$6,000,000	1.3	$7,800,000
Chemical Systems	5			$100,000	$500,000	1.3	$650,000
Sulfuric Acid							
Anti-Scalant							
High pH Cleaner							
Low pH Cleaner							
Corrosion Control							
RO Feed Tank	1			$200,000	$200,000	1.3	$260,000
TOTAL EQUIPMENT					$7,575,000	IE=	$9,847,500
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
RO Building	1	6,750	sq ft	$ 500	$3,375,000	1	$3,375,000
GR Pump Station Building	1	400	sq ft	$ 750	$300,000	1	$300,000
Floor Demolition					$50,000	1	$50,000
New Raised Floor					$100,000	1	$100,000
Basin 3 Pump Station Building	1	900	sq ft	$ 750	$675,000	1	$675,000
Misc. Civil & Structural (Including Yard Piping)					% of IE	1%	$98,475
Electrical					% of IE	12%	$1,181,700
Instrumentation					% of IE	6%	$590,850
TOTAL UNMARKED UP COST							$16,218,525
GENERAL REQUIREMENTS					% of Above	8%	$1,297,500
CONTRACTOR O&P					% of Above	10%	$1,751,600
TOTAL CONSTRUCTION COST							$19,267,625
ENGINEERING					% of Above	15%	$2,890,100
CONTINGENCY[2]					% of Above	30%	$6,647,300
TOTAL WITH CONTINGENCY							$28,805,025
BRINE DISPOSAL	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Pipeline to Injection Sites[3]	1	73,920	LF	$100	$7,392,000	1.3	$9,609,600
Deep Injection Wells[4]	5			$5,000,000	$25,000,000	1.3	$32,500,000
BRINE DISPOSAL COST							$42,109,600
TOTAL COST							$70,900,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2 - Contigency of 30% based on limited design development.
3 - Pipeline estimate of 14 miles based on minimum distance to reach outside of town limits and minimum of 1 mile between wells. Actual length could be significantly greater depending on distance of wells from town.
4 - Estimate of five wells based on minimum pumping rate of 300 gpm/well and need for one redundant well.

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 03/16/2020
Made by - MAL
Checked by - KK
AACE Class 4 Estimate[1]

Option 3: Settle Gunnison River and Blend with Clifton

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment and Materials							
Gunnison River Pumps	3			$50,000	$150,000	1.3	$195,000
Chemical Systems for Corrosion	1			$100,000	$100,000	1.3	$130,000
Post-Clarifier Pumps	5	3.3	MGD	$50,000	$250,000	1.3	$325,000
Pipeline from CWD WTP to GJ WTP	54,120	20	in	$200.00	$10,824,000	1	$10,824,000
						IE[2]=	$650,000.00
TOTAL EQUIPMENT					$11,324,000		$11,474,000
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
GR Pump Station Building	1	400	sq ft	$750/sq ft	$300,000	1	$300,000
Floor Demolition					$50,000	1	$50,000
New Raised Floor					$100,000	1	$100,000
PS 3 Building	1	900	sq ft	$ 750	$675,000	1	$675,000
Misc. Civil & Structural (Including Yard Piping)					% of IE	4%	$26,000
Electrical					% of IE	12%	$78,000
Instrumentation					% of IE	4%	$26,000
TOTAL UNMARKED UP COST							$12,729,000
GENERAL REQUIREMENTS					% of Above[3]	8%	$152,400
CONTRACTOR O&P					% of Above[3]	10%	$205,700
TOTAL CONSTRUCTION COST							$13,087,100
ENGINEERING					% of Above	15%	$1,963,100
CONTINGENCY[4]					% of Above	20%	$3,010,000
TOTAL WITH CONTINGENCY							$18,100,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2 - IE only includes major equipment and does not include other materials such as pipeline.
3 -General Requirements and Contractor O&P included in pipeline estimate, so pipeline cost has been excluded from % of Above to prevent double counting.
4 - Contigency of 20% based on uncertainty involved with routing pipeline through city.

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 03/16/2020
Made by - MAL
Checked by -KK
AACE Class 4 Estimate[1]

Option 4: Settle Gunnison River and Use for Raw Water Supply

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment							
Gunnison River Pumps	3	1.5	MGD	$50,000	$150,000	1.3	$195,000
Control Valve and Valve House	1			$325,000	$325,000	1	$325,000
Interconnect between PMFL and KCFL	1			$250,000	$250,000	1	$250,000
KCFL Replacement	84,480	20	in	$200	$16,896,000	1	$16,896,000
						IE[2]=	$520,000
TOTAL EQUIPMENT					$17,621,000		$17,666,000
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
GR Pump Station Building	1	400	sq ft	$750/sq ft	$300,000	1	$300,000
Floor Demolition					$50,000	1	$50,000
New Raised Floor					$100,000	1	$100,000
Misc. Civil & Structural (Including Yard Piping)					% of IE	4%	$20,800
Electrical					% of IE	12%	$62,400
Instrumentation					% of IE	4%	$20,800
TOTAL UNMARKED UP COST							$18,220,000
GENERAL REQUIREMENTS					% of Above[3]	8%	$85,900
CONTRACTOR O&P					% of Above[3]	10%	$116,000
TOTAL CONSTRUCTION COST							$18,421,900
DESIGN & CONSTRUCTION PHASE ENG. SERVICES					% of Above	15%	$2,763,300
CONTINGENCY[4]					% of Above	10%	$2,118,500
TOTAL WITH CONTINGENCY							$23,300,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2 - IE only includes major equipment and does not include other materials such as pipeline.
3 -General Requirements and Contractor O&P included in pipeline estimate, so pipeline cost has been excluded from % of Above to prevent double counting.
4 - Contigency of 10% based on higher level of detail in pipeline estimates.

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 03/16/2020
Made by - MAL
Checked by - KK
AACE Class 4 Estimate[1]

Option 5: Replace Kannah Creek Pipeline (24 in) and Install New Interconnect

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment							
Control Valve and Valve House	1			$350,000	$350,000	1	$350,000
Interconnect between PMFL and KCFL	1			$500,000	$500,000	1	$500,000
KCFL Replacement	84,480	24	in	$250	$21,120,000	1	$21,120,000
						IE[2]=	$350,000
TOTAL EQUIPMENT					$21,970,000		$21,970,000
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
Misc. Civil & Structural (Including Yard Piping)					% of IE	0%	
Electrical					% of IE	0%	
Instrumentation					% of IE	0%	
TOTAL UNMARKED UP COST							$21,970,000
GENERAL REQUIREMENTS					% of Above[3]	8%	$28,000
CONTRACTOR O&P					% of Above[3]	10%	$37,800
TOTAL CONSTRUCTION COST							$22,035,800
DESIGN AND CONSTRUCTION PHASE ENG. SERVICES					% of Above	15%	$3,305,400
CONTINGENCY[4]					% of Above	10%	$2,534,100
TOTAL WITH CONTINGENCY							$27,900,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2 - IE only includes major equipment and does not include other materials such as pipeline.
3 -General Requirements and Contractor O&P included in pipeline estimate, so pipeline cost has been excluded from % of Above to prevent double counting.
4 - Contigency of 10% based on higher level of detail in pipeline estimates.

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 03/16/2020
Made by - MAL
Checked by - KK
AACE Class 4 Estimate[1]

Option 6: Replace Kannah Creek Pipeline (20 in) and Install New Interconnect

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment							
Control Valve and Valve House	2			$325,000	$650,000	1	$650,000
Interconnect between PMFL and KCFL	1			$500,000	$500,000	1	$500,000
KCFL Replacement	84,480	20	in	$200	$16,896,000	1	$16,896,000
						IE[2]=	$650,000
TOTAL EQUIPMENT					$18,046,000		$18,046,000
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
Misc. Civil & Structural (Including Yard Piping)					% of IE	0%	
Electrical					% of IE	0%	
Instrumentation					% of IE	0%	
TOTAL UNMARKED UP COST							$18,046,000
GENERAL REQUIREMENTS					% of Above[3]	8%	$52,000
CONTRACTOR O&P					% of Above[3]	10%	$70,200
TOTAL CONSTRUCTION COST							$18,168,200
DESIGN AND CONSTRUCTION PHASE ENG. SERVICES					% of Above	15%	$2,725,200
CONTINGENCY[4]					% of Above	10%	$2,089,300
TOTAL WITH CONTINGENCY							$23,000,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2 - IE only includes major equipment and does not include other materials such as pipeline.
3 -General Requirements and Contractor O&P included in pipeline estimate, so pipeline cost has been excluded from % of Above to prevent double counting.
4 - Contigency of 10% based on higher level of detail in pipeline estimates.

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 03/16/2020
Made by - MAL
Checked by - KK
AACE Class 4 Estimate[1]

Option 7: Replace Kannah Creek Pipeline, Install New Interconnect and Add Turbine

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment							
Hydro Turbine Equipment	1			$600,000	$600,000	1	$600,000
Electrical Distribution Line[2]	1	34320	ft	$160/LF	$5,500,000	1	$5,500,000
Control Valve and Valve House	1			$350,000	$350,000	1	$350,000
Interconnect between PMFL and KCFL	1			$500,000	$500,000	1	$500,000
KCFL Replacement	84,480	24	in	$250	$21,120,000	1	$21,120,000
						IE[3]=	$6,450,000
TOTAL EQUIPMENT					$28,070,000		$28,070,000
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
Turbine Building	1	1000	sq ft	$500	$500,000	1	$500,000
Misc. Civil & Structural (Including Yard Piping)					% of IE	4%	$258,000
Electrical					% of IE	6%	$387,000
Instrumentation					% of IE	4%	$258,000
TOTAL UNMARKED UP COST							$29,473,000
GENERAL REQUIREMENTS					% of Above[4]	8%	$628,200
CONTRACTOR O&P					% of Above[4]	10%	$848,100
TOTAL CONSTRUCTION COST							$30,949,300
DESIGN AND CONSTRUCTION PHASE ENG. SERVICES					% of Above	15%	$4,642,400
CONTINGENCY[5]					% of Above	10%	$3,559,200
TOTAL WITH CONTINGENCY							$39,200,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2 - Electrical distribution line cost estimate does not include environmental, permitting, or right of way acquisition costs.
3 - IE only includes major equipment and does not include other materials such as pipeline.
4 -General Requirements and Contractor O&P included in pipeline estimate, so pipeline cost has been excluded from % of Above to prevent double counting.
5 - Contigency of 10% based on higher level of detail in pipeline estimates.

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 03/16/2020
Made by - MAL
Checked by - KK
AACE Class 4 Estimate[1]

Option 8: New Water Treatment Plant in Kannah Creek Watershed

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment							
Raw water intake					$500,000	1.3	$650,000
Raw water pumps	4	3.3	MGD	$100,000	$400,000	1.3	$520,000
Floc/Sed	1			$1,235,000	$1,235,000	1.3	$1,605,500
Media Filters	1			$1,300,000	$1,300,000	1.3	$1,690,000
Chemical Systems	5			$100,000	$500,000	1.3	$650,000
Control Valve and Valve House	1			$350,000	$350,000	1	$350,000
Interconnect between PMFL and KCFL	1			$500,000	$500,000	1	$500,000
KCFL Replacement	84,480	24	in	$250	$21,120,000	1	$21,120,000
Misc. Internal Piping					% of IE	15%	$819,800
						IE[2]=	$5,465,500
TOTAL EQUIPMENT					$25,905,000		$27,905,300
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
WTP Building	1	13,000	sq ft	$750	$9,750,000	1	$9,750,000
Abandon ex WTP in place					$100,000	1	$100,000
Misc. Civil & Structural (Including Yard Piping)					% of IE	15%	$819,800
Electrical					% of IE	12%	$655,900
Instrumentation					% of IE	5%	$273,300
TOTAL UNMARKED UP COST							$39,504,300
GENERAL REQUIREMENTS					% of Above[3]	8%	$3,160,300
CONTRACTOR O&P					% of Above[3]	10%	$4,266,500
TOTAL CONSTRUCTION COST							$46,931,100
DESIGN & CONSTRUCTION PHASE ENG. SERVICES					% of Above	15%	$7,039,700
CONTINGENCY[4]					% of Above	10%	$5,397,100
TOTAL WITH CONTINGENCY							$59,400,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2 - IE only includes major equipment and does not include other materials such as pipeline.
3 -General Requirements and Contractor O&P included in pipeline estimate, so pipeline cost has been excluded from % of Above to prevent double counting.
4 - Contigency of 10% based on higher level of detail in pipeline estimates.

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 06/09/2020
Made by - MAL
Checked by - BDP
AACE Class 4 Estimate[1]

Option 10: Exchange Colorado River Rights with Clifton for Emergency Supply (Full Expansion, 24 inch)

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment							
Colorado River Intake Modifications					$0.00	1	$0.00
Raw water pumps	2	6.1	MGD	$100,000	$200,000	1.3	$260,000
Rapid Mix	1			$50,000	$50,000	1.3	$65,000
4 stage floc, inclined plates, solids collect	1			$500,000	$500,000	1.3	$650,000
MF Feed Pumps	3	3.4	MGD	$60,000	$180,000	1.3	$234,000
MF Feed Strainers	1	8.2	MGD	$30,000	$30,000	1.3	$39,000
Microfiltration/Ultrafiltration Racks	3	2	MGD	$600,000	$1,800,000	1.3	$2,340,000
Nanofiltration Racks	3	0.6	MGD	$800,000	$2,400,000	1.3	$3,120,000
RO Feed Pumps	2	1.7	MGD	$40,000	$80,000	1.3	$104,000
RO Dual Media Filters	5	0.4	MGD	$25,000	$125,000	1.3	$162,500
RO Cartridge Filters	4	0.8	MGD	$25,000	$100,000	1.3	$130,000
Chemical Systems	7			$50,000	$350,000	1.3	$455,000
Evaporation Ponds - Class A Impoundment	50	1	acre	$129,000	$6,450,000	1.3	$8,385,000
High Service Pumps	2			$150,000	$300,000	1.3	$390,000
Pipeline from CWD WTP to 30th Rd	21,120	24	inch	$250	$5,280,000	1	$5,280,000
Misc. Internal Piping					% of IE	15%	$1,192,400
						IE[2]=	$7,949,500
TOTAL EQUIPMENT					$17,845,000		$22,806,900
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
Pretreatment Building	1	3,031	sq ft	$500	$1,515,520	1.3	$1,970,176
Main Process Building			sq ft		$0	1.3	$0
NF/RO Building			sq ft		$0	1.3	$0
CCC Expansion	1700	1	sq ft	$500	$850,000	1.3	$1,105,000
Misc. Civil & Structural (Including Yard Piping)					% of IE	10%	$795,000
Electrical					% of IE	12%	$953,900
Instrumentation					% of IE	5%	$397,500
TOTAL UNMARKED UP COST							$28,028,476
GENERAL REQUIREMENTS					% of Above[3]	8%	$1,819,900
CONTRACTOR O&P					% of Above[3]	10%	$2,456,800
TOTAL CONSTRUCTION COST							$32,305,176
DESIGN & CONSTRUCTION PHASE ENG. SERVICES					% of Above	15%	$4,845,800
CONTINGENCY[4]					% of Above	20%	$7,430,200
TOTAL WITH CONTINGENCY							$44,600,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2 - IE only includes major equipment and does not include other materials such as pipeline or evaporation ponds.
3 -General Requirements and Contractor O&P included in pipeline estimate, so pipeline cost has been excluded from % of Above to prevent double counting.
4 - Contigency of 20% based on uncertainty of Clifton expansion.

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 06/18/2020
Made by - MAL
Checked by - BDP
AACE Class 4 Estimate[1]

Option 11: Exchange Colorado River Rights with Clifton for Emergency Supply (Partial Expansion, 20 inch)

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment							
Colorado River Intake Modifications					$0.00	1	$0.00
Raw water pumps	1	6.1	MGD	$100,000	$100,000	1.3	$130,000
Rapid Mix					$0	1	$0
4 stage floc, inclined plates, solids collect					$0	1	$0
MF Feed Pumps	2	3.4	MGD	$60,000	$120,000	1.3	$156,000
MF Feed Strainers	1	4.1	MGD	$30,000	$30,000	1.3	$39,000
Microfiltration/Ultrafiltration Racks	1	2	MGD	$600,000	$600,000	1.3	$780,000
Nanofiltration Racks	2	0.6	MGD	$800,000	$1,600,000	1.3	$2,080,000
RO Feed Pumps	1	1.7	MGD	$40,000	$40,000	1.3	$52,000
RO Dual Media Filters	3	0.4	MGD	$25,000	$75,000	1.3	$97,500
RO Cartridge Filters	2	0.8	MGD	$25,000	$50,000	1.3	$65,000
Chemical Systems	7			$30,000	$210,000	1.3	$273,000
Evaporation Ponds - Class A Impoundment	35	1	acre	$129,000	$4,515,000	1.3	$5,869,500
High Service Pumps	1			$150,000	$150,000	1.3	$195,000
Pipeline from CWD WTP to 30th Rd	21,120	20	inch	$200	$4,224,000	1	$4,224,000
gall					% of IE	15%	$580,100
						IE[2]=	$3,867,500
TOTAL EQUIPMENT					$11,714,000		$14,541,100
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
Pretreatment Building			sq ft		$0	1.3	$0
Main Process Building			sq ft		$0	1.3	$0
NF/RO Building			sq ft		$0	1.3	$0
CCC Expansion	755	1	sq ft	$500	$377,500	1.3	$490,750
Misc. Civil & Structural (Including Yard Piping)					% of IE	10%	$386,800
Electrical					% of IE	12%	$464,100
Instrumentation					% of IE	5%	$193,400
TOTAL UNMARKED UP COST							$16,076,150
GENERAL REQUIREMENTS					% of Above[3]	8%	$948,200
CONTRACTOR O&P					% of Above[3]	10%	$1,280,000
TOTAL CONSTRUCTION COST							$18,304,350
DESIGN & CONSTRUCTION PHASE ENG. SERVICES					% of Above	15%	$2,745,700
CONTINGENCY[4]					% of Above	20%	$4,210,000
TOTAL WITH CONTINGENCY							$25,300,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2 - IE only includes major equipment and does not include other materials such as pipeline or evaporation ponds.
3 -General Requirements and Contractor O&P included in pipeline estimate, so pipeline cost has been excluded from % of Above to prevent double counting.
4 - Contigency of 20% based on uncertainty of Clifton expansion.

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 06/18/2020
Made by - MAL
Checked by - BDP
AACE Class 4 Estimate[1]

Option 13: Purchase Treated Water from Ute (Break Point Chlorinate)

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment							
Linden Vault Modifications	1			$400,000	$400,000	1.3	$520,000
Pipeline to GJ WTP	4,066	24	inch	$250	$1,016,400	1	$1,016,400
Mixer	1			$9,000	$9,000	1.3	$11,700
Injection Quill	1			$5,000	$5,000	1.3	$6,500
Chemical Feed Pumps	2			$11,000	$22,000	1.3	$28,600
FRP Storage Tanks	2	5000	gal	$56,000	$112,000	1.3	$145,600
Chemical Feed Piping	1			$8,000	$8,000	1.3	$10,400
Sodium Hypochlorite System Expansion	1			$130,000	$130,000	1.3	$169,000
Misc. Internal Piping	1				% of IE	40%	$81,120
						IE[2]=	$202,800
TOTAL EQUIPMENT					$1,702,400		$1,989,320
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
Misc. Civil & Structural (Including Yard Piping)					% of IE	3%	$6,084
Electrical					% of IE	17%	$34,476
Instrumentation					% of IE	5%	$10,140
TOTAL UNMARKED UP COST							$2,040,020
GENERAL REQUIREMENTS					% of Above[3]	8%	$81,900
CONTRACTOR O&P					% of Above[3]	10%	$110,600
TOTAL CONSTRUCTION COST							$2,232,520
DESIGN & CONSTRUCTION PHASE ENG. SERVICES					% of Above	15%	$334,900
CONTINGENCY[4]					% of Above	30%	$770,200
TOTAL WITH CONTINGENCY							$3,300,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2 - IE only includes major equipment and does not include other materials such as pipeline.
3 -General Requirements and Contractor O&P included in pipeline estimate, so pipeline cost has been excluded from % of Above to prevent double counting.
4 - Contigency of 30% based on uncertainty of routing through plant.

Client - City of Grand Junction
Project Number - 117086
Description - Construction Cost Option Breakdown

Date - 06/09/2020
Made by - MAL
Checked by - BDP
AACE Class 4 Estimate[1]

Option 14: Purchase Treated Water from Ute (Chloramine Conversion)

Line Item Description	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor	Installed Cost
Major Equipment							
Linden and Riverside Vault Modifications	2			$400,000	$800,000	1.3	$1,040,000
Mixer	1			$9,000	$9,000	1.3	$11,700
Injection Quill	1			$5,000	$5,000	1.3	$6,500
Chemical Feed Pumps	2			$11,000	$22,000	1.3	$28,600
FRP Storage Tanks	2	5000	gal	$56,000	$112,000	1.3	$145,600
Chemical Feed Piping	1			$8,000	$8,000	1.3	$10,400
LAS System	1			$100,000	$100,000	1.3	$130,000
Misc. Internal Piping	1				% of IE	40%	$81,120
						IE^2=	$202,800
TOTAL EQUIPMENT					$1,056,000		$1,453,920
MISC. SUB-CONTRACTORS	No.	Size ea.	Units	Unit Purchased Cost	Purchased Cost	Installation Factor or Complexity	Installed Cost
Building Expansion	1	700	sq ft	$500	$350,000	1.3	$455,000
Misc. Civil & Structural (Including Yard Piping)					% of IE	3%	$6,084
Electrical					% of IE	17%	$34,476
Instrumentation					% of IE	5%	$10,140
TOTAL UNMARKED UP COST							$1,959,620
GENERAL REQUIREMENTS					% of Above	8%	$156,800
CONTRACTOR O&P					% of Above	10%	$211,600
TOTAL CONSTRUCTION COST							$2,328,020
DESIGN & CONSTRUCTION PHASE ENG. SERVICES					% of Above	15%	$349,200
CONTINGENCY[3]					% of Above	30%	$803,200
TOTAL WITH CONTINGENCY							$3,500,000

Notes:
1- AACE Class 4 Estimates are used for feasibility studies. The expected accuracy range is -15% to -30% on the low end, and +20% to +50% on the high end.
2 - IE only includes major equipment and does not include other materials such as pipeline.
3 - Contigency of 30% based on uncertainty of routing through plant.

APPENDIX C – INITIAL WORKSHOP SCORING

Initial Screening

The following options are recommended for disqualification from the evaluation for the reasons presented in Table 1.

Table1: Disqualified Options

	Option	Reason
2	Treat Gunnison by Reverse Osmosis	High capital cost to treat Gunnison River Option 1 (lime softening) provides lower cost of treatment
4	Settle Gunnison in Existing Reservoirs and Use for Raw Water	Does not provide acceptable water quality for raw water irrigation
7	Replace KCFL (24 inch) and Add Turbine	Feasibility not confirmed with Grand Valley Power. Potential energy production of turbine does not pay for extensive electrical upgrades
8	New WTP in Kannah Creek Watershed	High capital cost for new facility New WTP is redundant to the existing WTP KCFL update required to deliver water to City
9	Clifton Water Emergency Interconnect	Does not provide a fully redundant alternative Capacity well less than future peak day demand of 13 mgd
11	Route Gunnison to Clifton WTP	High infrastructure cost to send Gunnison River to Clifton replaced by water transfer Transfer City's Colorado River rights to Clifton and replace with City's Gunnison River allocation at confluence Becomes same as Option 10

Table 2: Options Evaluated by Project Team

#	Option
1	Treat Gunnison River by Lime Softening
3	Settle Gunnison River in Existing Reservoirs and Blend with Clifton
5	Replace Kannah Creek Flow Line (24 inch)
6	Replace Kannah Creek Flow Line (20 inch)
10	Transfer Colorado River Rights to Clifton for Treatment
12	Purchase Treated Water from Ute

Selection Workshop

A multi-step process was used to evaluate the technical, qualitative and monetary criteria of each option. The first step involved developing the non-monetary criteria and then ranking the criteria in a Workshop with the Project Team. The selected criteria are shown in Table 3.

Table 3: Selection Criteria

Criteria Category	Description
Redundancy	Ability to provide full redundancy to the Purdy Mesa flowline. Options scoring high in this category can provide full redundancy to Purdy Mesa flowline without concern over water rights. Low scoring options do not provide the full capacity of 13 mgd.
Raw Water Quality	Measure of the raw water quality of the source water(s) included within the option. Options scoring high in this category mean the sources have water quality similar to Purdy Mesa. Low scoring options have poor source water quality.
Finished Water Quality	Measure of the anticipated finished water quality as a result of the treatment associated with the option. Options scoring high in this category mean the treatment is expected to produce finished water similar or better than the current WTP. This criteria also considers the satisfaction of raw water customers.
Regulatory Challenges	Evaluates the likelihood of permitting-related challenges associated with the option, including but not limited to, CDPHE permits and land easements. Options scoring high in this category require little to no permitting.
Complexity of Sources	Evaluates the number of sources required to provide a fully-redundant capacity and the complexity to operate multiple sources. Options scoring high in this category only require one source to create redundancy.
Ease of Operations	Evaluates the complexity of operations and maintenance, number of treatment process steps and units and chemical dosing systems associated with the option. Options scoring high in this category apply operating procedures similar or less complex than the current WTP.
Public Perception	Evaluates the public perception to the alternate water source. Public opinion prefers elevated sources, considered pristine mountain source. Less favorable view of using river sources

The second step ranked the non-monetary criteria used a paired comparison to identify the weighting for each criterion (Table 4). Each criteria were paired against the other criteria, with the criteria of higher importance being preferred. The alphanumeric identification of the preferred criteria is recorded in Table 4(e.g. B). Then the degree to which the criteria was preferred were scored on their relative importance on a scale of 1 to 3, with 3 as a high importance. The numeric score of the preferred criteria is recorded in Table 4(e.g. 2), resulting in a paired score (e.g. B2).

Table 4: Weighted Criteria

DEVELOP CRITERIA & WEIGHTED MATRIX										
ITEM	CRITERIA	RELATIVE IMPORTANCE							SCORE	NORMALIZED
A	Redundancy	A	A 3	A 3	A 2	A 1	A 2	A 1	12	3
B	Raw Water Quality		B	C 3	B 1	B 2	B 1	G 3	4	1
C	Finished Water Quality			C	C 3	C 1	C 2	C 1	10	2
D	Regulatory Challenges				D	E 3	F 3	G 3	0	0
E	Complexity of Sources					E	E 3	G 2	6	1
F	Ease of Operations						F	G 1	3	1
G	Public Perception							G	9	2
Directions: For each pair, select the more important criteria. Then choose a relative importance between 1-3 (3 as high importance).									44	10

Next, the Project Team scored each Option against the criteria on a scale of 1 to 5, with 5 being high (Table 5).

Table 5: Scored Options

SCORED OPTIONS								
Option	Redundancy	Raw Water Quality	Finished Water Quality	Regulatory Challenges	Complexity of Sources	Ease of Operations	Public Perception	Total
Option 1: Treat GR by Lime Softening	5	1	2	3	1	1	1	14
Option 3: Blend GR with Clifton	5	2	1	3	1	2	2	16
Option 5: 24" KCFL	5	5	5	4	5	5	5	34
Option 6: 20" KCFL	5	5	5	4	5	4	5	28
Option 10: Transfer Add. CR to Clifton	5	1	3	4	2	3	3	21
Option 12: Purchase Treated Ute Water	5	4	4	4	4	4	4	29
Directions: Score each option for each criteria between 1-5 (5 is high).								

The weighting criteria was then applied to the scores to establish a weighted score (Table 6).

Table 6: Weighted Scored Options

WEIGHTED SCORES								
Option	Redundancy	Raw Water Quality	Finished Water Quality	Regulatory Challenges	Complexity of Sources	Ease of Operations	Public Perception	Total
Option 1: Treat GR by Lime Softening	60	4	20	0	6	3	9	102
Option 3: Blend GR with Clifton	60	8	10	0	6	6	18	108
Option 5: 24" KCFL	60	20	50	0	30	15	45	220
Option 6: 20" KCFL	60	20	50	0	30	12	45	217
Option 10: Transfer Add. CR to Clifton	60	4	30	0	12	9	27	142
Option 12: Purchase Treated Ute Water	60	16	40	0	24	12	36	188
Directions: Table autopopulates based on weight of criteria and scored options.								

High Score	Option 5: 24" KCFL

The Options were then ranked by their weighted score and compared against the EOPCC (Table 7). The cost/benefit for each Option was calculated by dividing the EOPCC by the weighted score. A low cost/benefit indicates a favorable Option, with more benefit achieved at a lower cost investment.

Table 7: Comparison of EOPCC and Weighted Score

Comparison of EOPCC and Weighted Score					
Option		EOPCC	Weighted Score		Cost/Benefit
Option 5: 24" KCFL	$	27,900,000	220	$	127,000
Option 6: 20" KCFL	$	23,000,000	217	$	106,000
Option 12: Purchase Treated Ute Water	$	3,300,000	188	$	18,000
Option 10: Transfer Add. CR to Clifton	$	56,000,000	142	$	394,000
Option 3: Blend GR with Clifton	$	18,100,000	108	$	168,000
Option 1: Treat GR by Lime Softening	$	41,900,000	102	$	411,000

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2020 FLOWLINE
PURDY MESA
JUNE, 2020

1 COVER
2 LEGEND AND SYMBOLS
3 SUMMARY OF APPROXIMATE QUANTITIES
4 VICINITY MAP
5 PHASE I STA 0+00 TO STA 10+00
6 PHASE I STA 10+00 TO STA 20+00
7 PHASE I STA 20+00 TO STA 30+00
8 PHASE I STA 30+00 TO STA 40+00
9 PHASE I STA 40+00 TO STA 50+00
10 PHASE I STA 50+00 TO STA 60+00
11 PHASE I STA 60+00 TO STA 70+00
12 PHASE I STA 70+00 TO STA 80+00
13 PHASE I STA 80+00 TO STA 90+00
14 PHASE I STA 90+00 TO STA 100+00
15 PHASE I STA 100+00 TO STA 110+00
16 PHASE I STA 110+00 TO STA 120+00
17 PHASE I STA 120+00 TO STA 130+00
18 PHASE I STA 130+00 TO STA 140+00
19 PHASE I STA 140+00 TO STA 150+00
20 PHASE I STA 150+00 TO STA 155+00
21 PHASE II STA 215+00 TO STA 225+00
22 PHASE II STA 225+00 TO STA 235+00
23 PHASE II STA 235+00 TO STA 245+00
24 PHASE II STA 245+00 TO STA 255+00
25 PHASE II STA 255+00 TO STA 265+00
26 PHASE II STA 265+00 TO STA 275+00
27 PHASE II STA 275+00 TO STA 285+00
28 PHASE II STA 285+00 TO STA 295+00
29 PHASE II STA 295+00 TO STA 305+00
30 PHASE II STA 305+00 TO STA 315+00
31 PHASE II STA 315+00 TO STA 325+00
32 PHASE II STA 325+00 TO STA 335+00
33 PHASE II STA 335+00 TO STA 345+00
34 PHASE II STA 345+00 TO STA 355+00
35 PHASE II STA 355+00 TO STA 365+00
36 PHASE II STA 365+00 TO STA 375+00
37 PHASE II STA 375+00 TO STA 385+00
38 PHASE II STA 385+00 TO STA 395+00

UTILITIES AND AGENCIES

AGENCY	NAME	POSITION	ROLE	MAILING ADDRESS	STREET ADDRESS	CITY, STATE	VOICE–WK	FAX
CITY OF GRAND JUNCTION	LEE COOPER	PROJECT ENGINEER	PROJECT ENGINEER	333 WEST AVE BLDG C	333 WEST AVE BLDG C	GRAND JCT., CO 81501	(970) 256–4155	(970) 256–4022
CITY OF GRAND JUNCTION	LEE COOPER	PROJECT ENGINEER	SANITARY SEWER	333 WEST AVE BLDG C	333 WEST AVE BLDG C	GRAND JCT., CO 81501	(970) 256–4155	(970) 256–4022
GRAND VALLEY IRRIGATION CO.	PHIL BERTRAND	MANAGER	IRRIGATION	688 26 RD	688 26 RD	GRAND JCT., CO 81506	(970) 242–2762	
SPECTRUM	JEFF VALDEZ	MANAGER	CABLE TV	2502 FORESIGHT CIRCLE	2502 FORESIGHT CIRCLE	GRAND JCT., CO 81504	(970) 245–8750	(970) 245–6803
CENTURYLINK	CHRIS JOHNSON	ENGINEER	TELEPHONE	2524 BLICHMANN AVE	2524 BLICHMANN AVE	GRAND JCT., CO 81504	(970) 244–4311	(970) 240–4349
UTE WATER	JUSTIN BATES	SUPERVISOR	WATER	PO BOX 460	2190 H ¼ RD	GRAND JCT., CO 81502	(970) 242–7491	(970) 242–9189
XCEL	STEVE PIBURN	UNIT MANAGER	ELECTRIC	2538 BLICHMANN AVE	2538 BLICHMANN AVE	GRAND JCT., CO 81506	(970) 244–2664	(970) 244–2664
XCEL	SARAH BARRICAU	UNIT MANAGER	GAS	2538 BLICHMANN AVE	2538 BLICHMANN AVE	GRAND JCT., CO 81506	(970) 244–2656	(970) 244–2656

CITY OF Grand Junction COLORADO

Public Works
Engineering Division

811 Know what's **below.** **Call** before you dig.

PROJECT NO. F000610

NOTE: NOTIFY AFFECTED UTILITY VENDOR 48 HOURS PRIOR TO EXCAVATIONS THAT WILL EXPOSE UTILITY LINES. THE COVER SHEET WILL HAVE A LISTING OF UTILITY VENDORS AND TELEPHONE NUMBERS.

	DESCRIPTION	DATE
REVISION △	–	
REVISION △	–	
REVISION △	–	
REVISION △	–	

DRAWING STATUS:
- ● PROGRESS
- ○ FINAL CONSTRUCTION DRAWINGS
- ○ ASBUILT

DESIGNED BY:
JOHN EKLUND, PROJECT ENGINEER 2020

REVIEWED BY:
TRENT C. PRALL, PUBLIC WORKS DIRECTOR 2020

AUTHORIZED FOR CONSTRUCTION
TRENT C. PRALL, PUBLIC WORKS DIRECTOR 2020

ACCEPTED AS CONSTRUCTED
JOHN EKLUND, PROJECT ENGINEER 2020

2020 FLOWLINE PURDY MESA

N:\Landproj\2020 Flowline Replacements\60CAD\00DESIGN\Purdy Mesa\1 TITLE.dwg, 1 COVER, 5/28/2020 3:46:07 PM

ABBREVIATIONS

AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY & TRANSPORTATION OFFICIALS
ABC	AGGREGATE BASE COURSE
AC	ASBESTOS CEMENT
AP	ANGLE POINT
ASB	ANCHORED STRAW BALES
ASP	ALUMINIZED STEEL PIPE
ASTM	AMERICAN SOCIETY FOR TESTING MATERIALS
AWWA	AMERICAN WATER WORKS ASSOCIATION
BC	BACK OF CURB
BF	BUTTERFLY VALVE
BOW	BACK OF WALK
BCR	BEGIN CURB RETURN
BOT	BOTTOM
BSWMP	BETTER STORM WATER MANAGEMENT PRACTICES
CH	CHORD
CAP	CORRUGATED ALUMINUM PIPE
CDOT	COLORADO DEPARTMENT OF TRANSPORTATION
CI	CAST IRON
C,G,& SW	CURB, GUTTER & SIDEWALK
℄	CENTER LINE
CL	CLEAR
CMP	CORRUGATED METAL PIPE
CO	CLEAN OUT
COMB	COMBINATION (AS IN STORM SEWER AND SANITARY SEWER)
CONC	CONCRETE
CSM	CITY SURVEY MONUMENT
CSP	CORRUGATED STEEL PIPE
CU	COPPER
DI	DUCTILE IRON
DWY	DRIVEWAY
E	ELECTRIC
ECR	END CURB RETURN
EG	EDGE OF GUTTER
EL	ELEVATION
EP	EDGE OF PAVEMENT
EX	EXISTING
FB	FULL BODY
FC	FACE OF CURB
FG	FINISHED GRADE
℄	FLOW LINE
FL	FLANGE
FM	FORCE MAIN
FO	FIBER OPTICS
FS	FAR SIDE
FTG	FOOTING
G	GAS
GB	GRADE BREAK
GM	GAS METER
GV	GATE VALVE
HBP	HOT BITUMINOUS PAVEMENT
HDPE	HIGH DENSITY POLYETHYLENE
INV	INVERT
IRR	IRRIGATION
L	LENGTH OF ARC
LC	LONG CHORD
LF	LINEAR FEET
LL	LONG ARC
LS	SHORT ARC
LT	LEFT
MB	MAILBOX
MCSM	MESA COUNTY SURVEY MONUMENT
MH	MANHOLE
MJ	MECHANICAL JOINT
MW	MILL WRAP
N/A	NOT APPLICABLE
NIC	NOT IN CONTRACT
NOP	NO ONE PERSON
NRCP	NON-REINFORMATIONRCED CONCRETE PIPE
NS	NEAR SIDE
NTS	NOT TO SCALE
OHP	OVERHEAD POWER
OHT	OVERHEAD TELEPHONE
PC	POINT OF CURVATURE
PCC	POINT OF COMPOUND CURVATURE
PE	POLYETHYLENE
PERF	PERFORATED
PI	POINT OF INTERSECTION
PIP	PLASTIC IRRIGATION PIPE
POC	POINT ON CURVE
POT	POINT ON TANGENT
PR	PROPOSED
PRC	POINT OF REVERSE CURVATURE
PT	POINT OF TANGENCY
PVC	POLYVINYL CHLORIDE
R	RADIUS
RCP	REINFORMATIONRCED CONCRETE PIPE
REQ'D	REQUIRED
RG	RESTRAINED GLANDS
RL	LONG RADIUS
ROW	RIGHT OF WAY
RP	RADIUS POINT
RR	RAIL ROAD
RS	SHORT RADIUS
RT	RIGHT
S	SLOPE
SAN	SANITARY
SC	SHORT CHORD
SCD	STANDARD CONTRACT DOCUMENTS
SCH	SCHEDULE
SF	SILT FENCE
SL	SECTION LINE
SSRB	STANDARD SPECIFICATIONS FOR ROAD & BRIDGE CONSTRUCTION
SSUU	STANDARD SPECIFICATIONS FOR CONSTRUCTION OF UNDERGROUND UTILITIES
STA	STATION
STL	STEEL
STM	STORM
T	TELEPHONE
TAN	LENGTH OF TANGENT
TC	TOP OF CURB
TH	TEST HOLE
TV	TELEVISION
(TYP)	TYPICAL
UU	UNDERGROUND UTILITIES
VC	VERTICAL CURVE
VCP	VITRIFIED CLAY PIPE
VPC	VERTICAL POINT OF CURVATURE
VPCC	VERTICAL POINT OF COMPOUND CURVATURE
VPRC	VERTICAL POINT OF REVERSE CURVATURE
VPI	VERTICAL POINT OF INTERSECTION
VPT	VERTICAL POINT OF TANGENCY
W	WATER
△	DELTA ANGLE

LEGEND

BSWMP DRAINAGE BASIN BOUNDARY

BSWMP ANCHORED STRAW BALES — ASB ASB ASB ASB ASB ASB ASB

BSWMP SILT FENCE — SF SF SF SF SF SF SF

BUILDING

CONCRETE CURB AND GUTTER — 2' CURB AND GUTTER

CONCRETE CURB,GUTTER, & SIDEWALK — 7' C, G, & SW

CONCRETE DITCH — CONCRETE

CONCRETE SIDEWALK — 4' SW

CULVERT — 18" RCP

EARTH DITCH — EARTH EARTH EARTH

EDGE OF GRAVEL

EDGE OF PAVEMENT

FENCE (BARBED WIRE)

FENCE (CHAIN LINK)

FENCE (IRON)

FENCE (PLASTIC)

FENCE (TEMPORARY CONSTRUCTION)

FENCE (WOOD)

FENCE (WOVEN WIRE)

GUARD RAIL — 9' 9'

HATCHING: INDICATES ASPHALT REMOVAL

HATCHING: INDICATES CONCRETE REMOVAL

HATCHING: INDICATES STAGING AREA — ~STAGING AREA~

LINE (CENTER OF IMPROVEMENTS) — CENTERLINE

LINE (CITY LIMITS) — CITY LIMITS

LINE (CONTROL) — CONTROL LINE

LINE (EASEMENT)

LINE (MONUMENT/SECTION) — MONUMENT/SECTION LINE

LINE (PROPERTY)

LINE (RIGHT OF WAY)

MATCH LINE — MATCH LINE SEE SHEET NO ?

PIPE (IRRIGATION) — 4" IRR

PIPE (SIPHON) — 4" SIPHON

PROPOSED CONCRETE CURB AND GUTTER

PROPOSED CONCRETE CURB,GUTTER,& SIDEWALK

PROPOSED CONCRETE SIDEWALK

PROPOSED "WET" UTILITIES (CONSTRUCTION NOTE WILL INDICATE TYPE, SIZE, AND MATERIAL OF NEW MAIN) — 8" PVC SANITARY SEWER

ALL PROPOSED FEATURES NOT SHOWN IN LEGEND WILL BE SHOWN THE SAME AS THEIR EXISTING COUNTERPART, BUT INDICATED BY BOLDER LINETYPE

RAIL ROAD

RETAINING WALL — 1' RETAINING WALL

STRIPING (CONTINUOUS WHITE) — WHITE

STRIPING (DASHED WHITE) — WHITE

STRIPING (CONTINUOUS YELLOW) — YELLOW

STRIPING (DASHED YELLOW) — YELLOW

4570

TOP OF SLOPE — 4580

CONTOUR LINES (SHOWN BETWEEN TOP & TOE)

TOE OF SLOPE — 4570

TRAFFIC DETECTOR LOOP

UTILITY LINE (ABANDON) (THIS CASE A WATER LINE) — W (ABANDON) 8" W

UTILITY LINE (CABLE TV) — TV TV

UTILITY LINE (ELECTRIC) — E E

UTILITY LINE (FIBER OPTIC) — FO QWEST FO

UTILITY LINE (GAS) — G 1 1/4" MW G

UTILITY LINE (HIGH VOLTAGE OVERHEAD POWER) — HVOHP

UTILITY LINE (OVERHEAD POWER) — OHP

UTILITY LINE (OVERHEAD TELEPHONE) — OHT

UTILITY LINE (SANITARY SEWER) — 8" SAN

UTILITY LINE (SANITARY SEWER FORCE MAIN) — 8" FM

UTILITY LINE (SANITARY SEWER SERVICE) — SS SS

UTILITY LINE (STORM SEWER) — 8" STM

UTILITY LINE (STORM SEWER, PERFORATED) — 6" PERF

UTILITY LINE (STORM/SANITARY SEWER SEWER COMBINATION) — 18" COMB

UTILITY LINE (TELEPHONE) — T T

UTILITY LINE (WATER) — W 8" W

SYMBOLS

BENCH MARK — (A)

CATCH BASIN

CLEAN OUT — SSCO

CURB STOP

FIRE HYDRANT

GUY WIRE ANCHOR

HEADGATE

IRRIGATION PUMP — P

MAILBOX — MB

MANHOLE (ELECTRIC) — E

MANHOLE (GAS) — G

MANHOLE (SANITARY/STORM)

MANHOLE (TELEPHONE) — T

MANHOLE (TV) — TV

MANHOLE (WATER) — W

METER (GAS) — GM

METER (WATER)

PEDESTAL (TELEPHONE)

PEDESTAL (TV) — TV

PROPERTY PIN

PULL BOX

REDUCER FITTING

SIGN OR POST (SIGN TYPE NOTED) — STOP

SPRINKLER HEAD

STREET LIGHT

SURVEY MONUMENT (CITY) — CSM

SURVEY MONUMENT (TYPE NOTED) — MCSM

TEST HOLE — TH #1

TRAFFIC PAINT MARKING

TRAFFIC SIGNAL POLE AND MAST ARM

UTILITY POLE

VALVE (GAS) — GV

VALVE (IRRIGATION) — IRR

VALVE (WATER)

VEGETATION (HEDGE OR BUSH)

VEGETATION (TREE STUMP)

VEGETATION (TREE) (CALIPER SIZE NOTED) — 8"

WATER HYDRANT

WEIR

YARD LIGHT

BAR SCALE:

0 5 10 20

(IN FEET)
1 inch = 20 feet

NORTH ARROW:

N W E S

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610	
DRAWN BY JCS	DATE 4-02
DESIGNED BY	DATE
CHECKED BY	DATE
APPROVED BY	DATE

SCALES: PLAN & PROFILE

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

CITY OF GRAND JUNCTION
STANDARD ABBREVIATIONS, LEGEND, AND SYMBOLS

N:\Landproj\2020 Flowline Replacements\60CAD\00DESIGN Purdy Mesa\1 TITLE.dwg, 2 LEGEND AND SYMBOLS, 5/28/2020 3:46:08 PM

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610	
DRAWN BY HMC	DATE 2020
DESIGNED BY JAE	DATE 2020
CHECKED BY JAE	DATE 2020
APPROVED BY JAE	DATE 2020

SCALES: PLAN & PROFILE

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
SUMMARY OF APPROXIMATE QUANTITIES

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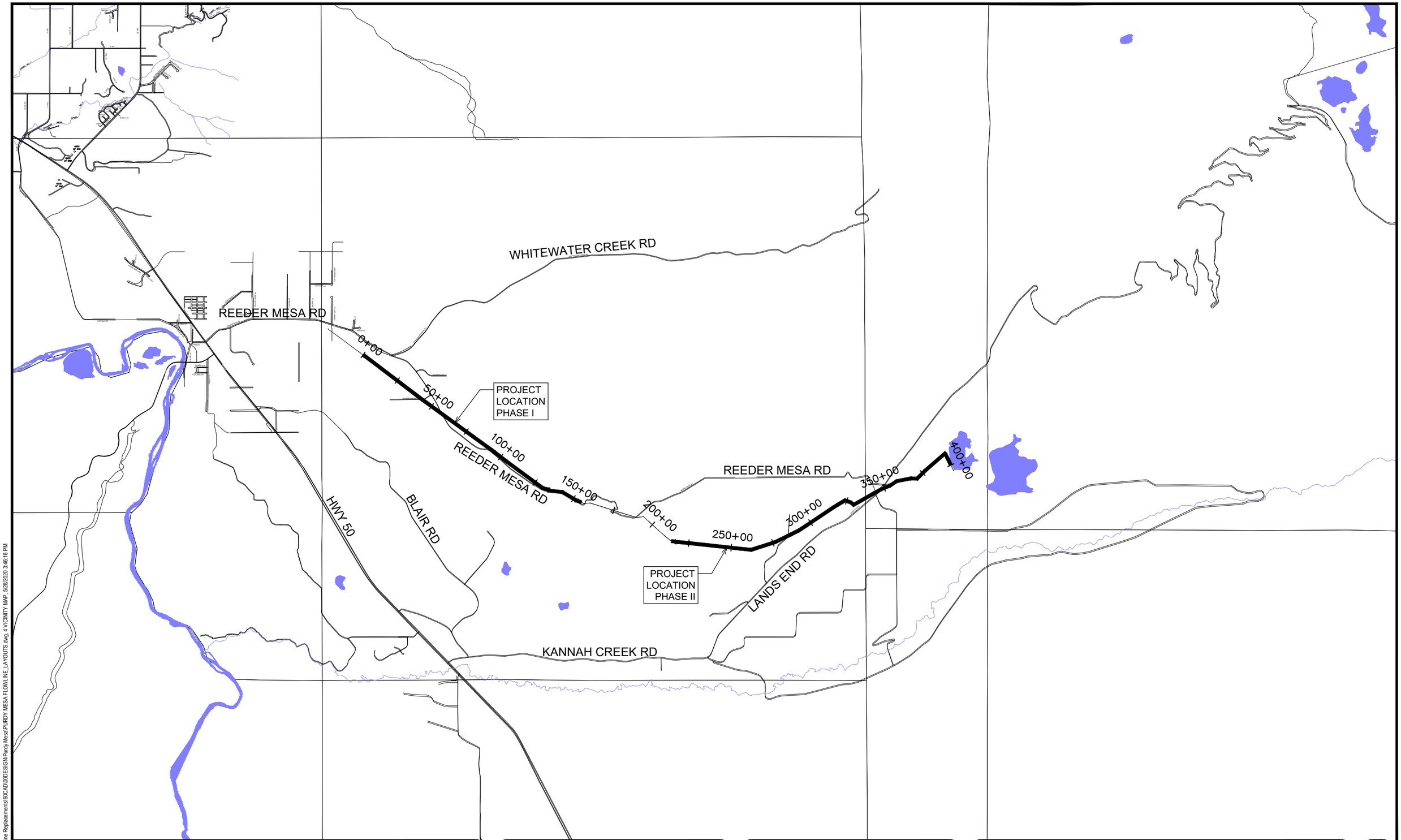

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DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

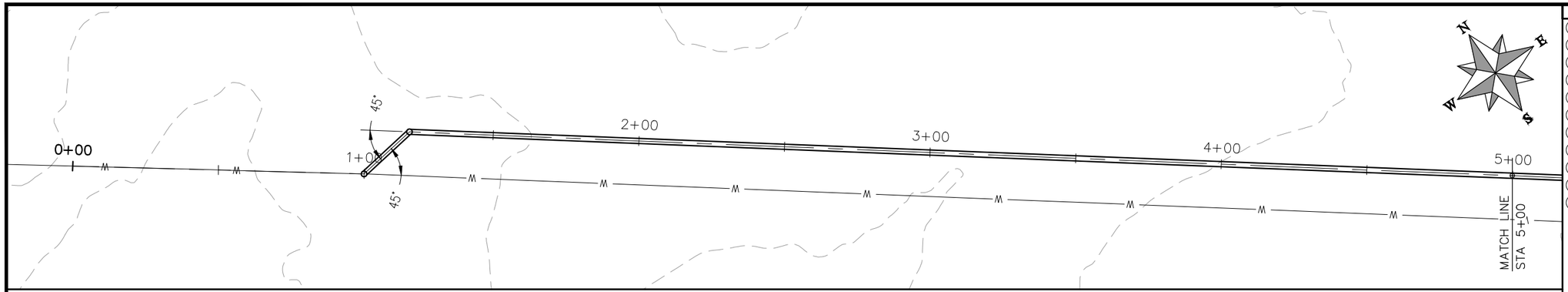
PROJECT NO. F000610			
DRAWN BY	HMC	DATE	2020
DESIGNED BY	JAE	DATE	2020
CHECKED BY	JAE	DATE	2020
APPROVED BY	JAE	DATE	2020

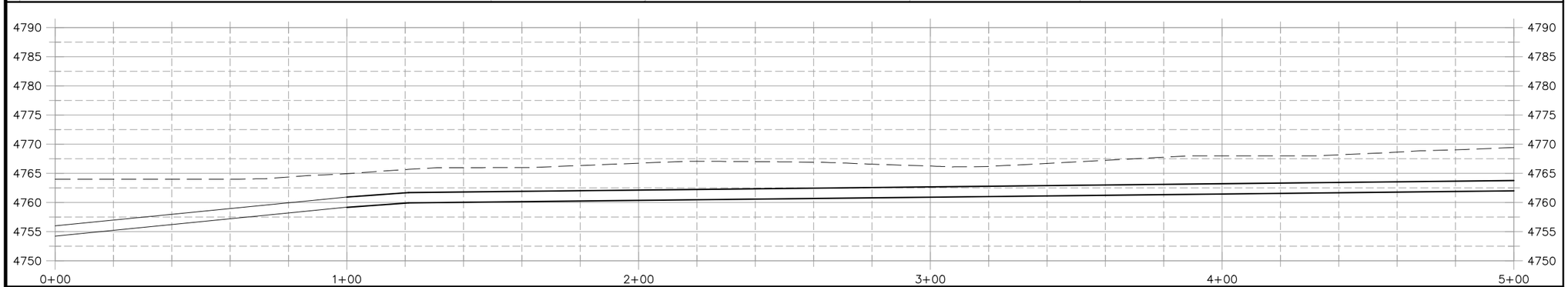
SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 5000'
0 1250 2500 5000

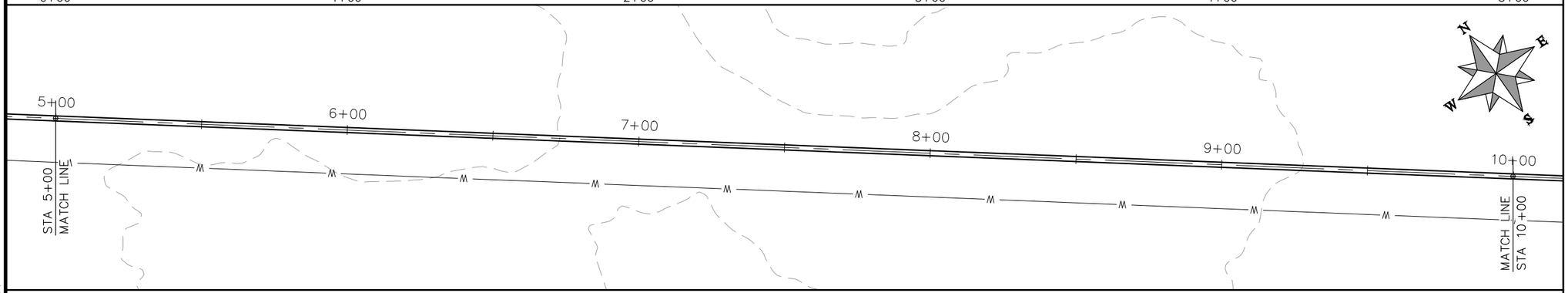
CITY OF Grand Junction COLORADO

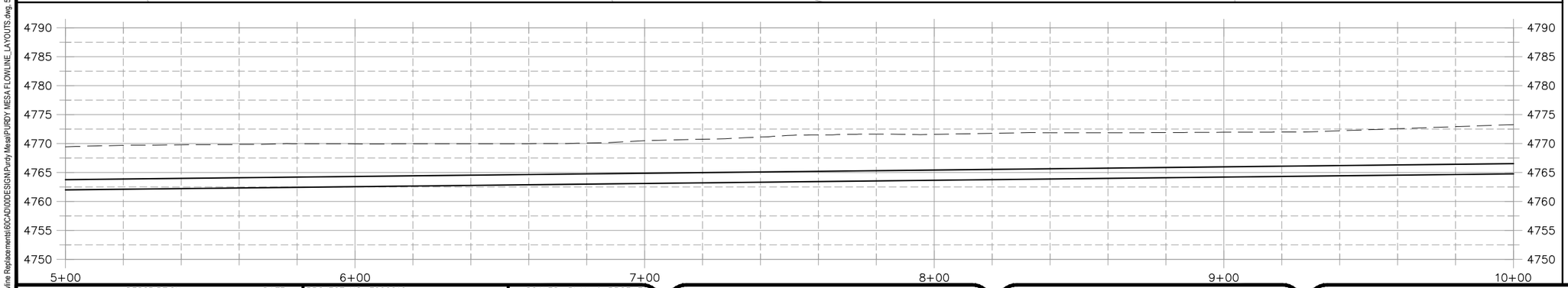
PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
VICINITY MAP









CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE I PLAN AND PROFILE STA 0+00 TO STA 10+00

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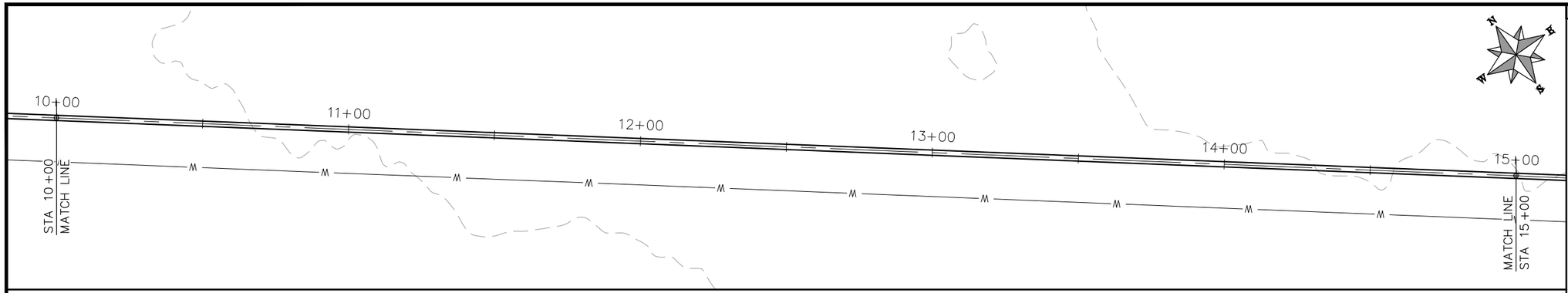

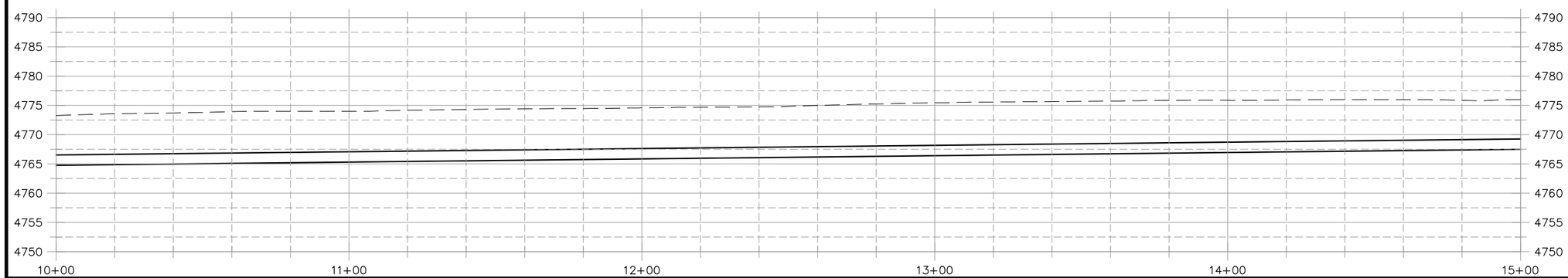

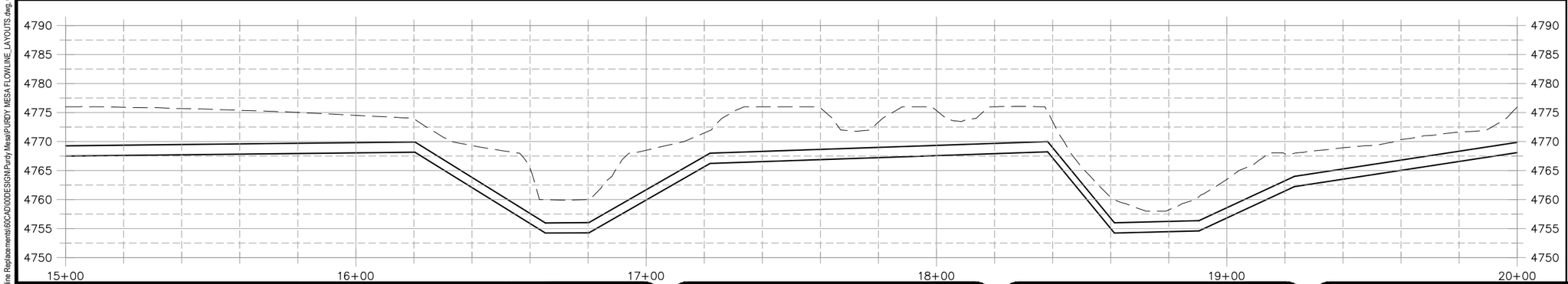

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE I PLAN AND PROFILE STA 10+00 TO STA 20+00

6

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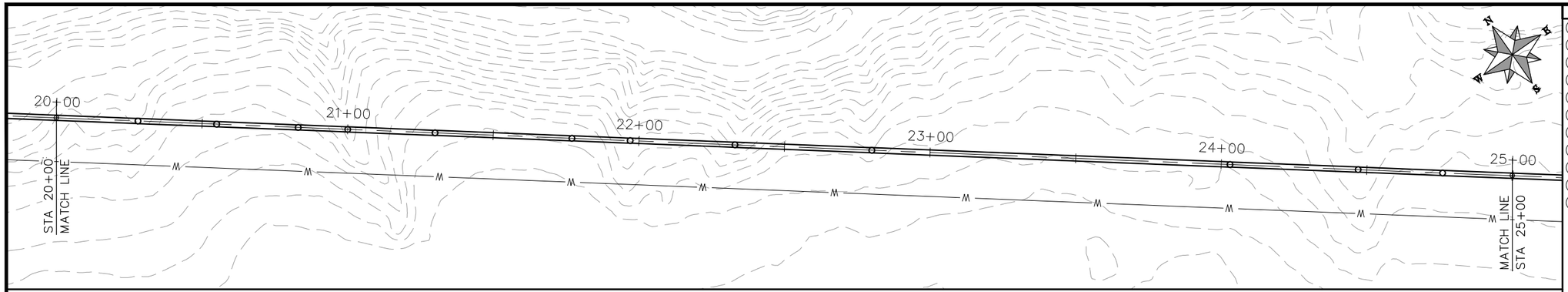

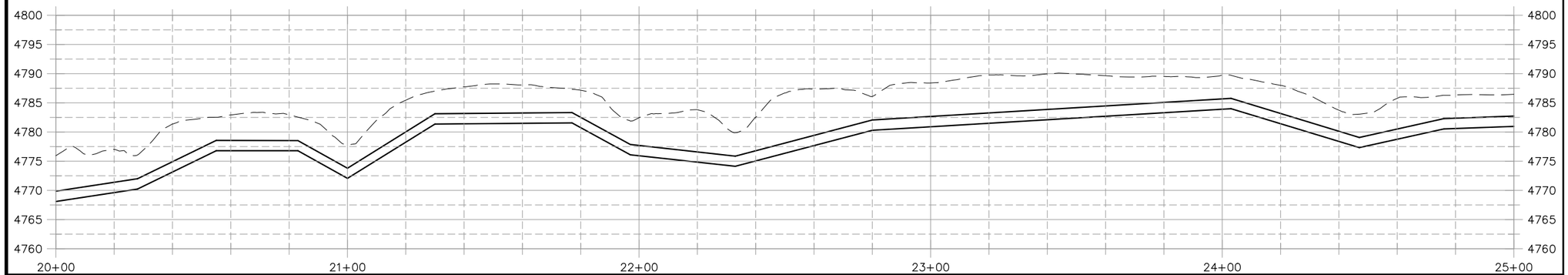

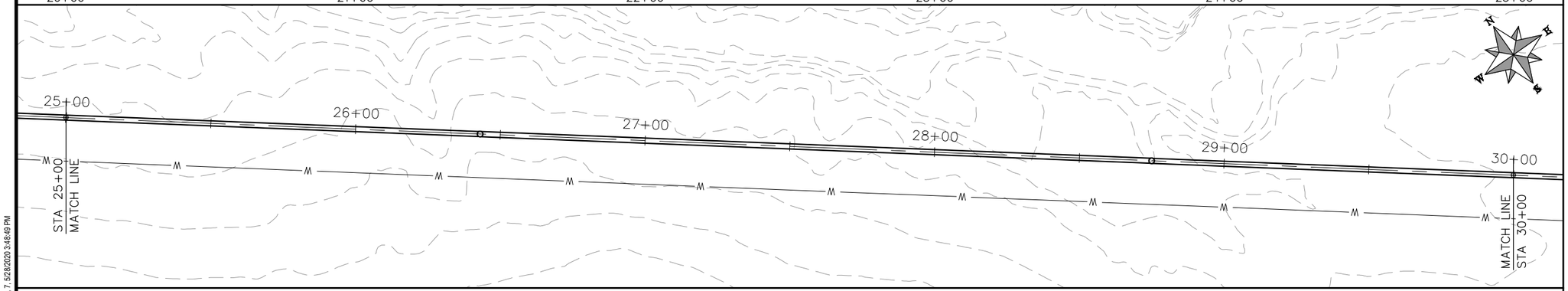

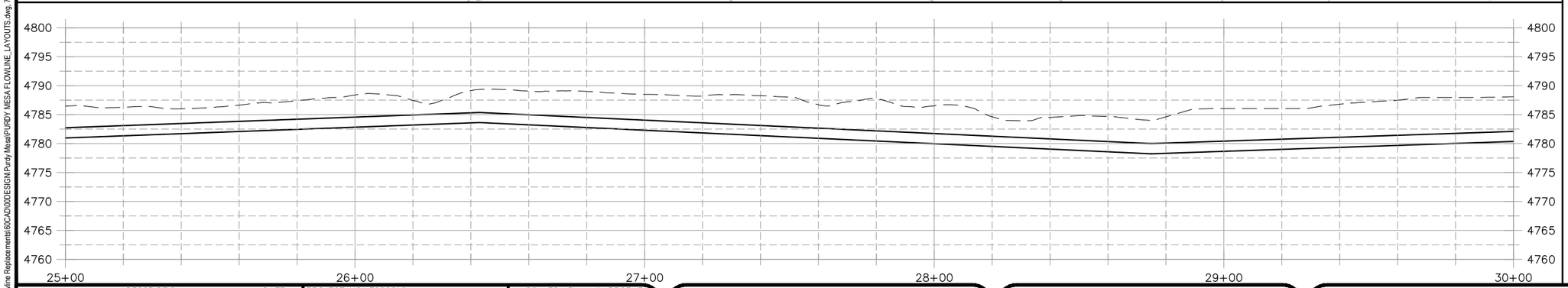

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE I PLAN AND PROFILE STA 20+00 TO STA 30+00

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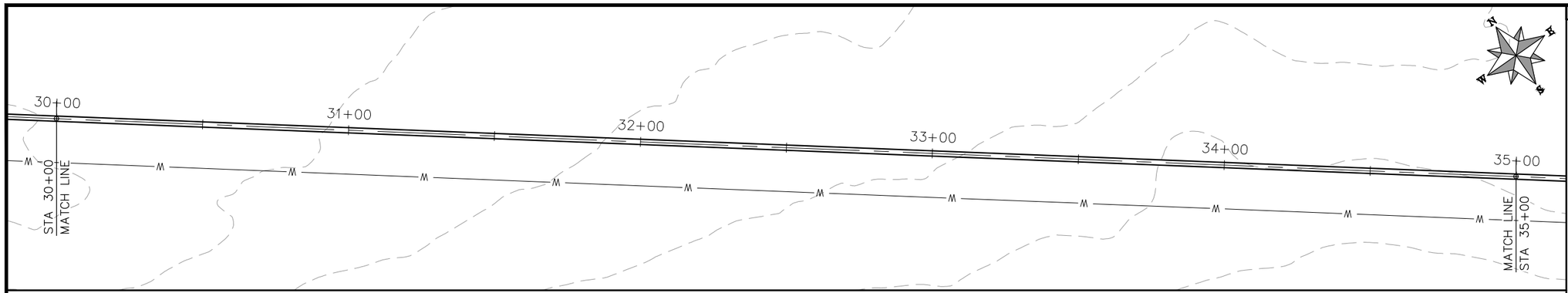

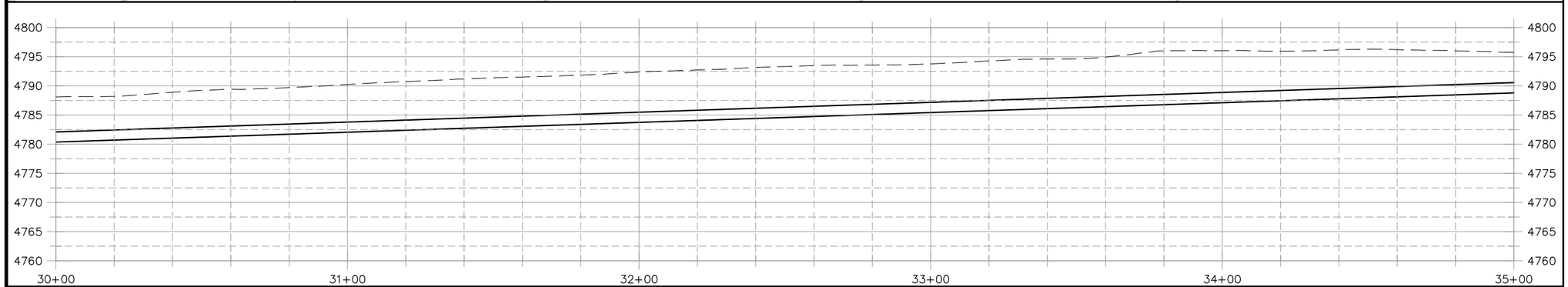

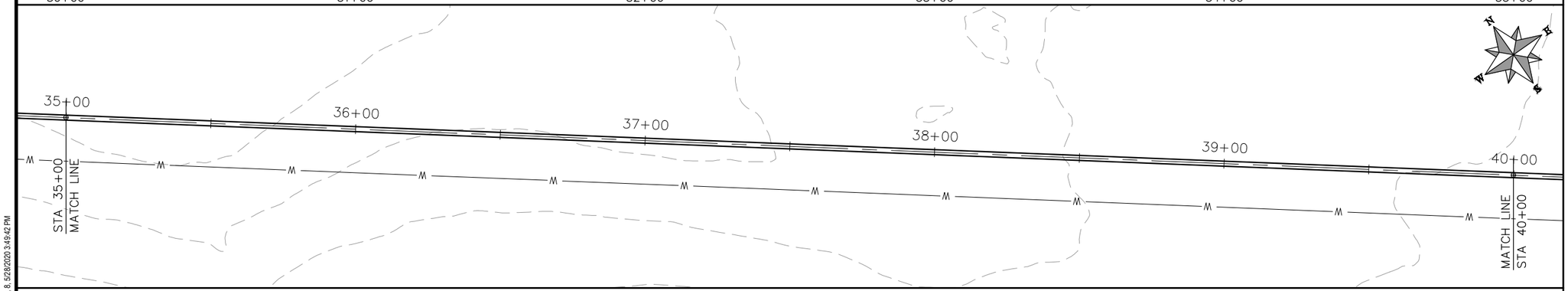

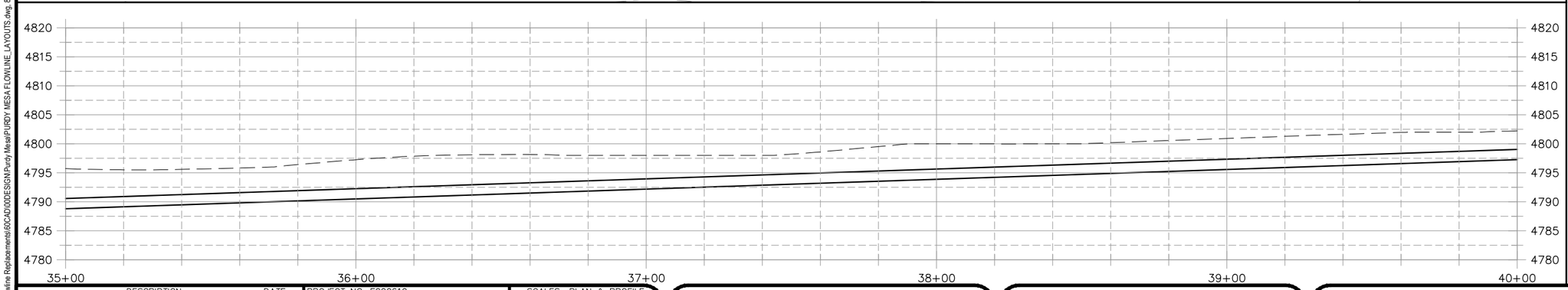

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO.	F000610
DRAWN BY	HMC DATE 2020
DESIGNED BY	JAE DATE 2020
CHECKED BY	JAE DATE 2020
APPROVED BY	JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE I PLAN AND PROFILE
STA 30+00 TO STA 40+00

8

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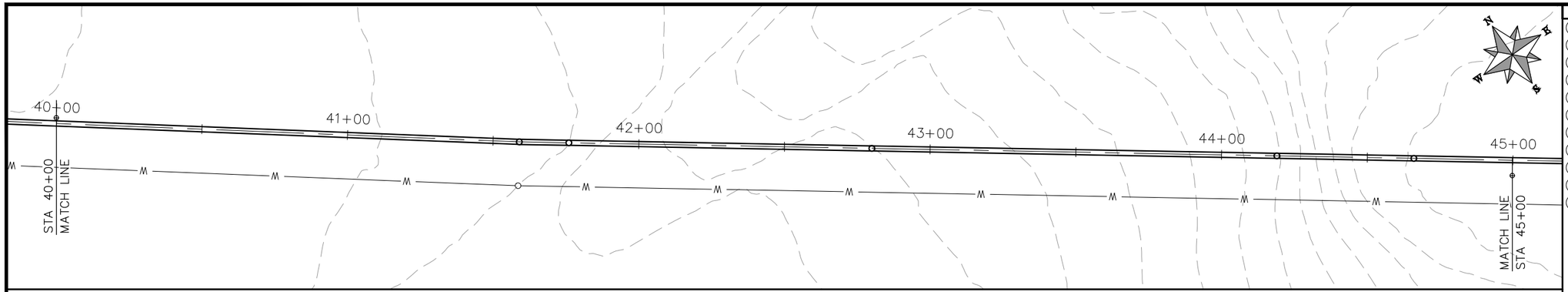

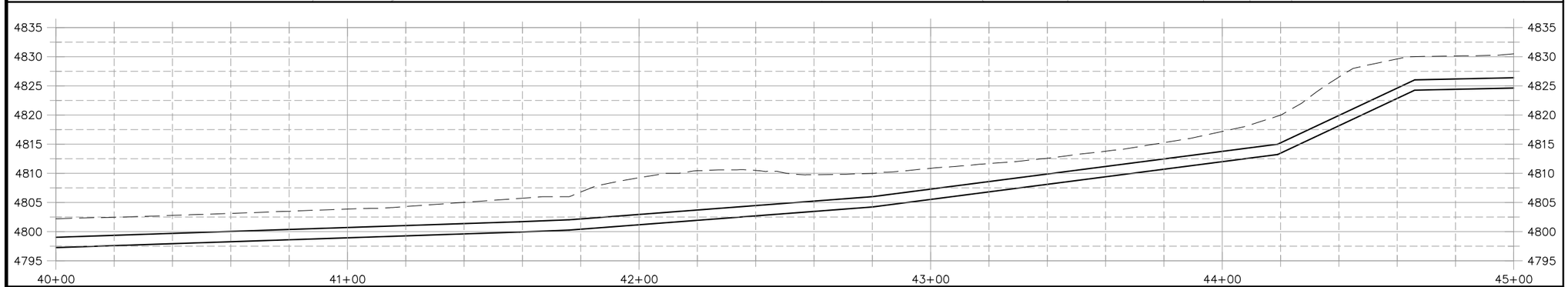

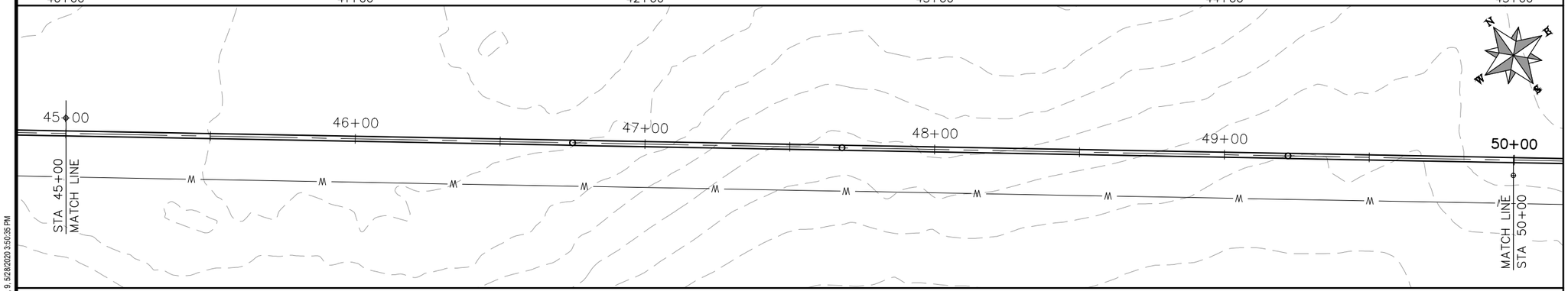

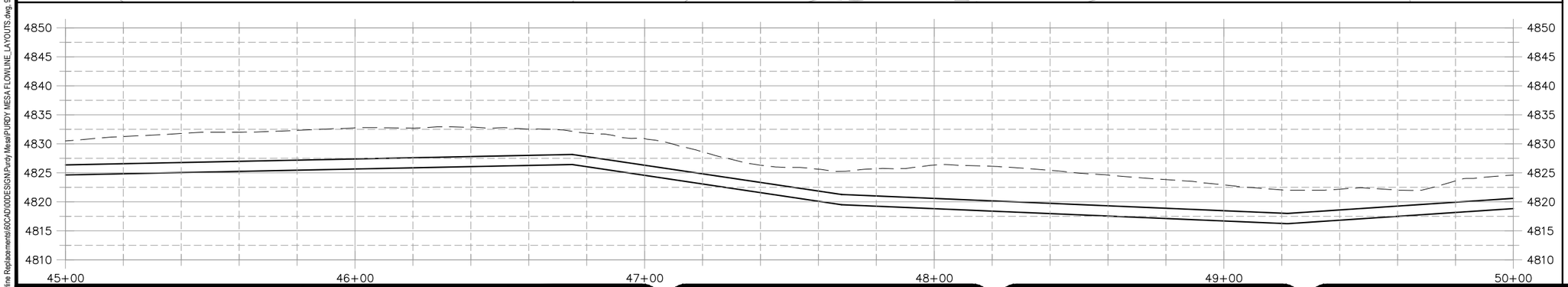

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610			
DRAWN BY	HMC	DATE	2020
DESIGNED BY	JAE	DATE	2020
CHECKED BY	JAE	DATE	2020
APPROVED BY	JAE	DATE	2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE I PLAN AND PROFILE
STA 40+00 TO STA 50+00

9

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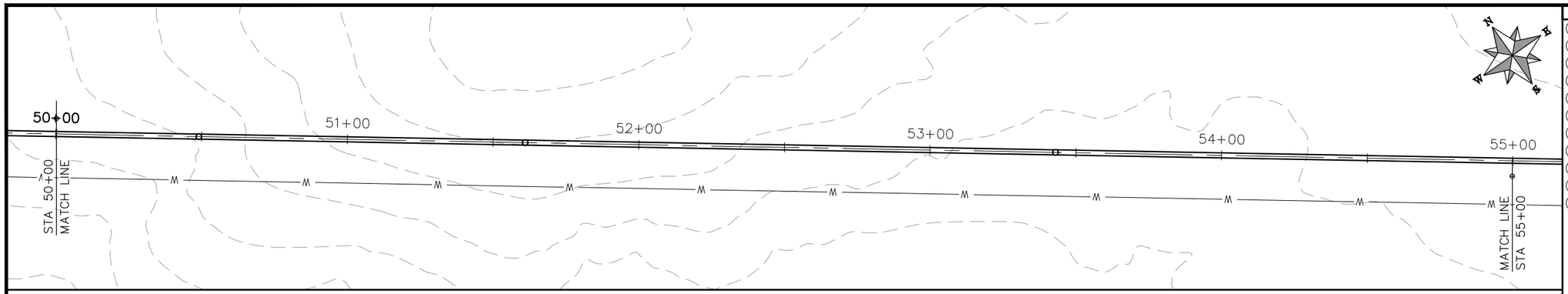

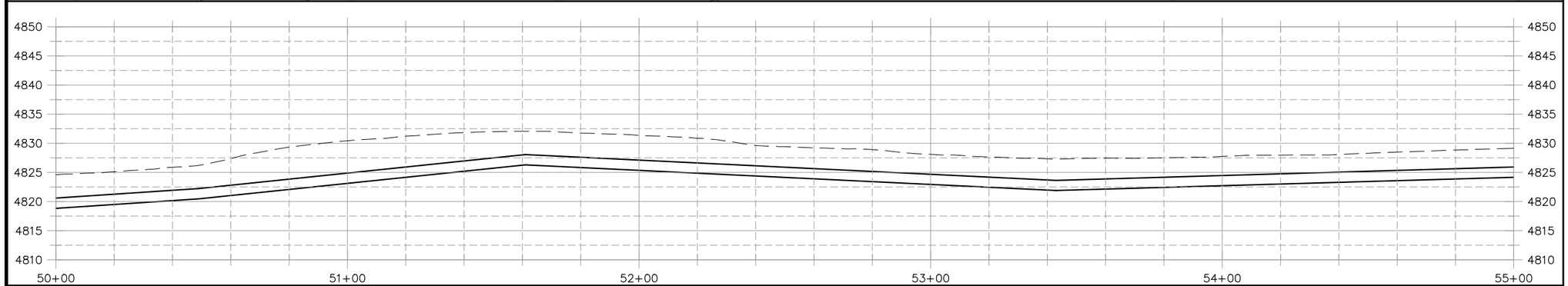

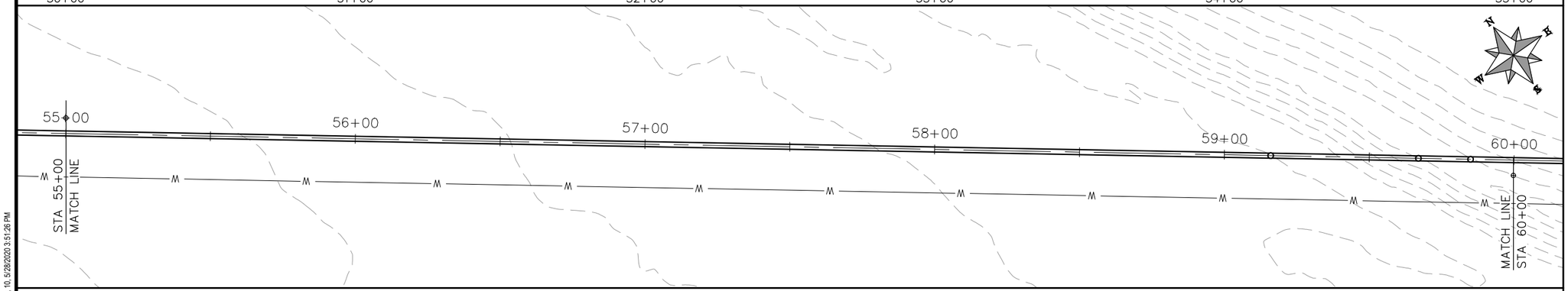

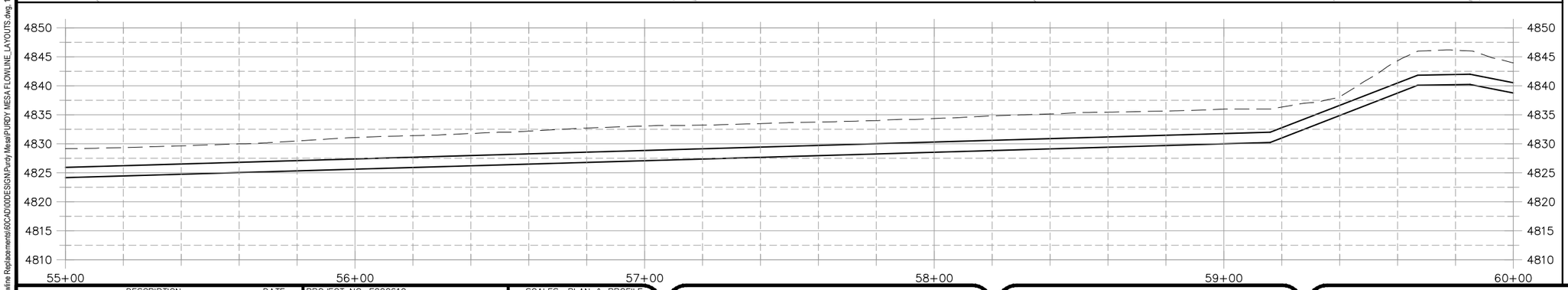

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE I PLAN AND PROFILE STA 50+00 TO STA 60+00

10

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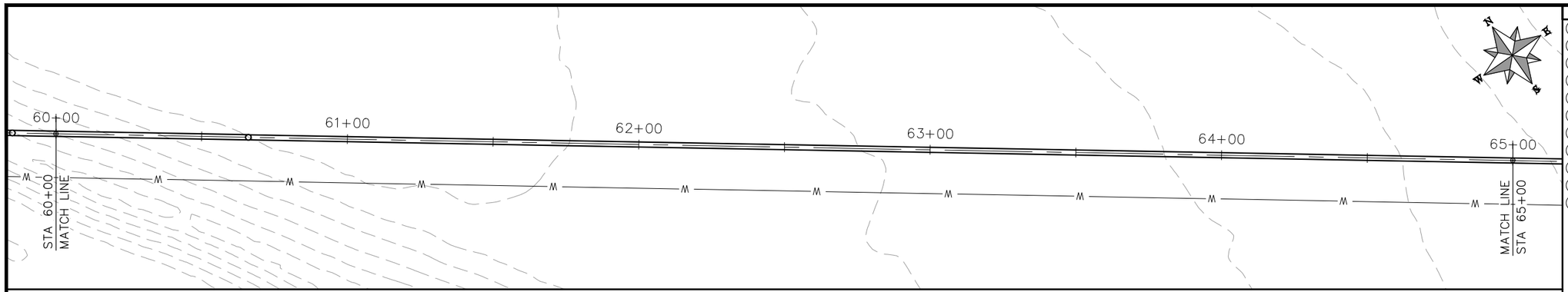

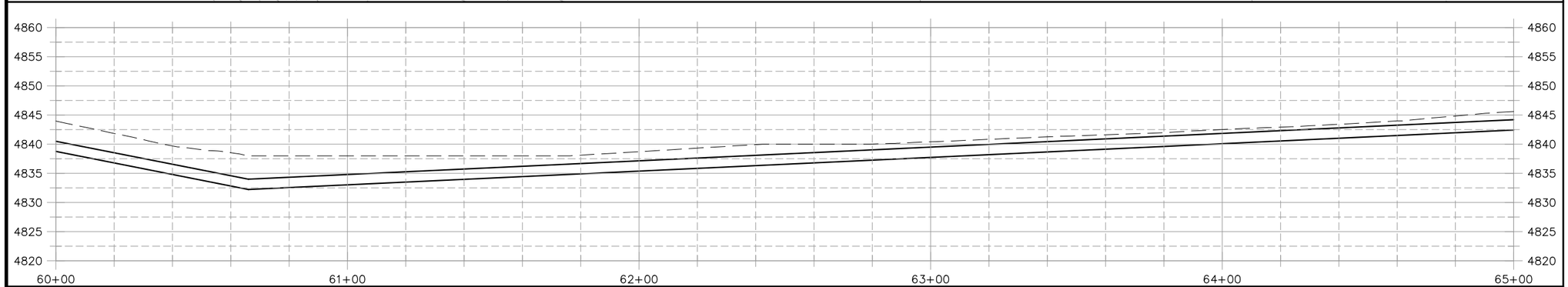

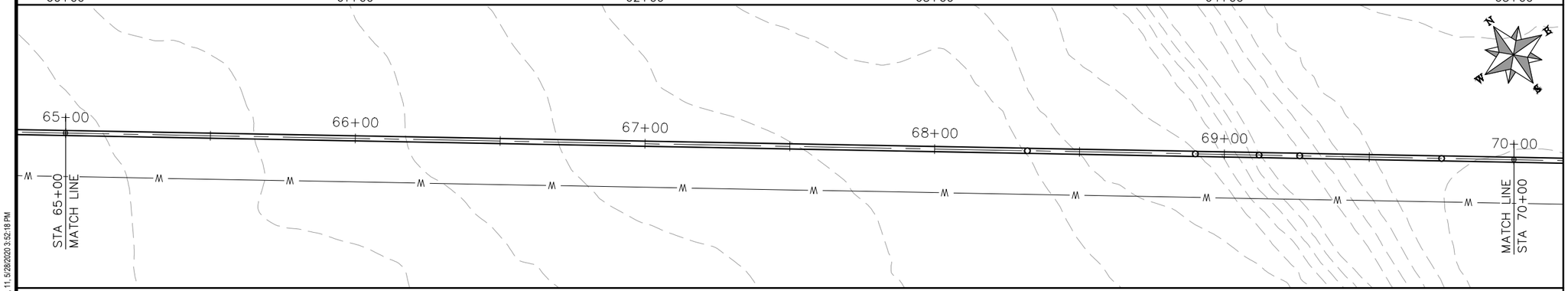

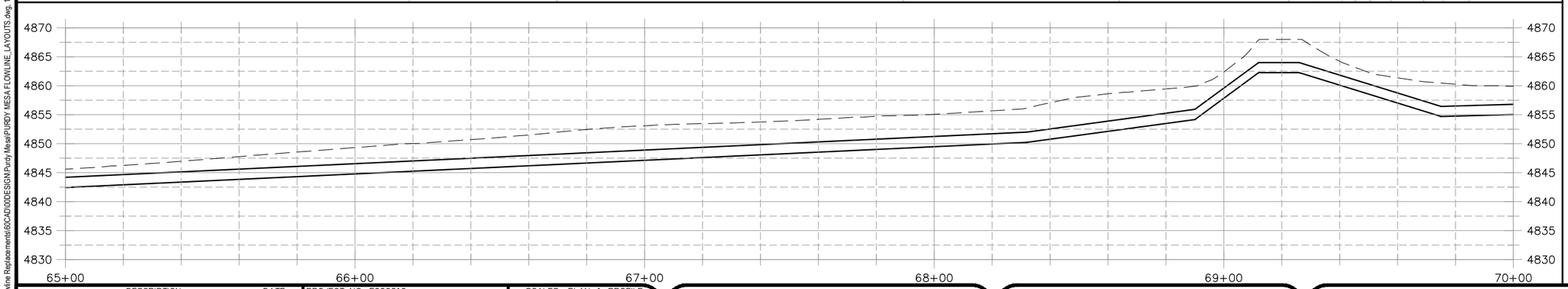

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE I PLAN AND PROFILE
STA 60+00 TO STA 70+00

11

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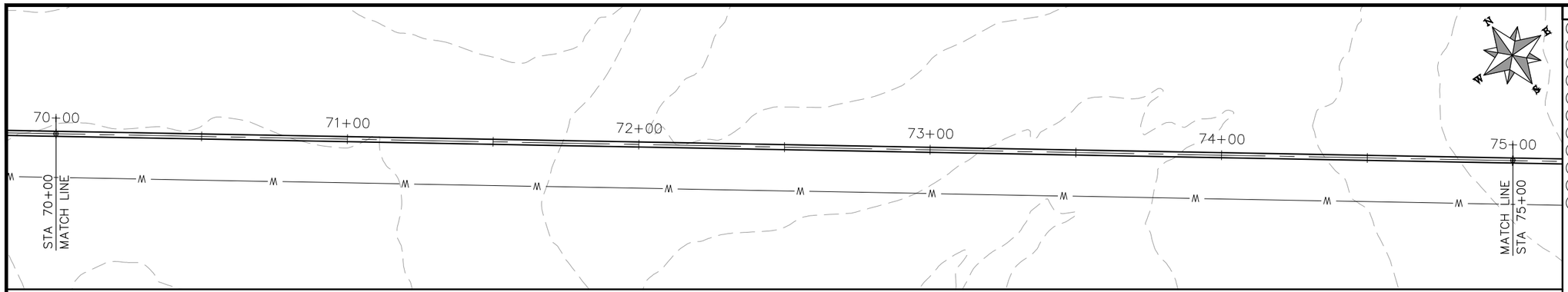

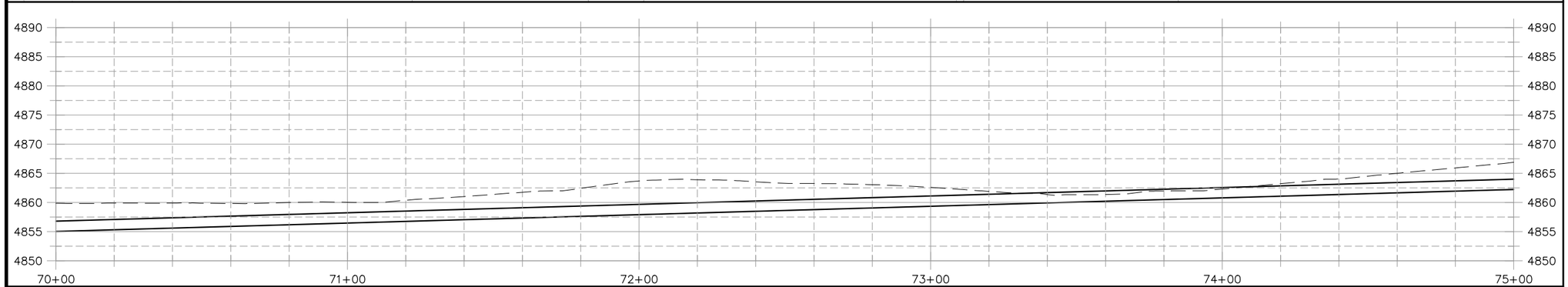

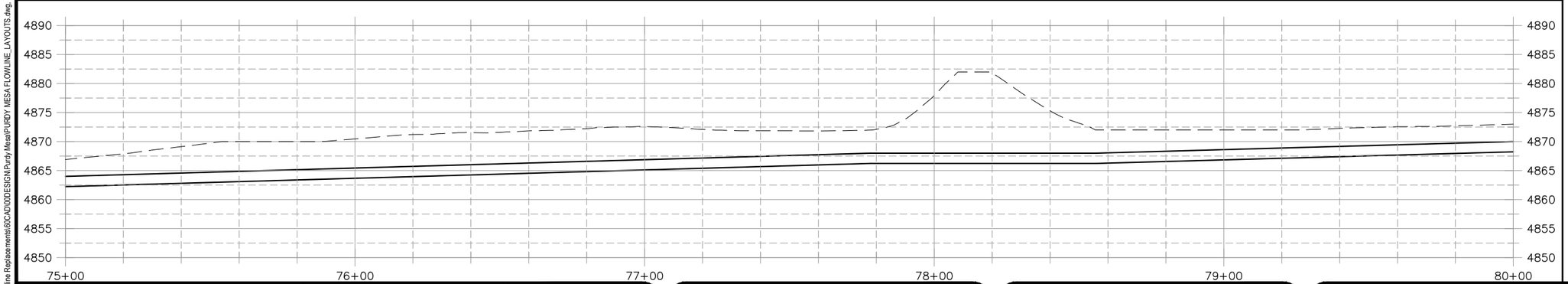

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE I PLAN AND PROFILE STA 70+00 TO STA 80+00

12

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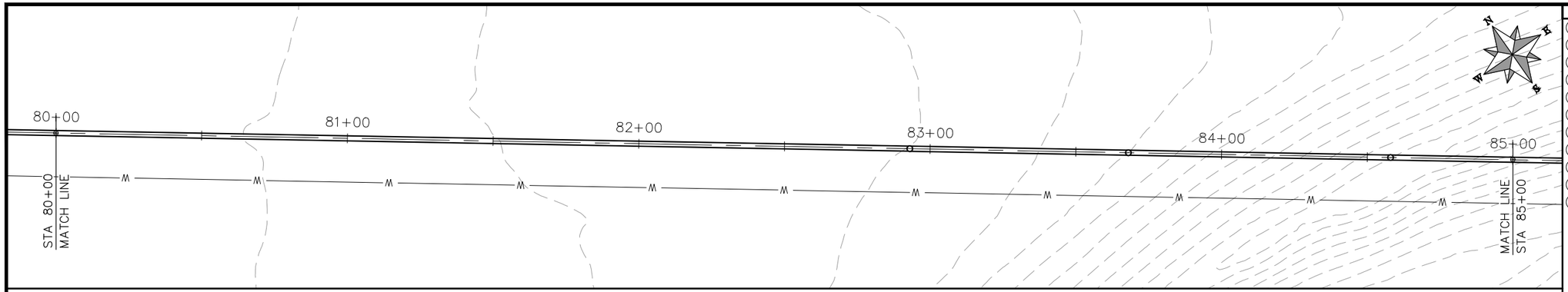

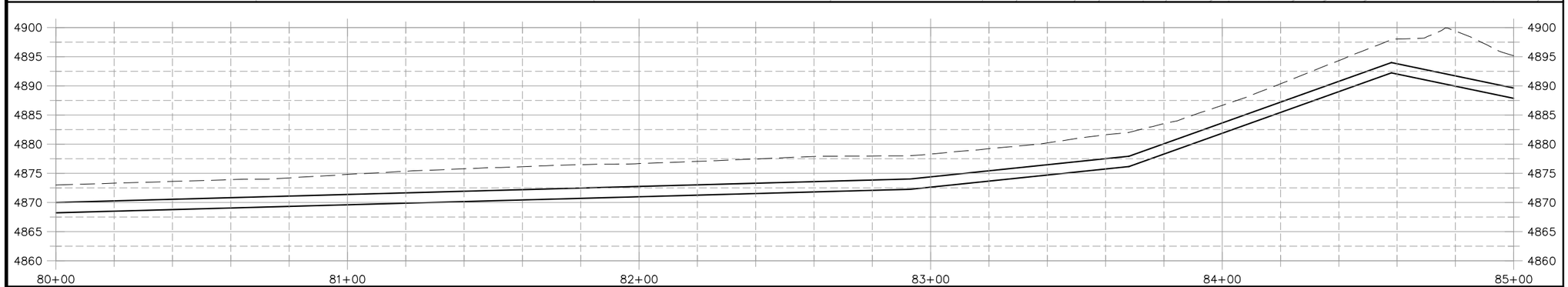

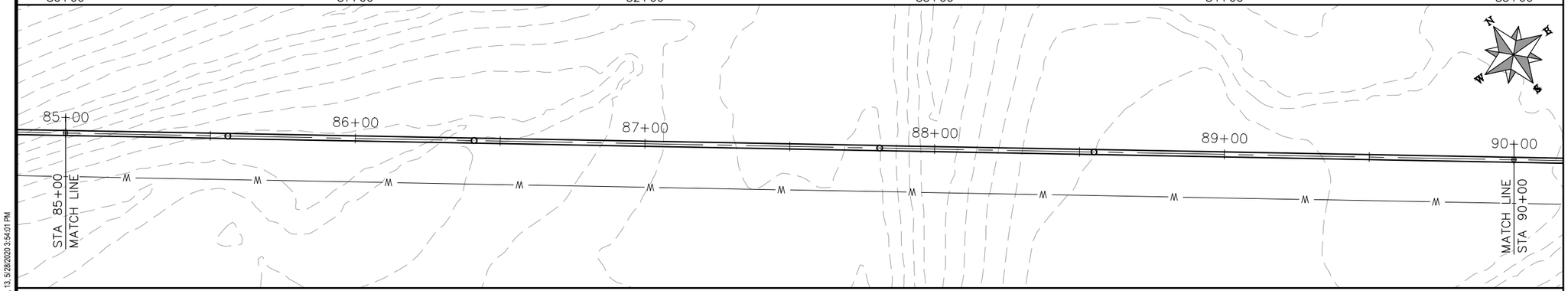

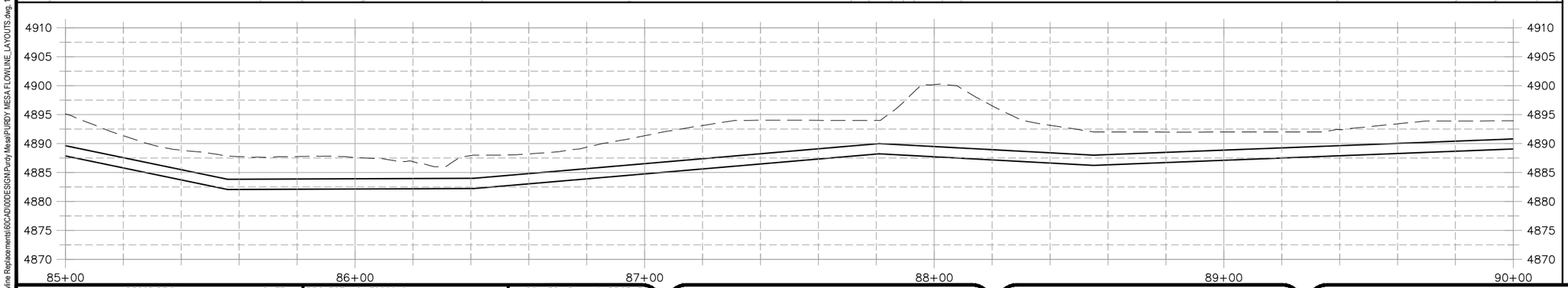

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610			
DRAWN BY	HMC	DATE	2020
DESIGNED BY	JAE	DATE	2020
CHECKED BY	JAE	DATE	2020
APPROVED BY	JAE	DATE	2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE I PLAN AND PROFILE
STA 80+00 TO STA 90+00

13

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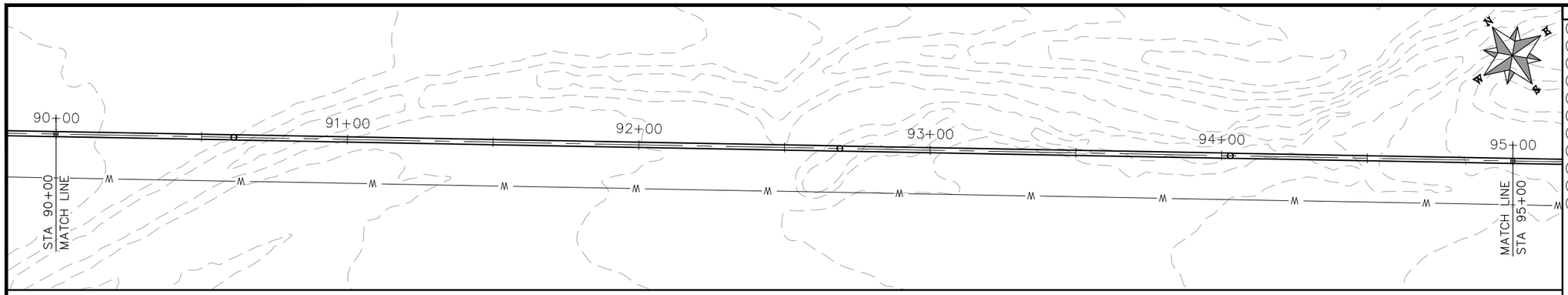

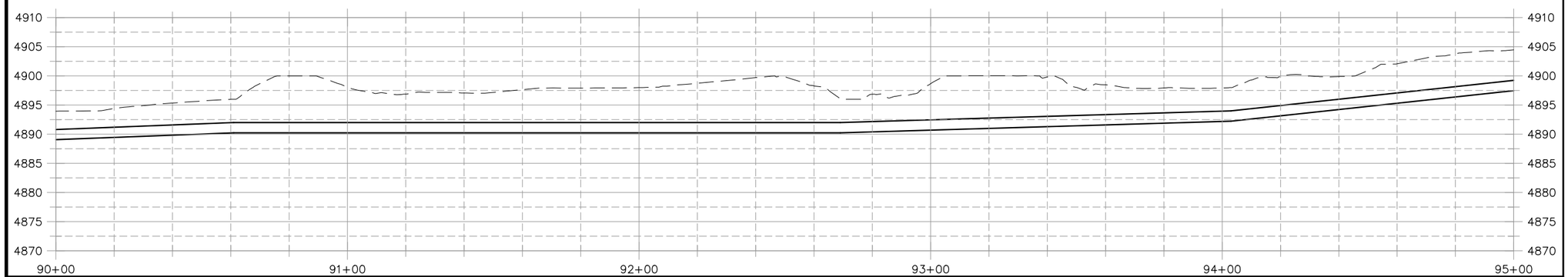

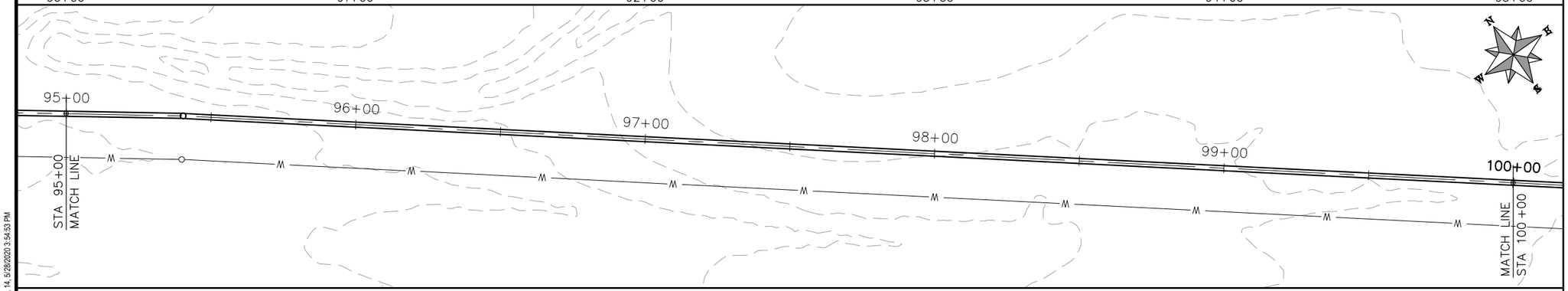

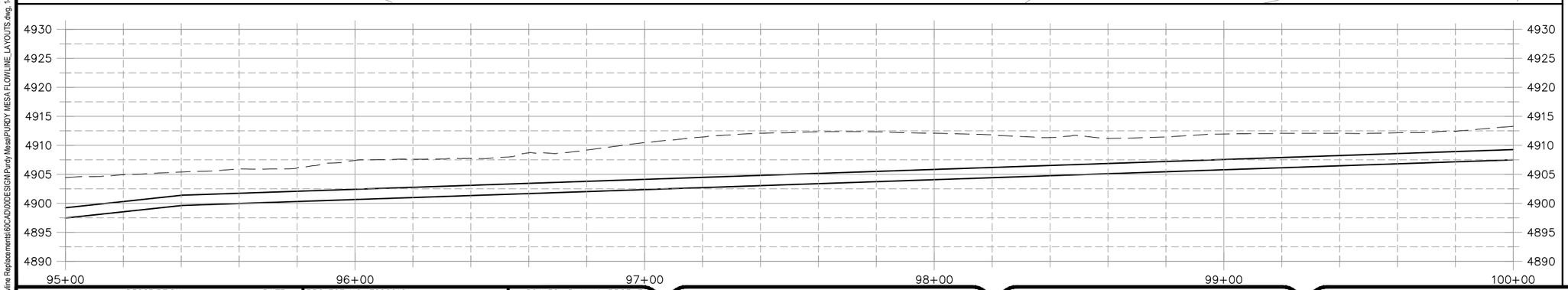

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE I PLAN AND PROFILE STA 90+00 TO STA 100+00

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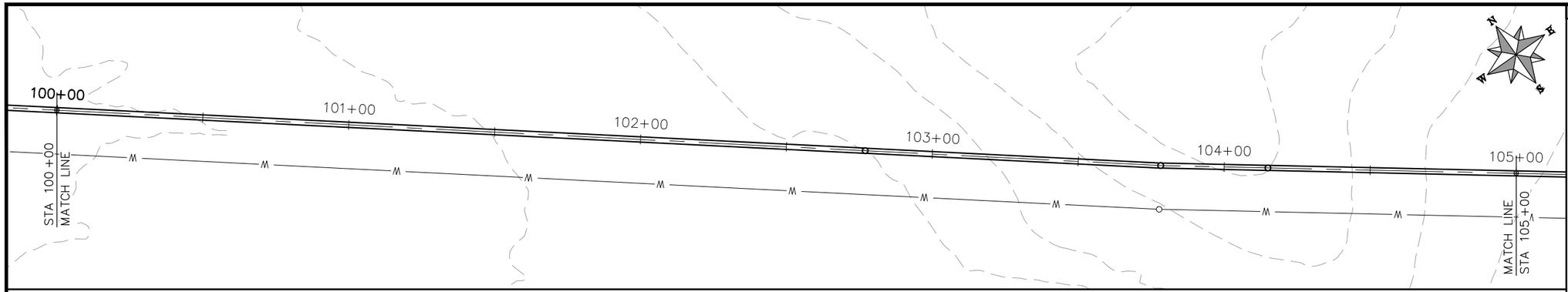

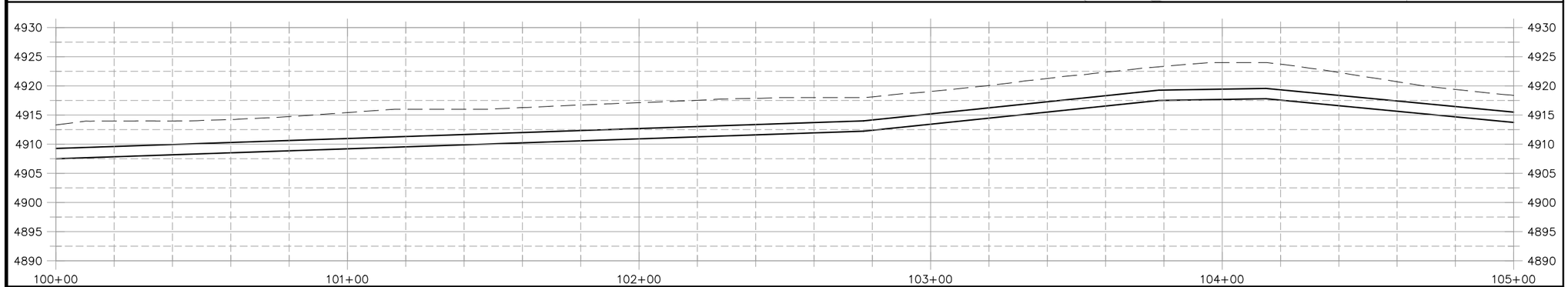

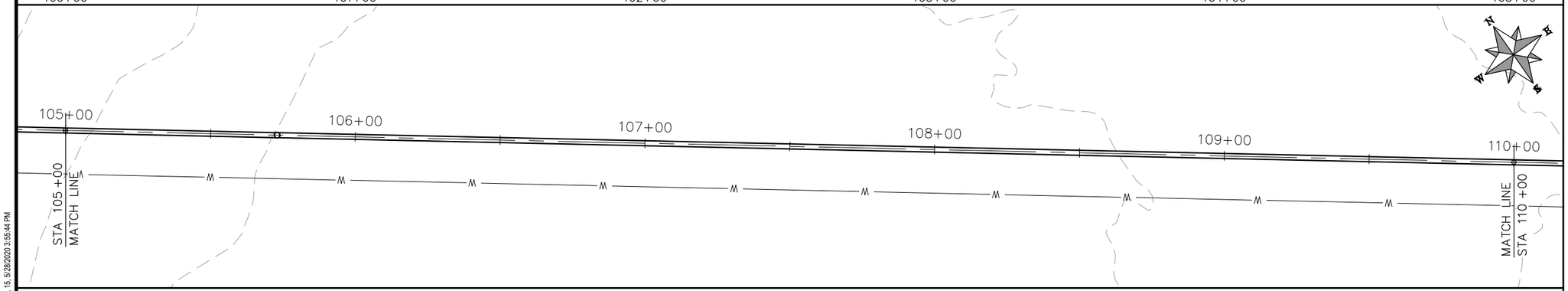

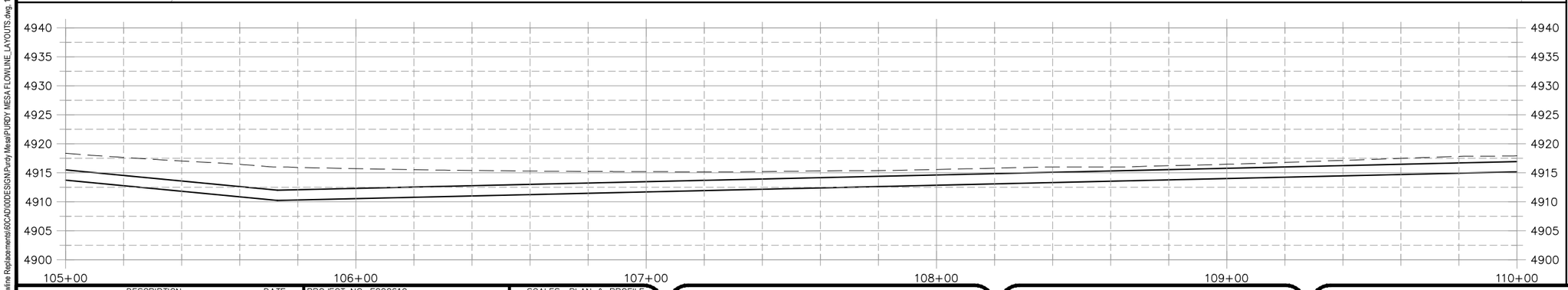

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE I PLAN AND PROFILE STA 100+00 TO STA 110+00

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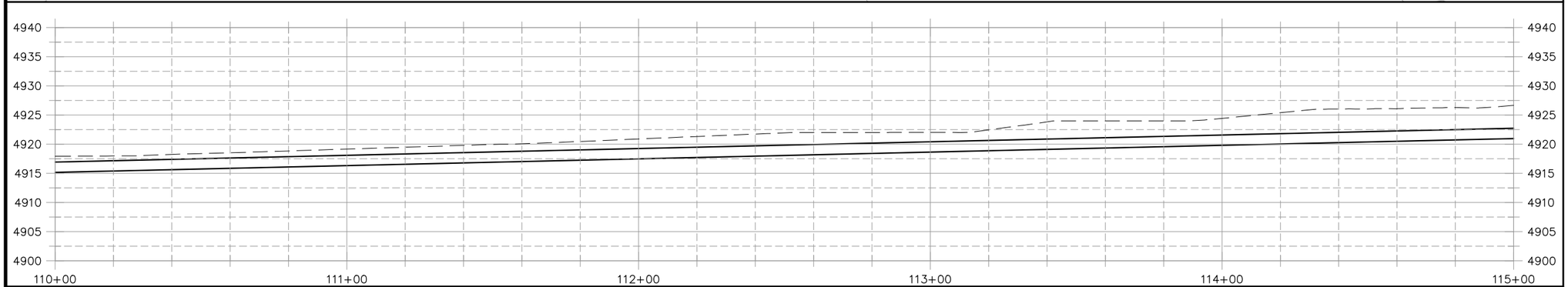

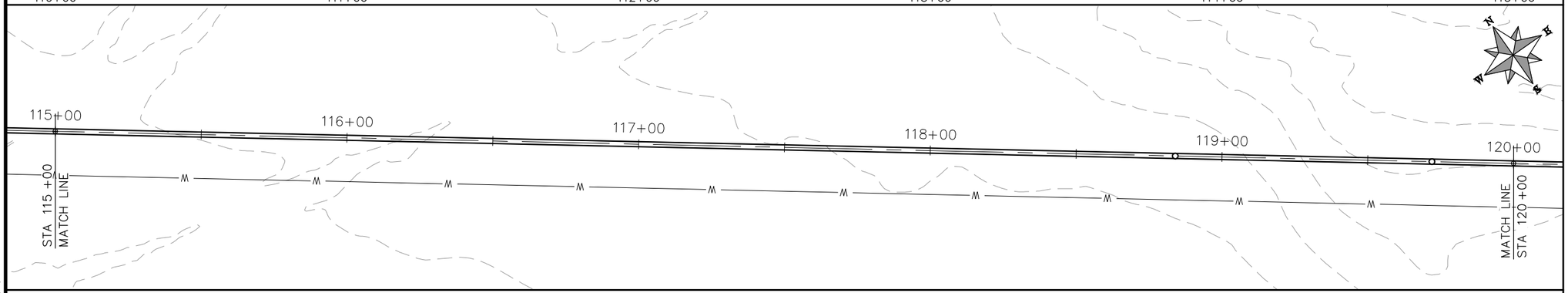

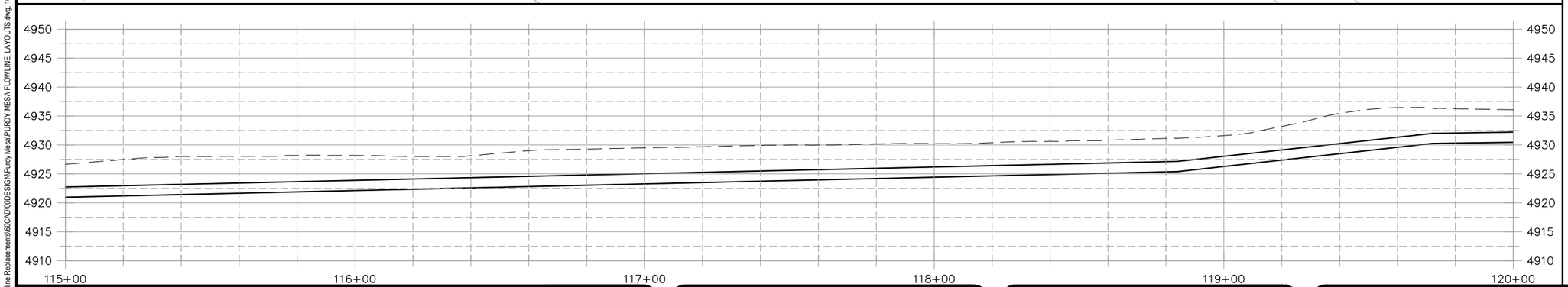

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE I PLAN AND PROFILE STA 110+00 TO STA 120+00

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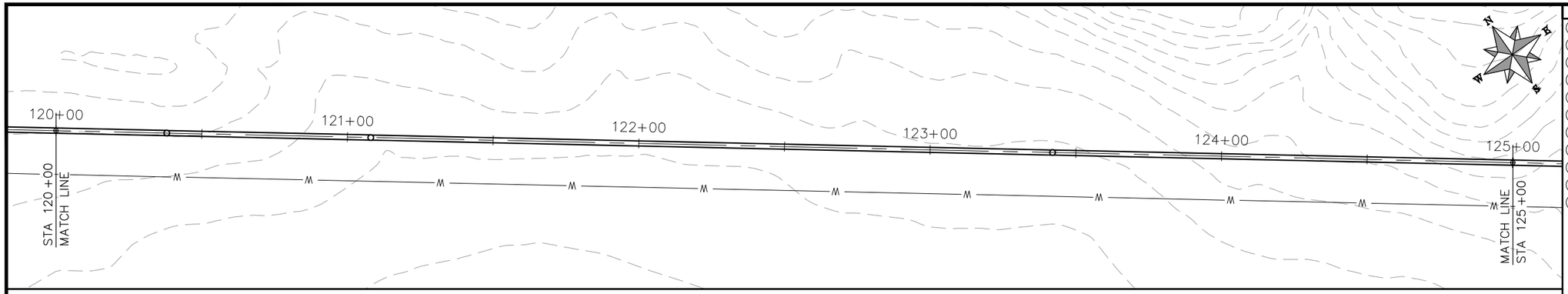

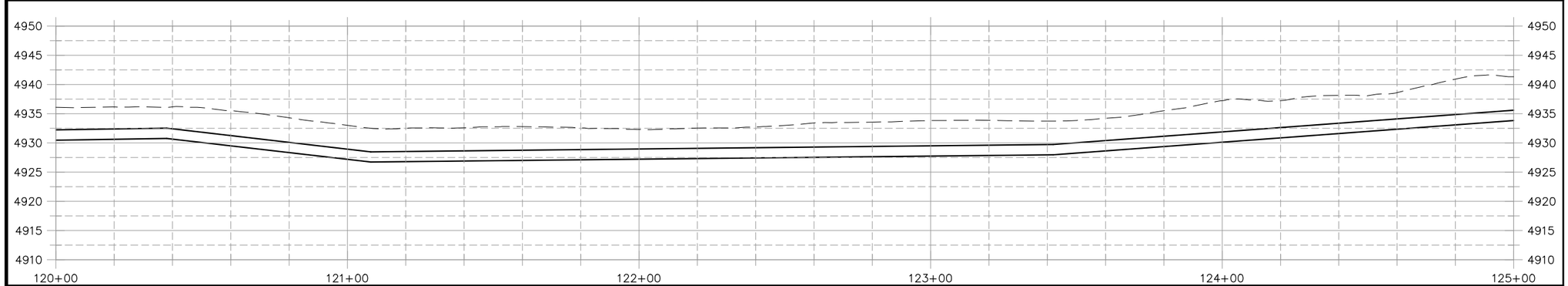

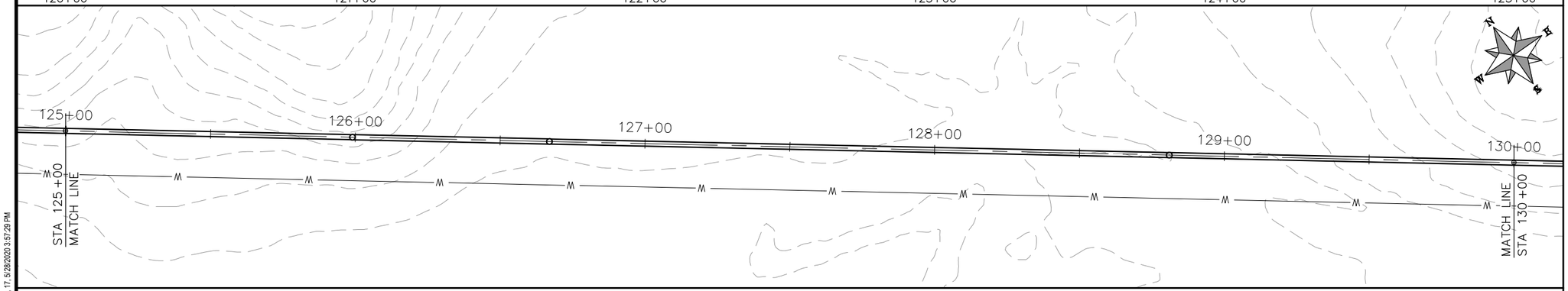

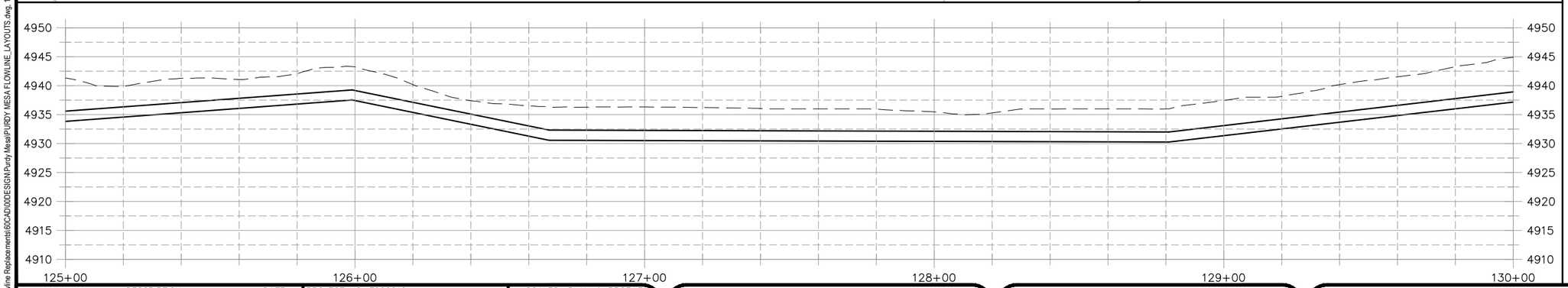

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE I PLAN AND PROFILE STA 120+00 TO STA 130+00

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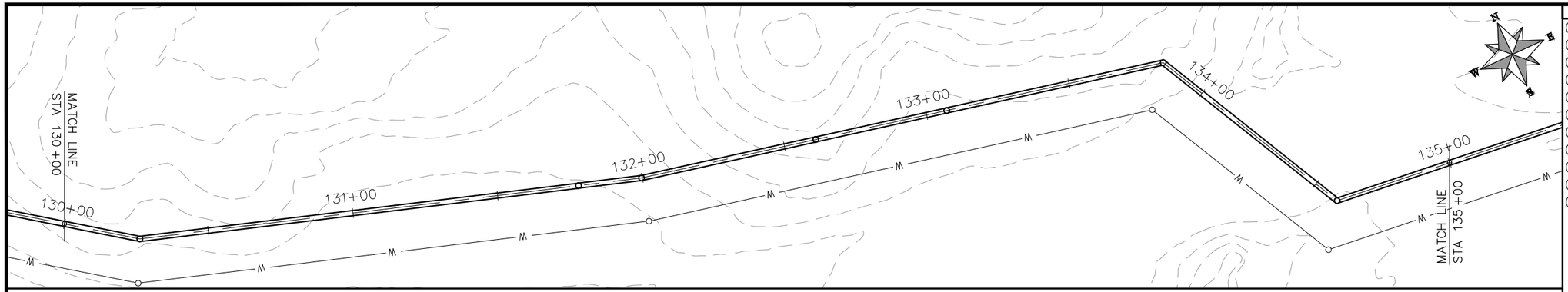

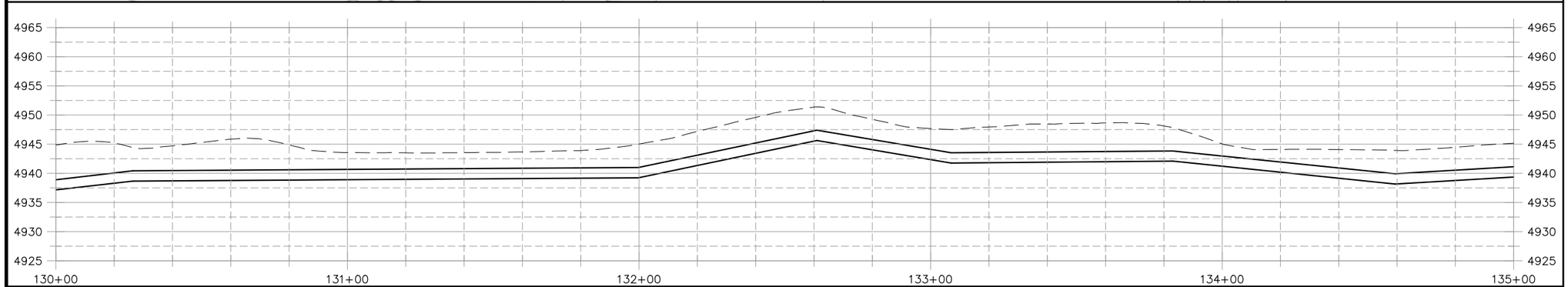

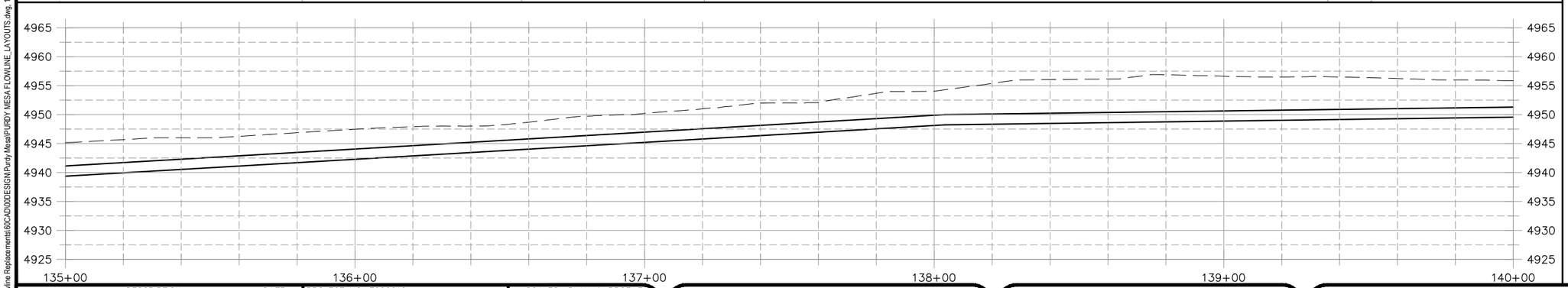

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE I PLAN AND PROFILE STA 130+00 TO STA 140+00

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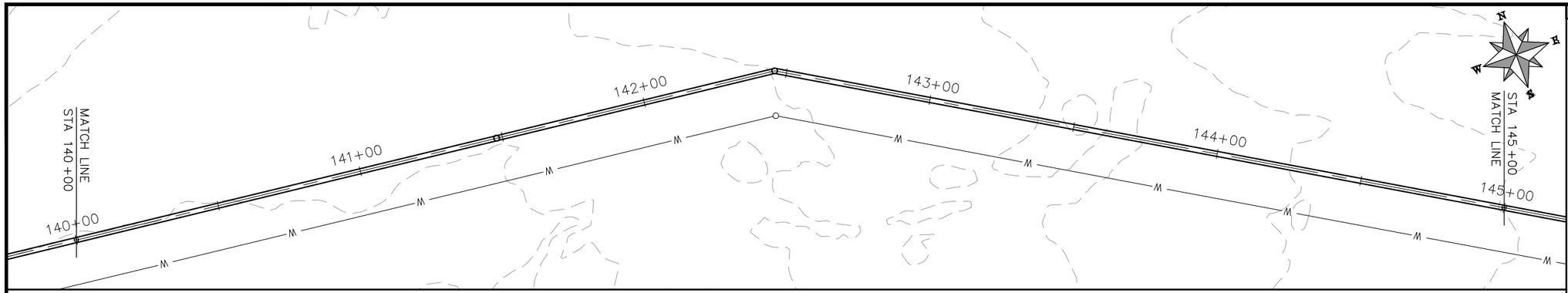

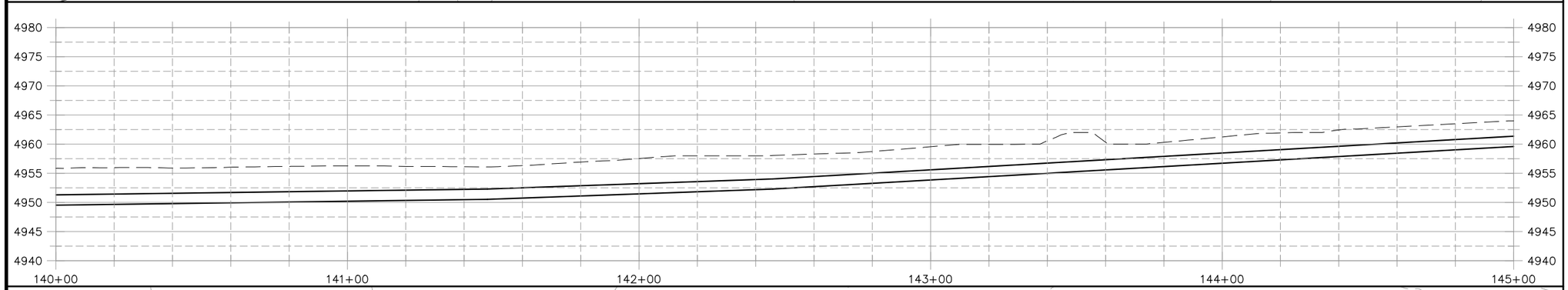

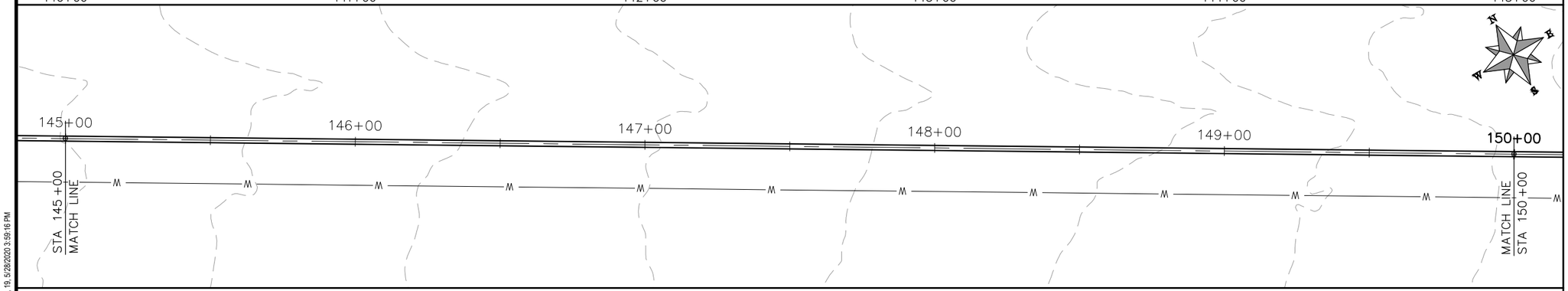

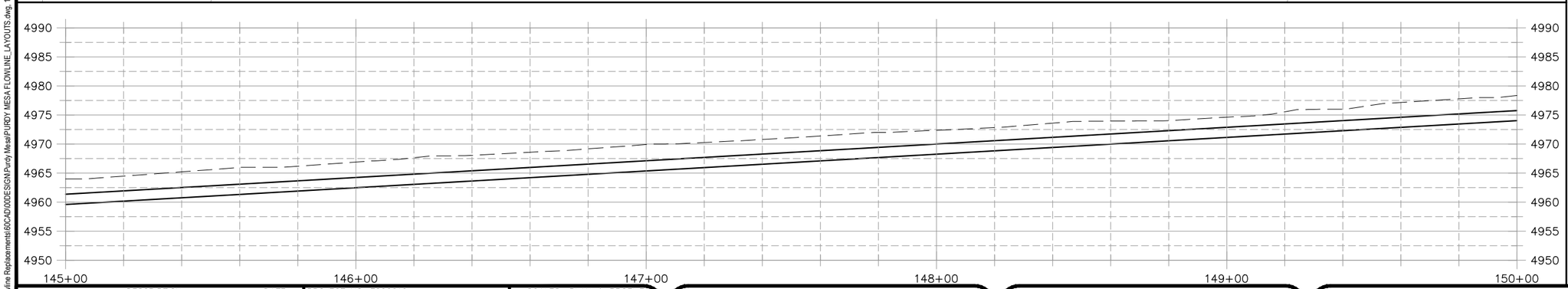

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE I PLAN AND PROFILE STA 140+00 TO STA 150+00

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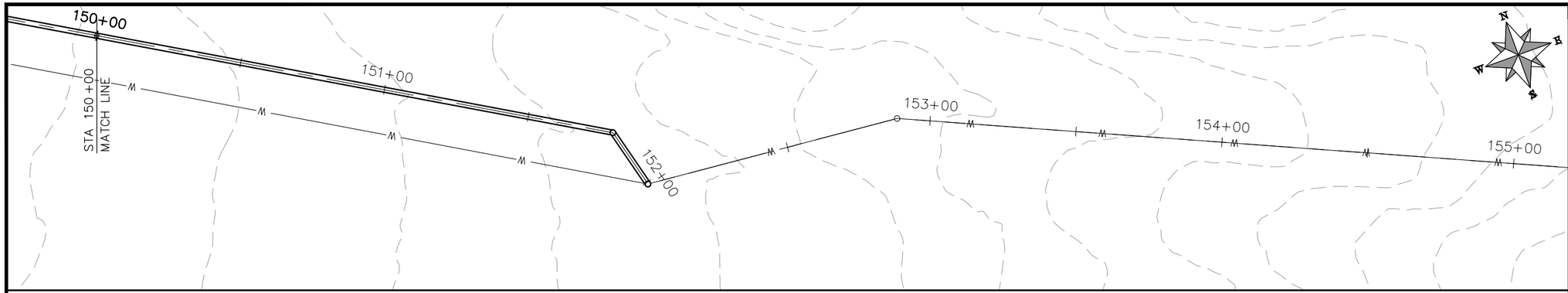

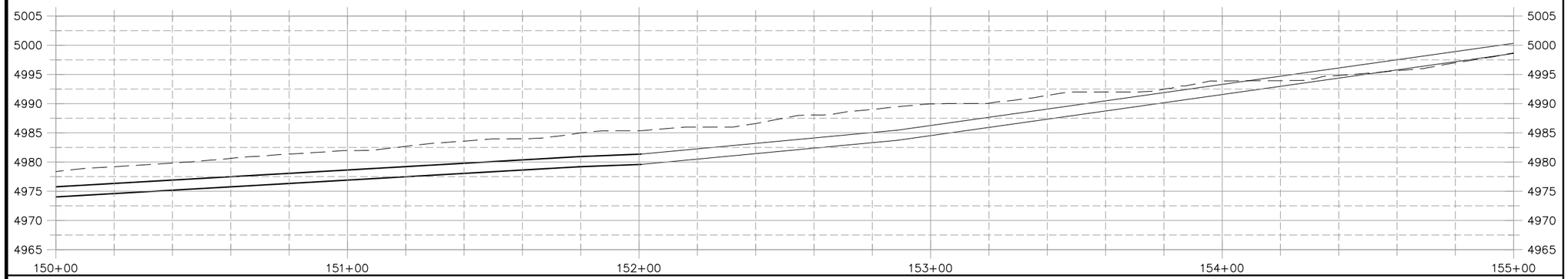

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE I PLAN AND PROFILE
STA 150+00 TO STA 155+00

20

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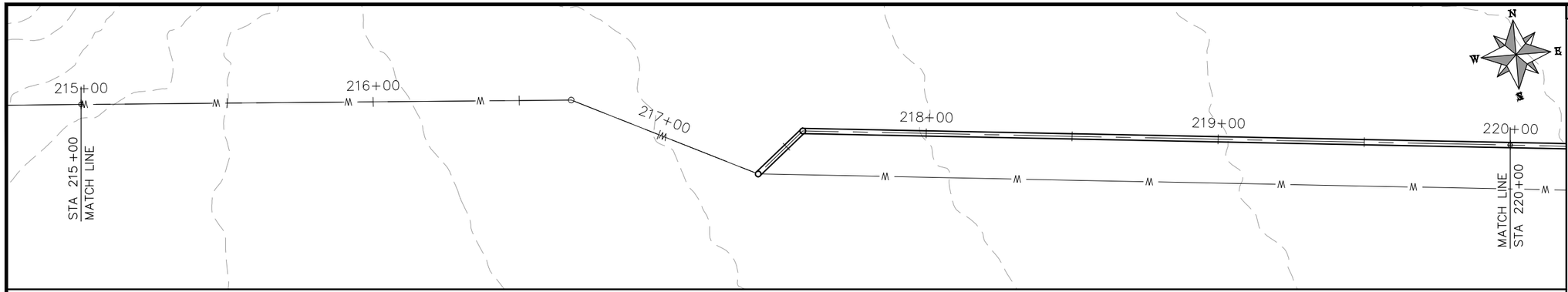

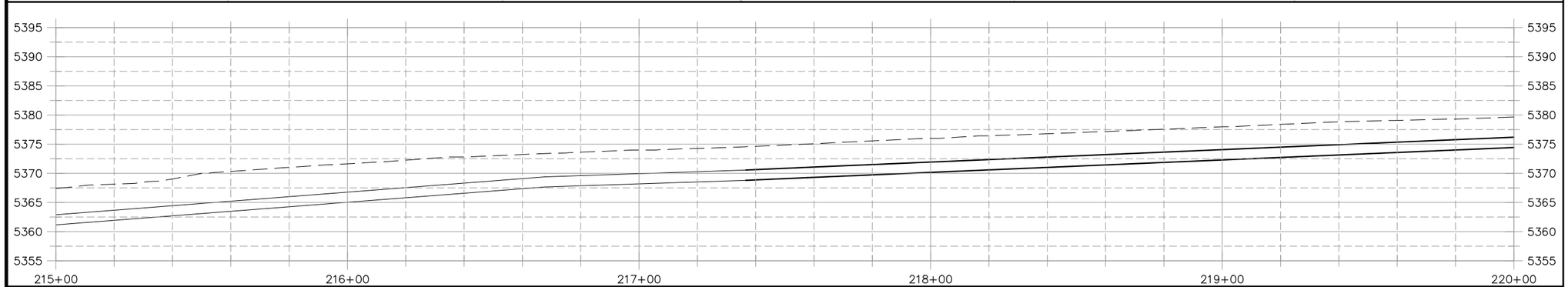

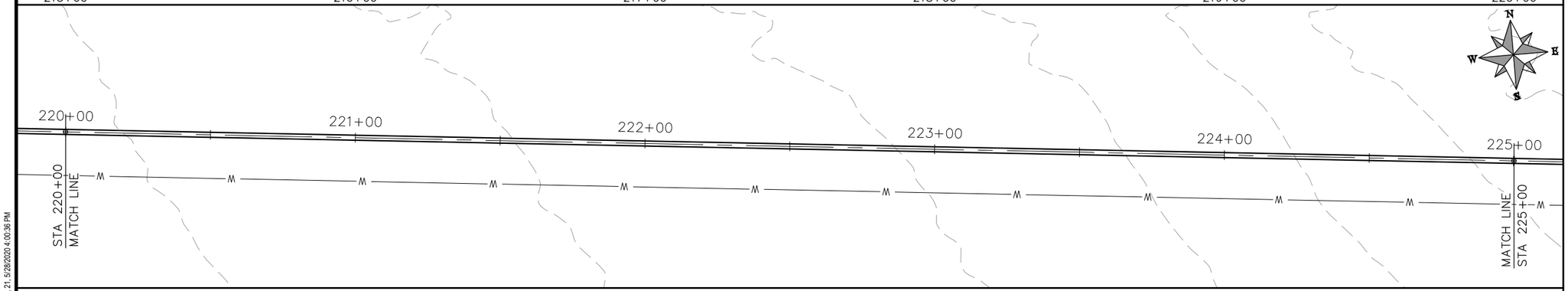

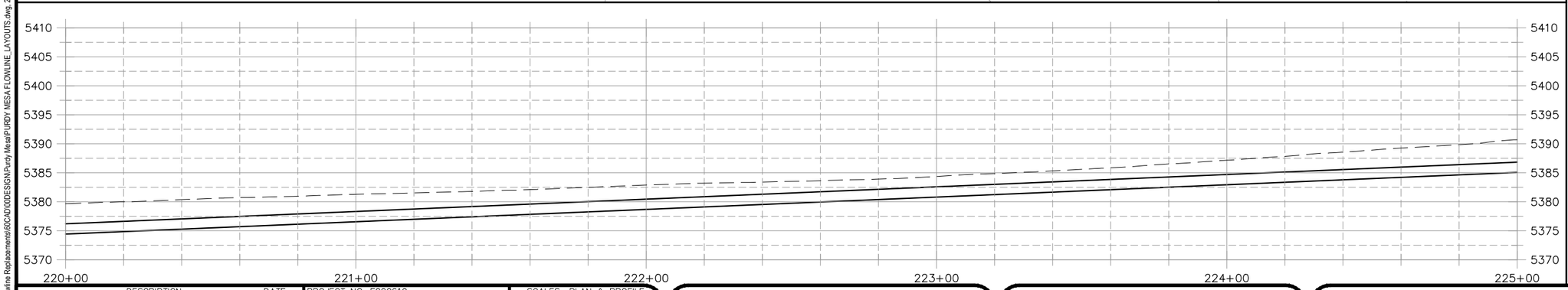

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO.	F000610
DRAWN BY	HMC DATE 2020
DESIGNED BY	JAE DATE 2020
CHECKED BY	JAE DATE 2020
APPROVED BY	JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE II PLAN AND PROFILE STA 215+00 TO STA 225+00

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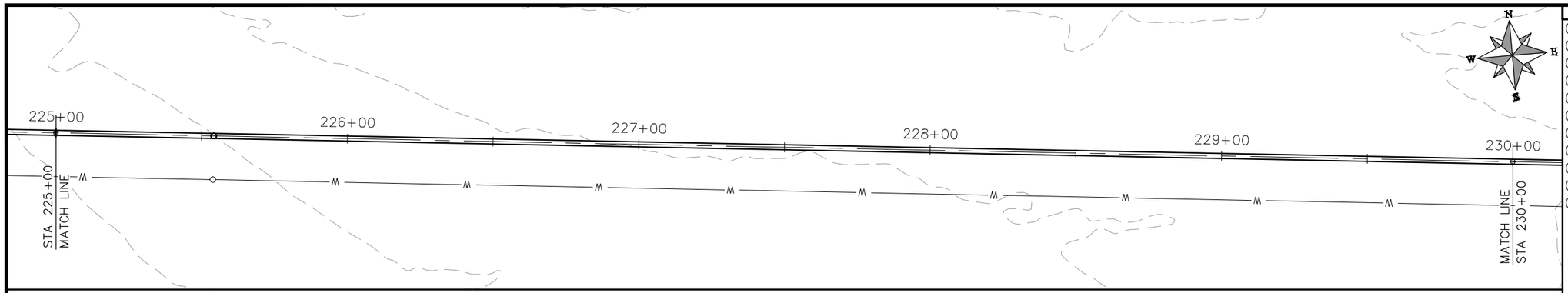

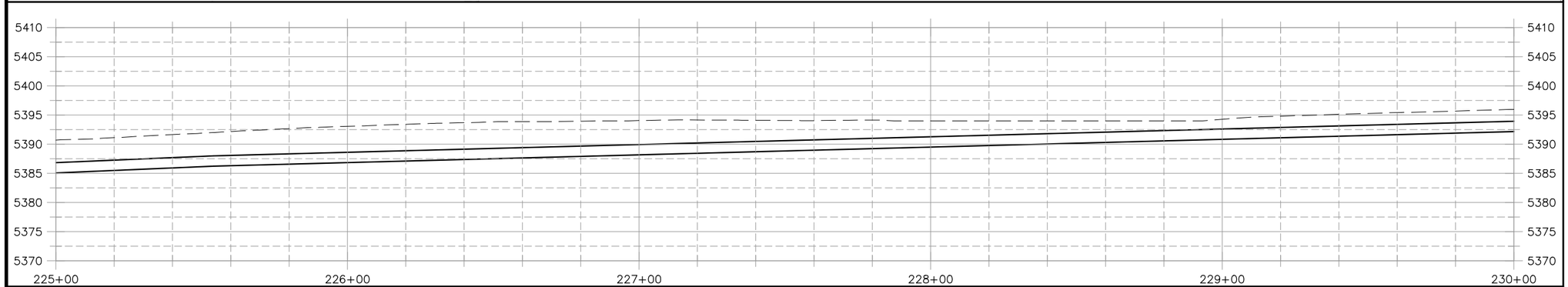

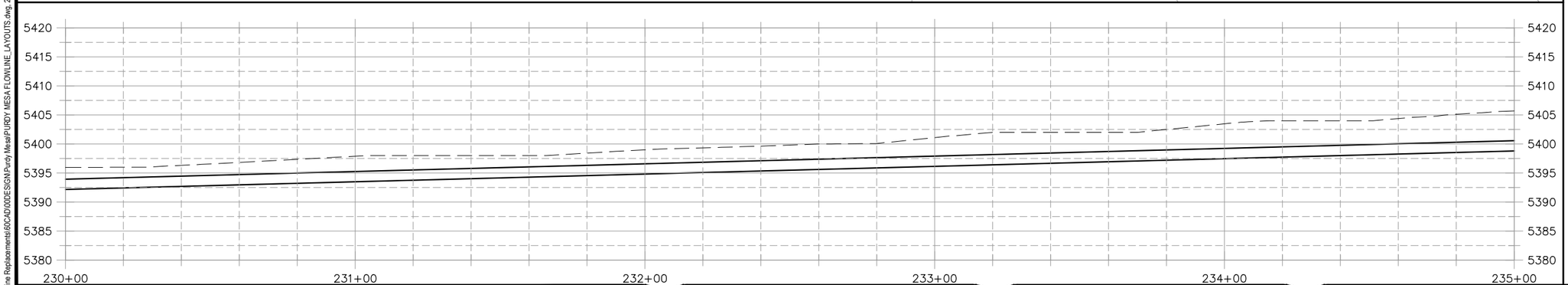

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610			
DRAWN BY	HMC	DATE	2020
DESIGNED BY	JAE	DATE	2020
CHECKED BY	JAE	DATE	2020
APPROVED BY	JAE	DATE	2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 225+00 TO STA 235+00

22

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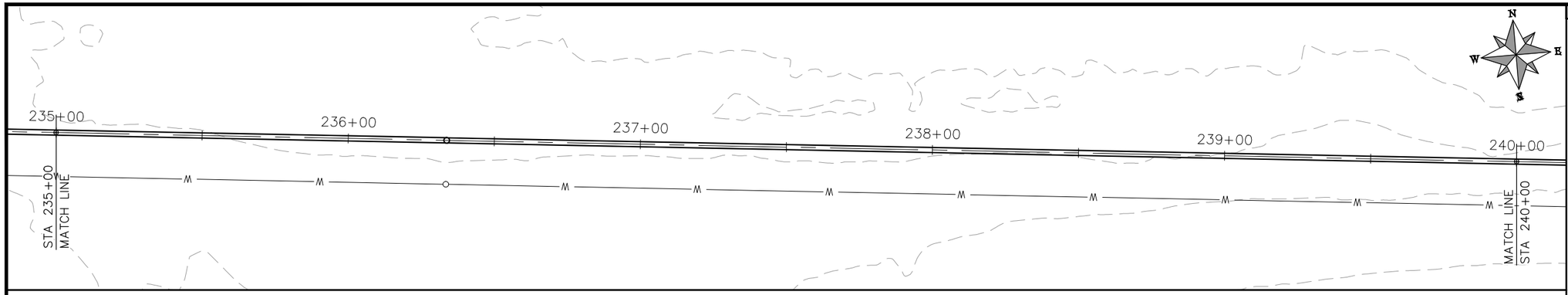

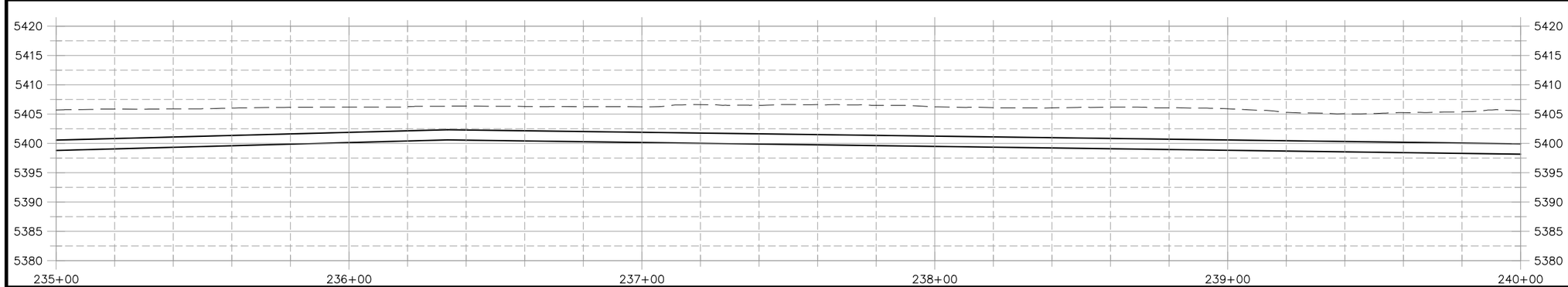

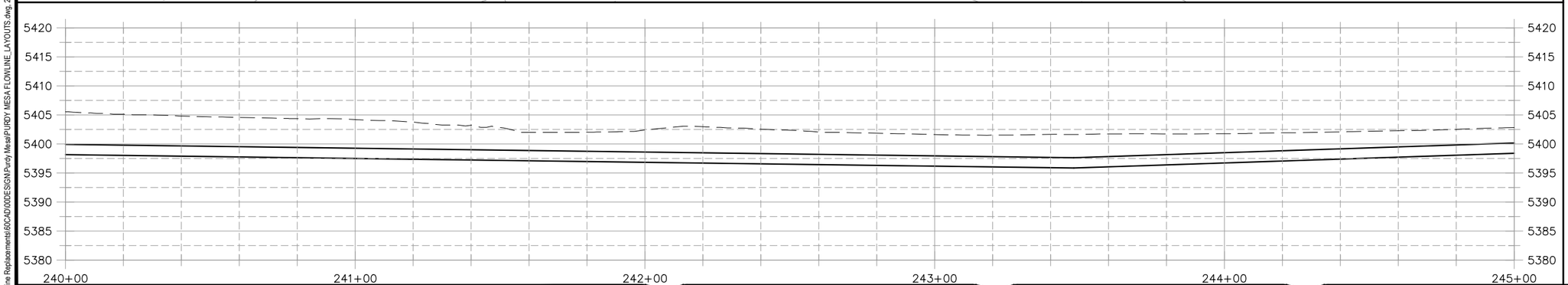

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 235+00 TO STA 245+00

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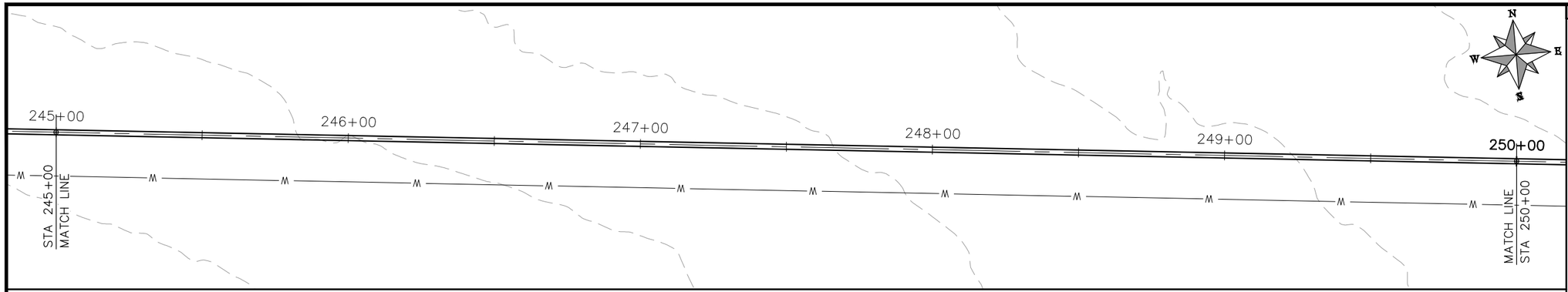

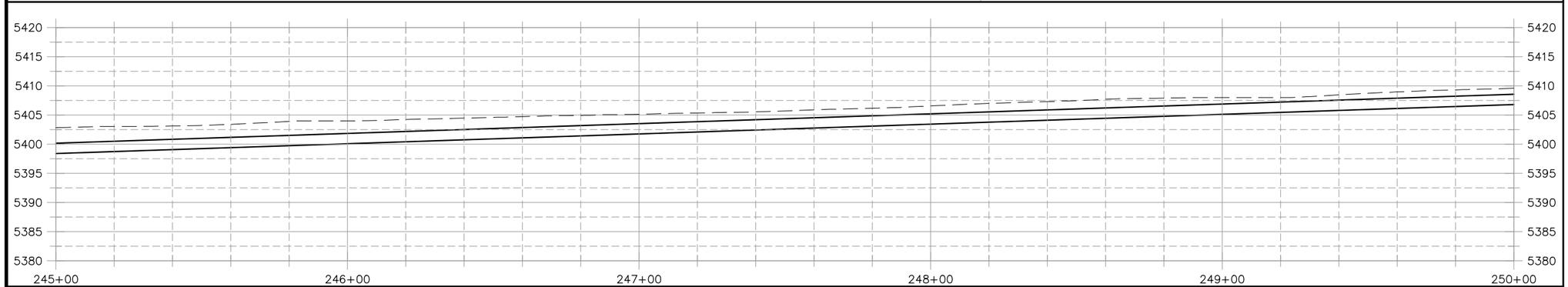

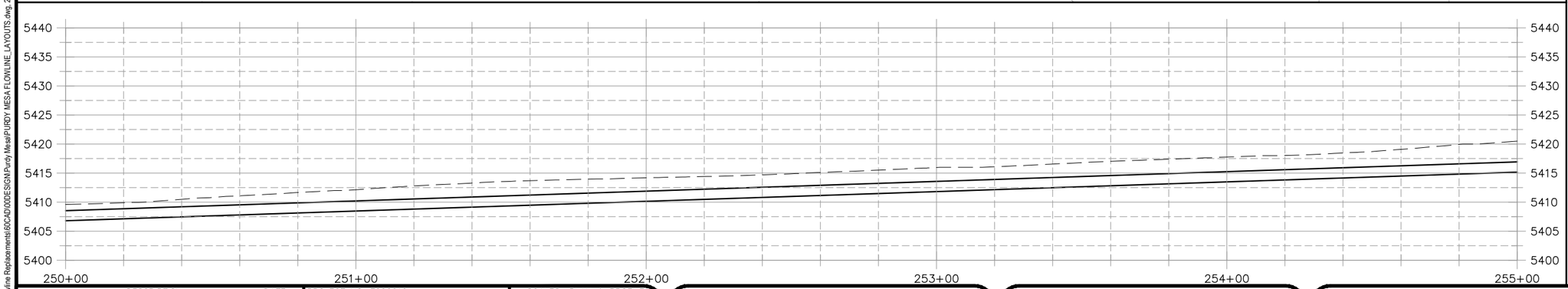

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE II PLAN AND PROFILE STA 245+00 TO STA 255+00

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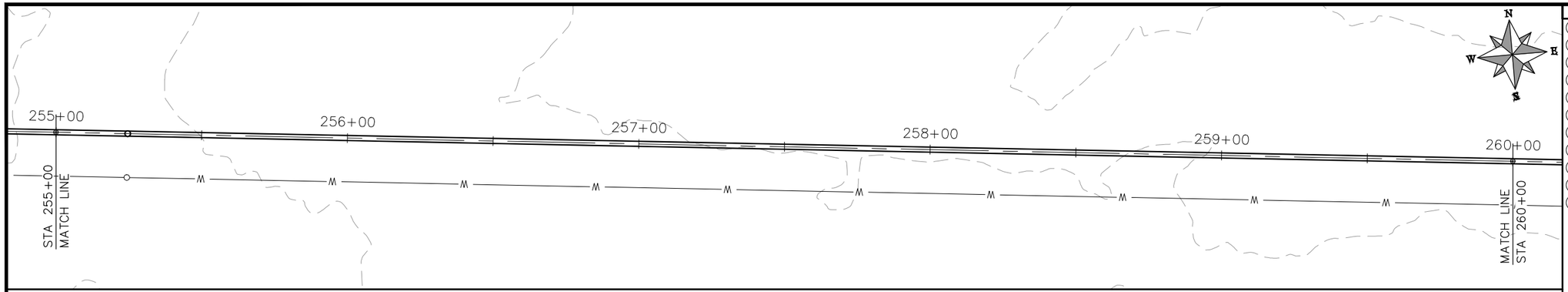
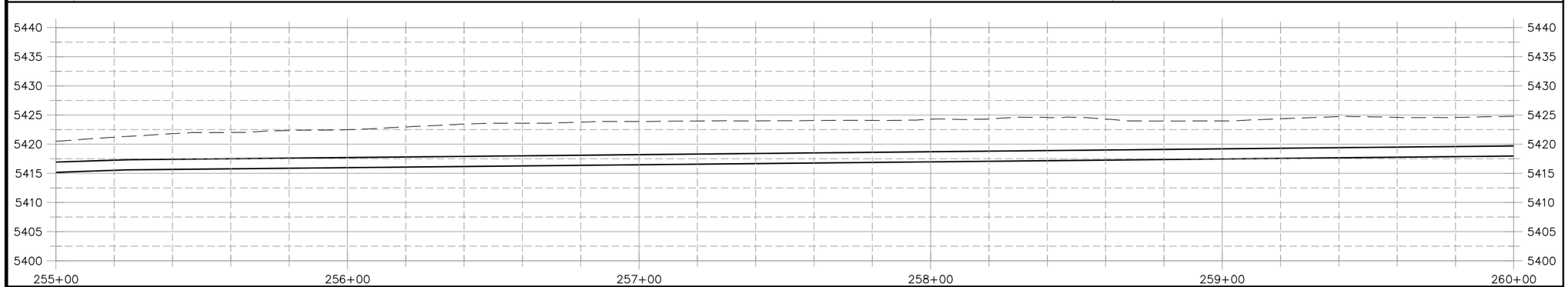
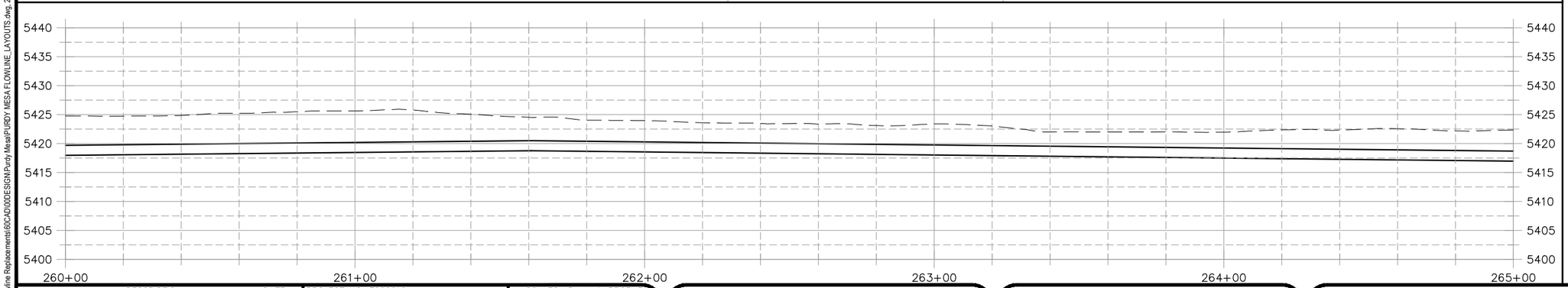






CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

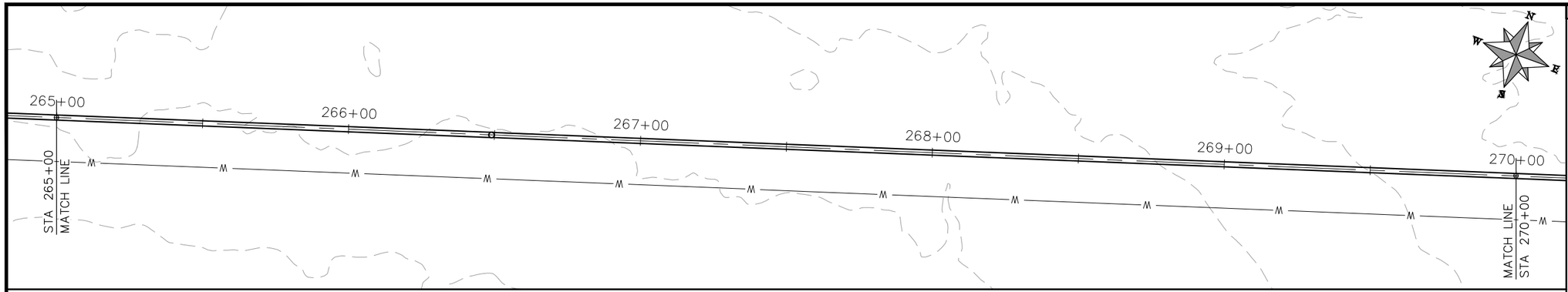
SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

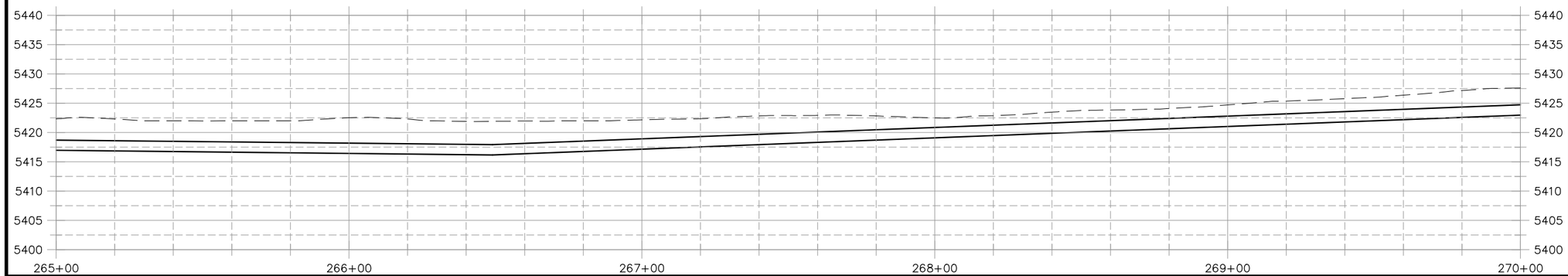
CITY OF Grand Junction COLORADO

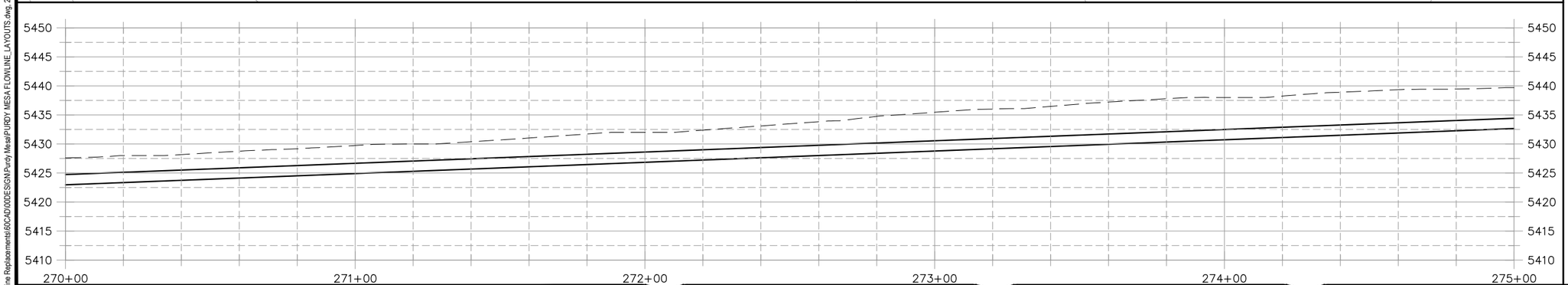
PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE II PLAN AND PROFILE STA 255+00 TO STA 265+00

N:\Landproj\2020 Flowline Replacements\60CAD\00DESIGN\Purdy Mesa\PURDY MESA FLOWLINE_LAYOUTS.dwg, 25, 5/28/2020 4:04:03 PM







CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610	
DRAWN BY HMC	DATE 2020
DESIGNED BY JAE	DATE 2020
CHECKED BY JAE	DATE 2020
APPROVED BY JAE	DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 265+00 TO STA 275+00

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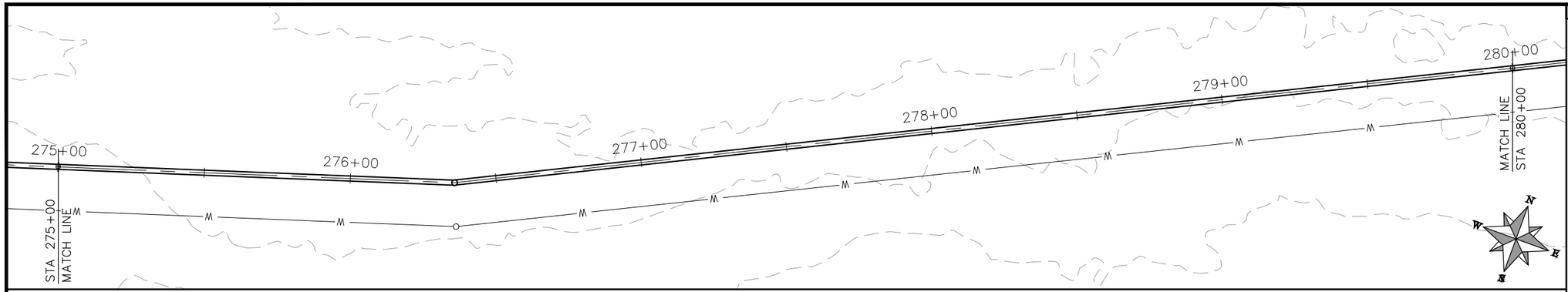
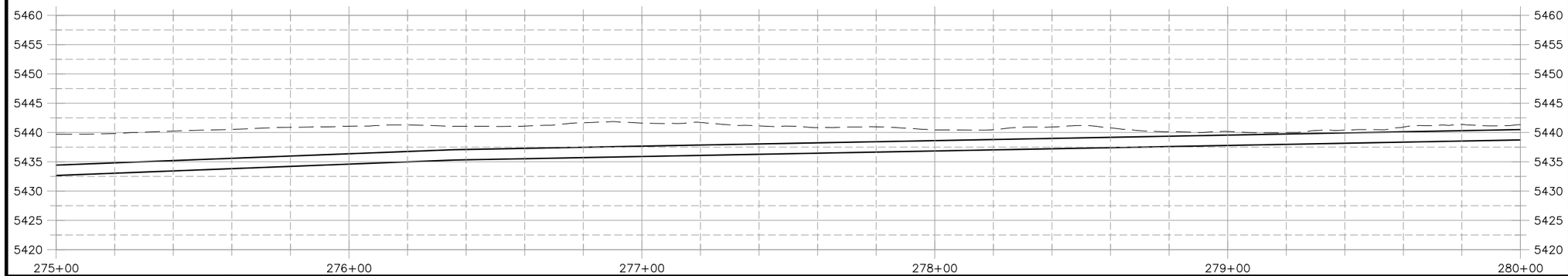
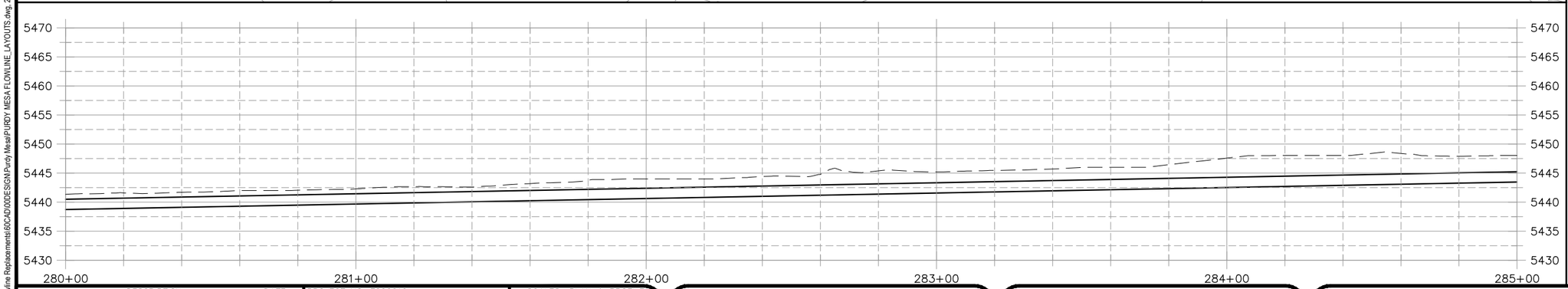






CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

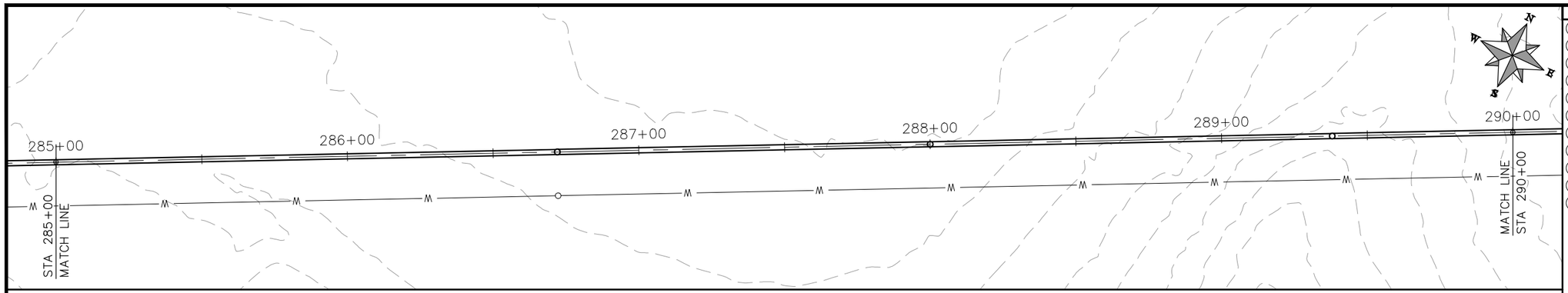
SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

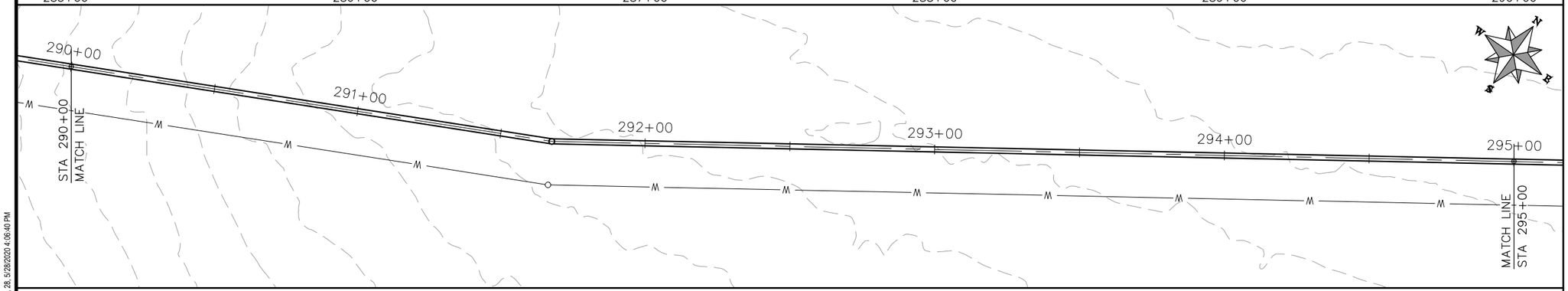
CITY OF Grand Junction COLORADO

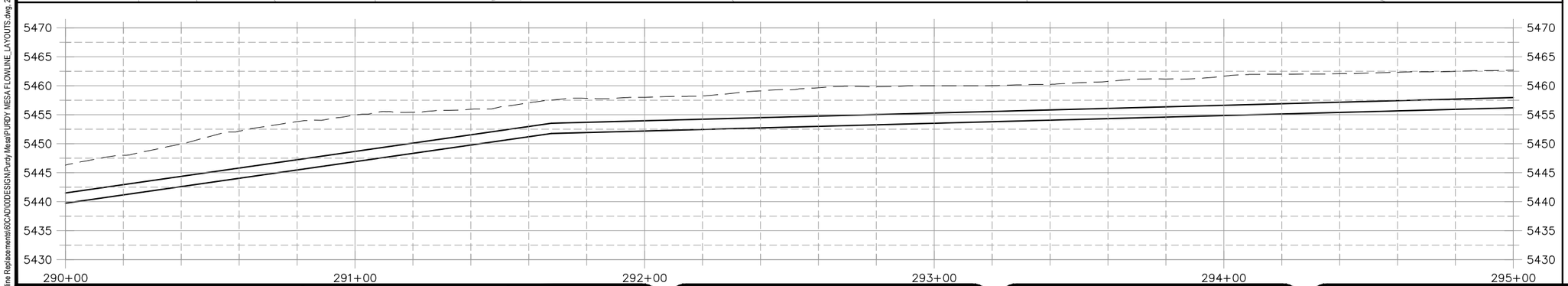
PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 275+00 TO STA 285+00

N:\Landproj\2020 Flowline Replacements\60CAD\00DESIGN\Purdy Mesa\PURDY MESA FLOWLINE_LAYOUTS.dwg, 27, 5/28/2020 4:05:48 PM







CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

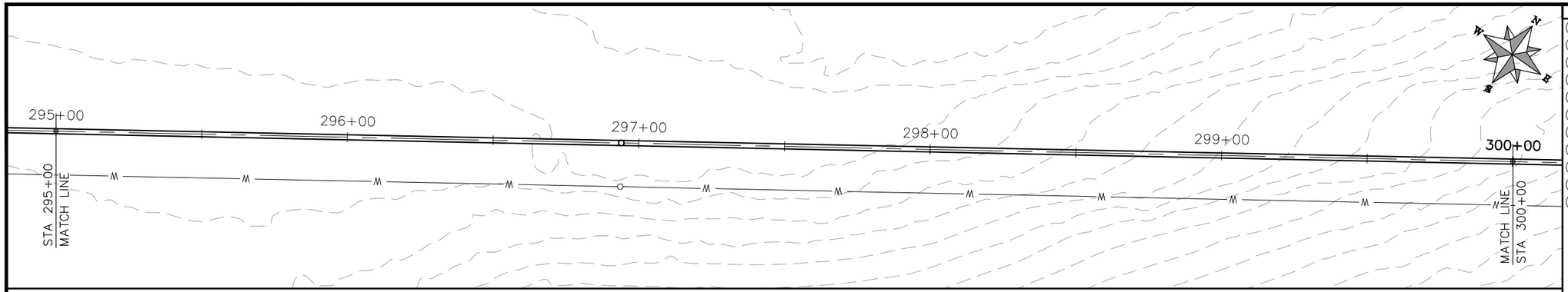
CITY OF Grand Junction COLORADO

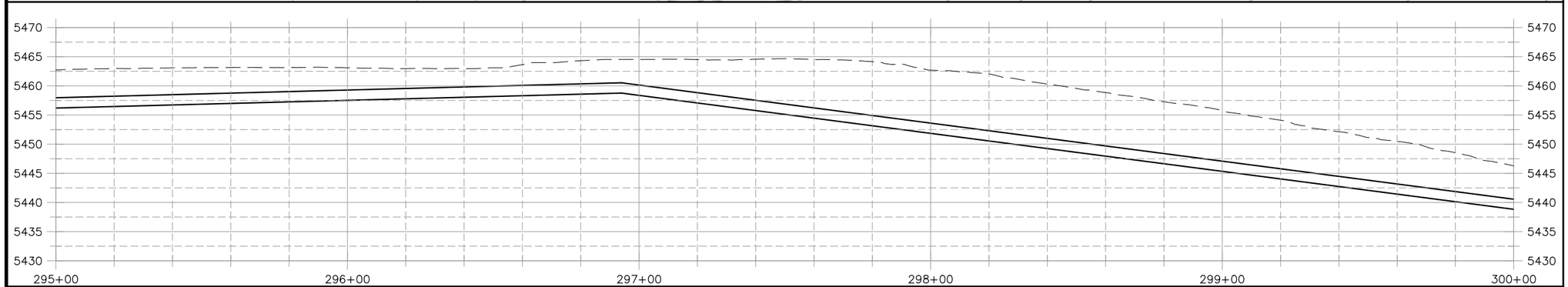
PUBLIC WORKS
ENGINEERING DIVISION

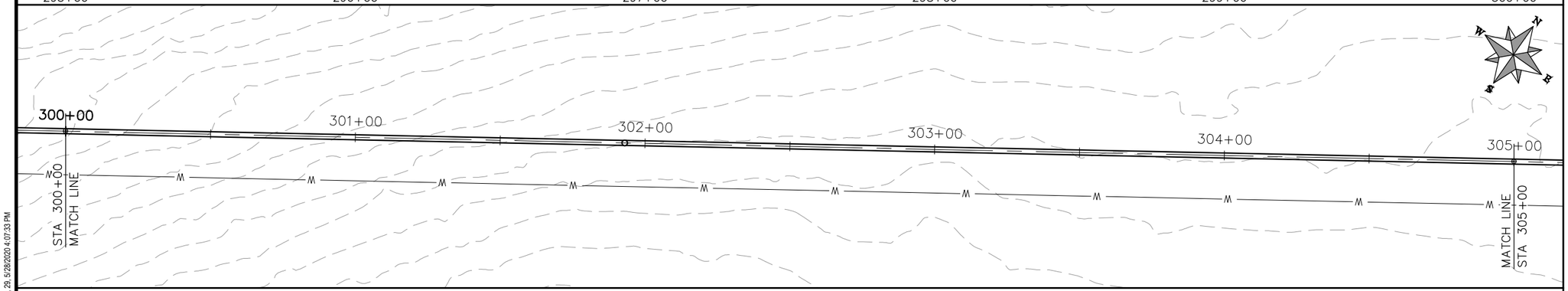
2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 285+00 TO STA 295+00

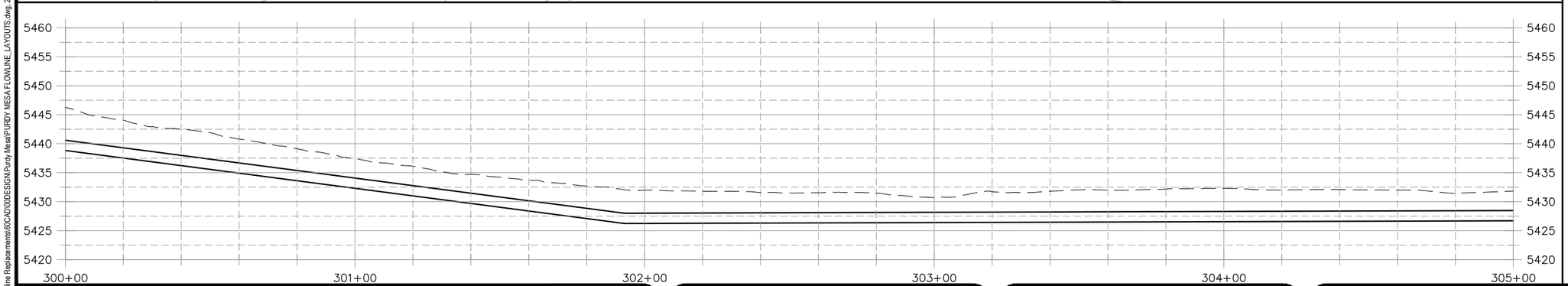
28

N:\Landproj\2020 Flowline Replacements\60CAD\00DESIGN\Purdy Mesa\PURDY MESA FLOWLINE_LAYOUTS.dwg, 28, 5/28/2020 4:06:40 PM









CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

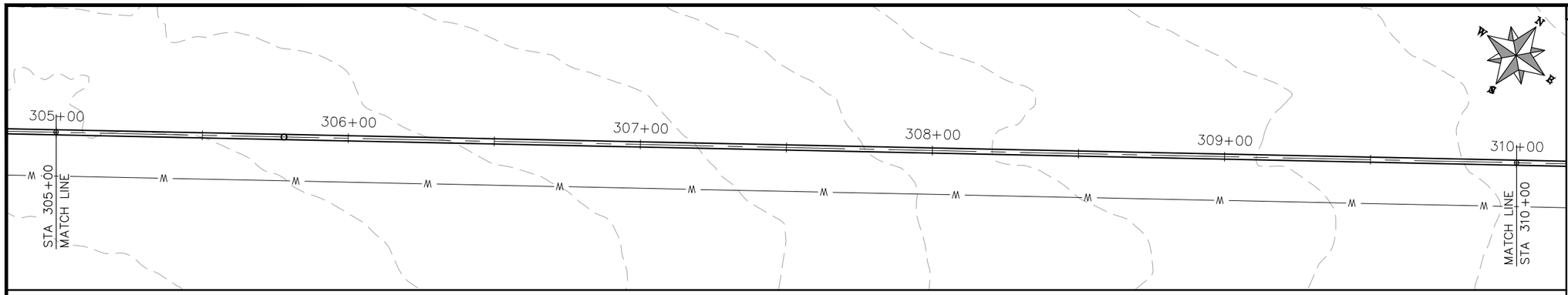
CITY OF Grand Junction COLORADO

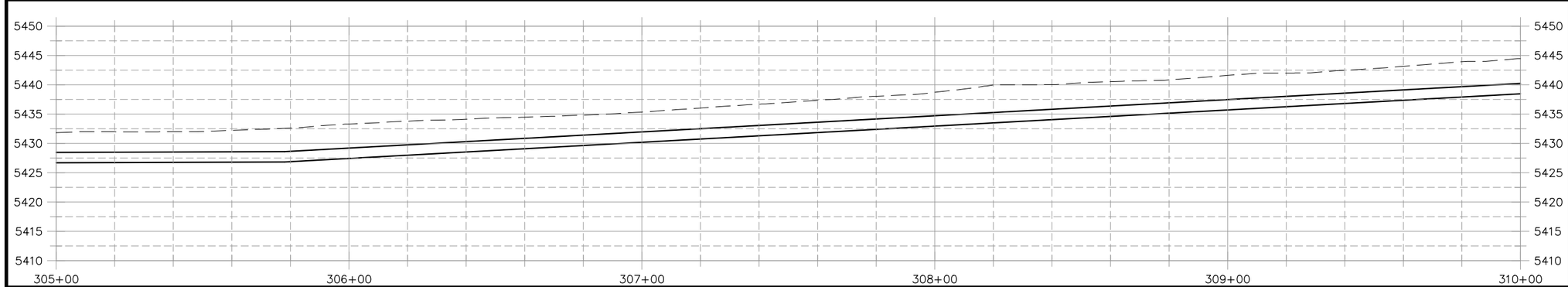
PUBLIC WORKS
ENGINEERING DIVISION

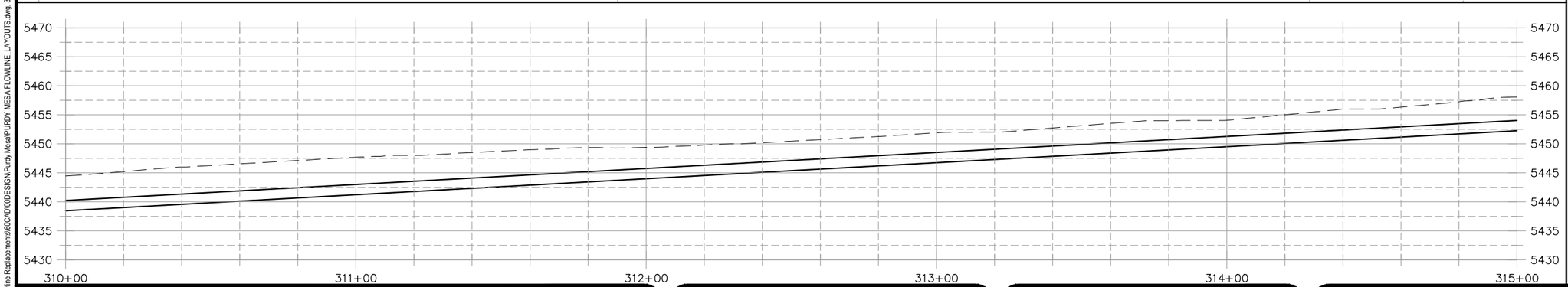
2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 295+00 TO STA 305+00

29

N:\Landproj\2020 Flowline Replacements\60CAD\00DESIGN\Purdy Mesa\PURDY MESA FLOWLINE_LAYOUTS.dwg, 29, 5/28/2020 4:07:33 PM







CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO.	F000610
DRAWN BY	HMC DATE 2020
DESIGNED BY	JAE DATE 2020
CHECKED BY	JAE DATE 2020
APPROVED BY	JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 305+00 TO STA 315+00

30

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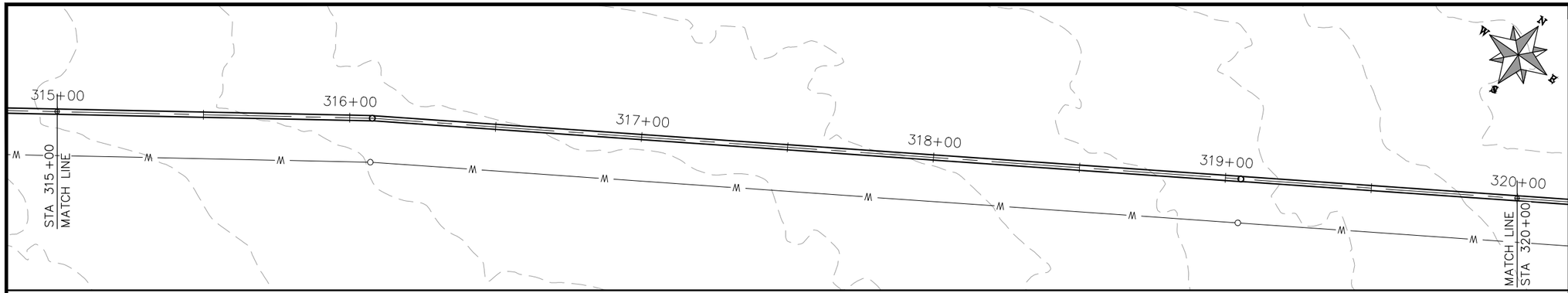
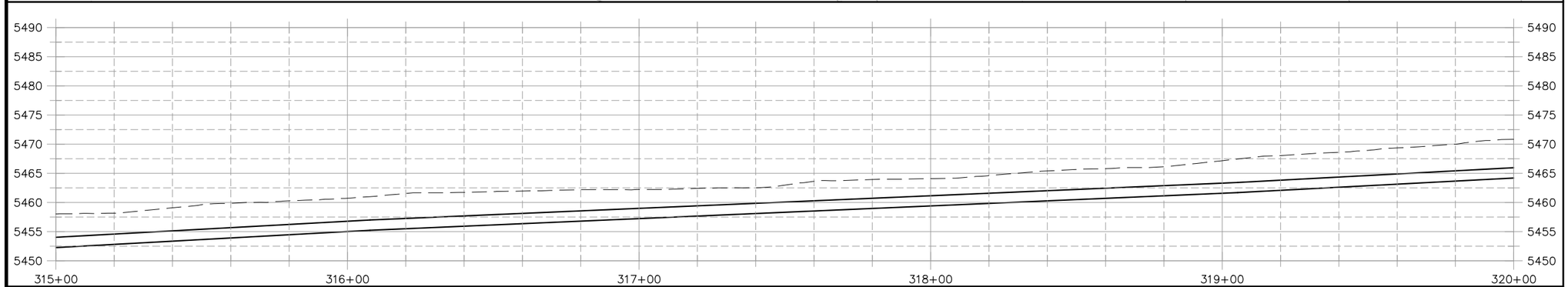
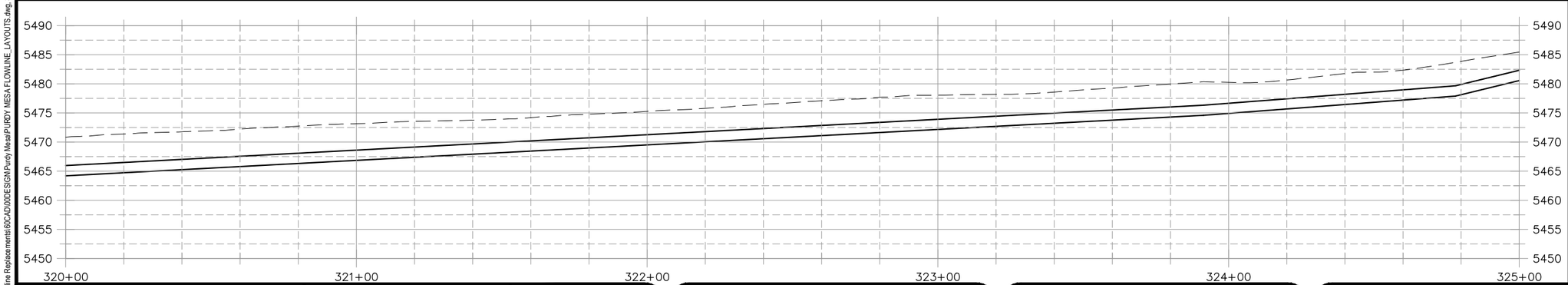






CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

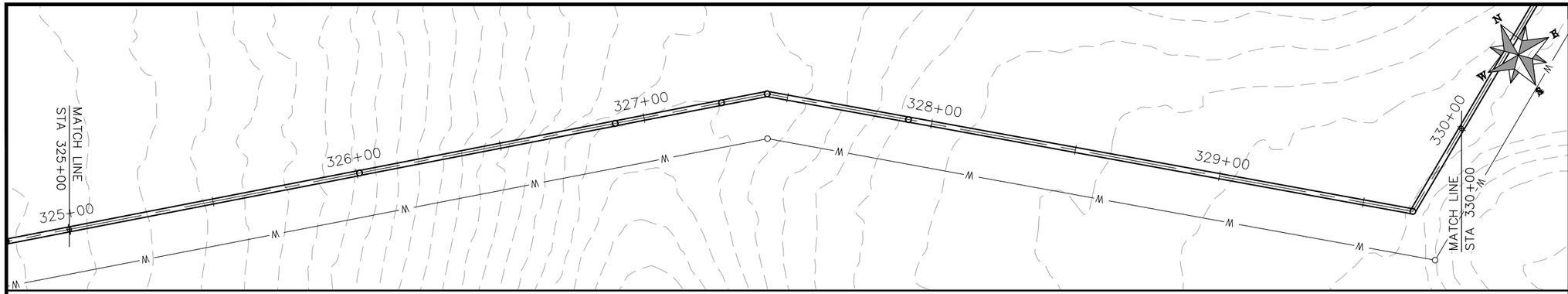
SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

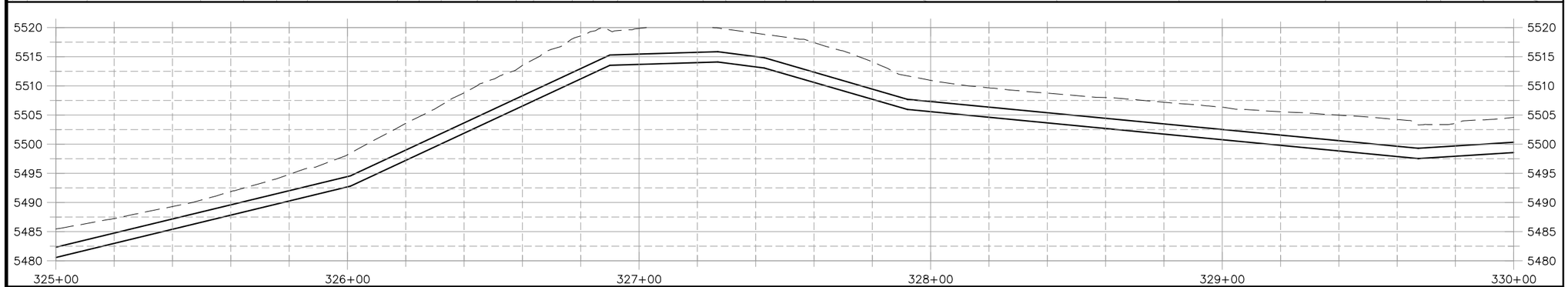
CITY OF Grand Junction COLORADO

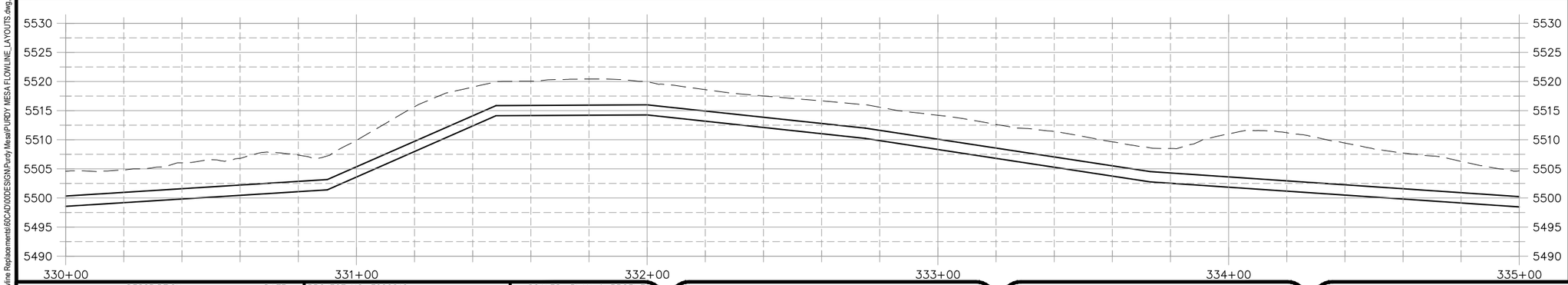
PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 315+00 TO STA 325+00

N:\Landproj\2020 Flowline Replacements\60CAD\00DESIGN\Purdy Mesa\PURDY MESA FLOWLINE_LAYOUTS.dwg 31, 5/28/2020 4:09:19 PM







CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

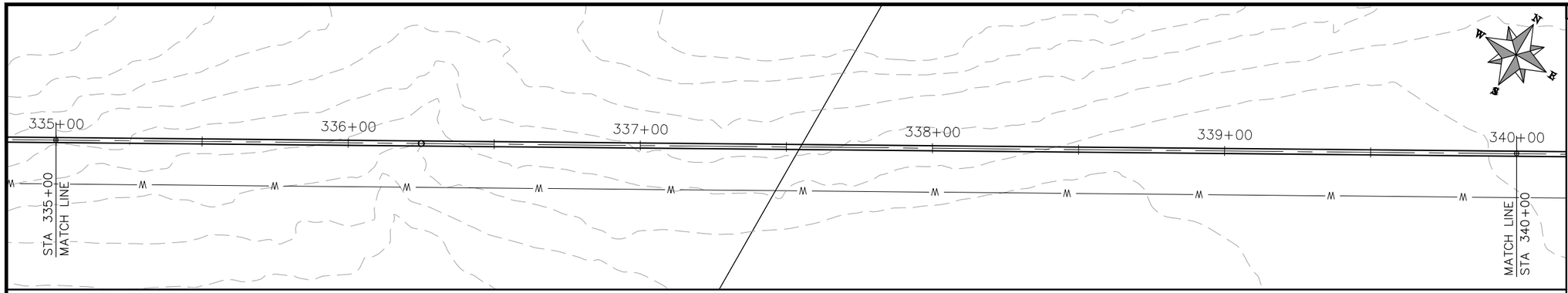
CITY OF Grand Junction COLORADO

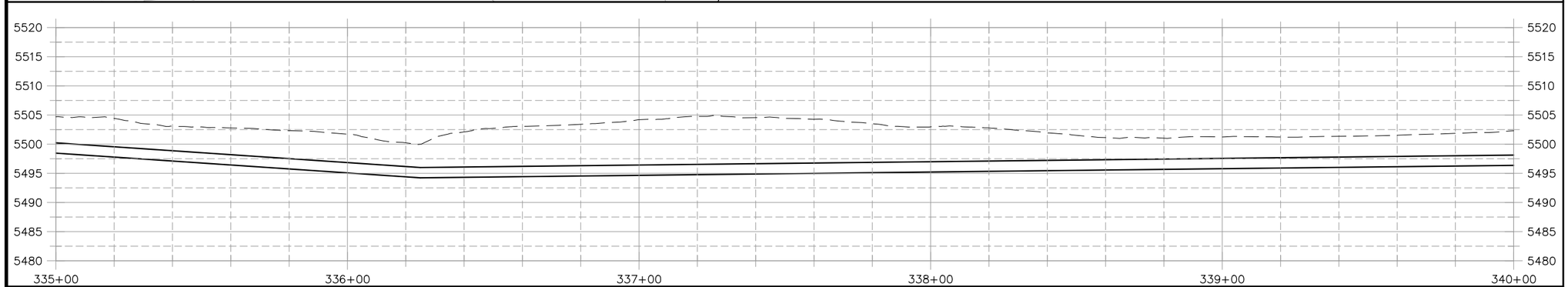
PUBLIC WORKS
ENGINEERING DIVISION

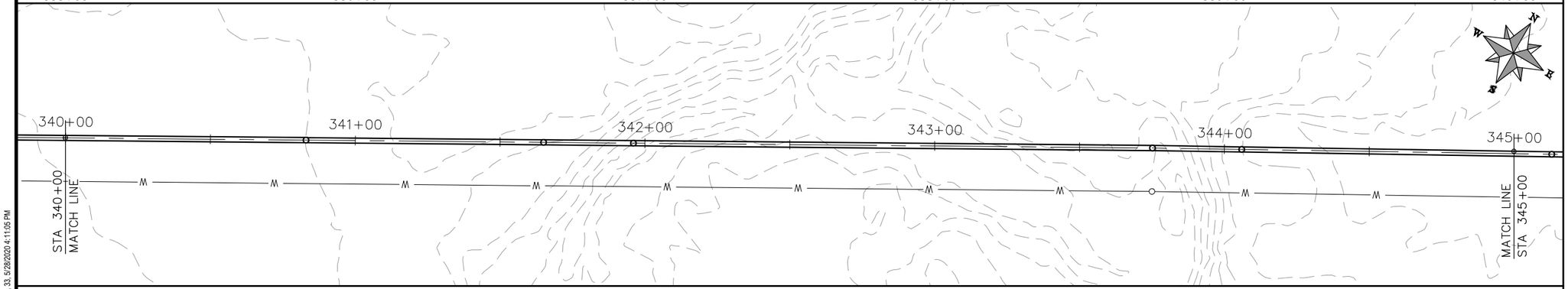
2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 325+00 TO STA 335+00

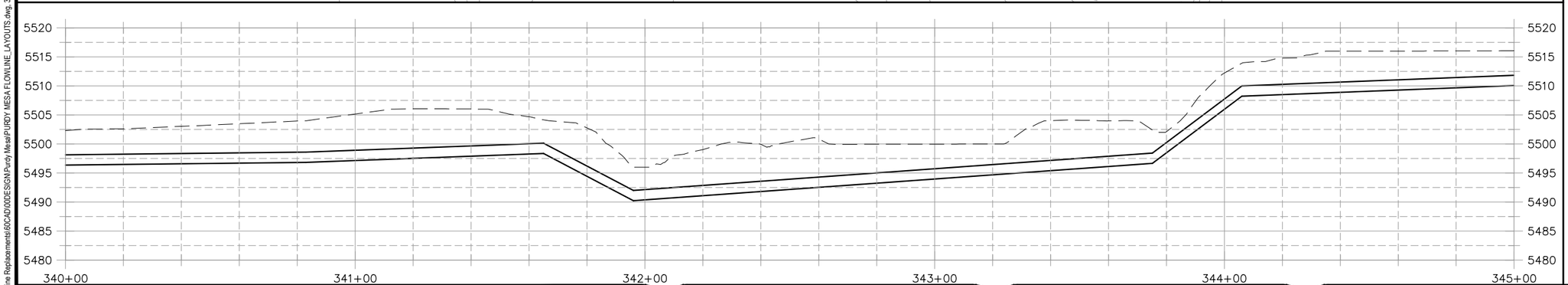
32

N:\Landproj\2020 Flowline Replacements\60CAD\0DESIGN\Purdy Mesa\PURDY MESA FLOWLINE_LAYOUTS.dwg, 32, 5/28/2020 4:10:12 PM









CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

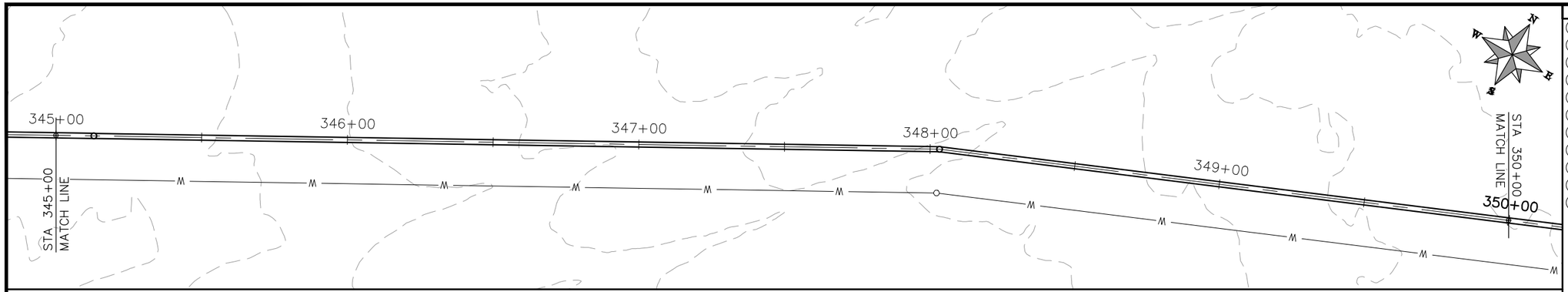
CITY OF Grand Junction COLORADO

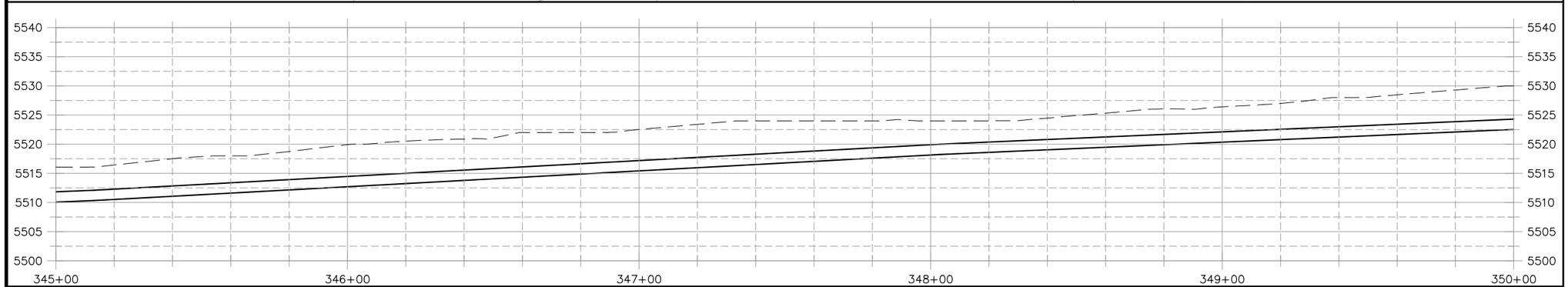
PUBLIC WORKS
ENGINEERING DIVISION

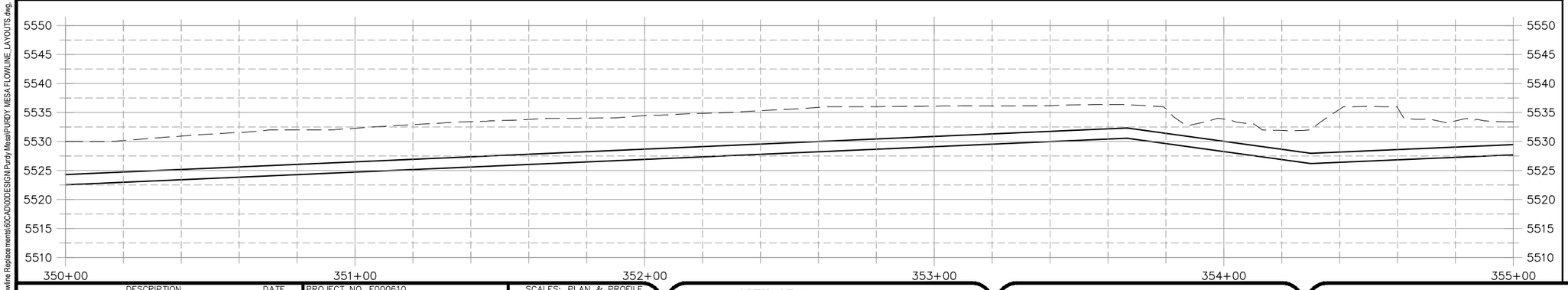
2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 335+00 TO STA 345+00

33

N:\Landproj\2020 Flowline Replacements\60CAD\00DESIGN\Purdy Mesa\PURDY MESA FLOWLINE_LAYOUTS.dwg, 33, 5/28/2020 4:11:05 PM







CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

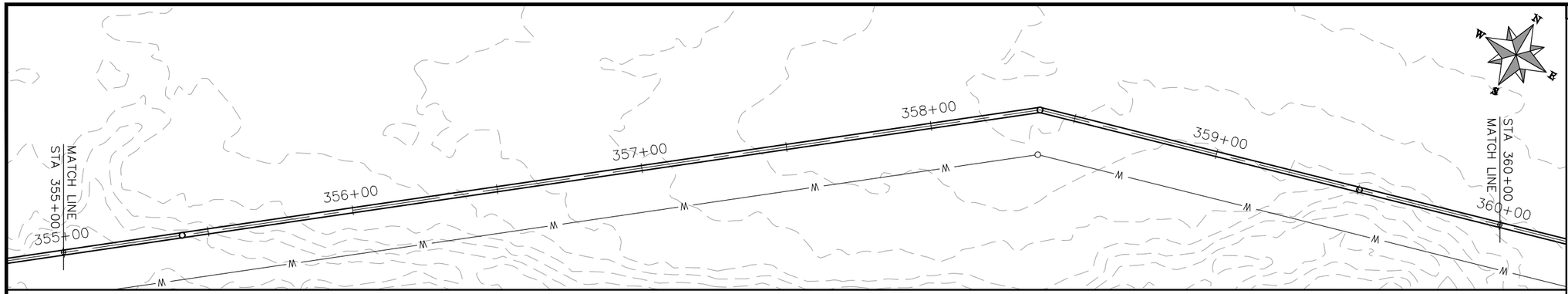
CITY OF Grand Junction COLORADO

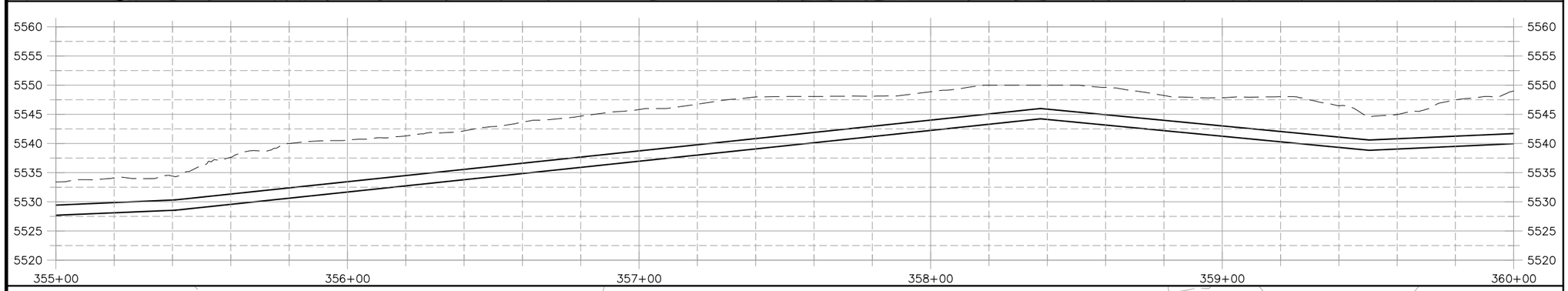
PUBLIC WORKS
ENGINEERING DIVISION

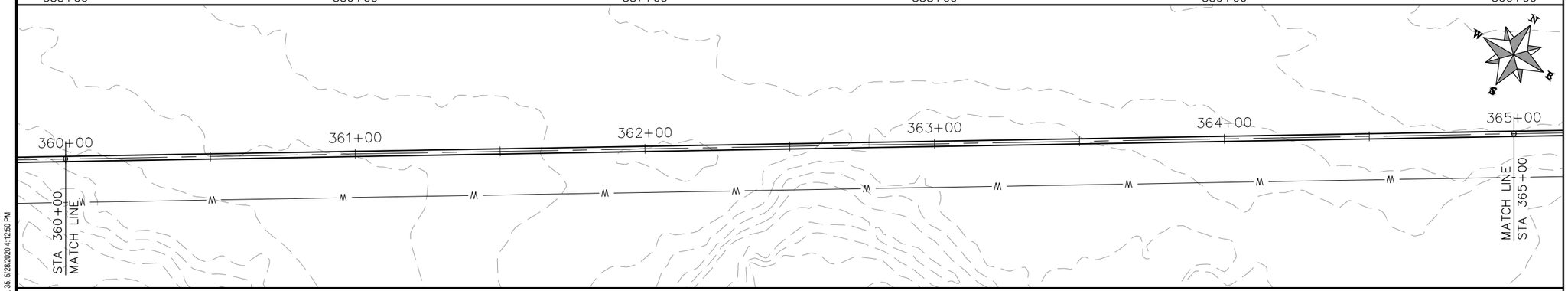
2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 345+00 TO STA 355+00

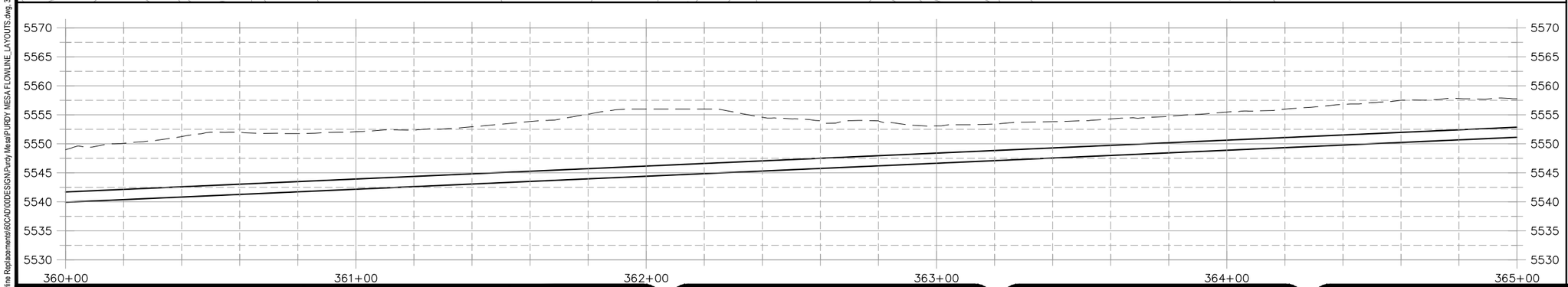
34

N:\Landproj\2020 Flowline Replacements\60CAD\00DESIGN\Purdy Mesa\PURDY MESA FLOWLINE_LAYOUTS.dwg, 34, 5/28/2020 4:11:58 PM









CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA PHASE II PLAN AND PROFILE STA 355+00 TO STA 365+00

35

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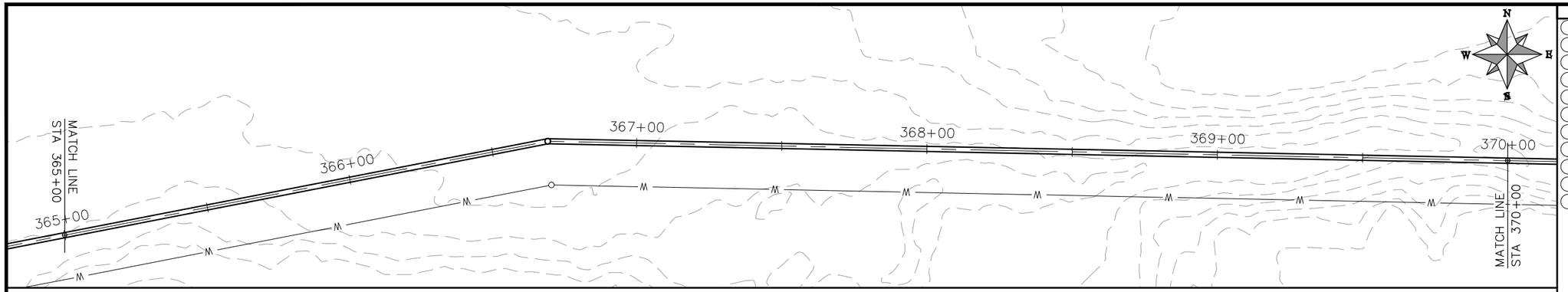

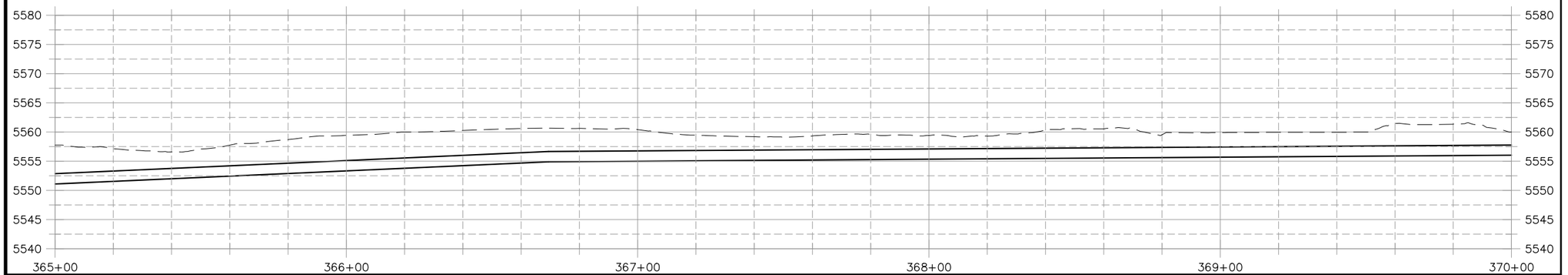

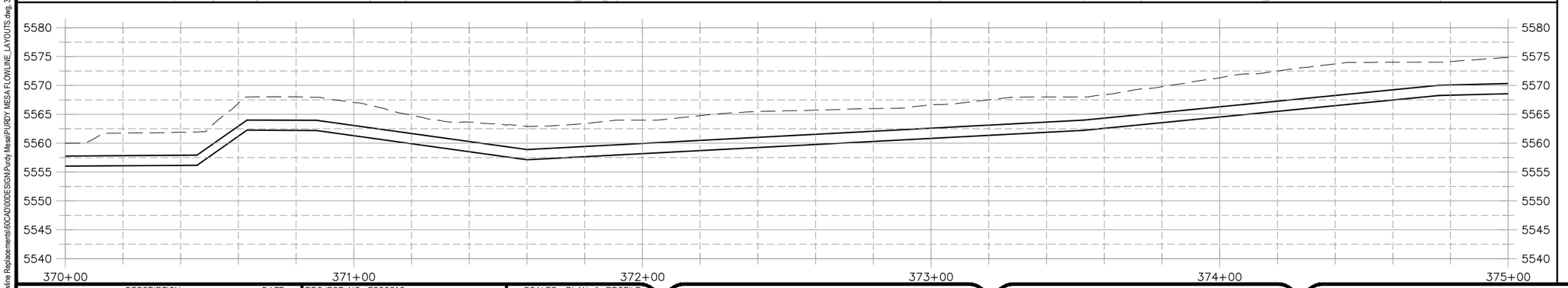

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 365+00 TO STA 375+00

36

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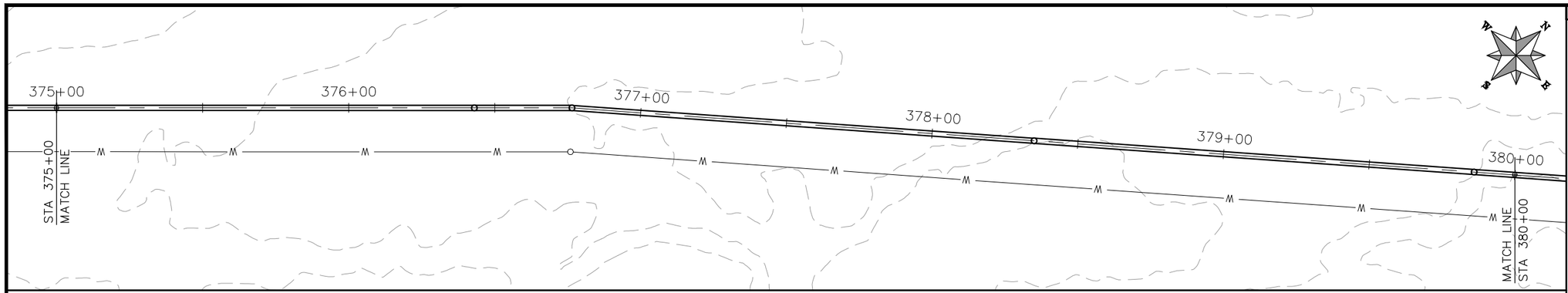

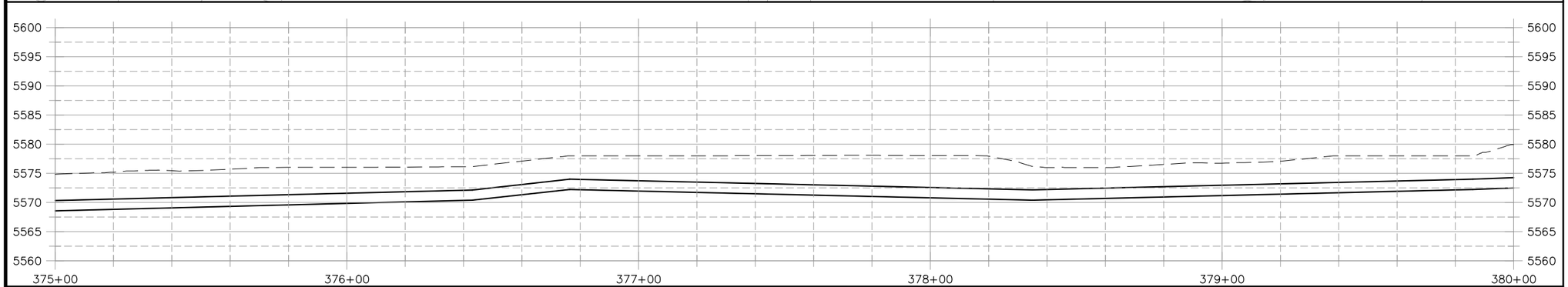

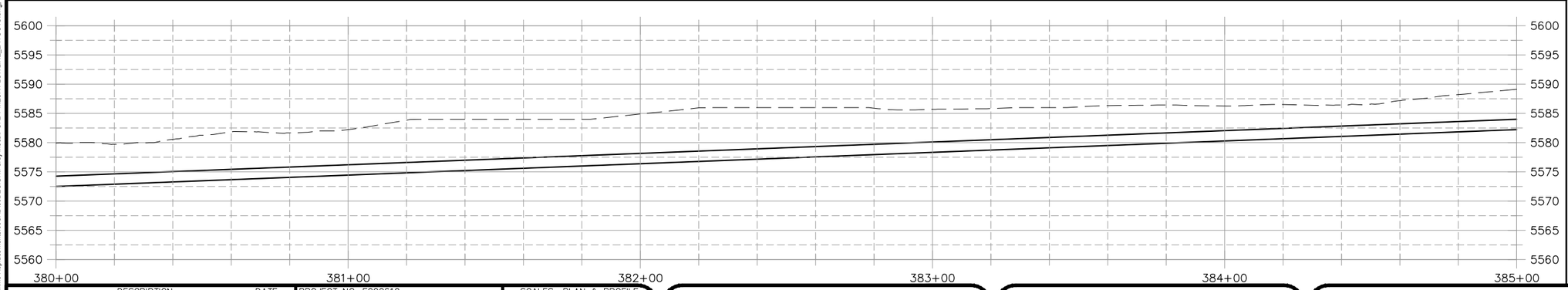

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
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REVISION △	–

PROJECT NO. F000610
DRAWN BY HMC DATE 2020
DESIGNED BY JAE DATE 2020
CHECKED BY JAE DATE 2020
APPROVED BY JAE DATE 2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 375+00 TO STA 385+00

37

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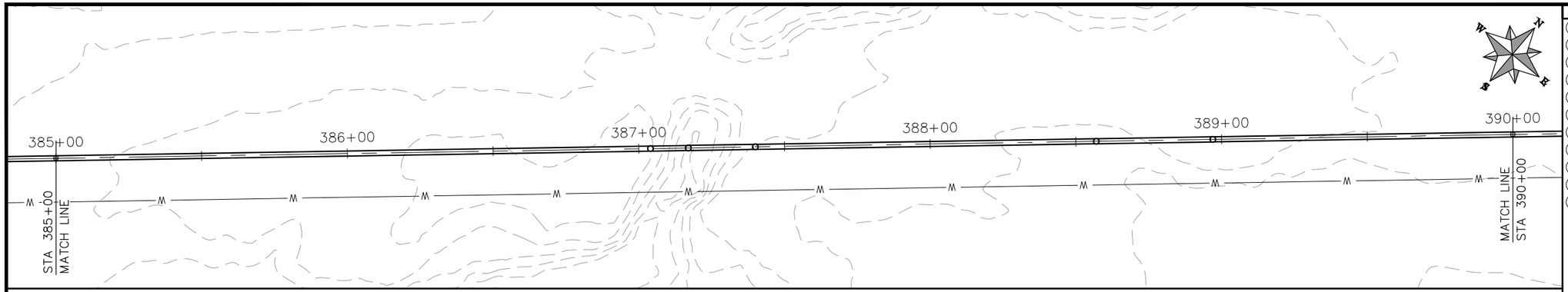

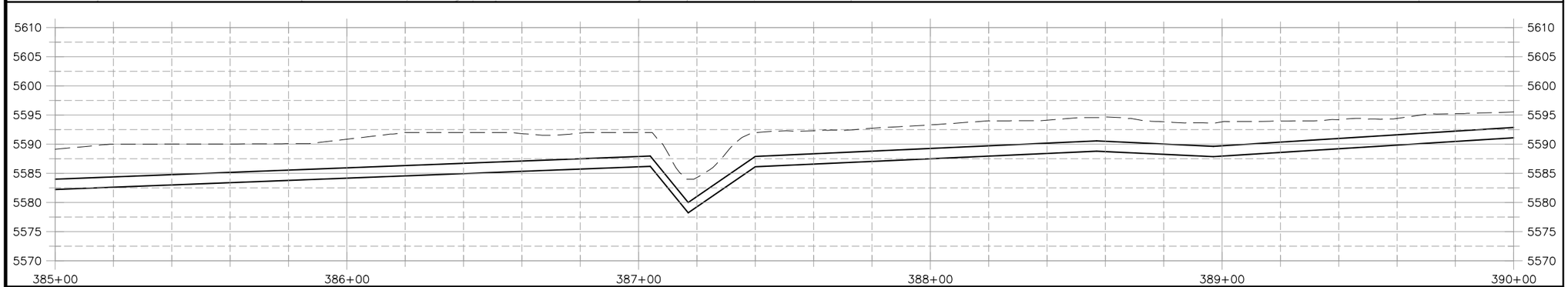

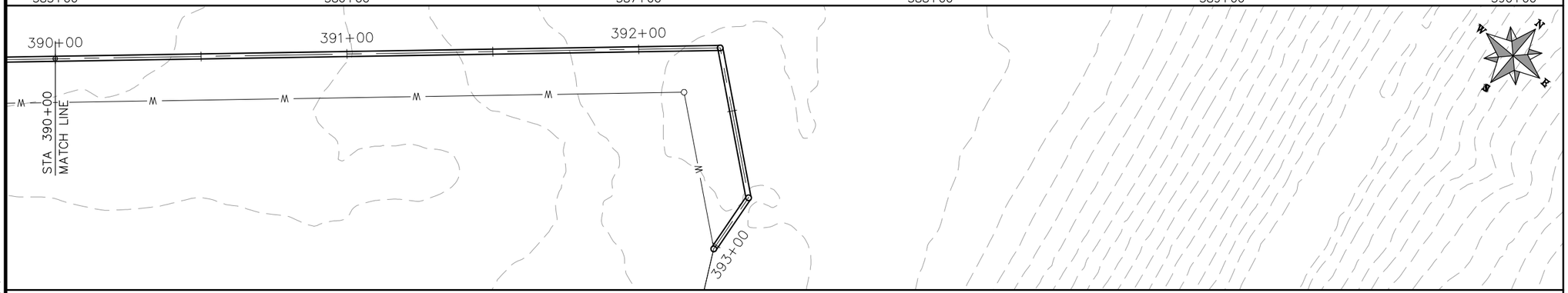

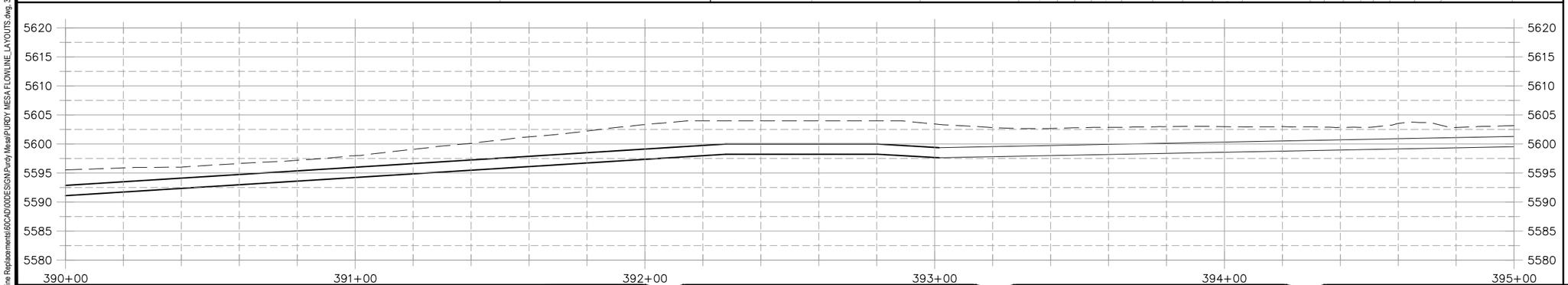

CONSTRUCTION NOTES

DESCRIPTION	DATE
REVISION △	–
REVISION △	–
REVISION △	–
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PROJECT NO. F000610			
DRAWN BY	HMC	DATE	2020
DESIGNED BY	JAE	DATE	2020
CHECKED BY	JAE	DATE	2020
APPROVED BY	JAE	DATE	2020

SCALES: PLAN & PROFILE
HORIZONTAL: 1" = 40'
0 10 20 40
VERTICAL: 1" = 20'
0 5 10 20

CITY OF Grand Junction COLORADO

PUBLIC WORKS
ENGINEERING DIVISION

2020 FLOWLINE PURDY MESA
PHASE II PLAN AND PROFILE
STA 385+00 TO STA 395+00

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CITY OF
Grand Junction
COLORADO

BID ALTERNATE 1 - KANNAH CREEK INTAKE
BID ALTERNATE 2 - PURDY MESA FLOWLINE - SULLIVAN DRAW REPLACEMENT
BID ALTERNATE 3 - PURDY MESA FLOW CONTROL TANK

OCTOBER 2018

BID SET

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G-003	LINE LEGEND & DETAIL KEY
G-004	SYMBOL LEGEND & ABBREVIATIONS
CIVIL – Bid Alternative 1	
C1-101	PLAN & PROFILE
C1-102	PLAN & PROFILE
C1-201	DEMOLITION PLAN
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C1-301	SECTION VIEWS
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CITY OF GRAND JUNCTION PUBLIC WORKS ENGINEERING DIVISION PLANS	
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2	STANDARD ABBREVIATIONS, LEGEND, AND SYMBOLS
3	SHEET NOT USED
4	VICINITY MAP
5	DEMO PLAN
6	CONCRETE PLAN
7	WATER LINE PLAN & PROFILE 0+00 – 2+50
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9	SHEET NOT USED
10	SERVICE & BYPASS LINES PLAN
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C2-204	PLAN AND PROFILE
C2-205	PLAN AND PROFILE
C2-206	PLAN AND PROFILE
C2-207	PLAN AND PROFILE
C2-208	PLAN AND PROFILE
C2-209	PLAN AND PROFILE
C2-210	PLAN AND PROFILE
C2-211	PLAN AND PROFILE
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S3-002	GENERAL STRUCTURAL NOTES AND SPECIFICATIONS
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PROJECT NO. 81-18-011 & 81-18-013

J-U-B ENGINEERS, INC.

305 South Main Street, Unit 6, Palisade, CO 81526
p 970 208 8508 w www.jub.com

OTHER J-U-B COMPANIES THE LANGDON GROUP GATEWAY MAPPING INC.

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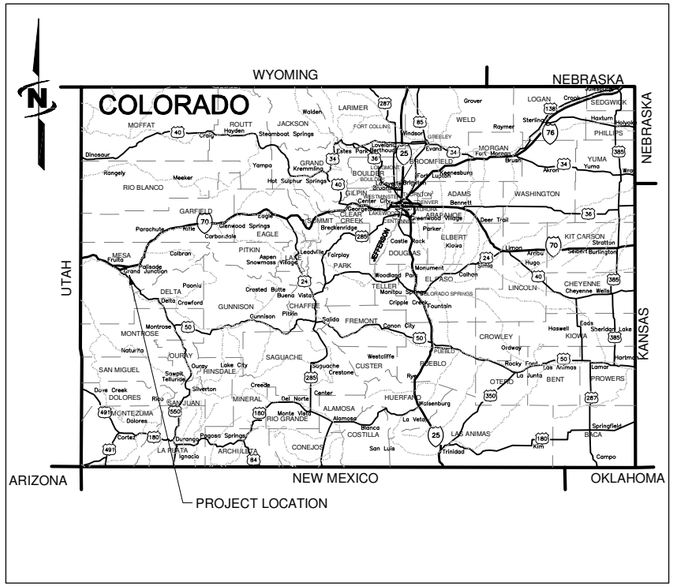
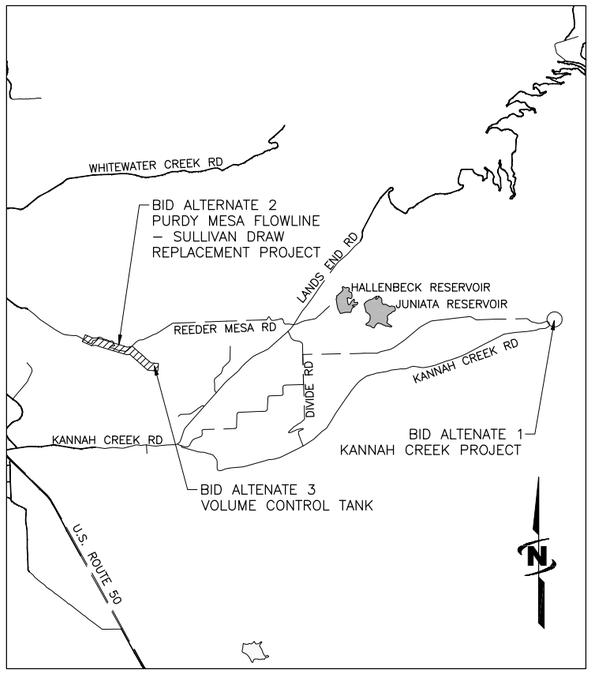
LAST UPDATED: 10/8/2018

SHEET NUMBER: G-001

Plot Date: 10/8/2018 - I:\DRAWFILES\PUBLIC PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE CAD\SHEET\81-18-013_G-001_COVER.DWG



AREA MAP



VICINITY MAP

GENERAL NOTES

1. CONTRACTOR SHALL OBTAIN ALL NECESSARY PERMITS AND BUSINESS LICENSES PRIOR TO CONSTRUCTION.
2. CONTRACTOR IS RESPONSIBLE FOR DUST ABATEMENT AND ANY LIABILITY ISSUES RELATED TO DUST AT ANY LOCATION WHICH MAY BE CAUSED BY THIS PROJECT.
3. THE CONTRACTOR IS RESPONSIBLE FOR TRAFFIC CONTROL AND PROTECTION OF PEDESTRIANS IN AND AROUND THIS WORK. REFERENCE THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD LATEST EDITION FOR WORK ZONE TRAFFIC CONTROL).
4. ANY WORK DONE WITHIN A PUBLIC RIGHT–OF–WAY SHALL BE COORDINATED WITH THE APPROPRIATE TRANSPORTATION AGENCY AND SHALL MEET THE REQUIREMENTS OF THAT AGENCY AND, IN PARTICULAR, REQUIREMENTS OF ANY RIGHT–OF–WAY SPECIAL USE PERMIT, OR OTHER PERMIT. ALL WORK SHALL MEET CURRENT OSHA REQUIREMENTS.
5. WHERE WORK IS PERFORMED ON EASEMENTS, THE CONTRACTOR SHALL TAKE EVERY PRECAUTION TO ELIMINATE ANY ADVERSE EFFECTS ON THE ADJACENT PROPERTY AND/OR TO RESTORE TO ITS ORIGINAL OR BETTER CONDITION. CONTRACTOR SHALL ALSO COMPLY WITH EASEMENT AGREEMENTS.
6. ALL DISTANCES AND DATA SHALL BE CHECKED BY THE CONTRACTOR PRIOR TO THE START OF CONSTRUCTION. IN CASE OF CONFLICT THE ENGINEER SHALL BE NOTIFIED IMMEDIATELY SO THAT CLARIFICATION MAY BE MADE PRIOR TO THE START OF THE WORK.
7. THE CONTRACTOR SHALL ARRANGE FOR, SECURE AND PAY FOR DIRECTLY, ANY AND ALL TEMPORARY UTILITY SUPPLIES (E.G. WATER POWER, AND TELEPHONE) IT MAY REQUIRE FOR PROSECUTION OF ITS WORK. THE COST OF SUCH UTILITIES SHALL BE INCLUDED IN THE APPROPRIATE BID ITEM WITH WHICH IT IS ASSOCIATED.
8. SHOULD CONSTRUCTION BE HALTED BECAUSE OF INCLEMENT WEATHER CONDITIONS, THE CONTRACTOR WILL COMPLETELY CLEAN UP ALL AREAS AND MAINTAIN THE SURFACE IN GOOD CONDITION DURING THE SHUT–DOWN PERIOD.
9. THE CONTRACTOR'S PERSONNEL, EQUIPMENT, AND OPERATIONS SHALL COMPLY FULLY WITH ALL APPLICABLE STANDARDS, REGULATIONS, AND REQUIREMENTS OF EXISTING FEDERAL, COLORADO STATE, AND LOCAL GOVERNMENTAL AGENCIES.
10. ALL WORK SHALL BE CONTAINED IN OR LIMITED TO THE EXISTING PROPERTY, EASEMENTS, OR APPROVED STAGING AREAS.
11. CONTRACTOR IS ALSO RESPONSIBLE FOR PROTECTION TO SAFE GUARD WORK SITE. PAY ITEM TO BE INCLUDED IN MOBILIZATION.
12. THE ENGINEER WILL PROVIDE VERTICAL AND HORIZONTAL CONTROLS ONE TIME ON THE PROJECT SITE. ANY ADDITIONAL CONSTRUCTION STAKING REQUIRED TO COMPLETE THE PROJECT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
13. CONTRACTOR SHALL LOCATE AND PROTECT ALL EXISTING UTILITIES AND BE RESPONSIBLE FOR DAMAGES TO EXISTING UTILITIES AND EXISTING IMPROVEMENTS AS A RESULT OF THE CONTRACTOR'S CONSTRUCTION ACTIVITIES.
14. CONTRACTOR SHALL DISPOSE OF LARGE ROCKS ENCOUNTERED DURING EXCAVATION IN ABANDONED DITCH R.O.W., AT STRUCTURE SPILLWAY, OR OTHER NEPA/CITY APPROVED SITE.
15. ALL BRANCH SADDLES TO BE ELECTROFUSED AND PRESSURE TESTED BEFORE REMOVING COUPON.
16. ALL EXPOSED PVC PIPE TO BE COATED W/ 2 COATS OF ACRYLIC LATEX ENAMEL.
17. ALL ELECTROFUSION AND WELD POINTS MUST BE COMPLETED BY CERTIFIED TECHNICIAN.
18. ALL WORK SHALL BE ACCOMPLISHED IN ACCORDANCE WITH THE CITY OF GRAND JUNCTION STANDARD CONTRACT DOCUMENTS FOR CAPITAL IMPROVEMENTS CONSTRUCTION REVISED JULY 2010, AND THE PLANS AND SPECIFICATIONS FOR THIS PROJECT.

EXISTING UTILITIES

1. APPROXIMATE LOCATIONS OF UTILITIES ARE SHOWN ON THE PLANS. THEY ARE TO BE USED FOR GENERAL INFORMATION ONLY. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO NOTIFY THE APPROPRIATE UTILITY COMPANIES WHEN CONSTRUCTION MIGHT INTERFERE WITH NORMAL OPERATION OF ANY UTILITIES. IT SHALL ALSO BE THE CONTRACTOR'S RESPONSIBILITY TO HAVE THE APPROPRIATE UTILITY COMPANY FIELD–LOCATE ANY UTILITY INSTALLATIONS WHICH MIGHT BE AFFECTED BY CONSTRUCTION PRIOR TO BEGINNING WORK IN THAT AREA. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING SERVICE OF EXISTING UTILITIES AND FOR RESTORING ANY UTILITIES DAMAGED DUE TO CONSTRUCTION AT NO ADDITIONAL COST TO THE OWNER. DEPTHS AND ELEVATIONS OF UTILITIES ARE UNKNOWN UNLESS OTHERWISE SHOWN. CONTRACTOR SHALL FIELD VERIFY UTILITY DEPTHS, ELEVATIONS, ANY DISCREPANCIES AND/OR CONFLICTS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER IMMEDIATELY.

INSPECTION AND TESTING

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MATERIALS TESTING INCLUDING BUT NOT LIMITED TO CONCRETE, FLUSHING, LEAK, PRESSURE, AND COMPACTION. ALL TESTS SHALL MEET MINIMUM ENGINEER REQUIREMENTS. SEE THE CONTRACT DOCUMENTS AND DRAWINGS FOR FREQUENCY OF TESTING. RESULTS ARE TO BE DELIVERED TO SPECIAL INSPECTOR, OWNER AND ENGINEER.
2. THE CONTRACTOR IS RESPONSIBLE TO COORDINATE WITH ENGINEER AND SPECIAL INSPECTOR FOR INSPECTIONS OF WORK AT APPROPRIATE INTERVALS. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO PAY FOR ADDITIONAL INSPECTIONS THAT ARE THE RESULT OF HIS WORKMANSHIP.

CONTACT PHONE NUMBERS

CITY OF GRAND JUNCTION –		
PROJECT ENGINEER –		
JOHN EKLUND	970–244–1558	johne@gjcity.org
UTILITIES DIRECTOR –		
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WATER SYSTEM MANAGER –		
MARK RITTERBUSH	970–256–4185	markri@gjcity.org
J–U–B ENGINEERS INC –		
PROJECT MANAGER –		
BRET GUILLORY	970–208–8508	bguillory@jub.com
GRAND VALLEY POWER –		
PERRY RUPP	970–623–8571	prupp@gvp.org

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NO.	DESCRIPTION	BY APP.	DATE
	REVISION		

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

VICINITY MAP & GENERAL NOTES

FILE : 81-18-013_G-002_VMAP
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ---
CHECKED BY: ---
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/20/2018

SHEET NUMBER:
G-002

Plot Date: 8/20/2018 4:06 PM Plotted By: Jalal Myers
Date Created: 8/17/2018 I:\OREMFILES\PUBLIC\PROJECTS\J-U-B\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_G-002_VMAP.DWG

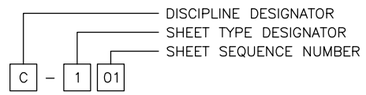
LINE LEGEND

LINE DESCRIPTION	PROPOSED LINE	EXISTING LINE
POWER / COMMUNICATIONS		
OVERHEAD POWER	OHP	OHP
UNDERGROUND POWER	UP	UP
OVERHEAD TELEPHONE	OHT	OHT
UNDERGROUND TELEPHONE	UT	UT
FIBER OPTIC	FO	FO
CABLE TELEVISION	CTV	CTV
UNDERGROUND POWER, TEL, CABLE TV		P,T,CTV
UNDERGROUND POWER, TEL, CABLE TV, GAS		P,T,CTV,G
STORM DRAIN		
STORM DRAIN (GENERAL)	SD	SD
STORM DRAIN	X"SD	X"SD
ROOF DRAIN	RD	RD
SANITARY SEWER		
SANITARY SEWER (GENERAL)	SS	SS
SANITARY SEWER	X"SS	X"SS
SANITARY SEWER SERVICE	SS SS	SS SS
SEWER FORCE MAIN	FM	FM
WATER		
WATER (GENERAL)	W	W
WATER (SPECIFIED SIZE)	X"W	X"W
WATER SERVICE	WS WS	WS WS
IRRIGATION		
IRRIGATION	IRR	IRR
GRAVITY IRRIGATION	GIRR	GIRR
PRESSURE IRRIGATION	PIRR	PIRR
POTABLE WATER	PW	PW
NON-POTABLE WATER	NPW	NPW
GAS		
NATURAL GAS	G	G
NATURAL GAS SERVICE	G G	G G
HIGH PRESSURE GAS	HPG	HPG
LIQUID GAS	LG	LG
UTILITY		
CHLORINE LINE	CHL	CHL
INDUSTRIAL WASTE WATER	IWW	IWW
DRAIN LINE		DL

LINE DESCRIPTION	PROPOSED LINE	EXISTING LINE
BOUNDARY		
PROPERTY LINE	P/L	P/L
PROPERTY LINE		
RIGHT OF WAY	R/W	R/W
TEMPORARY EASEMENT	T/E	T/E
PERMANENT EASEMENT	P/E	P/E
TOWNSHIP AND RANGE		
SECTION LINE		
QUARTER SECTION LINE		
1/16 SECTION LINE		
STATE LINE		
COUNTY LINE		
SITE		
FENCE	X	X
MAJOR CONTOUR	2521	
MINOR CONTOUR		
GRADE BREAK		GB
TOP OF BANK		TOB
TOE OF SLOPE		TOE
CUT LIMITS	CUT	
FILL LIMITS	FILL	
DITCH		
STORM SWALE		
EDGE OF WATER		
HIGH WATER		
WETLAND		WET
WETLAND BOG		BOG
WETLAND MARSH		MRSH
WETLAND SWAMP		SWMP
ROADWAY		
ROAD SHOULDER		
ROAD CENTERLINE		
ROAD ASPHALT		EP
ROAD GRAVEL		EG
TOP BACK OF CURB		
LIP OF GUTTER		
LANDSCAPING LIMITS	LS	LS

SHEET NUMBERING

SAMPLE: C-101



DISCIPLINE DESIGNATORS

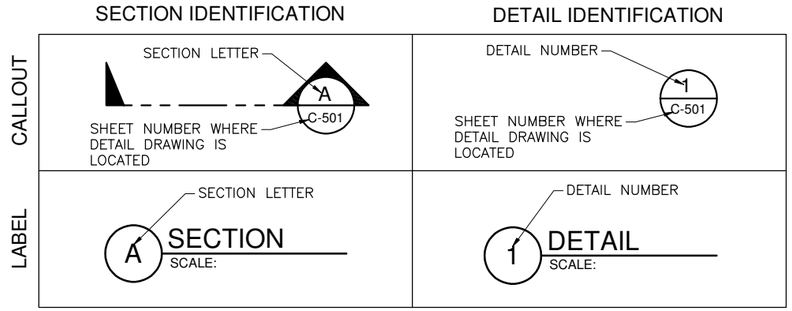
DISCIPLINE	DESIGNATOR	DESCRIPTION
GENERAL	G	ALL GENERAL
	GI	GENERAL INFORMATION
	GC	GENERAL CONTRACTUAL
	GR	GENERAL RESOURCE
SURVEY/MAPPING	V	ALL SURVEY
GEOTECHNICAL	B	ALL GEOTECHNICAL
CIVIL	C	ALL CIVIL
LANDSCAPE	L	ALL LANDSCAPE
STRUCTURAL	S	ALL STRUCTURAL
ARCHITECTURAL	A	ALL ARCHITECTURE
EQUIPMENT	Q	ALL EQUIPMENT
MECHANICAL	M	ALL MECHANICAL
ELECTRICAL	E	ALL ELECTRICAL
PLUMBING	P	ALL PLUMBING
PROCESS	D	ALL PROCESS
RESOURCE	R	ALL RESOURCE

SHEET TYPE DESIGNATORS

DESIGNATOR	SHEET TYPE
0	GENERAL (SYMBOLS, LEGENDS, NOTES, ETC.)
1	PLANS (HORIZONTAL VIEWS)
2	ELEVATIONS, PROFILES, COMBINED PLAN & PROFILES
3	SECTIONS (SECTIONAL VIEWS)
4	LARGE-SCALE VIEWS (PLANS, ELEVATIONS, ECT.)
5	DETAILS OR COMBINED DETAILS AND SECTIONS
6	SCHEDULES AND DIAGRAMS
7	USER DEFINED
8	USER DEFINED
9	3D REPRESENTATIONS (ISOMETRICS, PERSPECTIVES, PHOTOS)

SECTION AND DETAIL IDENTIFIERS

NOTE:
A DASH MAY BE PLACED IN THE LOWER PORTION OF THE IDENTIFIER IF THE DETAIL DRAWING OR SECTION VIEW IS LOCATED ON THE SAME SHEET.



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NO.	DESCRIPTION	BY APPR.	DATE
	REVISION		

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

LINE LEGEND & DETAIL KEY

FILE: 81-18-013_G-003_LINE_DET
JUB PROJ. #: 81-18-013
DRAWN BY: JMM
DESIGN BY: ---
CHECKED BY: ---
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/17/2018

SHEET NUMBER:
G-003

Plot Date: 8/20/2018, 7:34 AM Plotted By: Jubal Myers
Date Created: 5/7/2018 \\OREFILES\PUBLIC\PROJECTS\JUB\GRAND_JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_G-003_LINE_DET.DWG

SYMBOL DESCRIPTION	EXISTING SYMBOL	PROPOSED SYMBOL
SURVEY		
CAP (ALUMINUM)		
CAP (BRASS)		
CHISELED X		
CTRL PT GENERIC		
CTRL PT ½" REBAR	1/2" PIN CONTROL PT	
CTRL PT ⅝" REBAR	5/8" PIN CONTROL PT	
CTRL PT 60D NAIL	60D	
CTRL PT HUB & TACK	HT	
CTRL PT PK NAIL	PK	
CTRL PT TEMP BENCH MARK	TBM	
NAIL		
NAIL AND TAG	N/T	
NAIL (PK)	PK	
BOLT		
DRILL STEEL		
REBAR (½")		
REBAR (⅝")		
STAINLESS STEEL ROD		
IRON PIPE		
RAILROAD SPIKE		
R/W MONUMENT		
STONE		
SECTION CORNER. MON.	22 15 21 16	
SECTION QUARTER MON.	15 22	
SITE		
BOLLARD		
BOULDER		
DRINKING FOUNTAIN	DF	
FLAGPOLE	F	F
GATE		
MAIL BOX	M	M
PARKING METER	PM	PM
POST		
SIGN		
SPOT ELEVATION		
TREE (SHRUB)		
TREE (STUMP)		
TREE (CONIFEROUS)		
TREE (DECIDUOUS)		
TEST HOLE	TH	
WELL	W	
WELL (MONITORING)	M	M

SYMBOL DESCRIPTION	EXISTING SYMBOL	PROPOSED SYMBOL
UTILITIES		
MANHOLE (GENERIC)		
PRESSURE CLEAN OUT AT GRADE	PCO	PCO
THRUST BLOCK		
VAULT	V	V
COMMUNICATION		
TELE. MANHOLE	T	
TELE. PEDASTAL	T	T
TELE. POLE		
TV PEDASTAL	TV	TV
GUY WIRE		
DOMESTIC WATER		
FIRE HYDRANT		
SPIGOT		
YARD HYDRANT		
WATER MANHOLE	W	
WATER METER		
WATER VALVE	W	W
ELECTRIC		
ELEC. MANHOLE	E	
ELEC. METER	E	E
ELEC. TRANS.	E	E
JUNCTION BOX	J	J
POWER POLE		
POWER STUB	E	E
STREET LIGHT BASE		
TRAFFIC SIGNAL POLE		
IRRIGATION		
IRRIGATION VALVE	IRR	IRR
IRRIGATION VALVE BOX		
SPRINKLER		
NATURAL GAS		
GAS METER	G	G
GAS VALVE	G	G
SANITARY SEWER		
CLEANOUT		
SEWER STUB	S	S
SS MANHOLE	S	
STORM DRAIN		
CATCH BASIN		
DRY WELL	DW	DW
FLARE END		
GREASE TRAP		
SD MANHOLE	D	

SYMBOL DESCRIPTION	EXISTING SYMBOL	PROPOSED SYMBOL
FITTINGS		
BEND (11.25°)		
BEND (22.5°)		
BEND (45°)		
BEND (90°)		
CAP		
COUPLING		
CROSS		
REDUCER (CONCENTRIC)		
REDUCER (ECCENTRIC)		
TEE		
TRUE UNION		
WYE		
VALVES		
AIR VALVE	A	A
BLOW OFF	B	B
COMBO VALVE	C	C
BALL VALVE (N.C.)		
BALL VALVE (N.O.)		
BUTTERFLY VALVE		
CHECK VALVE		
CHECK VALVE (FLANGE)		
CHECK VALVE (MJ)		
GATE VALVE		
PLUG VALVE (N.C.)		
PLUG VALVE (N.O.)		
ROAD MARKINGS		
TURN ARROW		
ARROW STRAIGHT		
ARROW STRAIGHT/TURN		
BICYCLE ROUTE		
CAR		
HANDICAP SYMBOL		
ROADWAY		
INTERSTATE ROUTE	25	
MAST ARM		
PEDESTRIAN SIGNAL		
STATE ROUTE	14	
TRAFFIC LIGHT		

SYMBOL DESCRIPTION	EXISTING SYMBOL	PROPOSED SYMBOL
ROADWAY (CONT.)		
TYPE 2 BARRICADE		
US ROUTE	287	
TRAFFIC ATTENUATOR		
JERSEY BARRIER		

ABBREVIATIONS

ASSY	ASSEMBLY
>	ANGLE
@	AT (MEASUREMENTS)
BLDG	BUILDING
BM	BENCH MARK
BSC	BITUMINOUS SURFACE COURSE
BSW	BACK OF SIDEWALK
BW	BOTH WAYS
C	CHANNEL (STRUCTURAL)
C/L	CENTER LINE
CMP	CORRUGATED METAL PIPE
CO	CLEANOUT
CONC	CONCRETE
CONT	CONTINUOUS
CPLG	COUPLING
CU FT	CUBIC FEET
CU YD	CUBIC YARD
DEG OR °	DEGREE
DET	DETAIL
DIA OR ø	DIAMETER
DIP	DUCTILE IRON PIPE
DIST	DISTRIBUTION
DWG	DRAWING
EA	EACH
ELB	ELBOW
ELEV	ELEVATION
EW	EACH WAY
EXIST	EXISTING
FG	FINISH GRADE
FH	FIRE HYDRANT
FLG	FLANGE
FT OR '	FEET
GV	GATE VALVE
HORIZ	HORIZONTAL
ID	INSIDE DIAMETER
IN OR "	INCH
LB OR #	POUND
LF	LINEAL FEET
LN	LINEAL
MAX	MAXIMUM
MIN	MINIMUM
NO OR #	NUMBER
PE	POLYETHYLENE
PL	PLATE
PL	PROPERTY LINE
PVC	POLYVINYL–CHLORIDE
R	RADIUS
RP	RADIUS POINT
R&R	REMOVE & REPLACE
REM	REMOVE
REQ'D	REQUIRED
REV	REVISION
R/W	RIGHT–OF–WAY

S	SLOPE
SPEC	SPECIFICATION
STA	STATION
STD	STANDARD
STL	STEEL
ST STL	STAINLESS STEEL
TBC	TOP BACK OF CURB
TYP	TYPICAL
TFC	TOP FACE OF CONCRETE
W/	WITH
W/O	WITHOUT
W/REQ'D	WHERE REQUIIRED

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NO.	DESCRIPTION	BY APPR	DATE
	REVISION		

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

SYMBOL LEGEND & ABBREVIATIONS

FILE : 81-18-013_G-004_SYM_ABBR
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ---
CHECKED BY: ---
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/17/2018

SHEET NUMBER:
G-004

Plot Date: 8/20/2018 7:34 AM Plotted By: Jubal Mems
Date Created: 5/7/2018 I:\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CADD\SHEET\81-18-013_G-004_SYM_ABBR.DWG

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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

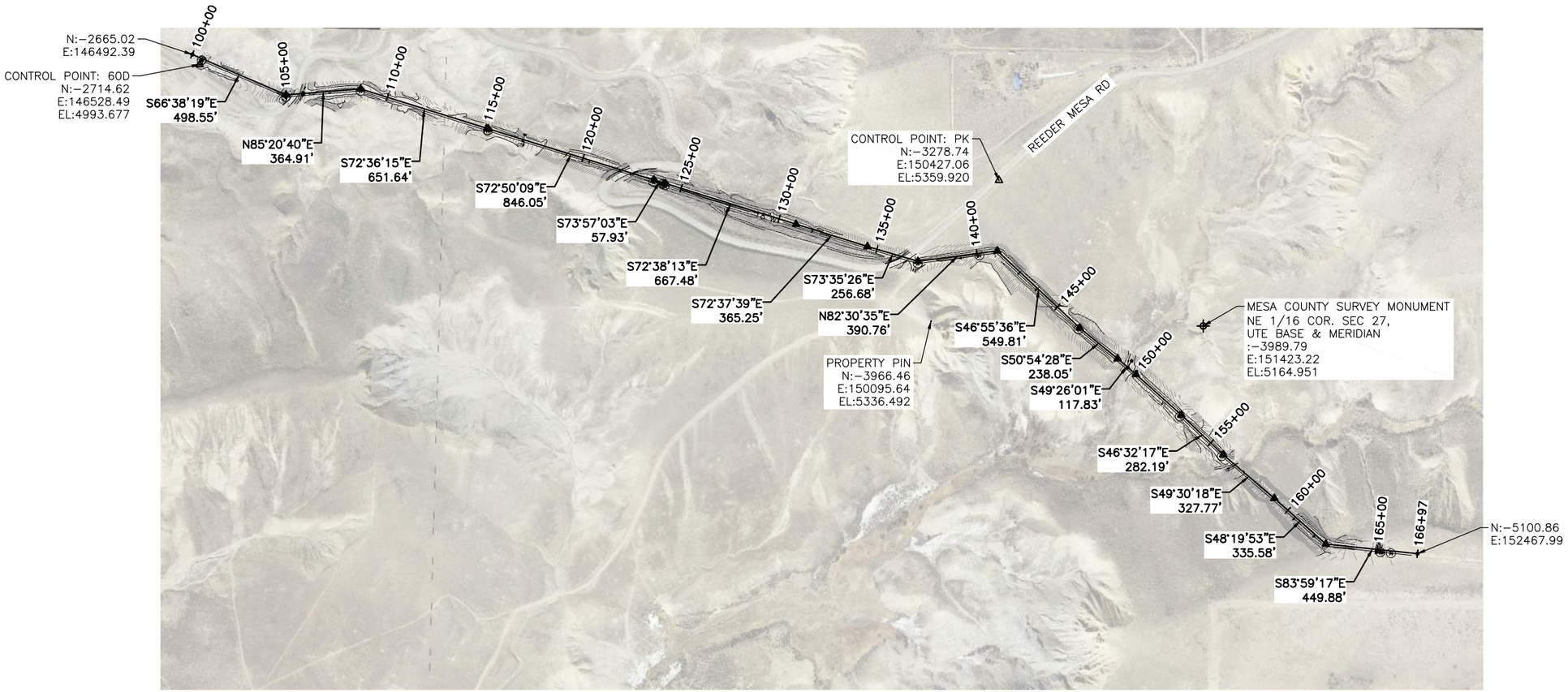
PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
SHEET KEY

FILE : 81-18-013_C-001_INDEX
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/17/2018

SHEET NUMBER:
C2-001

Plot Date: 8/20/2018 7:43 AM Plotted By: Jubal Myers
Date Created: 6/1/2018 I:\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOWLINE\CAD\SHEET\81-18-013_C-001_INDEX.DWG



0 200 400

SCALE IN FEET

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PRELIMINARY PLANS

NOT FOR CONSTRUCTION

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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
SURVEY CONTROL

FILE: 81-18-013_V-101_SCONTROL
JUB PROJ. #: 81-18-013
DRAWN BY: JMM
DESIGN BY: ---
CHECKED BY: ---
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 6/1/2018

SHEET NUMBER:
V2-101

Plot Date: 8/20/2018 7:45 AM Plotted By: Jubal Myers
Date Created: 6/1/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEETS\81-18-013_V-101_SCONTROL.DWG

(441) 102.7/108.2 20" WATER MAIN PIPE (DR-25 EAGLE LOC WITH INSERTION STOP). INCLUDES TYPE A BEDDING AND HAUNCHING MATERIAL AND BACKFILL TRENCH WITH NATIVE MATERIALS MEETING 103.16 EARTH BACKFILL MATERIAL.

(442) 102.8g/108.3 – 20" 45° ELBOW.

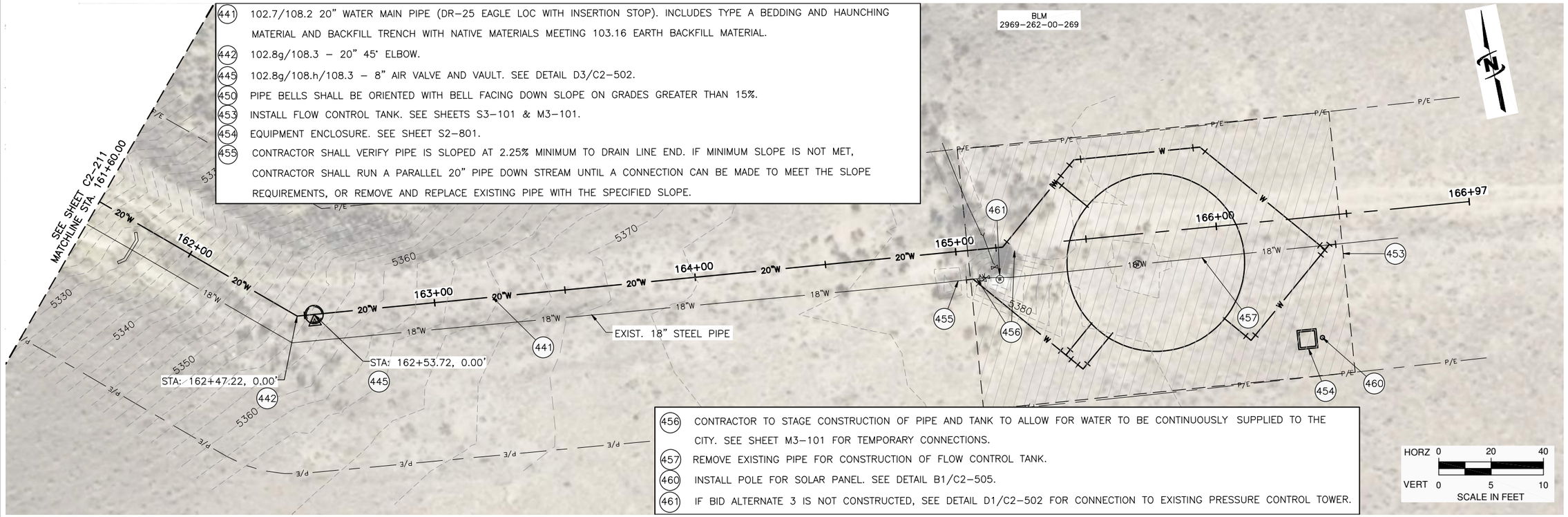
(445) 102.8g/108.h/108.3 – 8" AIR VALVE AND VAULT. SEE DETAIL D3/C2-502.

(450) PIPE BELLS SHALL BE ORIENTED WITH BELL FACING DOWN SLOPE ON GRADES GREATER THAN 15%.

(453) INSTALL FLOW CONTROL TANK. SEE SHEETS S3-101 & M3-101.

(454) EQUIPMENT ENCLOSURE. SEE SHEET S2-801.

(455) CONTRACTOR SHALL VERIFY PIPE IS SLOPED AT 2.25% MINIMUM TO DRAIN LINE END. IF MINIMUM SLOPE IS NOT MET, CONTRACTOR SHALL RUN A PARALLEL 20" PIPE DOWN STREAM UNTIL A CONNECTION CAN BE MADE TO MEET THE SLOPE REQUIREMENTS, OR REMOVE AND REPLACE EXISTING PIPE WITH THE SPECIFIED SLOPE.



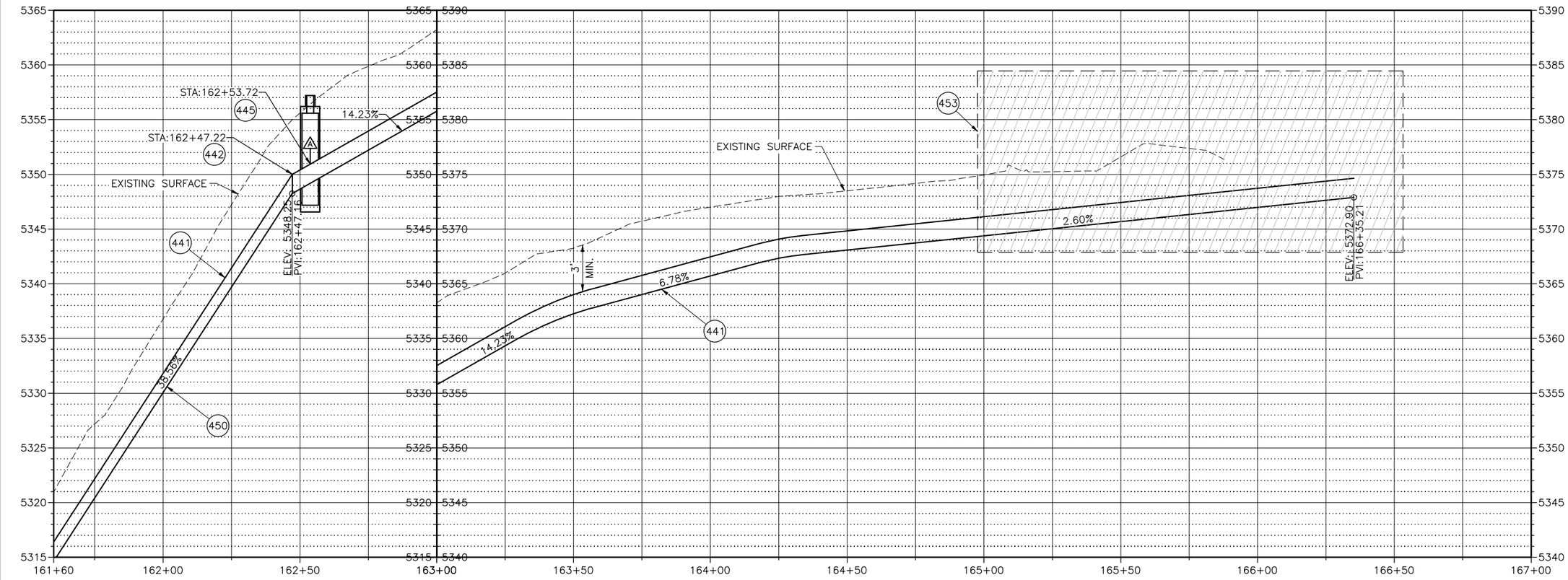
(456) CONTRACTOR TO STAGE CONSTRUCTION OF PIPE AND TANK TO ALLOW FOR WATER TO BE CONTINUOUSLY SUPPLIED TO THE CITY. SEE SHEET M3-101 FOR TEMPORARY CONNECTIONS.

(457) REMOVE EXISTING PIPE FOR CONSTRUCTION OF FLOW CONTROL TANK.

(460) INSTALL POLE FOR SOLAR PANEL. SEE DETAIL B1/C2-505.

(461) IF BID ALTERNATE 3 IS NOT CONSTRUCTED, SEE DETAIL D1/C2-502 FOR CONNECTION TO EXISTING PRESSURE CONTROL TOWER.

HORZ 0 20 40
VERT 0 5 10
SCALE IN FEET



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NO.	DESCRIPTION	DATE	BY APPR
	REVISION		

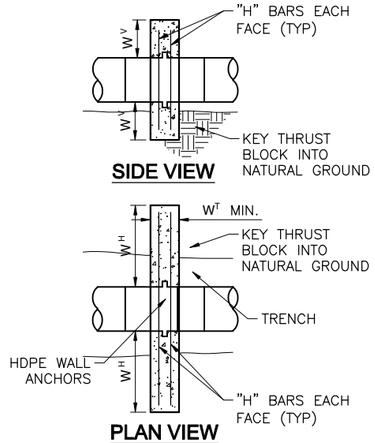
PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
PLAN AND PROFILE

FILE : 81-18-013_C-20X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: CSF
CHECKED BY: SBG
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/20/2018

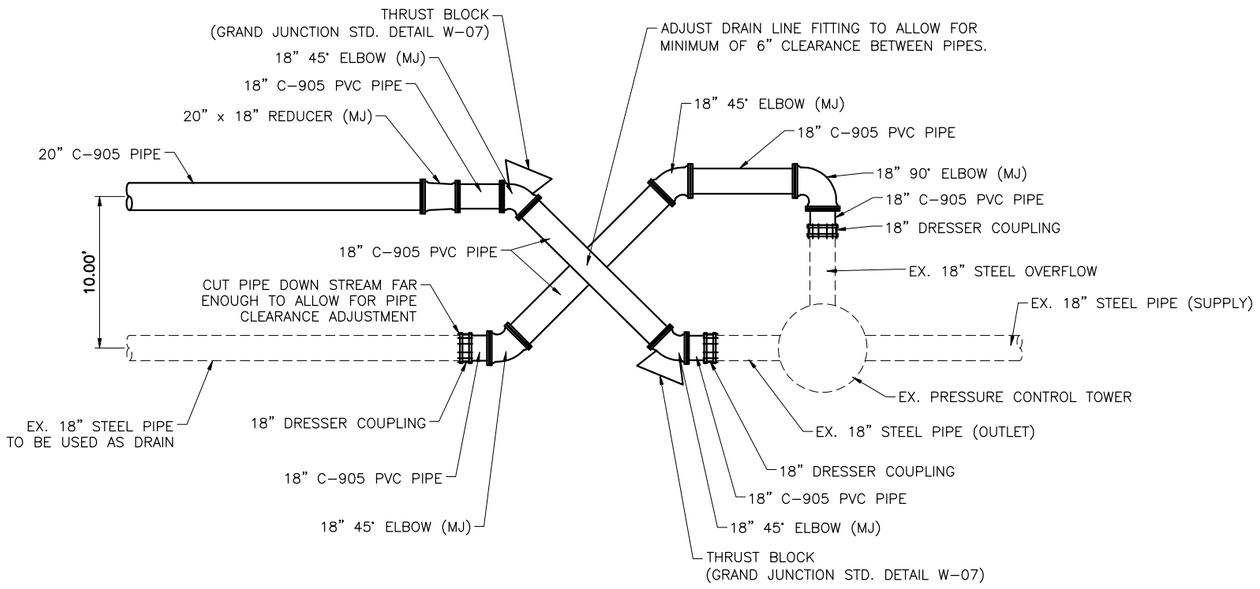
SHEET NUMBER:
C2-212

Plot Date: 8/20/2018 4:09 PM Plotted By: Jubal Myers
Date Created: 8/17/2018 I:\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_C-20X.DWG



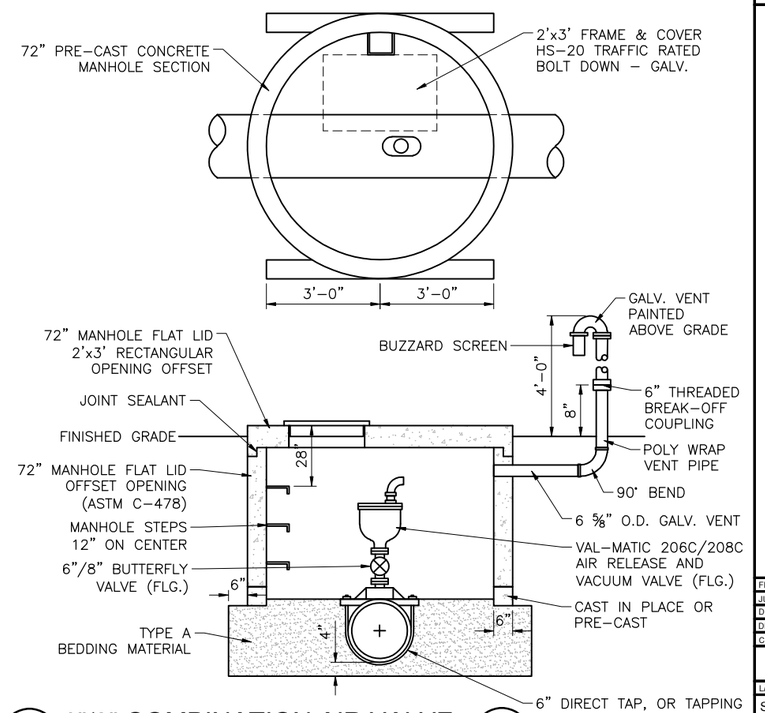
THRUST BLOCK DIMENSIONS									
PIPE SIZE	W^H	W^V	W^T	"H" BARS		"V" BARS		"D" BARS	
				SIZE	NO.	SIZE	NO.	SIZE	NO.
4"–8"	1.5'	0.5'	1.0'	#4	2	#4	4	#4	4
10"–12"	1.5'	1.0'	1.0'	#4	4	#4	4	#4	4
14"–20"	2.0'	1.0'	1.0'	#4	4	#4	6	#4	4
22"–24"	2.5'	1.0'	1.0'	#4	4	#4	6	#4	4
30"	2.75'	1.5'	2.0'	#5	6	#5	8	#5	4
32"	2.75'	1.75'	2.0'	#5	8	#5	8	#5	4
34"	2.75'	2.0'	2.0'	#5	8	#5	8	#5	4

B3 INLINE THRUST BLOCK DIMENSIONS MAINLINE
SCALE: N.T.S.



D1 ALTERNATE CONNECTION TO EXISTING PRESSURE CONTROL TOWER - TO BE INCLUDED IF BID ALTERNATE 3 IS NOT CONSTRUCTED
SCALE: N.T.S.

461



D3 6"/8" COMBINATION AIR VALVE
SCALE: N.T.S.

411

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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

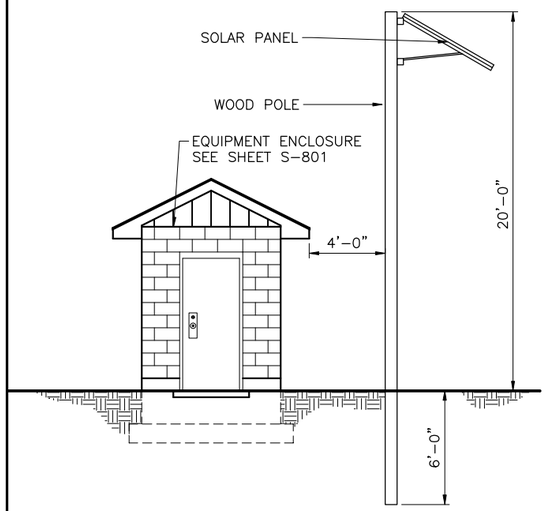
PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
DETAILS

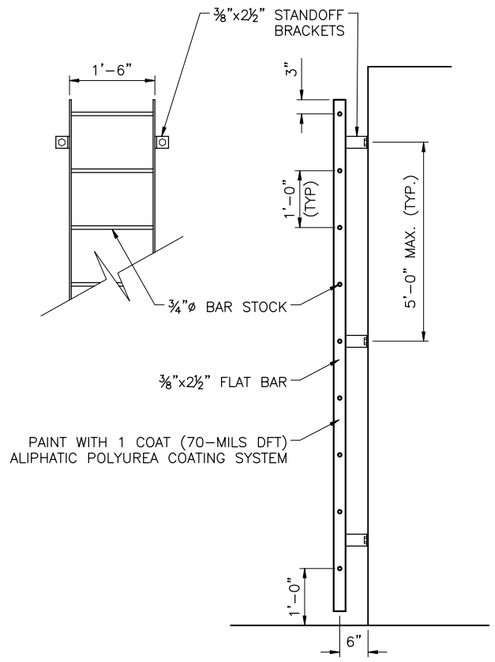
FILE: 81-18-013_C-501X_DETAILS
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: CSF
CHECKED BY: SBG
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/17/2018

SHEET NUMBER:
C2-502

Plot Date: 8/20/2018 7:55 AM Plotted By: Jukal Myers
Date Created: 8/15/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_C-501X_DETAILS.DWG



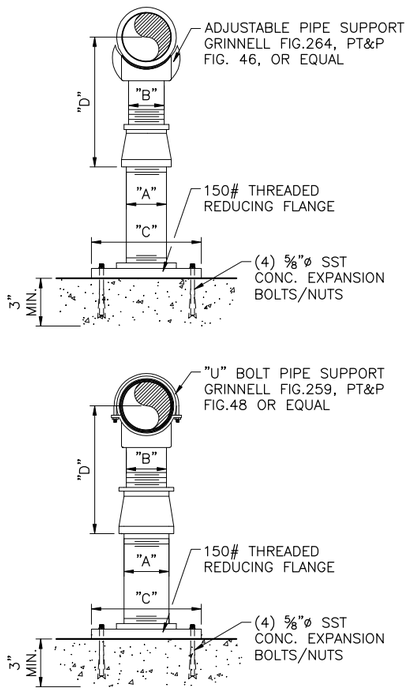
B1 SOLAR PANEL POLE (460)
SCALE: 1/4" = 1'-0"



B2 ACCESS LADDER DETAIL
SCALE: 3/4" = 1'-0"

ADJUSTABLE PIPE SUPPORT					
APPROXIMATE DIMENSIONS IN INCHES					
PIPE SIZE	A	B	C	D MINIMUM	D MAXIMUM
2½	2½	1½	9	8	13
3				8¼	13¼
3½				8½	13½
4	3	2½		9¼	14
5				10	14¾
6				10½	15¼
8				11¾	16½
10				13½	18¼
12				15	19¾
14	4	3	11	16¼	20¾
16				17¾	22¼
18	6	3½	13½	19½	24
20				21	25½
22		4		21 5/16	25 13/16
24				23¾	28¼
26				24 5/16	28 13/16
30			16	27	31½
32				28¼	32¾
36				30¼	34¾

NOTE:
PIPE SUPPORTS TO BE HOT DIP GALVANIZED AFTER FABRICATION.



D1 ADJUSTABLE PIPE SUPPORT
SCALE: 3/4" = 1'-0"

Plot Date: 8/20/2018 7:56 AM Plotted By: Jalal Myers
Date Created: 8/17/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_C-503X_VAULTS.DWG

J-U-B ENGINEERS, INC.
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NO.	DESCRIPTION	DATE	BY	APP.
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
DETAILS

FILE: 81-18-013_C-503X_VAULTS
JUB PROJ. #: 81-18-013
DRAWN BY: JMM
DESIGN BY: CSF
CHECKED BY: SBG
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/17/2018

SHEET NUMBER:
C2-505

Notes: (General and location specific)

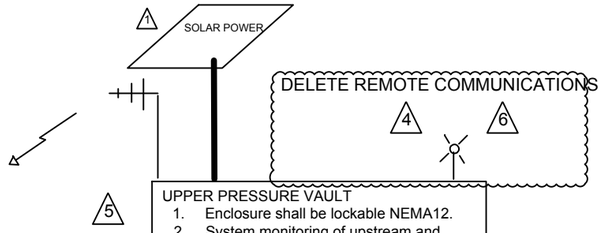
1) 12vdc Solar power system shall be sized for full system load for minimum of 3 consecutive days of full cloud cover. Batteries shall be kept in a separate box appropriate for storage. Solar panel(s) shall be mounted on contractor provided pole outside of building. Power wiring shall be run in conduit between the solar panel and the battery system.
2) Purdy Mesa Tank site will send the tank level signal to the existing Kannah Creek WTP site via the Kannah Creek Tank site. Integrator will add the Purdy Mesa tank level signal and associated high / low alarms to the Kannah Creek SCADA system.
3) ~~Integrator will setup communications via internet connection to the operator interface at the control vault location (cell link with fixed IP address). The Integrator will ensure that the WTP interface is secure to prevent unwanted outside access.~~
4) ~~The flow vault will be the primary pressure control site for the pipeline. Communications to this site will be via cellular modem. The modem will need additional security to prevent access from networks outside of the water treatment plant (Tosibox 500 or equivelant)~~
5) Pressure / flow control will be accomplished by monitoring both up and downstream pressures as well as system flow. In automatic mode, the PLC will actuate either the open or close solenoid on the Burmad valve in order to increase / decrease pressure as needed to maintain desired pressure / flow. The operator interface will display system pressures and flow as well as any alarm conditions (low / high pressure, sensor failure, low battery). A graphical representation of the vault will also be displayed. The operator will be able to enter desired flow / pressure setpoints (password protected). In manual mode, the operator will be able to actuate either the open or close solenoid as needed from the Operator interface (password protected.). Alarms will be emailed (or text via email) to appropriate city personnel.
6) ~~The city has been granted access to the radio tower on Whitewater hill (Clifton Water District). The integrator may do a radio path survey to determine if this will allow for a more desireable communications path than cellular network.~~
7) Integrator will ensure that they provide all necessary components and setup so that the system operates as intended.
8) Integrator will provide a minimum of (2) 3 hr. training sessions on the operation and maintenance of the system
9) Project submittals shall include bill of materials with associated cut sheets on all proposed equipment. Control panel layout and wiring drawings shall also be provided (11x17).
10) Project O&M shall include bill of materials and equipment manuals. As-built drawings shall be provided in 11x17 format. A flash drive shall be furnished with all O&M data as well as copy of drawings in PDF and Autocad 2016 or higher. Additionally, copies of the PLC and OIT programs shall be furnished on the flash drive.

DELETE WTP SITE WORK FROM SCOPE

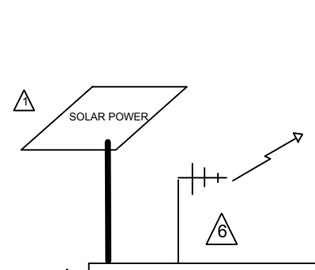
WTP SITE
1. ~~Monitor and control the flow vault site via IP address link~~
2. ~~Monitor the new tank level via existing remote connection to Kannah Creek~~
3. ~~Add new control panel in main flow control vault to monitor and control new pressure sustaining valve.~~
4. ~~All equipment will be fuse protected.~~
5. ~~Panel will need ethernet link to WTP control room and wiring from new vault to panel.~~
6. Primary Components
   - 6.1. ~~Allen Bradley Micrologix1100 PLC with 1762-IF4 analog input module~~
   - 6.2. ~~Red Lion G07S0000 Operator interface or equal. All data shall be logged to the OIT data storage device every 5 minutes.~~
   - 6.3. ~~Pressure transmitter with display. Range 0-150 PSI 4-20mA Output. (2) Rosemount 2088 series or equal~~
   - 6.4.

3

LOWER PRESSURE VAULT
1. Enclosure shall be lockable NEMA12. White in color.
2. System monitoring of upstream and downstream pressure and system flow
3. All equipment shall be fuse protected.
4. All I/O shall be wired through terminal blocks and tagged with Radio input / output address.
5. Primary Components
   - 5.1. Phoenix Contact RAD-900-IFS radio system with RAD-AI4-IFS analog module with appropriate lightning protection.
   - 5.3. Pressure transmitter with display. Range 0-150 PSI 4-20mA Output. (2) Rosemount 2088 series or equal



UPPER PRESSURE VAULT
1. Enclosure shall be lockable NEMA12.
2. System monitoring of upstream and downstream pressure and system flow
3. System control of upstream pressure
4. All equipment shall be fuse protected.
5. All I/O shall be wired through terminal blocks and tagged with PLC input / output address.
6. Primary Components
   - 6.1. Allen Bradley Micrologix1100 PLC with 1762-IF4 analog input module
   - 6.2. Red Lion G07S0000 Operator interface or equal. All data shall be logged to the OIT data storage device every 5 minutes.
   - 6.3. Phoenix Contact RAD-900-IFS. Use PLC serial port to communicate to lower vault.
   - 5.3. Pressure transmitter with display. Range 0-150 4-20mA Output. (2) Rosemount 2088 series or equal
   - 6.4 Insertion magnetic flowmeter Seametrics EX-250 with FT-440 display or equal
   - 6.5 4-20mA Loop powered Battery Voltage monitor



TANK SITE
1. Enclosure shall be lockable NEMA12.
2. System monitoring of tank level.
3. Tank level will be sent to the Kannah Creek WTP via the Kannah Creek Tank RTU for control of the Purdy Mesa Intake valve. Operations shall enter desired tank level setpoint for valve control.
4. All equipment shall be fuse protected.
5. All I/O shall be wired through terminal blocks and tagged with PLC input / output address.
6. Primary components
   - 6.1. Phoenix Contact point to point 900Mhz radio system to link to Kannah Creek. Radio shall have appropriate lightning protection.
   - 5.2 Submersible Pressure transmitter Range 0-10 PSI 4-20mA Output. E&H Waterpilot or equal
   - 5.3 The tank level transmitter shall have appropriate lightning protection

KANNAH CREEK WATER TANK SITE (EXISTING PHOENIX 900MHZ RADIOS) P/N 2885346 RAD-ISM-900-XD-BUS

KANNAH CREEK WTP (EXISTING PHOENIX 900MHZ RADIOS) P/N 2885346 RAD-ISM-900-XD-BUS
1. Tank level setpoint shall be added to the existing valve control system

NUMBER	REVISION	BY	DATE
6	Deletion of Cellular network	·	10/18
5	Change of material mfg.	·	9/18
4	90% Review Modifications	·	8/9/18
3	Addition of Pressure Vault at WTP	·	7/16/18
2	60% Review Modifications	·	6/27/18
1	60% Drawing Set	·	6/12/18

DRAWN BY: BRM 5/15/18	PROJECT NUMBER: 81-18-013
DESIGNED BY: BRM 5/15/18	CAD NUMBER: C2-505
APPROVED BY: . .	DRAWING SCALE: NONE
WITNESSED BY: . .	

PROJECT:
JUB ENGINEERS
PURDY MESA PIPELINE PROJECT

DRAWING TITLE:
SCADA SYSTEM
COMMUNICATIONS OVERVIEW

SHEET NO.
C2-505

REVISION
6

GENERAL STRUCTURAL NOTES AND SPECIFICATIONS

1. GENERAL
   - A. These general structural notes and specifications supplement the project written technical specifications and the project structural drawings.
   - B. The structures shown on the drawings have been designed for stability under final conditions only. These plans do not include the necessary components or equipment for the structures during construction. The Contractor is responsible for all construction bracing, temporary shoring, and other site safety controls required during construction in accordance with all applicable Local, State and Federal regulations, to insure the stability and safety of all construction until it is completed and self-supporting.
   - C. The Contractor is responsible for all water, both above and below ground, runoff and other environmental controls required during construction to insure the site is maintained in compliance with all applicable Local, State and Federal regulations.
   - D. Details on these plans are intended to depict the general construction details and methods for this structure. Connection details and conditions not specifically shown that are similar in nature to those that are specified shall be assumed one and the same. If questions regarding the application of details are encountered, notify the Engineer for clarification or instruction.
   - E. Where these General Structural Notes, the Project Geotechnical Report and/or the Project Technical Specifications differ or conflict, the more stringent requirement shall apply, unless otherwise directed by the Project Engineer.
   - F. Visits to the job site by the Engineer to observe the construction do not in any way mean that they are guarantors of the Contractor's work, nor responsible for comprehensive or special inspections, coordination, supervision, nor safety at the job site.

2. CONTRACTOR RESPONSIBILITY FOR COORDINATION
   - A. It is the Contractors Prime responsibility to coordinate the work shown on all of the Project Drawings, general, special and technical specifications.
   - B. The Contractor is responsible to verify all existing construction material types dimensions, elevations and conditions.
   - C. The Contractor shall verify and coordinate the dimensions among all drawings and in the field prior to proceeding with any work or fabrication, any discrepancy shall be immediately reported to the Engineer for direction and/or clarification. Any construction work done by the Contractor before obtaining such clarification from the project Engineer shall be at the Contractor's own risk and cost. Furthermore; any work required to correct, replace and/or restore the work as directed by the Engineer shall be at the Contractor's own risk and cost.
   - D. No structural members shall be cut for pipes, ducts, etc. unless specifically detailed or approved in writing by the Engineer.

3. CODES
   - A. Unless otherwise noted, all referenced building codes and standards refer to their current editions, including any local, state, or federal amendments or changes, as adopted in the locality of the Project on the date these drawings are signed and sealed by the Project Engineer.
   - B. GENERAL:
     - B.1. International Code Council, ICC, International Building Code, IBC.
     - B.2. Minimum Design Loads for Buildings and Other Structures, ASCE 7.
   - C. CONCRETE:
     - C.1. American Concrete Institute, ACI 301, Specifications for Structural Concrete.
     - C.2. American Concrete Institute, ACI 318, Building Code Requirements for Structural Concrete.
   - D. MASONRY:
     - D.1. The Masonry Society, TMS 402, Building Code Requirements for Masonry Structures.
     - D.2. The Masonry Society, TMS 602, Specification for Masonry Structures.
   - E. WOOD:
     - E.1. American Wood Council National Design Specification for Wood Construction, NDS.

4. DESIGN CRITERIA
   - A. Occupancy or Use; IBC Table 1607.1:
     - A.1. Equipment Enclosure:
       - A.1.a. Occupancy Category: U
       - A.1.b. Risk Category; ASCE Table 1.5-2: II
   - B. DEAD LOADS:
     - B.1. Equipment Enclosure Roof Dead Load: 20 psf
   - C. LIVE LOADS:
     - C.1. Equipment Enclosure Floor Live Load: 100 psf
     - C.2. Equipment Enclosure Roof Live Load: 20 psf
   - D. SNOW LOADS:
     - D.1. Ground Snow Load: P_g = 40 psf
     - D.2. Sloped Roof Snow Load P_s = 21.2 psf
     - D.3. Unbalanced Snow Load Max. P_u = 43 psf
     - D.4. Importance Factor: I_s = 1.10
     - D.5. Snow Exposure Factor: C_e = 1.0
     - D.6. Thermal Factor: C_t = 1.2
   - E. WIND:
     - E.1. Basic Wind Speed: V = 115 mph
     - E.2. Wind Site Exposure: C
   - F. SEISMIC:
     - F.1. Seismic Importance Factor: I_e = 1.25
     - F.2. Mapped Spectral Response Acceleration:
       - F.2.a. Short Period Acceleration: S_s = 0.253
       - F.2.b. 1-Second Acceleration: S_1 = 0.072
     - F.3. Site Class (Soil Profile): D
     - F.4. Spectral Response Coefficients:
       - F.4.a. Short Period Acceleration: S_{ds} = 0.269
       - F.4.b. 1-Second Acceleration: S_{d1} = 0.115
     - F.5. Seismic Design Category: B
   - G. SOIL LOADS:
     - G.1. Soil density: 130 pcf
     - G.2. Active Lateral Equivalent Fluid Pressure: 45 pcf
     - G.3. At-Rest Lateral Equivalent Fluid Pressure: 65 pcf
     - G.4. Passive Lateral Equivalent Fluid Pressure: 300 pcf

5. SPECIAL INSPECTIONS Special Inspections per IBC Chapter 17 are required for the following items:

Special Inspections

All special inspection shall be performed by approved inspectors.

		Material	Frequency
A.	Soils. (By Geotechnical Engineer)		
	A.1.	Site preparation	Periodic
	A.2.	Site excavations	Periodic
	A.3.	Fill material verification	Continuous
	A.4.	Fill placement and compaction	Continuous
	A.5.	Lift thickness	Continuous
B.	Concrete		
	B.1.	Reinforcement placement	Periodic
	B.2.	Reinforcing welding	Refer to Steel Welding Requirements
	B.3.	Placement of cast-in-place anchors	Periodic
	B.4.	Verification of use of required mix	Periodic
	B.5.	Concrete placement	Continuous
	B.6.	Concrete curing maintenance	Periodic
	B.7.	Verification of in-situ concrete prior to removal of forms and shores from elevated beams and slabs	Periodic
	B.8.	Verification of formwork	Periodic
C.	Post Installed Concrete Anchors		
	C.1.	Installation	Continuous
D.	Structural Masonry		
	E.1.	Verification of site proportioned mortar & grout	Periodic
	E.2.	Observation of prism preparation	Continuous
	E.3.	Placement of masonry units & mortar joints	Periodic
	E.4.	Verification of size and location of structural elements	Periodic
	E.5.	Anchorage of masonry to structural members and diaphragms including type, size and location of anchors	Periodic
	E.6.	Type, grade and size of reinforcing steel	Periodic
	E.7.	Reinforcing steel and connector placement	Periodic
	E.8.	Cold/Hot weather masonry protection	Periodic
	E.9.	Verify use of grout mix design	Periodic
	E.10.	Verify grout space is clean prior to grouting	Continuous
	E.11.	Grout placement	Continuous
E.	Wood		
	F.1.	Fabrication of pre-fabricated structural elements	Periodic
	F.2.	Material verification of structural panels and nails for diaphragms and shear walls with edge nailing	Periodic
	F.3.	Verification of framing size at diaphragm and shear wall panel edges with edge nailing less than or equal to 4"	Periodic

6. SUBMITTALS
   - A. Submit required copies, one (1) electronic .pdf file or three (3) minimum hardcopy, of product or material design information to the Engineer for review for the following items:
     - A.1. Concrete mix designs and admixtures.
     - A.2. Non-shrink grout.
     - A.3. Expansion bolts.
     - A.4. Epoxy Anchors.
     - A.5. Structural masonry grout and mortar mix designs.
     - A.6. Structural concrete block or brick.
   - B. Submit required copies of shop drawings, one (1) electronic .pdf file or three (3) minimum hardcopy, to the Engineer for review prior to fabrication of the following items:
     - B.1. Reinforcing steel for all concrete.
     - B.2. Reinforcing steel for masonry walls.
   - C. The following items to be designed by others are considered "Deferred Submittals". Deferred submittals shall be accompanied by design drawings, shop drawings and structural calculations, stamped and signed by a Professional Structural Engineer currently registered in the State of Colorado.
     - C.1. Pre-engineered and shop fabricated wood joists and trusses.

7. FOUNDATIONS
   - A. All footings to be placed on firm undisturbed, inorganic material. Proof roll sub-grade prior to placing concrete where the material has been disturbed by the excavating equipment.
   - B. All soil bearing surfaces shall be inspected by the Geotechnical Engineer prior to placement of reinforcing steel.
   - C. All piers and footings outside or at the perimeter of the structure, or in other unheated areas shall be set to a depth of at least 30" below finish grade, unless otherwise noted on the plans.
   - D. All foundations and retaining walls below finish grade shall receive an approved damp-proof coating. Foundation walls below maximum anticipated ground water levels shall receive an approved water-proof coating; extend water-proofing to a minimum of 1-ft above the maximum anticipated ground water level.
   - E. Allowable bearing pressure for all footings Qa=3,000 psf on 24 inches of structural fill.
   - F. Excavations shall be shored as required to prevent subsidence or damage to adjacent existing structures, streets, utilities, etc.
   - G. Local areas of soft and/or unacceptable material encountered at bottom of footing elevations indicated on the plans must be over-excavated and brought up to design grade with compacted structural fill or lean concrete fill, at no additional cost to the owner.
   - H. All structural fill and/or backfill shall be a CDOT Class 6 base course or granular, free draining, material; Unified Soils Classification GW, GP, GM or SW; maximum aggregate size of 3-in. and no more than 15% passing a number 200 sieve. Material shall be placed in lifts no greater than 6-in. in depth and compacted to 95% of maximum density as determined per ASTM D1557.
   - I. Design for the mitigation of subsurface water flow and/or perched water tables shall be the responsibility of others.
   - J. The Engineer shall be notified in writing if any ground water, clay type soils, debris or unconsolidated materials are encountered during excavations for foundations.
   - K. Refer to the final Project Geotechnical Report by Huddleston-Berry Engineering & Testing, LLC which includes a letter dated June 5, 2018 titled "Geotechnical Investigation, Purdy Mesa Flowline, Whitewater, Colorado" and a second letter dated June 19, 2018 titled "Geotechnical Engineering, Purdy Mesa Flowline Project, Whitewater, Colorado" which shall be considered part of these plans and specifications.

8. CONCRETE
   - A. GENERAL
     - A.1. Concrete shall be proportioned to provide an average compressive strength, f'c, as prescribed in ACI 318 and shall satisfy the durability criteria of ACI 318.
   - B. PROJECT CONCRETE MIX TYPES: Concrete shall be proportioned and furnished for the various project uses as indicated on the plans and as follows:
     - B.1. M4000-std: Standard structural concrete mix for all structural walls and foundation: f'c = 4,000 psi, Absolute water-cement ratio by weight = 0.45, Air Content = 6% (+/-1.5%), maximum aggregate size ¾-inch.
   - C. CONCRETE MIX COMPONENTS.
     - C.1. A water-reducing admixture conforming to ASTM C494, used in strict conformance with the manufacturer's instructions, shall be incorporated in all concrete mix designs.
     - C.2. For all water-retaining concrete structural walls and slabs, a high-range water-reducing (HRWR) admixture conforming to ASTM C494, Type F or G, shall be used. The total slump shall be less than 10-in.
     - C.3. Higher water-cement ratios than shown above may be used if substantiated in accordance with ACI 318.
     - C.4. Fly-ash conforming to ASTM C618 Type F or C, may replace up to 20% of the cement content, provided that the mix strength is substantiated by test data.
     - C.5. Cement: ASTM C150 Type II.
     - C.6. Cement: ASTM C845 Type E-1 (K) for Shrinkage Compensating mixes.
     - C.7. Water: Clean & Potable.
     - C.8. Air entraining agent: ASTM C260. Except where concrete is noted to be non-air entrained.
     - C.9. Aggregate: 1-inch Maximum aggregate per ASTM C33. Unless noted otherwise.
     - C.10. Mix Proportioning: ACI 211.1 and 350R.
   - D. CONCRETE ACCESSORIES:
     - D.1. REINFORCING STEEL: Reinforcing steel shall conform to ASTM A615 Grade 60; #3 bars may be Grade 40.
     - D.2. WELDED WIRE FABRIC: ASTM A185 or A497.
     - D.3. WIRE: Plain wire shall conform to ASTM A 82. Deformed wire shall conform to ASTM A 496, and Epoxy coated wire shall conform to ASTM A 884.
     - D.4. JOINTING MATERIALS: In accordance with ACI 350 Section 4.5.2. All jointing materials including water-stops, expansion joints and sealants, shall be resistant to chemical attack for the design life of the facility. Sealants shall conform to ASTM C 920 and Federal Specification TT-S-00277E and PVC Water-stop shall conform to ASTM D 570, ASTM D 746, STM D 1149 and CRD-C572.
   - E. NON-SHRINK GROUT: All non-shrink grout noted on the plans shall be non-shrink, non-metallic grout with a minimum 28-day compressive strength of 7,000 psi.
   - F. EXPANSION BOLTS: Bolts noted on the plans as Expansion Bolts shall be HILTI Kwik Bolt-II, stud anchors; size and embedment as noted on the drawings, installed per the manufacturers recommendations; or an approved equal.
   - G. EPOXY SET BOLTS & REBAR: Bolts and reinforcing steel bars noted on the plans as Epoxy or Construction Adhesive Set Bolts or Rebar shall be set in place utilizing the SIMPSON SET High Strength Epoxy system; size and embedment as noted on the drawings, installed per the manufacturers recommendations; or an approved equal.
   - H. CONCRETE PROPORTIONS.
     - H.1. Concrete mix proportioning shall be in accordance with ACI 211.1; Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
     - H.2. Concrete mix proportioning for lightweight concrete shall be in accordance with ACI 211.2; Standard Practice for Selecting Proportions for Lightweight Concrete.
   - I. CONCRETE MIX VERIFICATION: Concrete mix designs shall be verified by standard 28-day cylinder tests per ASTM C39.
   - J. EVALUATION AND ACCEPTANCE OF CONCRETE. Concrete shall be tested in accordance with the requirements of ACI 318/350.
   - K. MIXING & PLACING CONCRETE. Concrete shall be prepared, mixed, placed and consolidated in accordance with ACI 318/350 and as follows:
     - K.1. ACI 304; Guide for Measuring, Mixing, Transporting, and Placing Concrete.
     - K.2. ACI 309; Guide for Consolidation of Concrete.
   - L. MINIMUM TIME BETWEEN ADJACENT PLACEMENTS:
     - L.1. Non-liquid Retaining Structures:
       - L.1.a. Construction Joints: Five (5) days wet cure, or seven (7) days dry cure.
       - L.1.b. Control Joints: Two (2) days.
       - L.1.c. Expansion Joints: One (1) day.
     - L.2. Floor Slabs:
       - L.2.a. Construction Joints: Seven (7) days wet cure, or ten (10) days dry cure.
       - L.2.b. Control Joints: Four (4) days.
       - L.2.c. Expansion Joints: One (1) day.
   - M. CONCRETE CURING. Concrete shall be maintained above 50-degrees F and in a moist condition for at least 7 days after placement, except when cured in accordance with ACI 318.
     - M.1. Curing of concrete shall be per the recommendations given in ACI 308; Guide to Curing Concrete.
   - N. COLD WEATHER REQUIREMENTS. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather. The recommended procedures listed in ACI 306; Cold Weather Concreting shall be followed.
     - N.1. Cold weather is defined as a period when, for more than three (3) consecutive days, the following conditions exist:

J-U-B ENGINEERS, INC.
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BID SET

COLORADO REGISTERED STEPHEN E. ROBERTS 48706 PROFESSIONAL ENGINEER

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NO.	DESCRIPTION	DATE	BY	APP.
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
GENERAL STRUCTURAL NOTES AND SPECIFICATIONS

FILE : 81-18-013_S2-001X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/23/2018

SHEET NUMBER:
S2-001

Plot Date:8/23/2018 8:57 PM Plotted By: Erick Christiansen
Date Created:8/15/2018 I:\DREMFILES\PUBLIC\PROJECTS-JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S2-001X.DWG

GENERAL STRUCTURAL NOTES AND SPECIFICATIONS CONTINUED

N.1.a. The average daily air temperature is less than 40–degrees F and
N.1.b. The air temperature is not greater than 50–degrees F, for more than one–half of any 24–hour period.

O. HOT WEATHER REQUIREMENTS. During hot weather, proper attention shall be given to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The recommended procedures listed in ACI 305; Hot Weather Concreting shall be followed.
O.1. Hot weather is any combination of the following conditions that tends to impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration, or otherwise causing detrimental results:
O.1.a. High ambient temperature.
O.1.b. High concrete temperature.
O.1.c. Low relative humidity.
O.1.d. Wind speed.
O.1.e. Solar radiation.

9. FORMWORK.

A. Forms shall result in a final structure that conforms to shapes, lines, and dimensions of the members as required by the design drawings and specifications.
A.1. Design of formwork shall be in accordance with ACI 318.
A.2. Formwork shall be in accordance with ACI 347; Guide to Formwork for Concrete.
B. Tolerances for finished concrete surfaces shall meet the following requirements, class of surface is per ACI 117 Section 4.8.3:
B.1. Footings: Class C
B.2. Foundation walls: Class B
B.3. Above grade concrete not visible to sight: Class B
B.4. Above–grade concrete visible to sight: Class A
C. REMOVAL OF FORMS.
C.1. Concrete forms shall not be removed until the retained concrete has reached the following minimum percentage of the required 28 day compressive strength:
C.1.a. Footings and base slabs on grade: 50% of f'c.
C.1.b. Foundation walls and columns: 67% of f'c.
C.1.c. Elevated structural slabs, beams & joists: 95% f'c.
C.2. Where concrete cylinder tests are not available for strength verification the following guide may be used when permitted by the Project Engineer:
C.2.a. Footings and base slabs on grade: 12 hours.
C.2.b. Foundation walls and columns: 24 hours.
C.2.c. Elevated structural slabs, beams and joists:
C.2.c.1. Spans under 10–feet: 4 days
C.2.c.2. Spans between 10–feet and 15–feet.: 7 days.
C.2.c.3. Spans between 15–feet and 20–feet: 10 days
C.2.c.4. Spans greater than 20–feet: by cylinder strength verification only.
D. OPENINGS AND EMBEDMENTS IN CONCRETE.
D.1. Conduits, pipes, and sleeves of any material not harmful to concrete and within limitations of ACI 318 shall be permitted to be embedded in concrete with approval of the Project Engineer, provided they are not considered to replace structurally the displaced concrete, except as provided per code requirements.
D.2. The Contractor shall coordinate placement of all openings, curbs, dowels, sleeves, conduits, bolts, and inserts prior to placement of concrete.
D.3. Conduits and pipes of aluminum shall not be embedded in structural concrete unless effectively coated or covered to prevent aluminum–concrete reaction or electrolytic action between aluminum and steel.
E. CONSTRUCTION JOINTS.
E.1. Construction joints shall only be placed where indicated on the project drawings or as approved by the Project Engineer. Contractor may revise the locations of joints, subject to specified requirements, and shall submit all revised joint locations for review by the engineer prior to placing any concrete.
E.2. Roughen and clean all construction joints as specified prior to placing adjacent concrete. Sandblasting or other preparation of horizontal and vertical joints is required.
E.3. Construction joints shall be constructed in accordance with ACI 318.

10. DETAILS OF REINFORCEMENT.

A. Placement of all reinforcing steel within concrete structures shall be in conformance with ACI 318.
B. All reinforcing steel shall be uncoated unless specifically noted otherwise.
C. Reinforcing steel hooks, bends, ties, splices and other reinforcement details shall be in accordance with ACI 315; Details and Detailing of Concrete Reinforcement.
D. All reinforcing steel shall be bent by the fabricator prior to delivery to the site. Reinforcing steel shall not be field bent, unless specifically approved by the Engineer in writing.
E. Spacing limits for reinforcement shall be in conformance with ACI 318.
F. Concrete protection for reinforcement. Unless noted elsewhere on the drawings, all reinforcing steel shall have the following concrete cover:
F.1. For non–liquid containing concrete structures; per ACI 318:
F.1.a. Concrete cast against earth: 3.00 inch
F.1.b. Concrete exposed to earth or weather;
F.1.b.1. No. 5 or smaller bars: 1.50–inch
F.1.b.2. No. 6 or larger bars: 2.00–inch
F.1.c. Concrete not exposed to earth or weather;
F.1.c.1. No. 11 or smaller bars: 0.75–inch
F.1.c.2. No. 14 or larger bars: 1.50–inch
F.1.d. Beams and columns;
F.1.d.1. Primary rein., ties, stirrups or spirals: 1.50–inch
G. Concrete blocks or plastic–coated bar chairs shall be provided for support of all slab reinforcing steel, sufficient in number to prevent settlement or sagging, but in no case shall such support be continuous. Metal clips or supports shall not be placed in contact with the forms or the sub–grade.
H. Dowels and anchor bolts shall be wired or otherwise held in correct position prior to placing concrete. Care shall be taken to insure that dowels and anchor bolts remain plum after concrete is poured and vibrated. In no case shall dowels or anchor bolts be stabbed into freshly poured concrete.
I. Provide dowels in footings and at construction joints to match vertical reinforcing bar size and spacing, unless otherwise noted on the drawings.
J. Where drilled in anchors are to be post–installed into concrete surfaces take care to locate reinforcing steel so that it will not interfere with the drilling operations. Move bars plus or minus 1 to 2 inches in order to avoid drilling conflicts.
K. All bar bends, hooks, splices and other reinforcing steel details shall conform to the requirements of ACI 315.
L. Unless otherwise noted on the plans all bars shall be spliced with a minimum Class B lap splice; lap splices of deformed bars and deformed wire in tension zones shall be Class A splices.
M. At all corners and wall intersections provide bent bars to match the horizontal reinforcing steel and in accordance with the typical corner reinforcing details.
N. Chamfer all exposed corners and fillet entrant angles 3/4–inch unless otherwise noted on the drawings.
O. At slab and wall openings provide a minimum of (4) #5 bars; over, under and at either side of the openings. Extend these bars a minimum of 24–in. past the opening edge. Provide (1) matt of (4) #5 bars for walls or slabs with single–layer reinforcing and (2) matts of (4) #5 bars for double–layer reinforcing walls or slabs. Provide #4, 48–inch long diagonal bars at each re–entrant corner in slabs; (1) bar for slabs with single layer reinforcing and (2) bars for slabs with double layer reinforcing.

11. CONCRETE FINISHING. All concrete surfaces shall be finished in accordance with ACI 301.

A. Formed Concrete Surfaces. After removal of forms, give each formed surface one or more of the following finishes in conformance with ACI 301:
A.1. Non–liquid Retaining Concrete Structures:
A.1.a. Foundation wall and other surfaces below grade and not exposed to view. Provide an As–Cast, SF–1.0 surface finish.
A.1.b. Interior, exterior and top surfaces exposed to view to 6–inches below grade. Provide an Smooth–rubbed, SF–2.0 surface finish.
A.1.c. Interior concrete surfaces to be painted or receive other coating systems. Provide an As–cast, SF–3.0 surface finish.
B. Unformed Concrete Surfaces. Unformed concrete surfaces including the top surface of all concrete roof and floor slabs shall be finished in accordance with ACI 301 and ACI 302.
B.1. For the top surfaces of walls, provide a scratch finish.
B.2. Interior areas receiving only light foot traffic shall receive a Troweled finish.
B.3. Provide a Nonslip finish for exterior surfaces and where indicated on the plans.
C. Sawed contraction joints. Conform to ACI 301.

13. STRUCTURAL MASONRY REQUIREMENTS

A. MASONRY: The masonry assemblage shall have a minimum 28 day compressive strength of 1,500 psi. Assembly shall be verified per IBC standards.
B. STRUCTURAL MASONRY UNITS:
B.1. CONCRETE MASONRY UNITS: All concrete masonry units (CMU) shall conform to ASTM C–90, Grade N, with a minimum net area compressive strength of 1,900 psi.
B.2. All block shall be laid up with a standard running bond unless specifically noted otherwise on the drawings.
B.3. Place masonry units in accordance with TMS 402/602.
C. MORTAR:
C.1. All mortar for use with structural masonry units shall conform to ASTM C270, Class S and have a minimum 28 day compressive strength of 1,900 psi.
C.2. Mortar shall be in accordance with TMS 402/602.
D. GROUT:
D.1. All grout for use with structural masonry units shall conform to ASTM C476 and have a minimum 28 day compressive strength of 2,500 psi.
D.2. Grout shall be in accordance with TMS 402/602.
D.3. Place grout in accordance with TMS 402/602.
D.4. Grout Pour Height. Do not exceed the maximum grout pour height listed in TMS 402/602.
D.5. Grout Lift Height. Do not exceed the maximum grout lift heights as defined by TMS 402/602.
E. CELLS: Fill all cells containing reinforcing steel and as directed on the drawings solid full height with grout.
F. BOND BEAMS: All bond beams shall be grouted solid to a minimum height of 8".
G. LINTELS: All masonry lintels (units over wall openings greater than 8" in length) shall be grouted solid from the bottom of the lintel to a total structural depth as indicated on the plans, or 16" minimum. Extend the length of solid grouting past the edge of each opening as indicated on the plans or 16" minimum.
H. REINFORCING:
H.1. REINFORCING STEEL: Reinforcing steel shall conform to ASTM A615 Grade 60; #3 bars may be Grade 40.
H.2. Fabricate bars used in masonry reinforcement in accordance with the fabricating tolerances of ACI 315, and in accordance with TMS 402/602.
H.3. Place reinforcement in accordance with TMS 402/602.
H.4. All reinforcing steel shall be in place and secured against displacement prior to grouting with wire ties, spacers or other suitable devices at tops and bottoms and intervals not exceeding 192 bar diameters nor 10–feet.
H.5. BAR PLACEMENT: Where one vertical bar is called for in each vertical core the bar is to be placed in the center of the masonry core. Where two vertical bars are called for they shall be placed near each wall face with ⅝" of clearance for fine grout and ½" of clearance for course grout.
H.6. LAPS: Lab all masonry reinforcing per bar size as follows:
H.6.1. Required lap lengths for single bars centered in each cell:
#3 = 16" #6 = 43" #9 = 82"
#4 = 22" #7 = 60"
#5 = 26" #8 = 72"
H.6.2. Required lap lengths for flush wall pilaster/column, 2 bars per cell with 2.5" cover:
#3 = 16" #6 = 54" #9 = 82"
#4 = 22" #7 = 63"
#5 = 32" #8 = 72"
I. ANCHOR BOLTS: Anchor bolts shall be accurately set with templates or by approved equivalent means and held in place to prevent movement. Conform to TMS 402/602.
J. WALL TIES: Install wall ties in accordance with TMS 402/602.
K. FOUNDATION DOWELS: It is the Contractor's responsibility to coordinate placement of dowels projecting from concrete foundations into reinforced masonry or brick walls.
L. Bond beams with one (1) #5 bar horizontally shall be provided at all floor and roof lines and at the top of walls. Provide a bond beam with one (1) #5 bar horizontally above and below all openings, and extend these bars 2'–0" past the opening edge. Provide full height vertical reinforcement, matching typical vertical reinforcing, each side of openings, at wall ends and intersections.
M. COLD–WEATHER CONSTRUCTION. When ambient air temperature is below 40–degrees F, implement Cold Weather procedures in accordance with TMS 402/602.
N. FIELD QUALITY CONTROL: Provide special inspection and verification in accordance with TMS 402/602.
O. CLEANING: Clean all exposed masonry surfaces in accordance with TMS 402/602.

14. WOOD

A. LUMBER: Grading shall be to the Standard Grading Rules of the WWPA. Typical structural lumber shall be Number 2 Douglas–Fir/Larch or better. Members noted as wood beams, posts or columns shall be Number 1 Douglas–Fir/Larch or better. Studs for interior non–bearing walls may be stud grade lumber. Lumber to be left exposed, without other finish and lumber in contact with concrete shall be pressure treated.
B. TREATED LUMBER: Lumber, including wood sheathing, to be left exposed without other finish, located within 8" of finish grade, or in contact with concrete shall be pressure treated material. Contractor shall coordinate and verify that all steel items in contact with the treated material, including steel hangars, connectors and fasteners have a galvanized finish of sufficient thickness, or other type of protection, that is compatible with the specific treatment type selected.
C. BOLTS & LAG SCREWS FOR WOOD CONSTRUCTION: Conform to ANSI/ASME Standards B18.2.1 and the National Design Specification for Wood Construction (NDS).
D. WOOD SCREWS: Conform to ANSI/ASME Standards B18.6.1 and the National Design Specification for Wood Construction (NDS).
E. NAILS & SPIKES: Conform to Federal Specification FF–N–105B and the National Design Specification (NDS).
F. NAILING: Where not otherwise specified on the plans, nailing shall conform to IBC Table 2304.9.1, Fastening Schedule. All nails shall be common wire nails or pneumatically driven nails with an equivalent cross–section and penetration, unless noted otherwise.
G. LUMBER HARDWARE: Wood construction connectors shall be as manufactured by Simpson Strong–Tie Company; current catalog, or an approved equal. Hardware exposed to weather or view, in unheated portions of the structure, or as indicated on the drawings or in the specifications shall be hot–dipped galvanized with galvanized fasteners.
H. ROOF SHEATHING: All roof sheathing shall be as noted in the plan drawings, details, and schedules. When a specific sheathing is not called for in the drawings, the contractor shall use 19/32" nominal, APA rated Exterior Sheathing (40/20) installed with ply–clips.
I. All wood framing, blocking and nailing shall conform to the current local building code.
J. All rafters, trusses and joists shall have full depth blocking, unless noted otherwise on the plans and details, at bearing supports, shear transfer supports, intermediate and cantilever supports and at mid–span, and as required by the building code or product supplier.
K. All framing hardware including column caps and bases, joist hangers, truss anchors, straps, etc. shall be approved (i.e. Simpson Co. or equivalent) or custom fabricated specifically as detailed on the plans. They shall be installed with nails, screws or bolts exactly as called for by the manufacturer or as noted on the plans.
L. WOOD SHEATHED ROOF DIAPHRAGMS:
L.1. Unless otherwise noted on the drawings, orient roof sheathing with face–grain perpendicular to supporting members, with joints in adjacent rows staggered ½ panel length.
L.2. Provide 2x4 flat blocking with continuous strapping (Simpson CS18) at unsupported panel edges in areas noted as "Blocked Roof Diaphragm".
L.3. Nail sheathing per roof sheathing schedule shown on drawings.
L.4. Minimum nailing where not noted otherwise shall be 10d nails @ 6" o.c. to all panel edges and 12" o.c. at intermediate supporting members.

15. PRE–ENGINEERED/FABRICATED WOOD TRUSSES

A. All pre–engineered/fabricated wood (PFT) trusses indicated on the drawings shall be metal press–plate connected wood trusses designed by a Professional Engineer registered in the State of Colorado per these notes and the specifications.
B. Design PFT trusses to the following deflection limits:
B.1. Roof Dead + Live Load: Span/240 or 1" maximum
B.2. Roof Live Load only: Span/360 or ½" maximum
C. Design PFT trusses to support the concentrated and other distributed loads as shown on the plans in addition to the following loads:
C.1. Dead Load (Top Chord) = 10 psf
C.2. Dead Load (Bottom Chord) = 10 psf
C.3. Snow Load (Top Chord) = 43 psf
C.4. Live Load* (Bottom Chord) = 10 psf
73 psf Max Total Load
* Does not occur concurrently with top chord live load
D. Design all PFT trusses and bearing attachments for wind uplift, assuming a dead load of 8 psf to resist uplift.
E. Shop drawings and design calculations signed and stamped by the Design Engineer shall be submitted to the Engineer for review prior to fabrication.
F. All necessary bridging, blocking, pre–notched or beveled plates, hangers, etc. shall be detailed or specified on the shop drawings and furnished by the truss manufacturer.
G. Truss manufacturer shall verify all setbacks, dimensions, overhangs, vertical controls and dimensions prior to fabrication.
H. Alteration of the truss layout shown on the plans may require supporting structural and foundation changes, therefore, prior approval by the Engineer is required for any proposed layout change.
I. Trusses shall not be field modified without written authorization from the truss manufacturer's Engineer of Record.
J. Trusses shall be handled, erected and braced as directed by the truss manufacturer and per the requirements of the Truss Plate Institute Manual HIB–91 or current edition.

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NO.	DESCRIPTION	DATE	BY	APP.
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

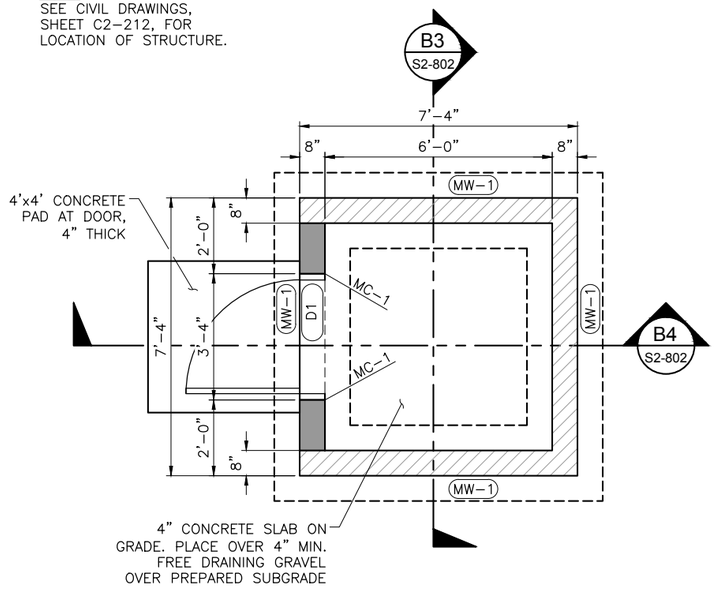
BID ALTERNATIVE 2
GENERAL STRUCTURAL NOTES AND SPECIFICATIONS

FILE : 81-18-013_S2-001X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE. IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/23/2018

SHEET NUMBER:
S2-002

Plot Date:8/23/2018 8:57 PM Plotted By: Erick Christiansen
Date Created:8/15/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013 CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S2-001X.DWG

NOTE:
SEE CIVIL DRAWINGS, SHEET C2-212, FOR LOCATION OF STRUCTURE.



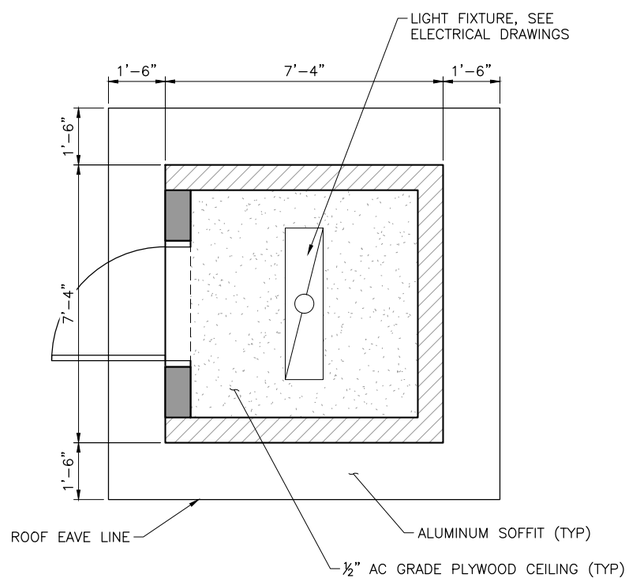
B1 EQUIPMENT ENCLOSURE FLOOR AND FOUNDATION PLAN
SCALE: 1/2" = 1'-0"

MARKS & SYMBOLS LEGEND

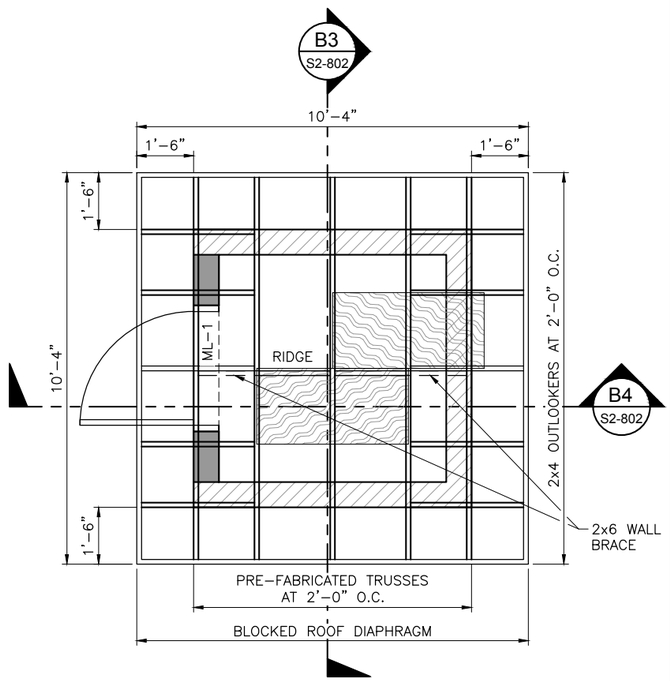
MARK	DESCRIPTION
	SECTION MARK SHEET NUMBER
	DEPRESSED FOUNDATION WALL, POUR SLAB OVER, SEE SECTIONS ON (S2-803)
	CONCRETE WALL, SEE DETAILS ON (S2-803) AND (S2-805)
	MASONRY WALL, SEE SCHEDULE ON (S2-806)
	MASONRY COLUMN, SEE SCHEDULE ON (S2-806)
MW-x	MASONRY WALL, SEE SCHEDULE ON (S2-806)
CJ	FLOOR CONTROL JOINT, SEE TYPICAL DETAILS
MC-x	MASONRY COLUMN, SEE SCHEDULE ON (S2-806)

FOUNDATION PLAN NOTES:

1. SEE LAYOUT AND DIMENSION DRAWINGS FOR EXTERIOR CONCRETE WORK AT DOORS, SIDEWALKS, ETC.
2. SEE CONCRETE DETAILS ON SHEET (S2-805) FOR STRUCTURAL FILL BENEATH FOOTINGS, IF REQUIRED BY SITE SOIL CONDITIONS.
3. SEE CONCRETE DETAILS ON SHEET (S2-805) FOR REINFORCING AROUND MISCELLANEOUS OPENINGS IN CONCRETE WALLS.
4. SEE CONCRETE DETAILS ON SHEET (S2-805) FOR BURIED PIPES RUNNING PARALLEL AND PERPENDICULAR TO FOOTINGS.
5. SEE CONCRETE DETAILS ON SHEET (S2-805) FOR CONCRETE REINFORCING STEEL LAP SCHEDULE.
6. SEE MASONRY DETAILS ON SHEET (S2-806) FOR REINFORCING AROUND MISCELLANEOUS OPENINGS IN MASONRY WALLS.
7. SEE MASONRY DETAILS ON SHEET (S2-806) FOR TERMINATION OF HORIZONTAL WALL REINFORCING AT ENDS OF WALLS AND OPENINGS.
8. SEE DETAILS ON SHEET (S2-804) FOR DOOR FRAME ATTACHMENT.



B3 EQUIPMENT ENCLOSURE REFLECTED CEILING PLAN
SCALE: 1/2" = 1'-0"



D1 EQUIPMENT ENCLOSURE ROOF FRAMING PLAN
SCALE: 1/2" = 1'-0"

MARKS & SYMBOLS LEGEND:

MARK	DESCRIPTION
	SECTION MARK SHEET NUMBER
	MASONRY WALL BELOW
	ROOF SHEATHING ORIENTATION, SEE SCHEDULE ON (S2-807)
	MASONRY COLUMN, SEE SCHEDULE ON (S2-806)
ML-x	MASONRY LINTEL, SEE SCHEDULE ON (S2-806)
T=C=x#	PFT TOP CHORD SHALL BE DESIGNED FOR AN ADDITIONAL LOAD OF "x"# IN TENSION AND COMPRESSION. LOADS PROVIDED ARE AT SERVICE LEVEL.

ROOF FRAMING PLAN NOTES:

1. VERIFY ROOF SLOPES, DRAINS, AND DECK BEARING ELEVATIONS WITH ENCLOSURE ELEVATIONS.
2. SEE ENCLOSURE ELEVATIONS FOR ALL CEILING, AND SOFFIT ELEVATIONS AND DETAILS.
3. ALL ROOF SHEATHING SHALL HAVE FACE GRAIN PERPENDICULAR TO FRAMING MEMBERS, UNLESS NOTED OTHERWISE. SEE SCHEDULE ON SHEET (S2-807) FOR SHEATHING TYPE AND NAILING REQUIREMENTS.
4. WEIGHTS AND LOCATIONS OF MECHANICAL EQUIPMENT SHALL BE SUBMITTED TO ENGINEER IN WRITING FOR REVIEW PRIOR TO PLACEMENT OF ROOF FRAMING.
5. TRUSS MANUFACTURER TO SUBMIT SHOP DRAWINGS FOR REVIEW OF ALL FRAMING WORK.
6. SEE GENERAL STRUCTURAL NOTES ON SHEET (S2-002) FOR DESIGN LOADS OF PREFABRICATED WOOD TRUSSES.
7. ALL TRUSS DETAILS, AND TRUSS TO GIRDER TRUSS DETAILS SHALL BE PROVIDED BY THE TRUSS MANUFACTURER.
8. TRUSS MANUFACTURER SHALL VERIFY ALL CEILING ELEVATIONS AND SPECIAL CONDITIONS PRIOR TO FABRICATION.
9. CONTRACTOR SHALL BE RESPONSIBLE TO PROPERLY BRACE BEAMS, TRUSSES, ETC. AS REQUIRED DURING CONSTRUCTION.

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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

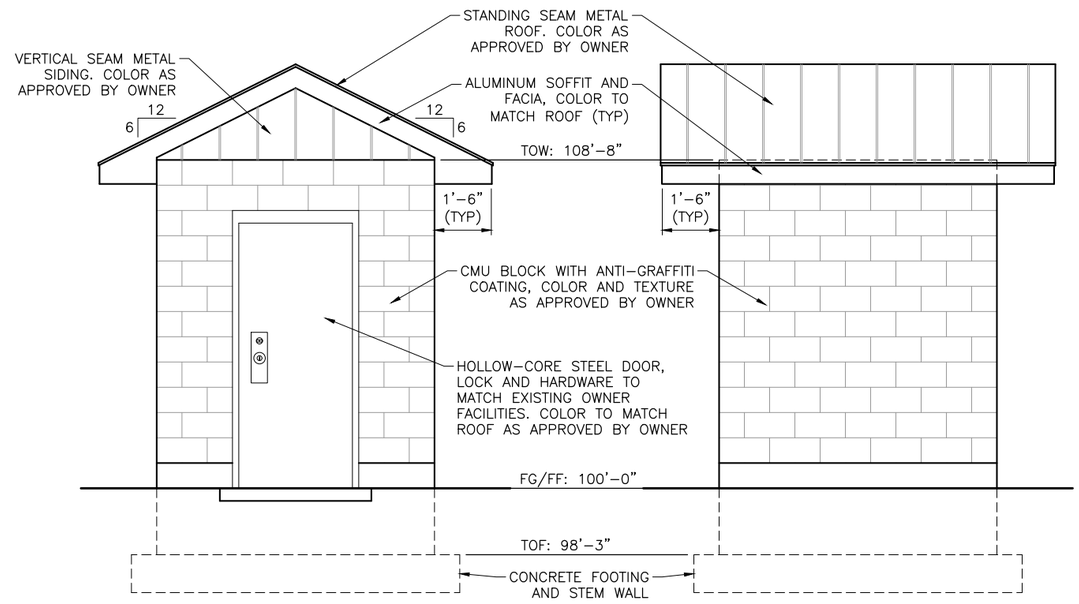
PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
EQUIPMENT ENCLOSURE DETAILS

FILE : 81-18-013_S-801X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/23/2018

SHEET NUMBER:
S2-801

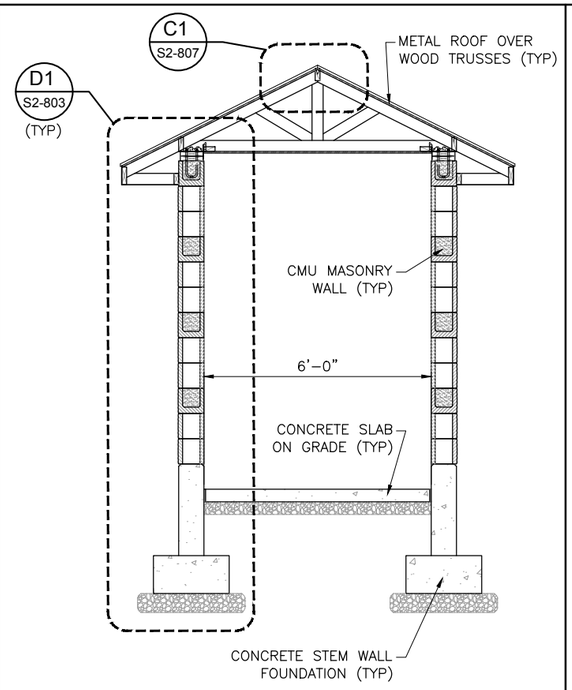
Plot Date:8/23/2018 8:59 PM Plotted By: Erick Christiansen
Date Created:8/15/2018 \\GREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-801X.DWG



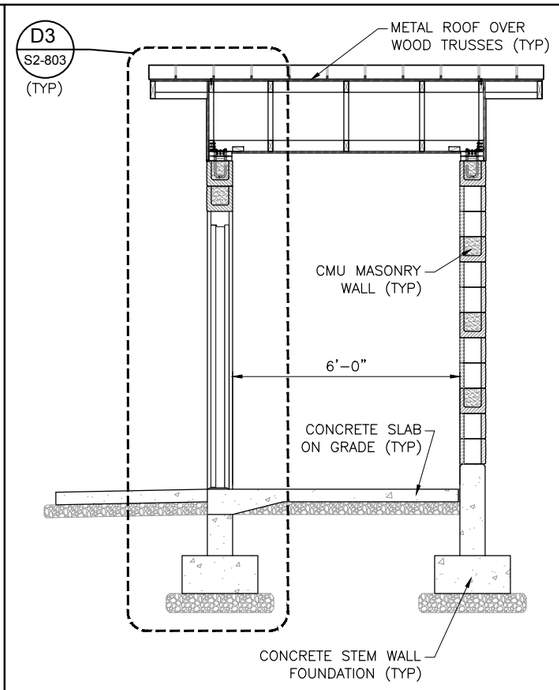
FRONT SIDE

NOTES:
1. ALL COLORS SHALL BE VERIFIED AND APPROVED WITH OWNER. PROVIDE SAMPLES TO VERIFY COLOR.
2. PROVIDE ANTI-GRAFFITI COATING TO ALL CMU BLOCK. COATING SHALL BE "PROSOCO" BLOK-GUARD AND GRAFFITI CONTROL OR APPROVED EQUAL.

B1 TYPICAL EQUIPMENT ENCLOSURE ELEVATIONS
SCALE: 1/2" = 1'-0"



B3 TYPICAL EQUIPMENT ENCLOSURE SECTION
SCALE: 1/2" = 1'-0"



B4 TYPICAL EQUIPMENT ENCLOSURE SECTION
SCALE: 1/2" = 1'-0"

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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
EQUIPMENT ENCLOSURE DETAILS

FILE : 81-18-013_S-801X
JUB PROJ. # : 81-18-013
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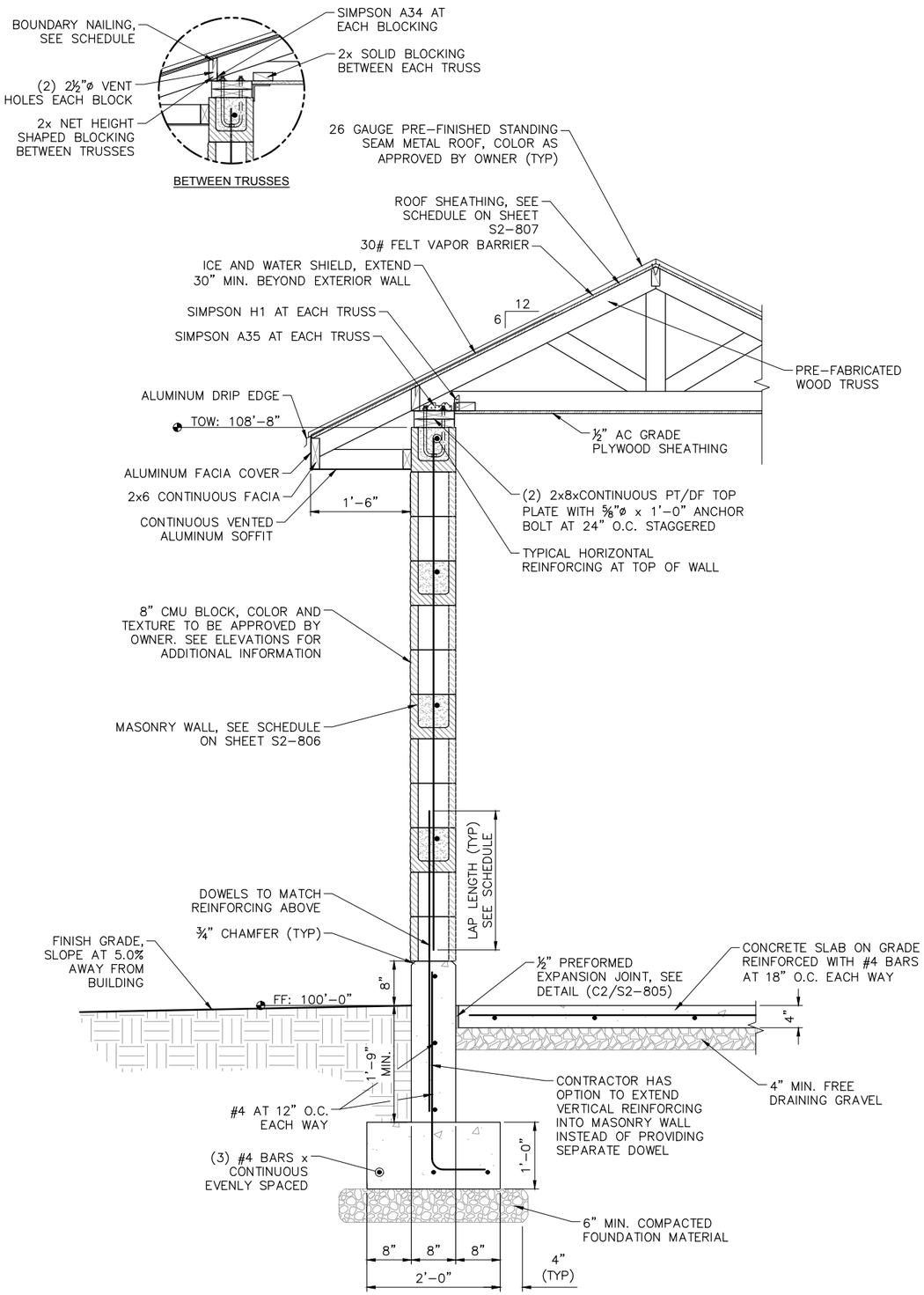
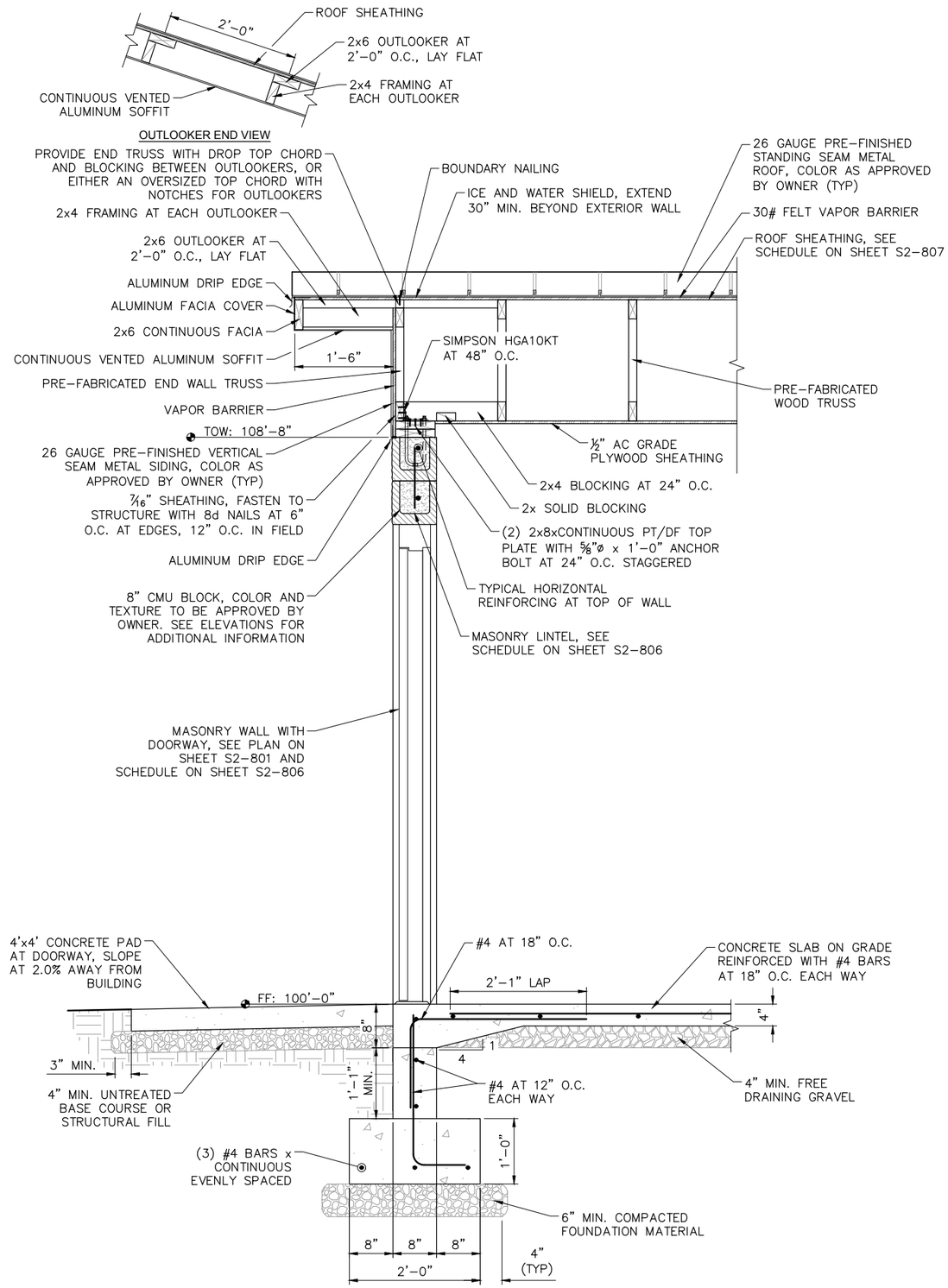
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/23/2018

SHEET NUMBER:
S2-802

Plot Date:8/23/2018 8:59 PM Plotted By: Erick Christiansen
Date Created:8/15/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-801X.DWG



D1 TYPICAL BEARING WALL AND ROOF SECTION
SCALE: 1" □ 1-0"



D3 TYPICAL NON-BEARING WALL AND ROOF SECTION (AT DOOR)
SCALE: 1" □ 1-0"

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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
EQUIPMENT ENCLOSURE DETAILS

FILE :	81-18-013_S-801X
JUB PROJ. # :	81-18-013
DRAWN BY:	JMM
DESIGN BY:	----
CHECKED BY:	----

ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY

LAST UPDATED: 8/23/2018

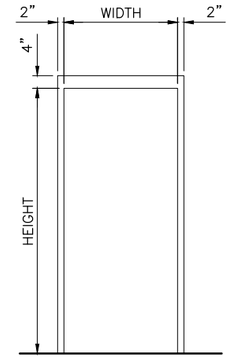
SHEET NUMBER:
S2-803

Plot Date:8/23/2018 8:56 PM Plotted By: Erick Christiansen
Date Created:8/15/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION, PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-801X.DWG

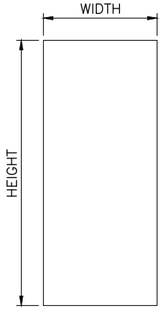
DOOR SCHEDULE

DOOR TAG	DOOR TYPE	DOOR MATERIAL	DOOR WIDTH	DOOR HEIGHT	DOOR THICKNESS	FRAME TYPE	FRAME MATERIAL	DETAILS HEAD	DETAILS JAMB	DETAILS THRESHOLD	GLAZING	FIRE RATING	COMMENTS	HINGES NUMBER	HINGES PIVOTS	HINGES BALL BEARING	HINGES BRONZE / BRASS	HINGES STAINLESS STEEL	HINGES NON-REMOVABLE PINS	LOCKSETS[1] DEADBOLT SINGLE CYLINDER	LOCKSETS[1] DEADBOLT DOUBLE CYLINDER	LOCKSETS[1] KEYED ENTRY	LOCKSETS[1] EXIT DEVICE	LOCKSETS[1] INTERCONNECT	LOCKSETS[1] PASSAGE	LOCKSETS[1] PRIVACY	LOCKSETS[1] STORE ROOM	LOCKSETS[1] FLUSH BOLTS	LOCKSETS[1] SURFACE BOLTS	STOPS WALL STOP	STOPS FLOOR STOP	DOOR SEAL SMOKE STRIP	DOOR SEAL WEATHER STRIP	DOOR SEAL ASTRAGAL	DOOR SEAL SWEEP	DOOR SEAL THRESHOLD	MISCELLANEOUS CLOSER	MISCELLANEOUS PUSH / PULL	MISCELLANEOUS COORDINATOR	MISCELLANEOUS KICK PLATE	MISCELLANEOUS ARMOR PLATE	MISCELLANEOUS PANIC BAR
D1	F	METAL	3'–0"	7'–0"	1¾"	M1	HOLLOW METAL							3		X		X	X	X						X				X				X		X	X			

DOOR SCHEDULE NOTES:
1. PROVIDE LOCKSETS TO MATCH EXISTING OWNER FACILITIES.

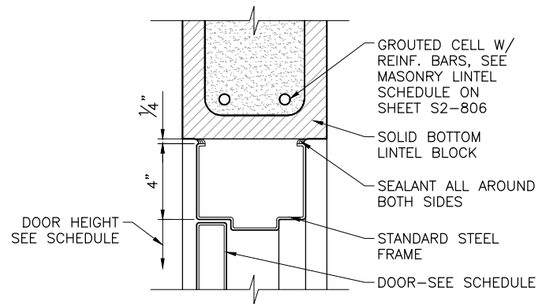


FRAME TYPE M1

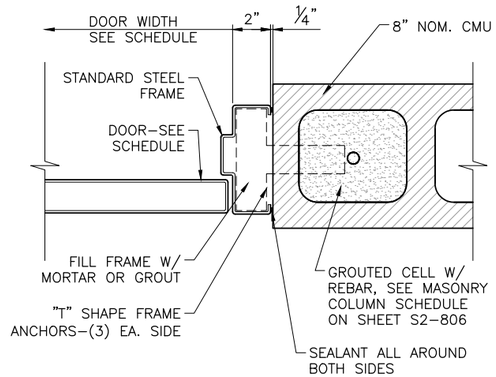


DOOR TYPE F

A1 DOOR SCHEDULE
SCALE:NOT TO SCALE



B1 DOOR HEAD-CMU PARTITION DETAIL
SCALE:NOT TO SCALE



B2 DOOR JAMB-CMU PARTITION
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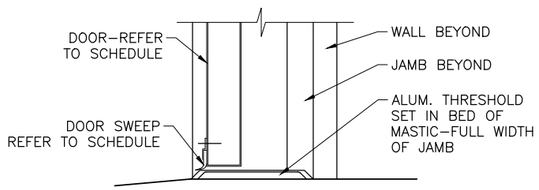

B3 DOOR THRESHOLD
SCALE:NOT TO SCALE

J-U-B ENGINEERS, INC.
J-U-B ENGINEERS, INC.
305 Main Street
Palisade, CO 81526
Phone: 970.208.8508
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PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
TYPICAL DOOR DETAILS

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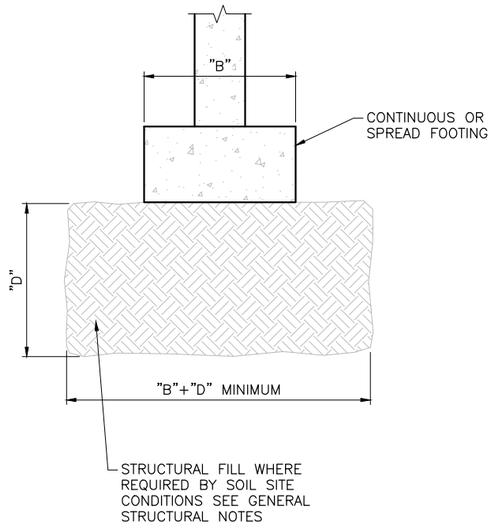
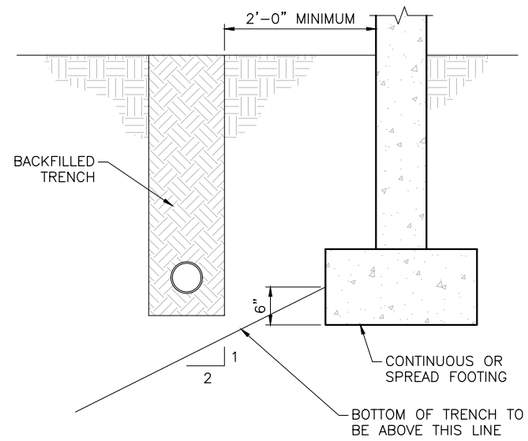
SHEET NUMBER:
S2-804

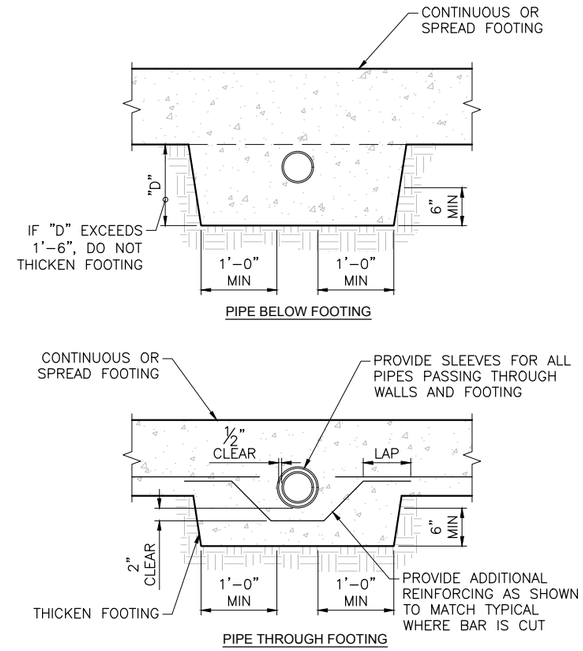
Plot Date:8/23/2018 8:56 PM Plotted By: Erick Christiansen
Date Created:8/15/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION, PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-801X.DWG



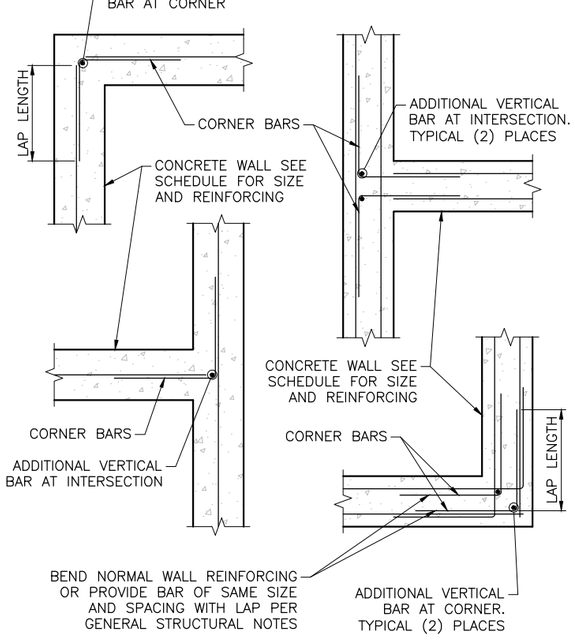
B1 STRUCTURAL FILL DETAIL
SCALE:NOT TO SCALE



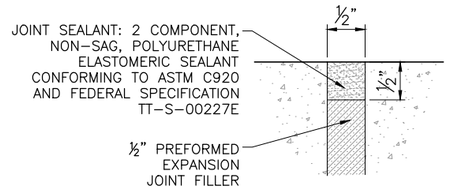
B2 PIPE PARALLEL TO FOOTING DETAIL
SCALE:NOT TO SCALE



B3 PIPE PERPENDICULAR TO FOOTING DETAIL
SCALE:NOT TO SCALE



D1 CORNER REINFORCEMENT DETAIL FOR CONCRETE WALLS
SCALE:NOT TO SCALE



C2 EXPANSION JOINT SEALANT DETAIL
SCALE:NOT TO SCALE

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PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
TYPICAL CONCRETE DETAILS

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CHECKED BY: ---
ONE INCH
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SHEET NUMBER:
S2-805

Plot Date:8/23/2018 9:14 PM Plotted By: Erick Christiansen
Date Created:8/15/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION, PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-801X.DWG

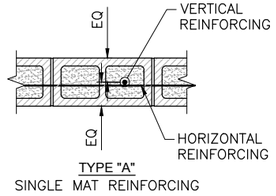
MASONRY WALL SCHEDULE

WALL MARK	THICKNESS	f'm (psi)	SOLID GROUT	REINFORCING			SPECIAL INSPECTION
				VERTICAL	HORIZONTAL	TYPE	
MW–1	8"	1500	NO	(1) #4 AT 24"oc	(1) #4 AT 24"oc	A	YES

MASONRY WALL NOTES:

1. DO NOT SOLID GROUT WALLS UNLESS NOTED OTHERWISE.
2. INSTALL LOOSE FILL INSULATION IN ALL UNGROUTED CELLS WHERE NOTED.
3. ALL MASONRY BELOW GRADE SHALL BE SOLID GROUTED.
4. VERTICAL REINFORCING SHALL BE CENTERED IN THE WALL UNLESS NOTED OTHERWISE.
5. (1) VERTICAL BAR MINIMUM AT ALL CORNERS AND END OF WALLS.
6. HORIZONTAL WALL REINFORCING SHALL BE PLACED BETWEEN VERTICAL MASONRY COLUMN REINFORCING BARS.
7. HORIZONTAL WALL REINFORCING SHALL CONTINUE THROUGH MASONRY LINTELS. WHERE BOTH HORIZONTAL WALL REINFORCING AND LINTEL REINFORCING OCCUR IN THE SAME COURSE, USE THE LARGER REINFORCING.
8. SEE GENERAL STRUCTURAL NOTES FOR ALL OTHER REQUIREMENTS.

WALL REINFORCING PLACEMENT TYPES:



TYPE "A"
SINGLE MAT REINFORCING

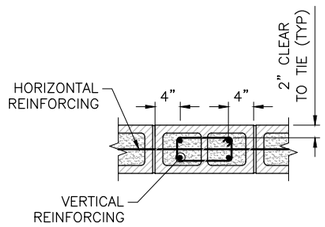
B1 MASONRY WALL SCHEDULE
SCALE:NOT TO SCALE

MASONRY COLUMN SCHEDULE

COLUMN MARK	COLUMN TYPE	COLUMN SIZE	REINFORCING			
			VERTICAL	TIES	CONFIGURATION	REMARKS
MC–1	A	8"x16"	(2) #5	NONE	• •	

MASONRY COLUMN NOTES:

1. THE CENTERLINE OF VERTICAL BARS SHALL BE LOCATED 2½" FROM THE FACE OF THE MASONRY. HORIZONTAL WALL REINFORCING SHALL BE LOCATED TO THE INSIDE OF THE VERTICAL BARS.
2. UNLESS NOTED OTHERWISE, VERTICAL REINFORCING AND TIES SHALL EXTEND TO FULL WALL HEIGHT.
3. VERTICAL MASONRY COLUMN REINFORCING SHALL EXTEND INTO THE FOOTING AND TERMINATE WITH A STANDARD 90° HOOK.
4. IN CONCRETE FOUNDATION WALLS, VERTICAL MASONRY COLUMN REINFORCING SHALL BE TIED WITH #3 TIES AT THE SAME SPACING AND CONFIGURATION AS MASONRY COLUMNS ABOVE.
5. SEE GENERAL STRUCTURAL NOTES FOR ALL OTHER REQUIREMENTS.



TYPE "A"

SCHEMATIC MASONRY COLUMN CONFIGURATIONS

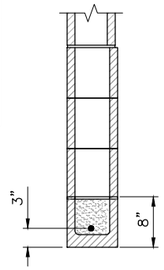
B2 MASONRY COLUMN SCHEDULE
SCALE:NOT TO SCALE

MASONRY LINTEL SCHEDULE

LINTEL MARK	LINTEL DEPTH	LINTEL SPAN MAXIMUM	REINFORCING	
			HORIZONTAL	STIRRUPS
ML–1	8"	3'–4"	(1) #6 BAR CONT.	NONE

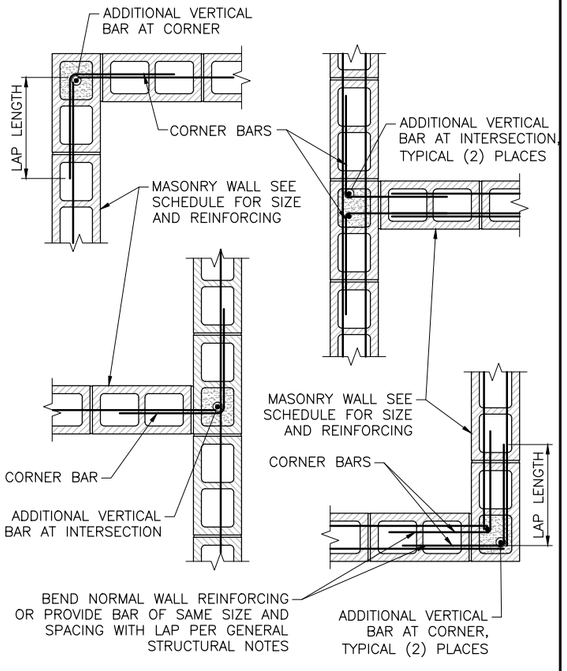
MASONRY LINTEL NOTES:

1. LINTEL WIDTH AND MATERIAL TYPE SHALL BE THE SAME AS THE WALL IN WHICH THE LINTEL IS CONSTRUCTED.
2. GROUT MASONRY LINTELS MONOLITHICALLY WITH THE SUPPORT WALL OR COLUMN AT EACH END.
3. MASONRY LINTEL ML–1 SHALL BE USED OVER OPENINGS IN MASONRY WALLS WHEN A SPECIFIC MASONRY LINTEL IS NOT OTHERWISE SPECIFIED. WHEN A LINTEL IS SPECIFIED ON THE PLANS, THE MAXIMUM SPAN AS NOTED IN THIS SCHEDULE SHALL NOT APPLY. CONSULT THE STRUCTURAL ENGINEER FOR LINTELS NOT SPECIFIED ON THE PLANS WHICH HAVE A SPAN GREATER THAN 3'–4".
4. EXTEND ALL HORIZONTAL REINFORCING 48 BAR DIAMETERS MINIMUM BEYOND THE EDGE OF ALL OPENINGS. IF HORIZONTAL REINFORCING CANNOT EXTEND 48 BAR DIAMETERS BEYOND EDGE OF OPENING, PROVIDE 90° STANDARD HOOK.
5. SPLICE TOP BARS AT MID–SPAN OF LINTEL ONLY AND BOTTOM BARS OVER SUPPORTS ONLY.
6. HORIZONTAL WALL REINFORCING SHALL CONTINUE THROUGH MASONRY LINTELS. WHERE BOTH HORIZONTAL WALL REINFORCING AND LINTEL REINFORCING OCCUR IN THE SAME COURSE, USE THE LARGER REINFORCING.
7. DOWEL VERTICAL REINFORCING OF WALL ABOVE LINTEL INTO THE FULL DEPTH OF LINTEL OR 48 BAR DIAMETERS, WHICHEVER IS LESS.
8. SEE GENERAL STRUCTURAL NOTES FOR ALL OTHER REQUIREMENTS.

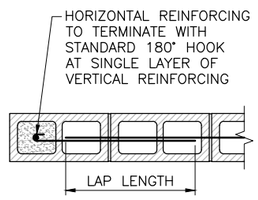


ML-1

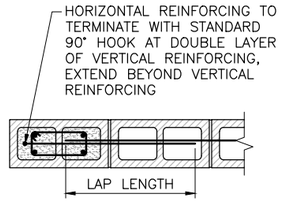
B3 MASONRY LINTEL SCHEDULE
SCALE:NOT TO SCALE



D1 CORNER REINFORCEMENT DETAIL FOR MASONRY WALLS
SCALE:NOT TO SCALE

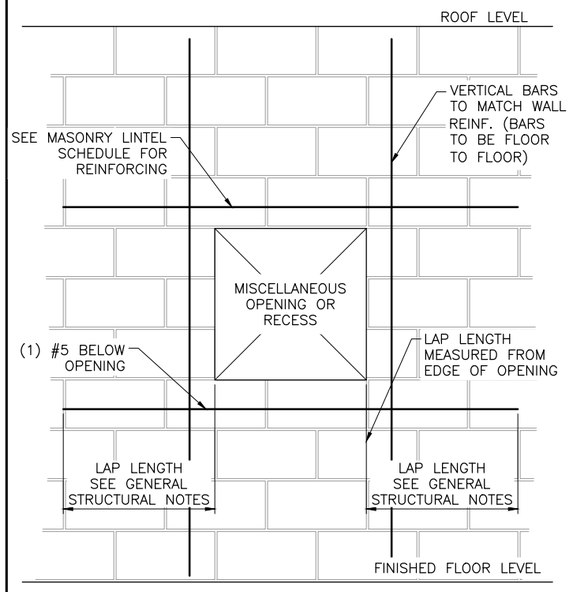


SINGLE LAYER REINFORCING



DOUBLE LAYER REINFORCING

D2 TERMINATION OF HORIZONTAL REINFORCING IN MASONRY WALLS
SCALE:NOT TO SCALE



D3 REINFORCING FOR MISCELLANEOUS OPENINGS IN MASONRY WALLS
SCALE:NOT TO SCALE

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NO.	DESCRIPTION	DATE	BY
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PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
TYPICAL MASONRY DETAILS

FILE : 81-18-013_S-801X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
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LAST UPDATED: 8/23/2018

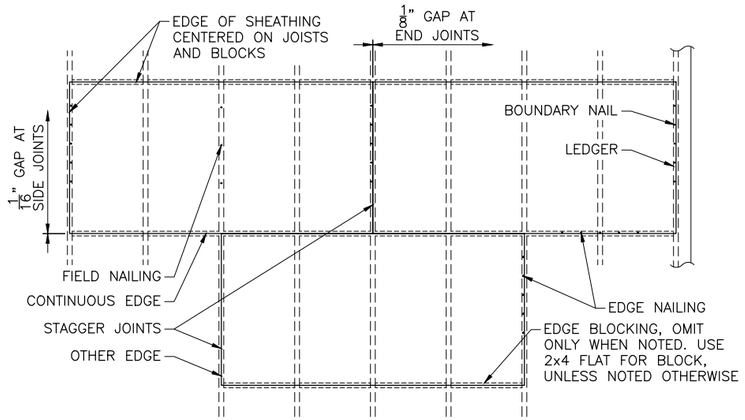
SHEET NUMBER:
S2-806

Plot Date:8/23/2018 8:59 PM Plotted By: Erick Christiansen
Date Created:8/15/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND_JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-801X.DWG

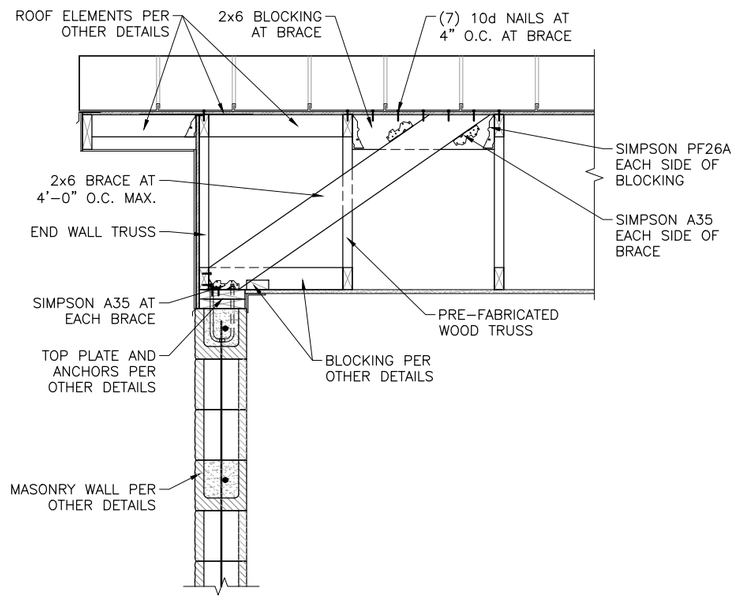
ROOF SHEATHING SCHEDULE							
LOCATION	WOOD SHEATHING THICKNESS	NAIL SIZE	EDGE NAIL		FIELD NAIL	BOUNDARY NAIL	EDGE BLOCK
			CONT. EDGE	OTHER EDGE			
BLOCKED	15/32" (32/16)	8d	6"oc	6"oc	12"oc	6"oc	YES

ROOF SHEATHING NOTES:

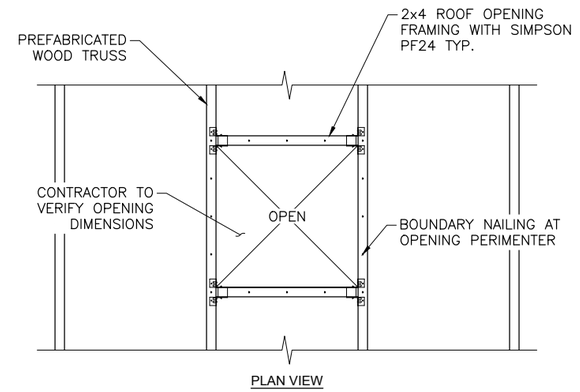
1. MINIMUM NAIL PENETRATION INTO FRAMING: 8d–1½", 10d–1⅝"
2. USE COMMON NAILS (8d DIAMETER=0.131", 10d DIAMETER=0.148")
3. SEE GENERAL STRUCTURAL NOTES FOR ALL OTHER REQUIREMENTS.



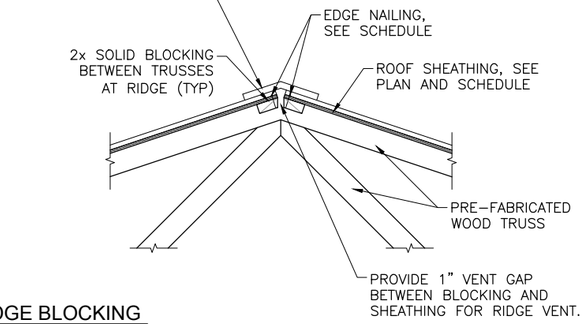
B1 ROOF SHEATHING SCHEDULE
SCALE:NOT TO SCALE



B2 TYPICAL WALL BRACE AT NON-BEARING EXTERIOR WALLS
SCALE:NOT TO SCALE



B3 TYPICAL ROOF OPENING DETAIL (OPENING LESS THAN 24" SQUARE)
SCALE:NOT TO SCALE



C1 RIDGE BLOCKING
SCALE:NOT TO SCALE

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PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 2
TYPICAL ROOF FRAMING DETAILS

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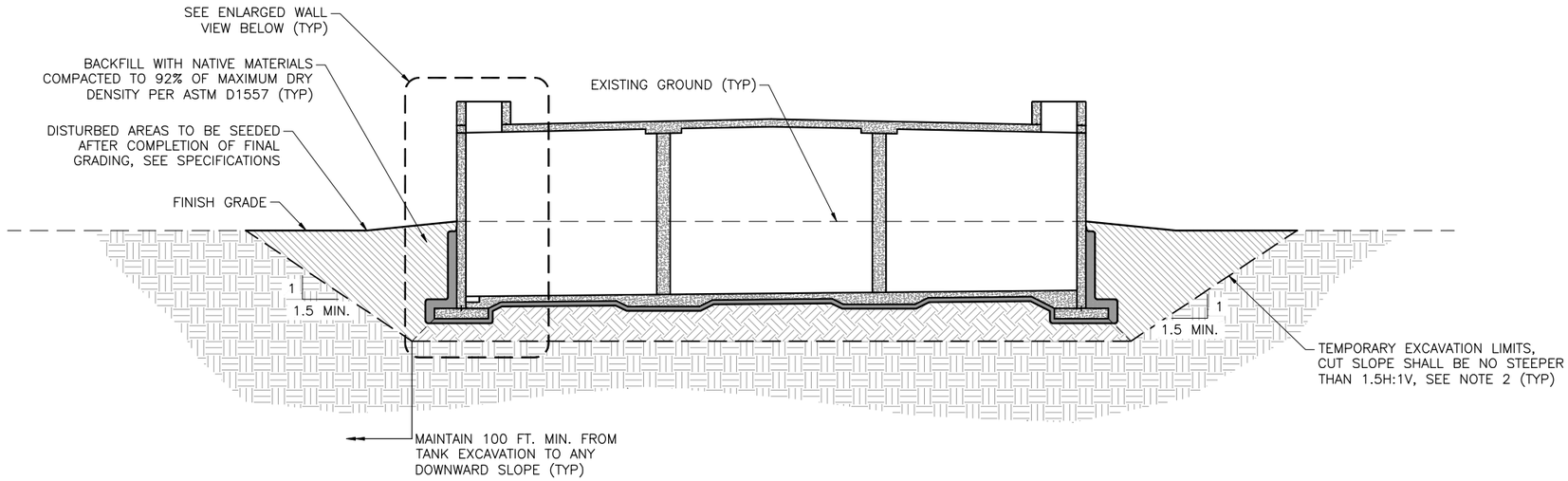


NOTES:

1. SUBGRADE MATERIAL BENEATH THE TANK SHALL BE OVER-EXCAVATED AND REPLACED WITH 24 INCHES OF COMPACTED STRUCTURAL FILL AND 6" OF CRUSHED ROCK.
2. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE SAFE WORKING CONDITIONS IN CONNECTION WITH TEMPORARY SLOPES AND UNDERGROUND EXCAVATIONS. THE CONTRACTOR IS RESPONSIBLE FOR DESIGNING AND CONSTRUCTING STABLE, TEMPORARY EXCAVATIONS AS REQUIRED TO MAINTAIN STABILITY OF BOTH EXCAVATION SIDES AND BOTTOM. ALL EXCAVATIONS SHOULD BE SLOPED OR SHORED IN THE INTEREST OF SAFETY FOLLOWING LOCAL AND FEDERAL GUIDELINES, INCLUDING CURRENT OCCUPATIONAL SAFETY AND HEALTH STANDARDS (OSHA REQUIREMENTS).
3. SOIL CONDITIONS ENCOUNTERED IN THE TEST EXCAVATIONS CONSISTED OF APPROXIMATELY 1.5 FEET OF TOP SOIL UNDERLAIN BY TAN, MOIST, DENSE SANDY GRAVEL AND COBBLE SOILS TO A DEPTH OF 10 FEET. REFER TO THE GEOTECHNICAL REPORT FOR ADDITIONAL INFORMATION.
4. ONLY LIGHT HAND-OPERATED COMPACTION EQUIPMENT SHOULD BE OPERATED WITHIN 5 FEET OF THE TANK WALLS. THE TANK ROOF IS NOT TRAFFIC RATED.
5. BACKFILL MATERIAL SHALL NOT BE PLACED UNTIL ROOF SLAB IS PLACED AND HAS OBTAINED A STRENGTH OF 95% OF f'c. LEAK TEST TO BE PERFORMED BEFORE PLACEMENT OF BACKFILL.
6. ALL FILL SHALL BE MOISTURE CONDITIONED TO NEAR OPTIMUM MOISTURE CONTENT, PLACED IN UNIFORM LIFTS NOT EXCEEDING 8 INCHES IN THICKNESS, AND BE COMPACTED TO MINIMUM OF 95% BENEATH THE FOUNDATIONS AND 92% FOR THE WALL BACKFILL OF THE SOIL MAXIMUM DRY DENSITY AS MEASURED BY ASTM D1557.

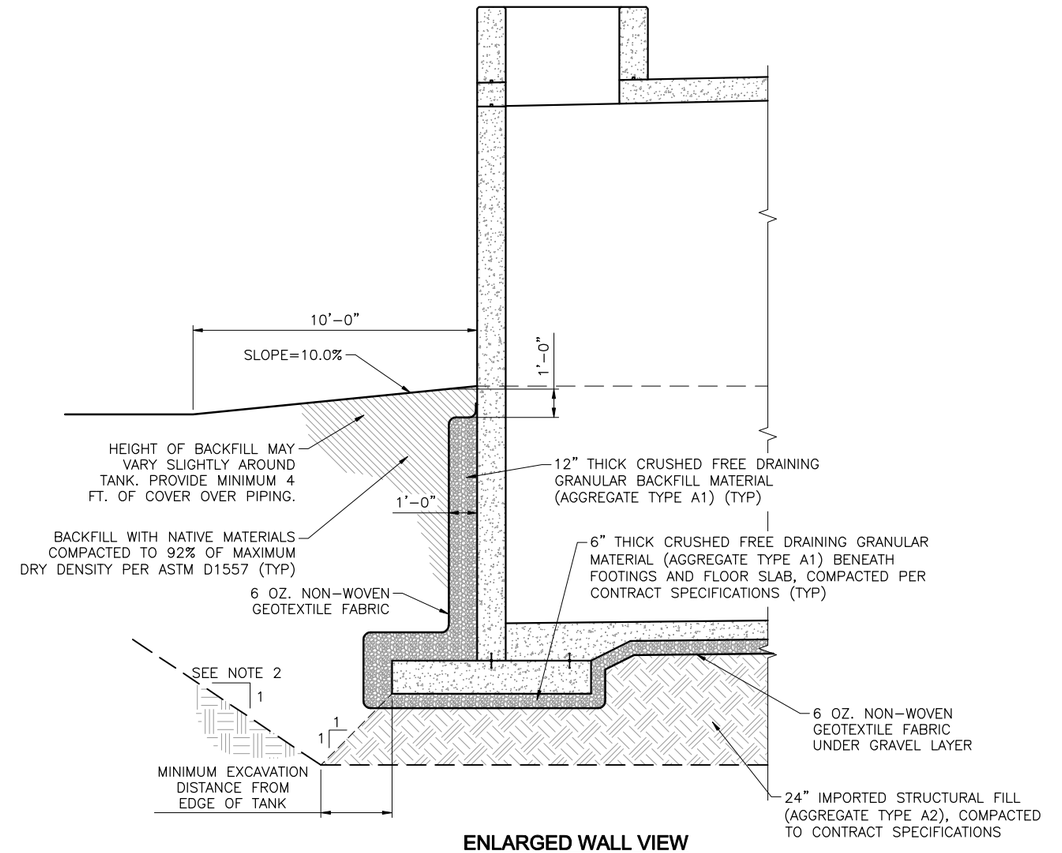
NATIVE SEED MIX

WESTERN WHEATGRASS (Pascopyrum smithii)	6.25 lbs/acre
IDAHO FESCUE (Festuca Idahoensis)	5.00 lbs/acre
BLUEBUNCH WHEATGRASS (Pseudoroegneria spicata)	5.00 lbs/acre
INDIAN RICEGRASS (Achnatherum hymenoides)	3.75 lbs/acre
SLENDER WHEATGRASS (Elymus trachycaulus)	2.00 lbs/acre
THICKSPIKE WHEATGRASS (Elymus lanceolatus)	1.25 lbs/acre
SANDBERG'S BLUEGRASS (Poa secunda)	1.25 lbs/acre
BOTTLEBRUSH SQUIRRELTAIL (Elymus elymoides)	0.50 lbs/acre
TOTAL:	25.0 lbs/acre

HATCH LEGEND

- UNDISTURBED NATIVE MATERIAL
- COMPACTED STRUCTURAL FILL
- NATIVE OR IMPORTED BACKFILL MATERIAL
- FREE DRAINING GRANULAR BACKFILL MATERIAL

D1 TYPICAL EXCAVATION AND BACKFILL DETAIL
SCALE:NOT TO SCALE



ENLARGED WALL VIEW

J-U-B ENGINEERS, INC.
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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
TYPICAL EXCAVATION AND BACKFILL DETAILS

FILE : 81-18-013_C-601X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ---
CHECKED BY: ---
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/16/2018

SHEET NUMBER:
C3-601

Plot Date: 8/20/2018 7:59 AM Plotted By: Jubal Mees
Date Created: 8/16/2018 I:\OREM\FILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEETS\81-18-013_C-601X.DWG

GENERAL STRUCTURAL NOTES AND SPECIFICATIONS

1. GENERAL
   - A. These general structural notes and specifications supplement the project written technical specifications and the project structural drawings.
   - B. The structures shown on the drawings have been designed for stability under final conditions only. These plans do not include the necessary components or equipment for the structures during construction. The Contractor is responsible for all construction bracing, temporary shoring, and other site safety controls required during construction in accordance with all applicable Local, State and Federal regulations, to insure the stability and safety of all construction until it is completed and self-supporting.
   - C. The Contractor is responsible for all water, both above and below ground, runoff and other environmental controls required during construction to insure the site is maintained in compliance with all applicable Local, State and Federal regulations.
   - D. Details on these plans are intended to depict the general construction details and methods for this structure. Connection details and conditions not specifically shown that are similar in nature to those that are specified shall be assumed one and the same. If questions regarding the application of details are encountered, notify the Engineer for clarification or instruction.
   - E. Where these General Structural Notes, the Project Geotechnical Report and/or the Project Technical Specifications differ or conflict, the more stringent requirement shall apply, unless otherwise directed by the Project Engineer.
   - F. Visits to the job site by the Engineer to observe the construction do not in any way mean that they are guarantors of the Contractor's work, nor responsible for comprehensive or special inspections, coordination, supervision, nor safety at the job site.

2. CONTRACTOR RESPONSIBILITY FOR COORDINATION
   - A. It is the Contractors Prime responsibility to coordinate the work shown on all of the Project Drawings, general, special and technical specifications.
   - B. The Contractor is responsible to verify all existing construction material types dimensions, elevations and conditions.
   - C. The Contractor shall verify and coordinate the dimensions among all drawings and in the field prior to proceeding with any work or fabrication, any discrepancy shall be immediately reported to the Engineer for direction and/or clarification. Any construction work done by the Contractor before obtaining such clarification from the project Engineer shall be at the Contractor's own risk and cost. Furthermore; any work required to correct, replace and/or restore the work as directed by the Engineer shall be at the Contractor's own risk and cost.
   - D. No structural members shall be cut for pipes, ducts, etc. unless specifically detailed or approved in writing by the Engineer.

3. CODES
   - A. Unless otherwise noted, all referenced building codes and standards refer to their current editions, including any local, state, or federal amendments or changes, as adopted in the locality of the Project on the date these drawings are signed and sealed by the Project Engineer.
   - B. GENERAL:
     - B.1. International Code Council, ICC, International Building Code, IBC.
     - B.2. Minimum Design Loads for Buildings and Other Structures, ASCE 7.
   - C. CONCRETE:
     - C.1. American Concrete Institute, ACI 301, Specifications for Structural Concrete.
     - C.2. American Concrete Institute, ACI 350, Code Requirements for Environmental Engineering Concrete Structures
   - D. STEEL:
     - D.1. American Institute of Steel Construction, AISC, Steel Construction Manual.
     - D.2. American Institute of Steel Construction, AISC 360, Specifications for Structural Steel Buildings.
     - D.3. American Institute of Steel Construction, AISC 341, Seismic Provisions for Structural Steel Buildings.
     - D.4. American Welding Society, AWS D1.1, Structural Welding Code.

4. DESIGN CRITERIA
   - A. Occupancy or Use; IBC Table 1607.1:
     - A.1. Water Storage Facility
       - A.1.a. Occupancy Category: U
       - A.1.b. Risk Category; ASCE Table 1.5-2: III
   - B. DEAD LOADS:
     - B.1. Tank Roof Dead Load: 125 psf
   - C. LIVE LOADS:
     - C.1. Tank Floor Live Load: 1,219 psf
     - C.2. Tank Roof Live Load: 50 psf
   - D. SNOW LOADS:
     - D.1. Ground Snow Load: P_g = 40 psf
     - D.2. Sloped Roof Snow Load P_s = 21.2 psf
     - D.3. Unbalanced Snow Load Max. P_u = 43 psf
     - D.4. Importance Factor: I_s = 1.10
     - D.5. Snow Exposure Factor: C_e = 1.0
     - D.6. Thermal Factor: C_t = 1.2
   - E. WIND:
     - E.1. Basic Wind Speed: V = 120 mph
     - E.2. Wind Site Exposure: C
   - F. SEISMIC:
     - F.1. Seismic Importance Factor: I_e = 1.25
     - F.2. Mapped Spectral Response Acceleration:
       - F.2.a. Short Period Acceleration: S_s = 0.253
       - F.2.b. 1-Second Acceleration: S_1 = 0.072
     - F.3. Site Class (Soil Profile): D
     - F.4. Spectral Response Coefficients:
       - F.4.a. Short Period Acceleration: S_{ds} = 0.269
       - F.4.b. 1-Second Acceleration: S_{d1} = 0.115
     - F.5. Seismic Design Category: B
   - G. SOIL LOADS:
     - G.1. Soil density: 130 pcf
     - G.2. Active Lateral Equivalent Fluid Pressure: 45 pcf
     - G.3. At-Rest Lateral Equivalent Fluid Pressure: 65 pcf
     - G.4. Passive Lateral Equivalent Fluid Pressure: 300 pcf

5. SPECIAL INSPECTIONS Special Inspections per IBC Chapter 17 are required for the following items:

Special Inspections

All special inspection shall be performed by approved inspectors.

		Material	Frequency
A.	Soils. (By Geotechnical Engineer)		
	A.1.	Site preparation	Periodic
	A.2.	Site excavations	Periodic
	A.3.	Fill material verification	Continuous
	A.4.	Fill placement and compaction	Continuous
	A.5.	Lift thickness	Continuous
B.	Concrete		
	B.1.	Reinforcement placement	Periodic
	B.2.	Reinforcing welding	Refer to Steel Welding Requirements
	B.3.	Placement of cast-in-place anchors	Periodic
	B.4.	Verification of use of required mix	Periodic
	B.5.	Concrete placement	Continuous
	B.6.	Concrete curing maintenance	Periodic
	B.7.	Verification of in-situ concrete prior to removal of forms and shores from elevated beams and slabs	Periodic
	B.8.	Verification of formwork	Periodic
C.	Post Installed Concrete Anchors		
	C.1.	Installation	Continuous
D.	Structural steel		
	D.1.	Fabrication of structural elements	Periodic
	D.2.	Material verification of structural steel	Periodic
	D.3.	Material verification of high strength bolts	Periodic
	D.4.	Material verification of anchor bolts and threaded rods	Periodic
	D.5.	Material verification of weld filler materials	Periodic
	D.6.	Welding stair and railing systems	Periodic
	D.7.	Snug-tight high strength bolt installation	Periodic
	D.8.	Welding performed in the shop of an Approved Fabricator shall not require Special Inspection.	------

6. SUBMITTALS
   - A. Submit required copies, one (1) electronic .pdf file or three (3) minimum hardcopy, of product or material design information to the Engineer for review for the following items:
     - A.1. Concrete mix designs and admixtures.
     - A.2. Non-shrink grout.
     - A.3. Expansion bolts.
     - A.4. Epoxy Anchors.
   - B. Submit required copies of shop drawings, one (1) electronic .pdf file or three (3) minimum hardcopy, to the Engineer for review prior to fabrication of the following items:
     - B.1. Reinforcing steel for all concrete.
     - B.2. Structural steel.
     - B.3. Miscellaneous steel fabrications including, but not limited to, stairs, ladders, grating, floor plate, railing, support brackets, vent pipes, access doors and hatches, etc.
     - B.4. Concrete control joint locations, and pour sequence in concrete tanks/basins for liquid retaining structures. Control joint spacing of 60'-0" maximum spacing.

7. FOUNDATIONS
   - A. All footings to be placed on firm undisturbed, inorganic material. Proof roll sub-grade prior to placing concrete where the material has been disturbed by the excavating equipment.
   - B. All soil bearing surfaces shall be inspected by the Geotechnical Engineer prior to placement of reinforcing steel.
   - C. All piers and footings outside or at the perimeter of the structure, or in other unheated areas shall be set to a depth of at least 36" below finish grade, unless otherwise noted on the plans.
   - D. All foundations and retaining walls below finish grade shall receive an approved damp-proof coating. Foundation walls below maximum anticipated ground water levels shall receive an approved water-proof coating; extend water-proofing to a minimum of 1-ft above the maximum anticipated ground water level.
   - E. Allowable bearing pressure for all footings Qa=3,000 psf on 24 inches of structural fill.
   - F. Excavations shall be shored as required to prevent subsidence or damage to adjacent existing structures, streets, utilities, etc.
   - G. Local areas of soft and/or unacceptable material encountered at bottom of footing elevations indicated on the plans must be over-excavated and brought up to design grade with compacted structural fill or lean concrete fill, at no additional cost to the owner.
   - H. All structural fill and/or backfill shall be a CDOT Class 6 base course or granular, free draining, material; Unified Soils Classification GW, GP, GM or SW; maximum aggregate size of 3-in. and no more than 15% passing a number 200 sieve. Material shall be placed in lifts no greater than 6-in. in depth and compacted to 95% of maximum density as determined per ASTM D1557.
   - I. Design for the mitigation of subsurface water flow and/or perched water tables shall be the responsibility of others.
   - J. The Engineer shall be notified in writing if any ground water, clay type soils, debris or unconsolidated materials are encountered during excavations for foundations.
   - K. For water retaining structures, do not backfill walls until structure has been leak tested and supporting floors or roof are completed and in place.
   - L. Refer to the final Project Geotechnical Report by Huddleston-Berry Engineering & Testing, LLC which includes a letter dated June 5, 2018 titled "Geotechnical Investigation, Purdy Mesa Flowline, Whitewater, Colorado" and a second letter dated June 19, 2018 titled "Geotechnical Engineering, Purdy Mesa Flowline Project, Whitewater, Colorado" which shall be considered part of these plans and specifications.

8. CONCRETE
   - A. GENERAL
     - A.1. Concrete shall be proportioned to provide an average compressive strength, f'c, as prescribed in ACI 350 and shall satisfy the durability criteria of ACI 350.
   - B. PROJECT CONCRETE MIX TYPES: Concrete shall be proportioned and furnished for the various project uses as indicated on the plans and as follows:
     - B.1. M3000-sec: Secondary concrete mix for fill and backfill around buried pipes which do not occur underneath structural footings and foundation slabs: f'c = 3,000 psi, Absolute water-cement ratio by weight = 0.55, Air Content = 6% (+/- 1.5%), maximum aggregate size 3/4-inch; slump 8-inch.
     - B.2. M4000-sec: Secondary concrete mix for fill and backfill around buried pipes underneath structural footings and foundation slabs: f'c = 4,000 psi, Absolute water-cement ratio by weight = 0.45, Air Content = 6% (+/- 1.5%), maximum aggregate size 1-inch; slump 3 to 5 inches.
     - B.3. M4000-std: Standard structural concrete mix for non-liquid-retaining structural concrete, including all structural walls, columns, foundation and roof slabs, and beams: f'c = 4,000 psi, Absolute water-cement ratio by weight = 0.45, Air Content = 6% (+/-1.5%), maximum aggregate size ¾-inch
     - B.4. M5000-std: Standard structural concrete mix for liquid-retaining structural concrete, including all structural walls, columns, foundation and roof slabs, and beams: f'c = 5,000 psi, Absolute water-cement ratio by weight = 0.45, Air Content = 6% (+/-1.5%), maximum aggregate size 1-inch.
     - B.5. M5000-sps: Super-plasticized concrete mix for liquid-retaining concrete structural walls and foundation slabs: f'c = 5,000 psi, absolute water-cement ratio by weight = 0.40, air content = 6% (+/- 1.5%)
   - C. CONCRETE MIX COMPONENTS.
     - C.1. A water-reducing admixture conforming to ASTM C494, used in strict conformance with the manufacturer's instructions, shall be incorporated in all concrete mix designs.
     - C.2. For all water-retaining concrete structural walls and slabs, a high-range water-reducing (HRWR) admixture conforming to ASTM C494, Type F or G, shall be used. The total slump shall be less than 10-in.
     - C.3. Higher water-cement ratios than shown above may be used if substantiated in accordance with ACI 318.
     - C.4. Fly-ash conforming to ASTM C618 Type F or C, may replace up to 20% of the cement content, provided that the mix strength is substantiated by test data.
     - C.5. Cement: ASTM C150 Type II.
     - C.6. Cement: ASTM C845 Type E-1 (K) for Shrinkage Compensating mixes.
     - C.7. Water: Clean & Potable.
     - C.8. Air entraining agent: ASTM C260. Except where concrete is noted to be non-air entrained.
     - C.9. Aggregate: 1-inch Maximum aggregate per ASTM C33. Unless noted otherwise.
     - C.10. Mix Proportioning: ACI 211.1 and 350R.
   - D. CONCRETE ACCESSORIES:
     - D.1. REINFORCING STEEL: Reinforcing steel shall conform to ASTM A615 Grade 60; #3 bars may be Grade 40.
     - D.2. WELDED WIRE FABRIC: ASTM A185 or A497.
     - D.3. WIRE: Plain wire shall conform to ASTM A 82. Deformed wire shall conform to ASTM A 496, and Epoxy coated wire shall conform to ASTM A 884.
     - D.4. JOINTING MATERIALS: In accordance with ACI 350 Section 4.5.2. All jointing materials including water-stops, expansion joints and sealants, shall be resistant to chemical attack for the design life of the facility. Sealants shall conform to ASTM C 920 and Federal Specification TT-S-00277E and PVC Water-stop shall conform to ASTM D 570, ASTM D 746, STM D 1149 and CRD-C572.
   - E. NON-SHRINK GROUT: All non-shrink grout noted on the plans shall be non-shrink, non-metallic grout with a minimum 28-day compressive strength of 7,000 psi.
   - F. EXPANSION BOLTS: Bolts noted on the plans as Expansion Bolts shall be HILTI Kwik Bolt-II, stud anchors; size and embedment as noted on the drawings, installed per the manufacturers recommendations; or an approved equal.
   - G. EPOXY SET BOLTS & REBAR: Bolts and reinforcing steel bars noted on the plans as Epoxy or Construction Adhesive Set Bolts or Rebar shall be set in place utilizing the SIMPSON SET High Strength Epoxy system; size and embedment as noted on the drawings, installed per the manufacturers recommendations; or an approved equal.
   - H. CONCRETE PROPORTIONS.
     - H.1. Concrete mix proportioning shall be in accordance with ACI 211.1; Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
     - H.2. Concrete mix proportioning for lightweight concrete shall be in accordance with ACI 211.2; Standard Practice for Selecting Proportions for Lightweight Concrete.
   - I. CONCRETE MIX VERIFICATION: Concrete mix designs shall be verified by standard 28-day cylinder tests per ASTM C39.
   - J. EVALUATION AND ACCEPTANCE OF CONCRETE. Concrete shall be tested in accordance with the requirements of ACI 318/350.
   - K. MIXING & PLACING CONCRETE. Concrete shall be prepared, mixed, placed and consolidated in accordance with ACI 318/350 and as follows:
     - K.1. ACI 304; Guide for Measuring, Mixing, Transporting, and Placing Concrete.
     - K.2. ACI 309; Guide for Consolidation of Concrete.
   - L. MINIMUM TIME BETWEEN ADJACENT PLACEMENTS:
     - L.1. Non-liquid Retaining Structures:
       - L.1.a. Construction Joints: Five (5) days wet cure, or seven (7) days dry cure.
       - L.1.b. Control Joints: Two (2) days.
       - L.1.c. Expansion Joints: One (1) day.
     - L.2. Floor Slabs:
       - L.2.a. Construction Joints: Seven (7) days wet cure, or ten (10) days dry cure.
       - L.2.b. Control Joints: Four (4) days.
       - L.2.c. Expansion Joints: One (1) day.
     - L.3. Liquid Retaining Structures:
       - L.3.a. Construction Joints: Ten (10) days wet cure, or fourteen (14) days dry cure.
       - L.3.b. Control Joints: Six (6) days.
   - M. HORIZONTAL JOINTS IN REINFORCED CONCRETE WALLS:
     - M.1. Provide a layer of slurry concrete in the bottom of all horizontal wall joints, 2-inch thick. Thoroughly vibrate to mix concrete & slurry together.

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NO.	DESCRIPTION	DATE	BY	APP.
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
GENERAL STRUCTURAL NOTES AND SPECIFICATIONS

FILE : 81-18-013_S3-001X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/23/2018

SHEET NUMBER:
S3-001

Plot Date:8/23/2018 8:58 PM, Plotted By: Erick Christiansen
Date Created:8/9/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S3-001X.DWG

GENERAL STRUCTURAL NOTES AND SPECIFICATIONS CONTINUED

N. HORIZONTAL CONSTRUCTION JOINTS CONTAINING WATER–STOP.
- N.1. Unless otherwise specifically directed, in all horizontal construction joints in new concrete construction containing water–stops, provide an initial layer of slurry mix to aid in consolidation of freshly placed concrete at the joint interface.
- N.2. Slurry mix shall be a mixture of 3/8–inch maximum aggregate, sand, cement and water.
- N.3. Place slurry mix 2–inch minimum to 4–inch maximum in thickness.
- N.4. Place with buckets or other means permitting visual verification that only enough slurry mix is deposited in the vicinity of the concrete pour to meet the thickness requirements.
- N.5. Place concrete over slurry mix while slurry mix is still flowable.
- N.6. Limit initial concrete placement on top of slurry mix to 12–inches in thickness. Thoroughly vibrate and consolidate concrete and slurry mix together.

O. CONCRETE CURING. Concrete shall be maintained above 50–degrees F and in a moist condition for at least 7 days after placement, except when cured in accordance with ACI 318.
- O.1. Curing of concrete shall be per the recommendations given in ACI 308; Guide to Curing Concrete.

P. COLD WEATHER REQUIREMENTS. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near–freezing weather. The recommended procedures listed in ACI 306; Cold Weather Concreting shall be followed.
- P.1. Cold weather is defined as a period when, for more than three (3) consecutive days, the following conditions exist:
  - P.1.a. The average daily air temperature is less than 40–degrees F and
  - P.1.b. The air temperature is not greater than 50–degrees F, for more than one–half of any 24–hour period.

Q. HOT WEATHER REQUIREMENTS. During hot weather, proper attention shall be given to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The recommended procedures listed in ACI 305; Hot Weather Concreting shall be followed.
- Q.1. Hot weather is any combination of the following conditions that tends to impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration, or otherwise causing detrimental results:
  - Q.1.a. High ambient temperature.
  - Q.1.b. High concrete temperature.
  - Q.1.c. Low relative humidity.
  - Q.1.d. Wind speed.
  - Q.1.e. Solar radiation.

9. FORMWORK.

A. Forms shall result in a final structure that conforms to shapes, lines, and dimensions of the members as required by the design drawings and specifications.
- A.1. Design of formwork shall be in accordance with ACI 318/350.
- A.2. Formwork shall be in accordance with ACI 347; Guide to Formwork for Concrete.

B. Tolerances for finished concrete surfaces shall meet the following requirements, class of surface is per ACI 117 Section 4.8.3:
- B.1. Footings: Class C
- B.2. Foundation walls: Class B
- B.3. Above grade concrete not visible to sight: Class B
- B.4. Above–grade concrete visible to sight: Class A

C. REMOVAL OF FORMS.
- C.1. Concrete forms shall not be removed until the retained concrete has reached the following minimum percentage of the required 28 day compressive strength:
  - C.1.a. Footings and base slabs on grade: 50% of f'c.
  - C.1.b. Foundation walls and columns: 67% of f'c.
  - C.1.c. Elevated structural slabs, beams & joists: 95% f'c.
- C.2. Where concrete cylinder tests are not available for strength verification the following guide may be used when permitted by the Project Engineer:
  - C.2.a. Footings and base slabs on grade: 12 hours.
  - C.2.b. Foundation walls and columns: 24 hours.
  - C.2.c. Elevated structural slabs, beams and joists:
    - C.2.c.1. Spans under 10–feet: 4 days
    - C.2.c.2. Spans between 10–feet and 15–feet.: 7 days.
    - C.2.c.3. Spans between 15–feet and 20–feet: 10 days
    - C.2.c.4. Spans greater than 20–feet: by cylinder strength verification only.

D. OPENINGS AND EMBEDMENTS IN CONCRETE.
- D.1. Conduits, pipes, and sleeves of any material not harmful to concrete and within limitations of ACI 318/350 shall be permitted to be embedded in concrete with approval of the Project Engineer, provided they are not considered to replace structurally the displaced concrete, except as provided per code requirements.
- D.2. The Contractor shall coordinate placement of all openings, curbs, dowels, sleeves, conduits, bolts, and inserts prior to placement of concrete.
- D.3. Conduits and pipes of aluminum shall not be embedded in structural concrete unless effectively coated or covered to prevent aluminum–concrete reaction or electrolytic action between aluminum and steel.

E. CONSTRUCTION JOINTS.
- E.1. Construction joints shall only be placed where indicated on the project drawings or as approved by the Project Engineer. Contractor may revise the locations of joints, subject to specified requirements, and shall submit all revised joint locations for review by the engineer prior to placing any concrete.
- E.2. Continuous waterstop as specified shall be installed in all construction joints except where specifically noted otherwise.
- E.3. Roughen and clean all construction joints as specified prior to placing adjacent concrete. Sandblasting or other preparation of horizontal and vertical joints is required.
- E.4. Construction joints shall be constructed in accordance with ACI 318/350.

10. DETAILS OF REINFORCEMENT.

A. Placement of all reinforcing steel within concrete structures shall be in conformance with ACI 318/350.

B. All reinforcing steel shall be uncoated unless specifically noted otherwise.

C. Reinforcing steel hooks, bends, ties, splices and other reinforcement details shall be in accordance with ACI 315; Details and Detailing of Concrete Reinforcement.

D. All reinforcing steel shall be bent by the fabricator prior to delivery to the site. Reinforcing steel shall not be field bent, unless specifically approved by the Engineer in writing.

E. Spacing limits for reinforcement shall be in conformance with ACI 318/350.

F. Concrete protection for reinforcement. Unless noted elsewhere on the drawings, all reinforcing steel shall have the following concrete cover:
- F.1. For non–liquid containing concrete structures; per ACI 318:
  - F.1.a. Concrete cast against earth: 3.00 inch
  - F.1.b. Concrete exposed to earth or weather;
    - F.1.b.1. No. 5 or smaller bars: 1.50–inch
    - F.1.b.2. No. 6 or larger bars: 2.00–inch
  - F.1.c. Concrete not exposed to earth or weather;
    - F.1.c.1. No. 11 or smaller bars: 0.75–inch
    - F.1.c.2. No. 14 or larger bars: 1.50–inch
  - F.1.d. Beams and columns;
    - F.1.d.1. Primary rein., ties, stirrups or spirals: 1.50–inch
- F.2. For liquid containing concrete structures; per ACI 350 Section:
  - F.2.a. Concrete cast against earth: 3.00 inch
  - F.2.b. Concrete exposed to earth, liquid or weather;
    - F.2.b.1. Slabs and joints: 2.00–inch
    - F.2.b.2. Walls: 2.00–inch
  - F.2.c. Beams and columns;
    - F.2.c.1. Ties, stirrups or spirals: 2.00–inch
    - F.2.c.2. Primary reinforcement: 2.50–inch
  - F.2.d. Footings and base slabs;
    - F.2.d.1. Formed surfaces: 2.00–inch
    - F.2.d.2. Top of footings and base slabs: 2.00–inch

G. Concrete blocks or plastic–coated bar chairs shall be provided for support of all slab reinforcing steel, sufficient in number to prevent settlement or sagging, but in no case shall such support be continuous. Metal clips or supports shall not be placed in contact with the forms or the sub–grade.

H. Dowels and anchor bolts shall be wired or otherwise held in correct position prior to placing concrete. Care shall be taken to insure that dowels and anchor bolts remain plum after concrete is poured and vibrated. In no case shall dowels or anchor bolts be stabbed into freshly poured concrete.

I. Provide dowels in footings and at construction joints to match vertical reinforcing bar size and spacing, unless otherwise noted on the drawings.

J. Where drilled in anchors are to be post–installed into concrete surfaces take care to locate reinforcing steel so that it will not interfere with the drilling operations. Move bars plus or minus 1 to 2 inches in order to avoid drilling conflicts.

K. All bar bends, hooks, splices and other reinforcing steel details shall conform to the requirements of ACI 315.

L. Unless otherwise noted on the plans all bars shall be spliced with a minimum Class B lap splice; lap splices of deformed bars and deformed wire in tension zones shall be Class A splices.

M. At all corners and wall intersections provide bent bars to match the horizontal reinforcing steel and in accordance with the typical corner reinforcing details.

N. Chamfer all exposed corners and fillet entrant angles 3/4–inch unless otherwise noted on the drawings.

O. WATERSTOP.
- O.1. All control and construction joints in liquid–retaining structures shall be doweled, keyed and provided with continuous water–stop, per the typical details, technical specifications or as directed by the Project Engineer.
- O.2. Install waterstop per manufacturer's recommendations. Waterstop shall be enveloped with concrete free of air pockets and debris. Prior to construction, the Contractor will demonstrate the method of placement of the concrete around the waterstop to the Engineer.

P. At slab and wall openings provide a minimum of (4) #5 bars; over, under and at either side of the openings. Extend these bars a minimum of 24–in. past the opening edge. Provide (1) matt of (4) #5 bars for walls or slabs with single–layer reinforcing and (2) matts of (4) #5 bars for double–layer reinforcing walls or slabs. Provide #4, 48–inch long diagonal bars at each re–entrant corner in slabs; (1) bar for slabs with single layer reinforcing and (2) bars for slabs with double layer reinforcing.

11. CONCRETE FINISHING.

All concrete surfaces shall be finished in accordance with ACI 301.

A. Formed Concrete Surfaces. After removal of forms, give each formed surface one or more of the following finishes in conformance with ACI 301:
- A.1. Non–liquid Retaining Concrete Structures:
  - A.1.a. Concrete footings and foundations not exposed to view. Provide an As–Cast, SF–1.0 surface finish.
  - A.1.b. Foundation wall and other surfaces below grade and not exposed to view. Provide an As–Cast, SF–1.0 surface finish.
  - A.1.c. Interior, exterior and top surfaces exposed to view to 6–inches below grade. Provide an Smooth–rubbed, SF–2.0 surface finish.
  - A.1.d. Column, beam and joist surfaces that are exposed to Provide an Smooth–rubbed, SF–2.0 surface finish.
  - A.1.e. Interior concrete surfaces to be painted or receive other coating systems. Provide an As–cast, SF–3.0 surface finish.
- A.2. Liquid Retaining Concrete Structures:
  - A.2.a. Interior surfaces from top of wall to floor slab, exterior and top surfaces exposed to view to 6–inches below. Pressure wash all concrete surfaces with high–pressure water and provide a Grout–cleaned rubbed, SF–2.0 surface finish.
  - A.2.b. Surfaces below grade and not exposed to view. Provide a Smooth–rubbed, SF–2.0 surface finish.

B. Unformed Concrete Surfaces. Unformed concrete surfaces including the top surface of all concrete roof and floor slabs shall be finished in accordance with ACI 301 and ACI 302.
- B.1. For the top surfaces of walls, provide a scratch finish.
- B.2. Interior areas receiving only light foot traffic shall receive a Troweled finish.
- B.3. Interior garage, industrial or work areas subject to equipment or traffic loads shall receive a Broom finish.
- B.4. Provide a Nonslip finish for exterior surfaces and where indicated on the plans.

C. Sawed contraction joints. Conform to ACI 301.

12. WATER–RETAINING CONCRETE STRUCTURES:

A. All materials used for water–retaining structures and associated mechanical devices which may come into contact with culinary water shall comply with ANSI/NSF 61. This includes, but is not limited to, concrete, concrete admixtures, release agents, sealers, piping, and metals.

B. Concrete tanks, vaults, wells and other structures intended to retain and hold water or other liquids shall be water–tight structures. The water–resisting walls and floor slabs shall be of monolithic concrete construction with water–tight joints, constructed as indicated on the plans or as directed by the Project Engineer. Water–resisting walls and floors shall be uniform in finished construction free of spalls, pockets, blemishes and or cracks that may weep or leak.

C. Cracks found in water–resisting walls, floors and/or foundation slabs that may weep or leak shall be repaired and/or sealed per the Project Specifications, notes or as approved by the project engineer.

13. STRUCTURAL STEEL AND METAL FABRICATIONS

A. STEEL MATERIALS:
- A.1. W & WT SHAPES: ASTM A572 Grade 50 with special requirements per AISC Technical Bulletin #3, dated March 1997; or ASTM A992 Grade 50, Fy=50 ksi.
- A.2. M & S SHAPES: ASTM A36, Fy=36 ksi.
- A.3. PLATES, BARS, CHANNELS & ANGLES: ASTM A36, Fy=36 ksi.
- A.4. STEEL PIPE: ASTM A53 Grade B, Fy=35 ksi.
- A.5. SQUARE, RECTANGULAR HSS, STEEL TUBING: ASTM A500 Grade B, Fy=46 ksi.
- A.6. RAISED PATTERN FLOOR PLATE: ASTM A786. Fy=36 ksi.

B. STRUCTURAL BOLTS: High Strength Bolts shall be ASTM A325, Type 1. Nuts for High Strength Bolts shall conform to ASTM A563, Grade DH, Heavy Hex.

C. ANCHOR RODS: Anchor Rods (bolts set into concrete) shall be ASTM F1554, Fy=36 ksi. Nuts for anchor rods shall conform to ASTM A563, Grade A, Heavy Hex.

D. THREADED STEEL RODS: Threaded steel rods shall conform to ASTM A36, Fy=36 ksi. Nuts for threaded rods shall conform to ASTM A563, Grade A, Heavy Hex.

E. WASHERS: All washers shall conform to ASTM F436.

F. BOLT PLACEMENT: All bolts shall be on member standard gage lines except as noted otherwise.

G. BLIND CONNECTION BOLTS FOR HSS SHAPES: Where bolted connections are indicated to be made to HSS shapes where access is unavailable to the back side of the fastener provide Type HB – Hollo–Bolt by Lindapter or approved equal. Bolt size shall be as indicated on the plans for the thickness of materials to be joined as indicated. Install bolts per the manufacturer's specifications. Provide galvanized fasteners for all exterior applications.

H. All structural steel shall be fabricated and erected in conformance with the AISC manual of steel construction, current edition.

I. All structural steel and miscellaneous metal to be connected shall be clean and free of paint, oil, soil, or other materials which would inhibit weld bonding or connection of the members.

J. All structural steel and miscellaneous metal to be embedded in concrete shall be clean and free of paint, oil, soil, or other materials which would inhibit bonding of metal and concrete.

K. WELDING OF STRUCTURAL STEEL:
- K.1. All welding shall conform to the requirements of the current AWS Structural Welding Code D1.1, current edition
- K.2. Weld Metal: Fexx=70 ksi, typical unless otherwise noted or required by AWS.
- K.3. All welders shall be tested and certified by an independent testing agency.
- K.4. Qualification of welders shall be in accordance with the Specifications for Standard Qualification Procedure of the AWS.
- K.5. All welds found defective shall be repaired and/or replaced and retested for adequacy at the Contractor's expense.
- K.6. At all field welds, embed plates, and angles; low heat and intermittent welds shall be utilized to avoid spalling or cracking the existing concrete.

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PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
GENERAL STRUCTURAL NOTES AND SPECIFICATIONS

FILE : 81-18-013_S3-001X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
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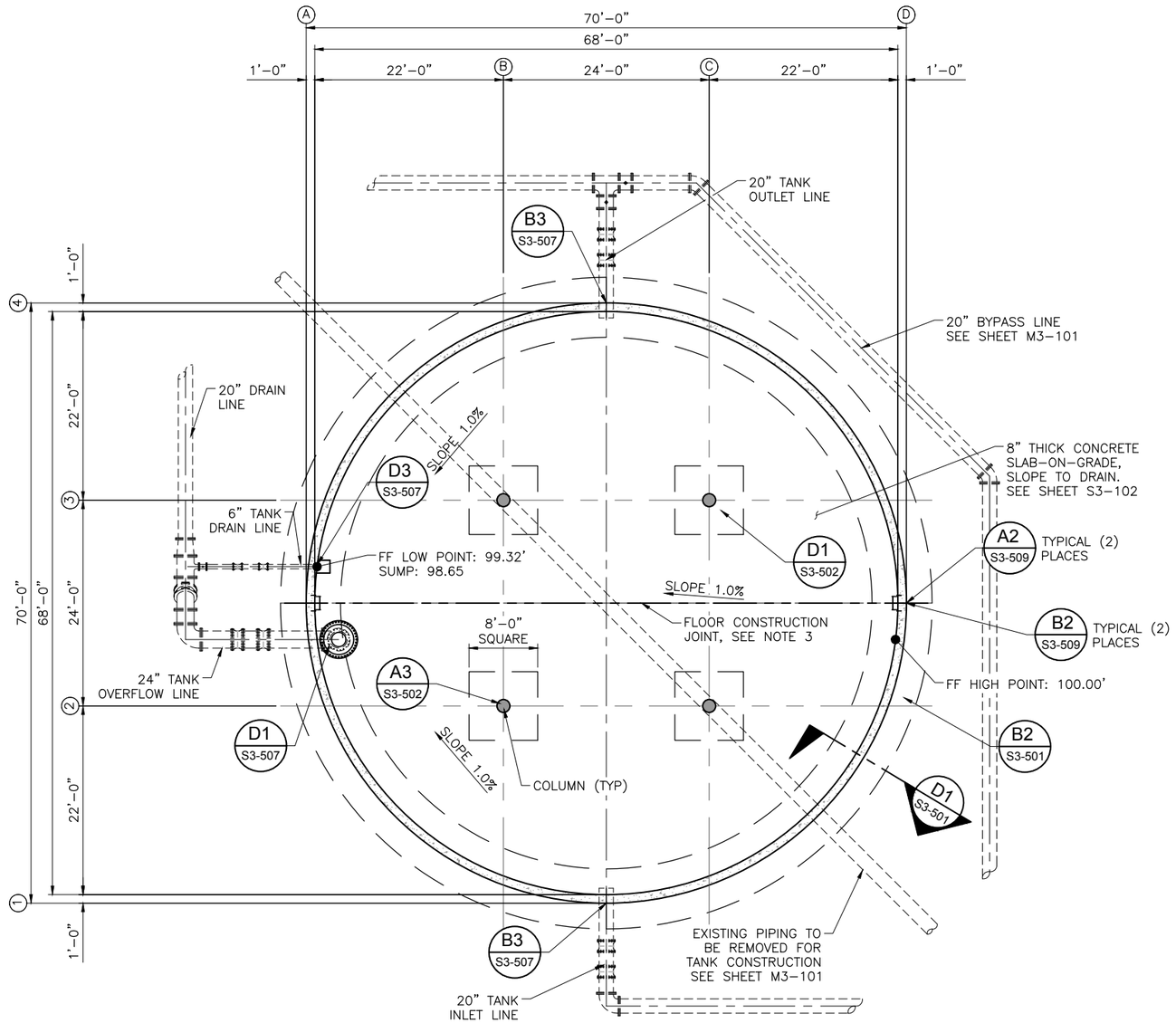
LAST UPDATED: 8/23/2018

SHEET NUMBER:
S3-002

Plot Date:8/23/2018 8:56 PM Plotted By: Erick Christiansen
Date Created:8/9/2018 \\OREMFILES\PUBLIC\PROJECTS-JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S3-001X.DWG



TANK FLOOR/FOUNDATION PLAN

SCALE: 1/8" □ 1'-0"

TANK FLOOR AND FOOTING NOTES:

1. PLACE 6" MIN. OF FREE DRAINING GRANULAR MATERIAL AND GEOTEXTILE FABRIC BENEATH ENTIRE FOUNDATION. SEE SHEETS C3–601 AND S3–301. GRADATION PER SPECIFICATIONS.
2. CENTER FLOOR REINFORCING IN CONCRETE SLAB ON GRADE. BOTTOM BARS OF REINFORCING SHALL MAINTAIN 3" MINIMUM CLEAR FROM BOTTOM OF CONCRETE.
3. TANK FLOOR IS TO BE PLACED IN A MINIMUM OF TWO PLACEMENTS. IF CONSTRUCTION JOINT LOCATIONS ARE MODIFIED CONSTRUCTION JOINT LOCATIONS SHALL BE APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION. SEE THE TANK WALL FOOTING AND FLOOR SLAB CONSTRUCTION JOINT DETAIL (A2/S3–509).
4. FOR PIPING SEE SHEETS M3–101 AND C2–212.
5. ALL SURFACES, PIPING, MISCELLANEOUS METAL FABRICATIONS, AND RELATED COMPONENTS WITHIN THE TANK INTERIOR, OR IN CONTACT WITH WATER, SHALL BE NSF 61 APPROVED.

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BID ALTERNATIVE 3
FLOW CONTROL TANK FOUNDATION PLAN

FILE :	81-18-013_S-101X
JUB PROJ. # :	81-18-013
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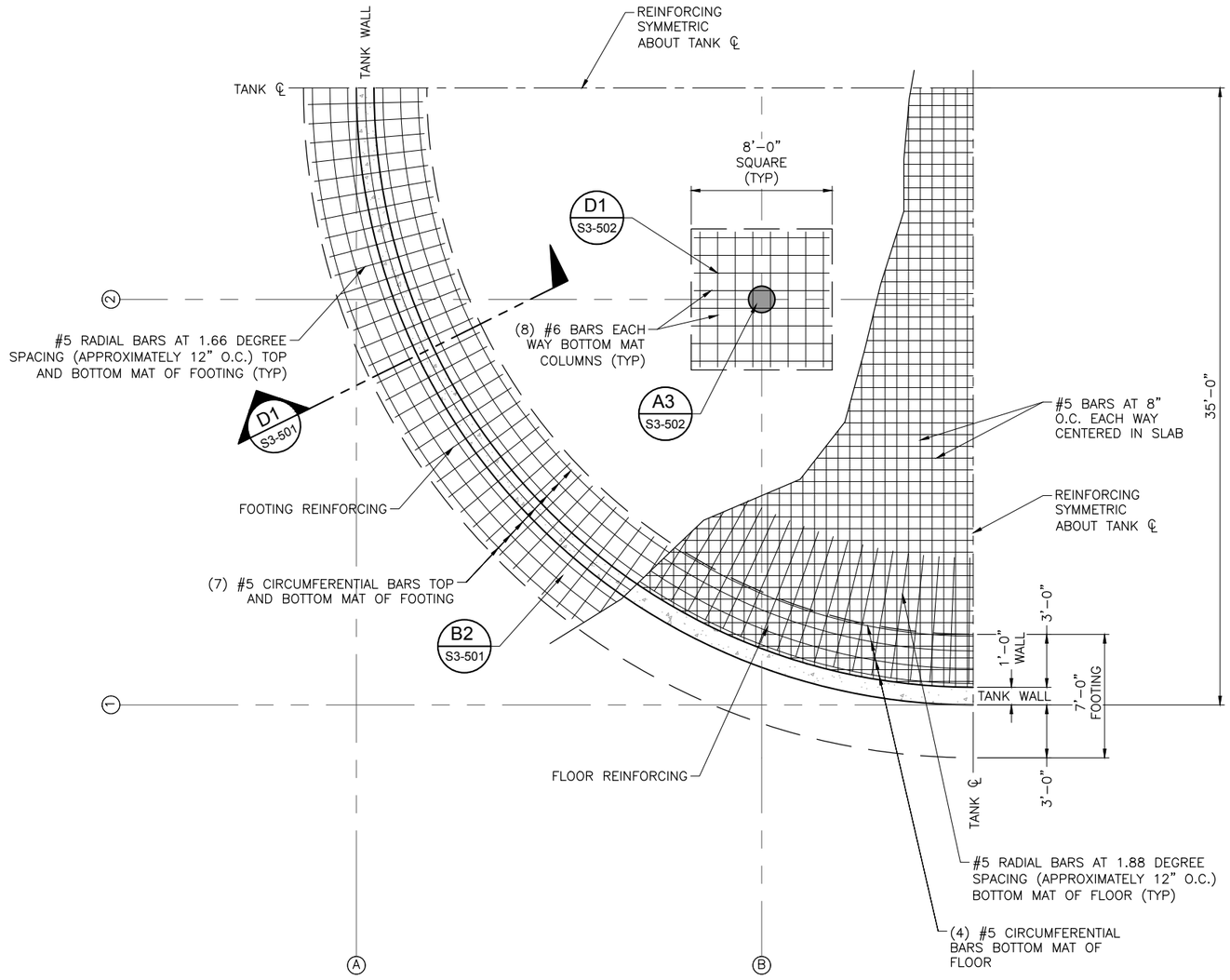
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY

LAST UPDATED: 8/23/2018

SHEET NUMBER:
S3-101

Plot Date:8/23/2018 8:59 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\OREMFILES\PUBLIC\PROJECTS\JUBGRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG



TANK FLOOR REINFORCING:

1. WALL AND COLUMN DOWELS NOT SHOWN FOR CLARITY.
2. FOOTING/FLOOR REINFORCEMENT IS SYMMETRICAL ABOUT TANK ℄.

TYPICAL FOUNDATION REINFORCING PLAN

SCALE: 1/4" □ 1-0"

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FLOW CONTROL TANK FOUNDATION REINFORCEMENT PLAN

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JUB PROJ. # : 81-18-013
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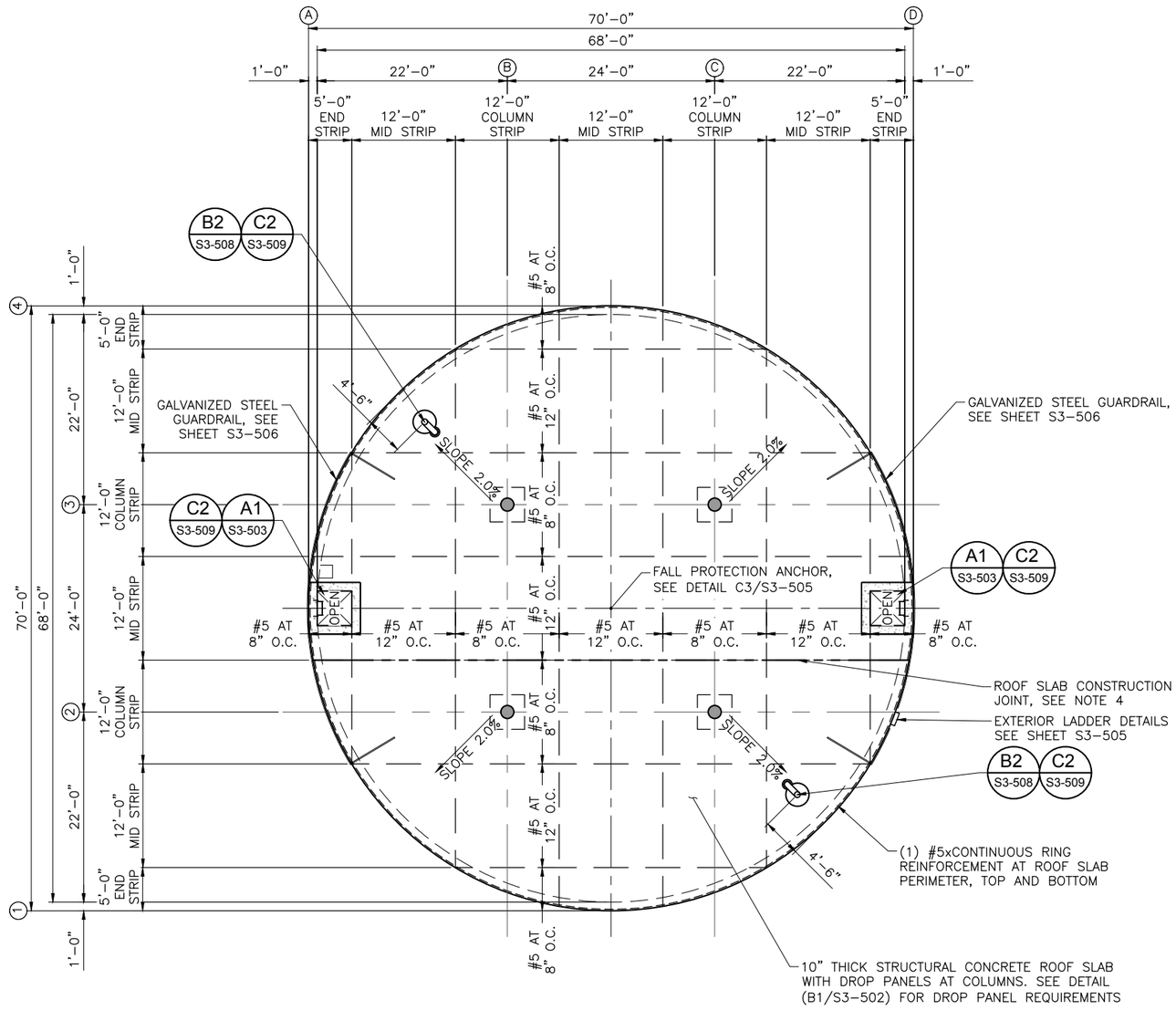
SHEET NUMBER:
S3-102

Plot Date:8/23/2018 8:59 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION, PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG



TANK ROOF NOTES:

1. REINFORCING STEEL IS SYMMETRICAL AROUND TANK.
2. BAR LAP LOCATIONS SHALL BE IN ACCORDANCE WITH ACI 350 SECTION 13 AND SECTIONS SHOWN ON SHEET S3–301.
3. #X @ XX" O.C. ◄► DENOTES BAR SIZE AND SPACING FOR BARS RUNNING IN THIS ↕ DIRECTION (PERPENDICULAR TO TEXT). BAR SIZE AND SPACING CHANGES WITH EACH NEW CALL OUT. SEE SHEET S3–301 FOR TOP AND BOTTOM STEEL SPLICE LOCATIONS.
4. ROOF SLAB CONSTRUCTION JOINT LOCATIONS ARE SHOWN. ANY ALTERNATE CONSTRUCTION JOINT LOCATIONS MUST BE APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION. SEE THE ROOF SLAB CONSTRUCTION JOINT DETAIL (B1/S3–509).
5. THE COLUMNS AND ROOF SLAB ARE TO BE PLACED SEPARATELY. THE DROP PANELS ARE TO BE PLACED WITH THE ROOF SLAB.
6. THE ROOF SLAB IS TO BE FORMED AND PLACED AS SHOWN IN THE PLANS AND SPECIFICATIONS AND SHALL MEET THE ALLOWABLE TOLERANCES GIVEN IN THE SPECIFICATIONS. ANY PONDING ON THE ROOF SLAB SHALL BE REPAIRED AT THE CONTRACTOR'S OWN EXPENSE.
7. ROOF SLAB SLOPES 2.0% FROM CENTER OUT TO EDGE OF TANK (TYP). CONTRACTOR TO SLOPE ROOF AROUND TANK ACCESSES TO ASSURE ROOF SLAB IS ABLE TO DRAIN.

ROOF REINFORCING PLAN - TOP AND BOTTOM MAT REINFORCING STEEL

SCALE: 1/8" □ 1=0"

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PURDY MESA FLOWLINE REPLACEMENT
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BID ALTERNATIVE 3
FLOW CONTROL TANK ROOF REINFORCEMENT PLAN

FILE :	81-18-013_S-101X
JUB PROJ. # :	81-18-013
DRAWN BY:	JMM
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LAST UPDATED: 8/23/2018

SHEET NUMBER:
S3-103

Plot Date:8/23/2018 8:59 PM Plotted By: Erick Christiansen
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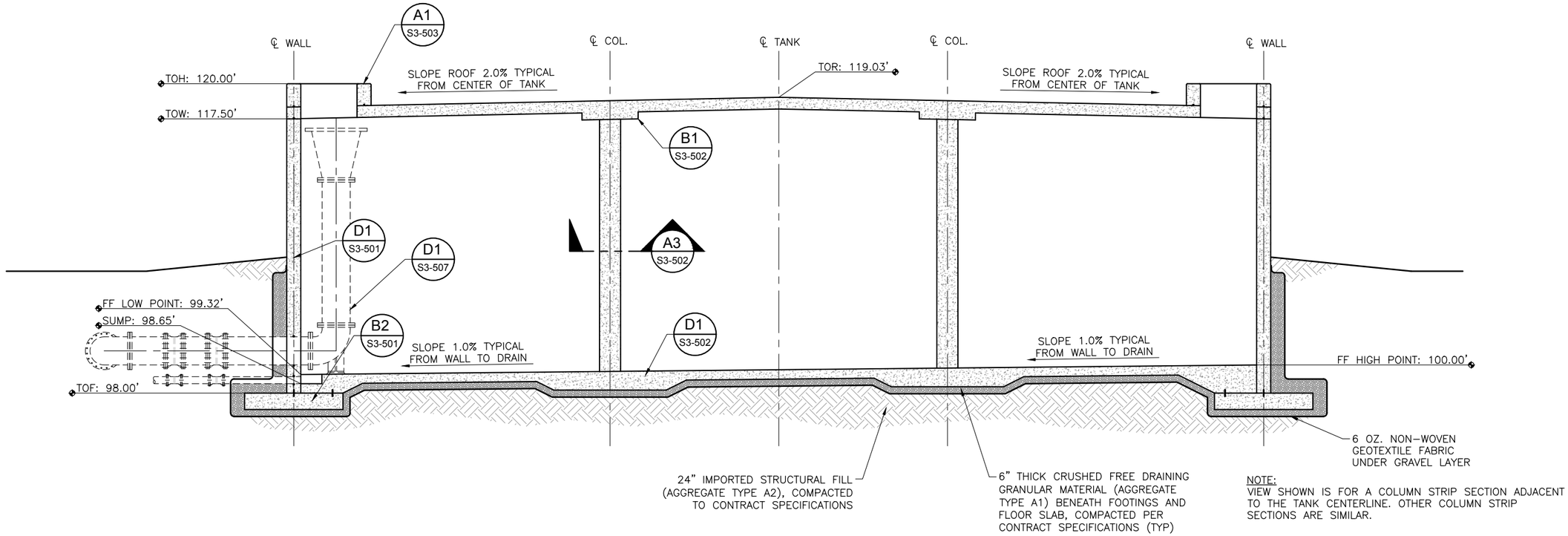
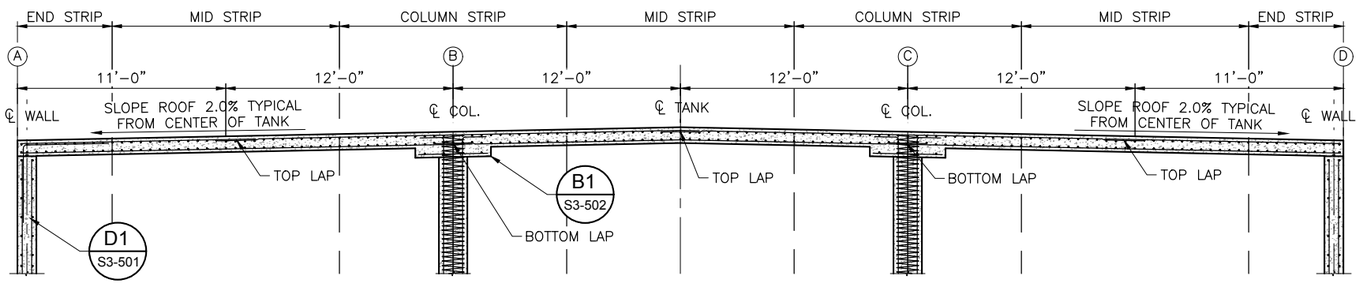


NOTE:
VIEW SHOWN IS FOR A COLUMN STRIP SECTION ADJACENT TO THE TANK CENTERLINE. OTHER COLUMN STRIP SECTIONS ARE SIMILAR.

B1 TYPICAL TANK SECTION
SCALE: 1/4" = 1'-0"



NOTES:
1. SECTION SHOWN IS FOR TYPICAL COLUMN STRIPS AND IS INTENDED TO CLARIFY ACCEPTABLE LAP LOCATIONS FOR TANK ROOF REINFORCEMENT. OTHER COLUMN STRIPS AND MIDDLE STRIPS ARE SIMILAR.
2. REFER TO ROOF REINFORCING PLAN, SHEET S3–103 FOR REINFORCEMENT REQUIREMENTS.
3. BOTTOM BARS SHALL BE 2" CLEAR AT BOTTOM OF SLAB, AND TOP BARS SHALL BE 2" CLEAR AT TOP OF SLAB.
4. ALL BARS IN THE SAME DIRECTION IN THE SAME LAYER (TOP AND BOTTOM) SHALL BE IN THE SAME PLANE. DO NOT WEAVE REINFORCEMENT.
5. IF REINFORCEMENT BAR IS CONTINUOUS ACROSS ADJACENT SPANS, NO LAP IS REQUIRED. IF LAPS ARE NEEDED, THEY MUST BE MADE AT THE LOCATIONS SHOWN. DIMENSIONS SHOWN ARE TO THE CENTER OF THE LAP.

D1 TYPICAL ROOF SLAB REINFORCEMENT SECTION
SCALE: 1/4" = 1'-0"

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PURDY MESA FLOWLINE REPLACEMENT
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BID ALTERNATIVE 3
TANK AND ROOF SLAB REINFORCEMENT SECTIONS

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JUB PROJ. # : 81-18-013
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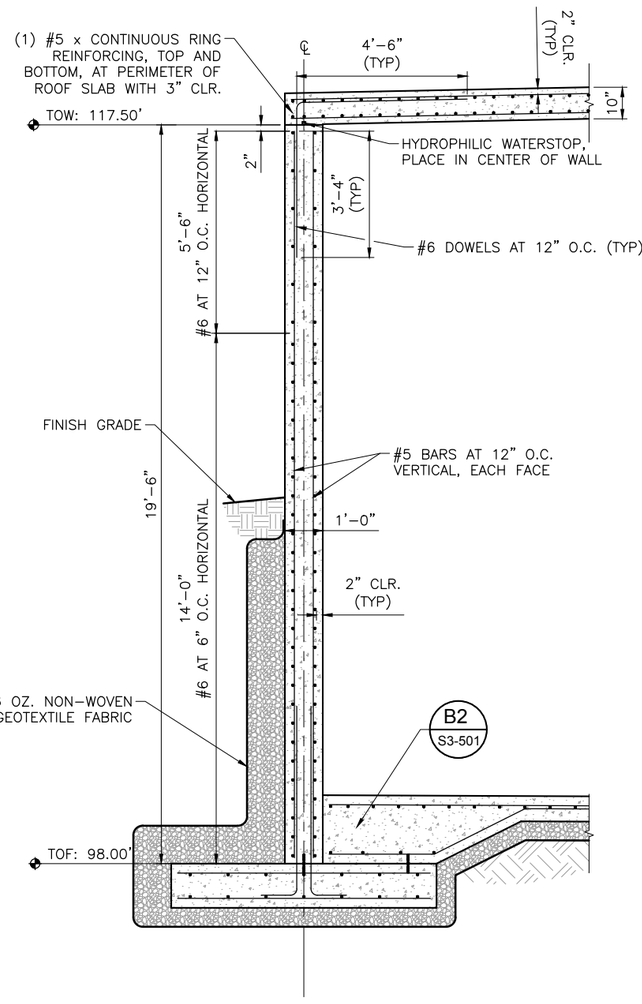
LAST UPDATED: 8/23/2018

SHEET NUMBER:
S3-301

Plot Date:8/23/2018 9:00 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\OREMFILES\PUBLIC\PROJECTS-JUB\GRAND_JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG

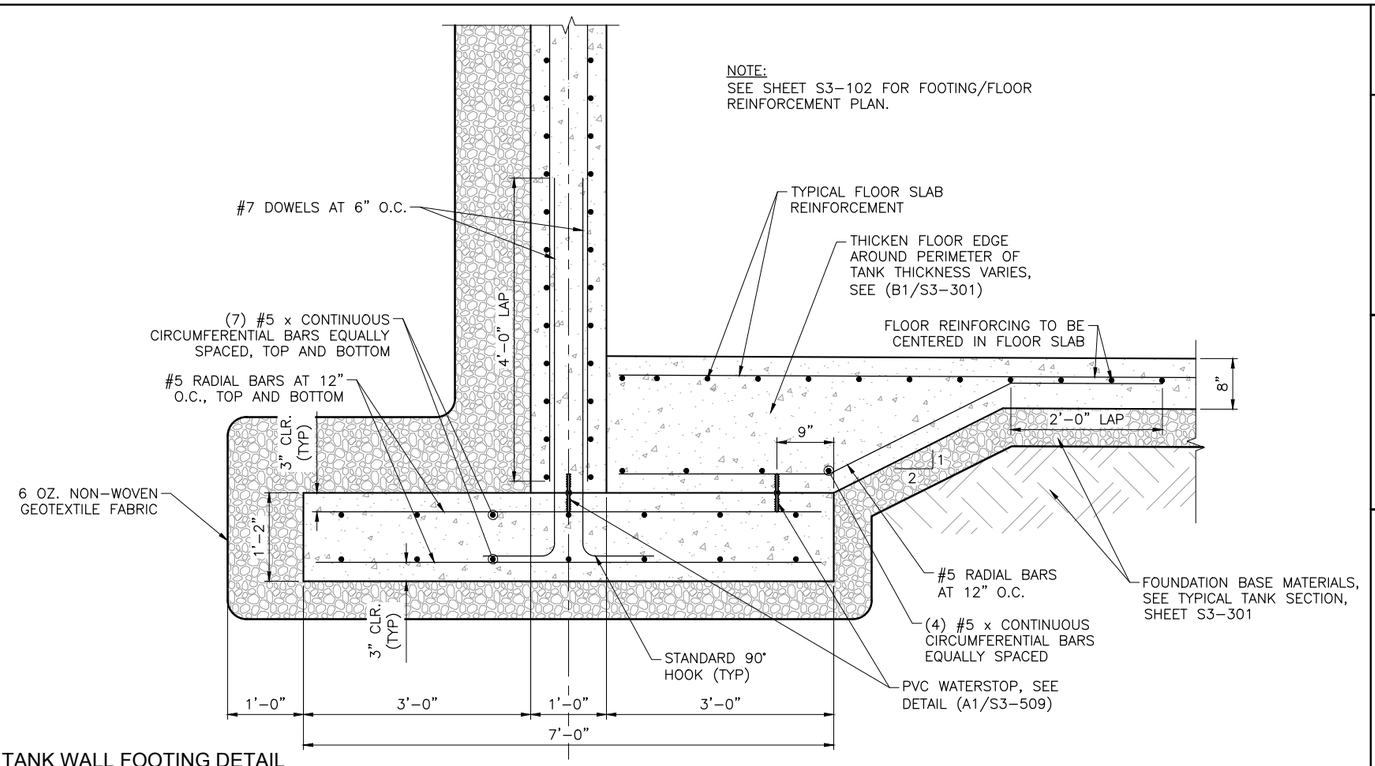
WALL NOTES:

1. THE BOTTOM 2 INCHES OF WALL IS TO BE PLACED WITH GROUT DURING WALL PLACEMENT, SEE SPECIFICATIONS.
2. FORM WORK TOLERANCES SHALL CONFORM TO ACI 347, STANDARD PRACTICE FOR CONCRETE WORK. IN NO CASE SHALL THE FINISHED CONCRETE WALL BE OUT OF PLUMB BY MORE THAN ±⅜".
3. COMPACT BACKFILL AROUND TANK AS SPECIFIED. BRING UP THE BACKFILL AROUND THE TANK SYMMETRICALLY AND IN UNIFORM LIFTS.
4. FOR TANK EXCAVATION AND BACKFILL REQUIREMENTS SEE TYPICAL EXCAVATION AND BACKFILL DETAIL (D1/C3-601).
5. FOR WALL SPLICE REQUIREMENTS, SEE TYPICAL SPLICE DETAIL (B3/S3-509).
6. SEE DETAIL (C1/S3-509) FOR FORM TIE THROUGH BOLT SEAL DETAIL.



D1 TYPICAL TANK WALL SECTION
SCALE:NOT TO SCALE

NOTE:
SEE SHEET S3-102 FOR FOOTING/FLOOR REINFORCEMENT PLAN.



B2 TYPICAL TANK WALL FOOTING DETAIL
SCALE:NOT TO SCALE

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PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
TANK WALL AND FOOTING DETAILS

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JUB PROJ. # : 81-18-013
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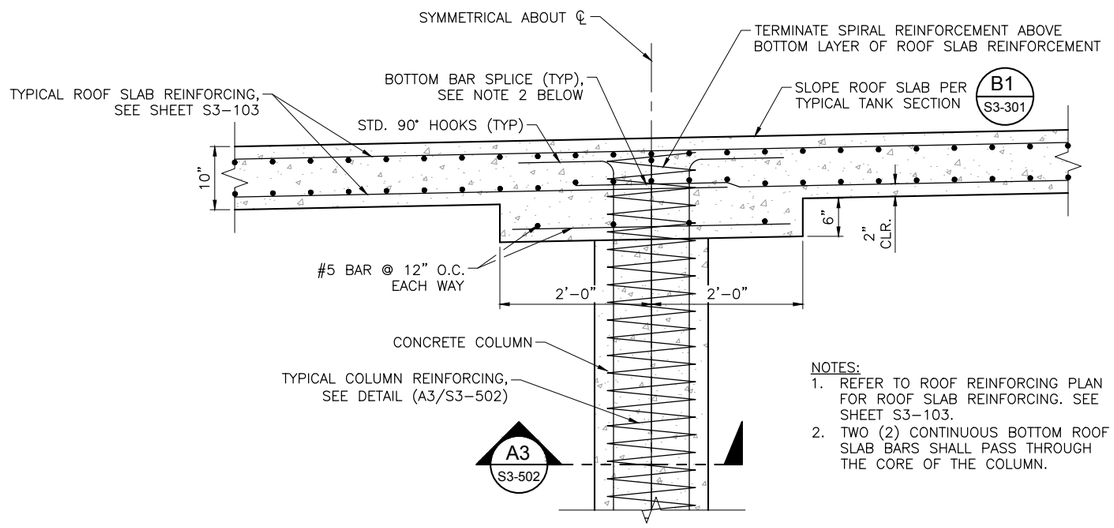
LAST UPDATED: 8/23/2018

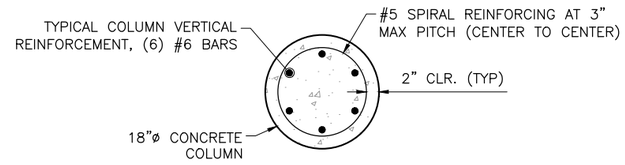
SHEET NUMBER:
S3-501

Plot Date:8/23/2018 9:01 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION, PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG

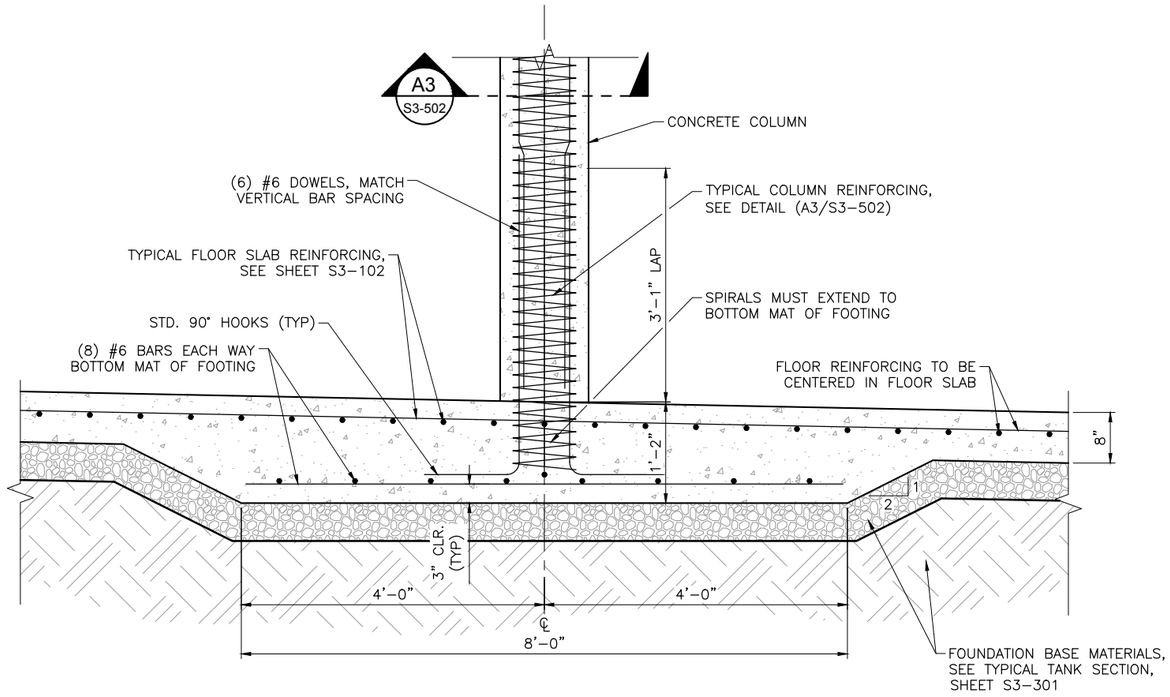


NOTES:
1. REFER TO ROOF REINFORCING PLAN FOR ROOF SLAB REINFORCING. SEE SHEET S3–103.
2. TWO (2) CONTINUOUS BOTTOM ROOF SLAB BARS SHALL PASS THROUGH THE CORE OF THE COLUMN.

B1 TYPICAL TANK COLUMN TO ROOF CONNECTION DETAIL
SCALE:NOT TO SCALE



A3 TYPICAL COLUMN SECTION
SCALE:NOT TO SCALE



D1 TYPICAL TANK COLUMN FOOTING DETAIL
SCALE:NOT TO SCALE

J-U-B ENGINEERS, INC.
J-U-B ENGINEERS, INC.
305 Main Street
Palisade, CO 81526
Phone: 970.208.8508
www.jub.com

BID SET

COLORADO REGISTERED STEPHEN E. KINNEY 48706 PROFESSIONAL ENGINEER

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NO.	DESCRIPTION	BY	APR.	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
TANK COLUMN DETAILS

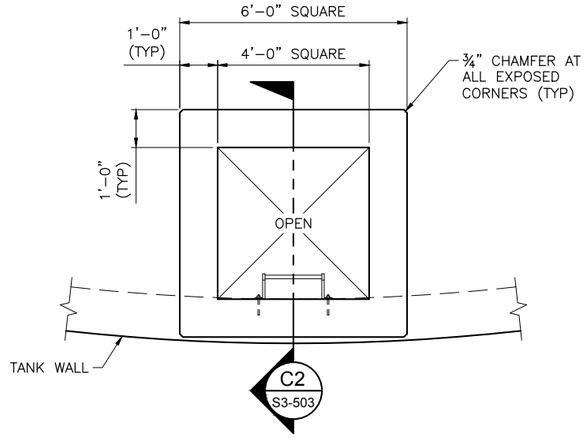
FILE :	81-18-013_S-101X
JUB PROJ. # :	81-18-013
DRAWN BY:	JMM
DESIGN BY:	----
CHECKED BY:	----

ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY

LAST UPDATED: 8/23/2018

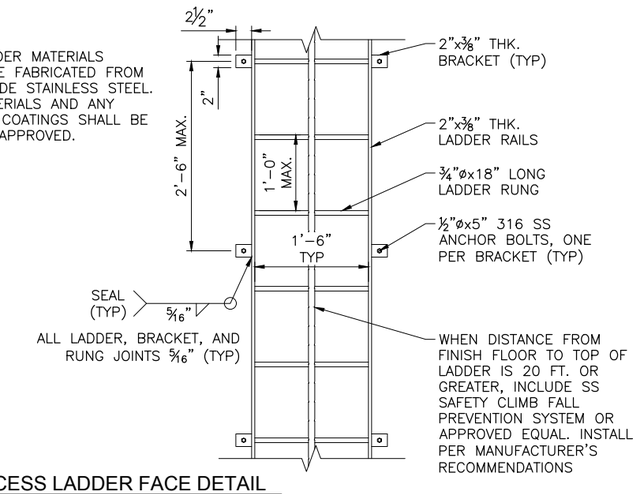
SHEET NUMBER:
S3-502

Plot Date:8/23/2018 9:02 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\GREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG



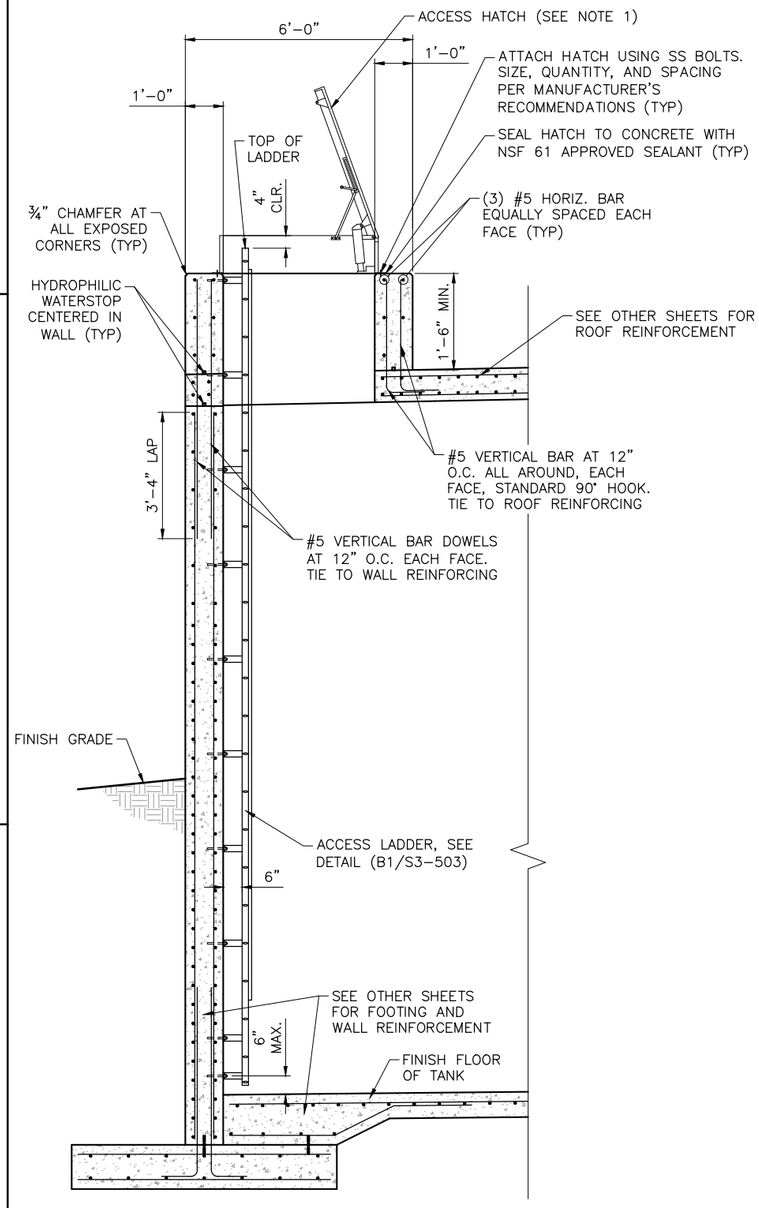
A1 4'x4' ACCESS HATCH
SCALE:NOT TO SCALE

NOTE:
ALL LADDER MATERIALS SHALL BE FABRICATED FROM 316 GRADE STAINLESS STEEL. ALL MATERIALS AND ANY APPLIED COATINGS SHALL BE NSF 61 APPROVED.



B1 ACCESS LADDER FACE DETAIL
SCALE:NOT TO SCALE

NOTES:
1. 4'x4' BILCO "F-50" ALUMINUM ROOF HATCH OR APPROVED EQUAL. OMIT STANDARD LOCK ASSEMBLY AND PROVIDE CONCEALED PADLOCK HASP. ALL HARDWARE TO BE STAINLESS STEEL AND CURB TO BE FULLY ENCLOSED. PROVIDE A CLOSE FITTING SOLID SHOE BOX TYPE COVER WHICH EXTENDS DOWN AROUND THE FRAME AT LEAST 2 INCHES AND IS FURNISHED WITH A GASKET BETWEEN THE LID AND FRAME.
2. ALL LADDER MATERIALS SHALL BE FABRICATED FROM 316 GRADE STAINLESS STEEL. ALL MATERIALS AND ANY APPLIED COATINGS SHALL BE NSF 61 APPROVED.
3. SEE TYPICAL TANK SECTION ON SHEET S3-301 FOR TANK ELEVATIONS.



C2 ACCESS HATCH AND LADDER SECTION
SCALE:NOT TO SCALE

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STEPHEN E. ROBERTS
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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

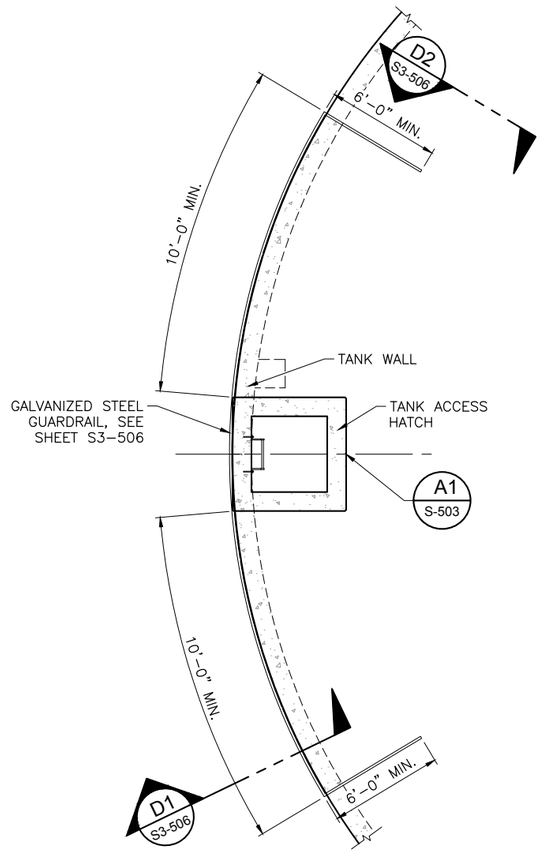
PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
TANK ACCESS HATCH AND LADDER DETAILS

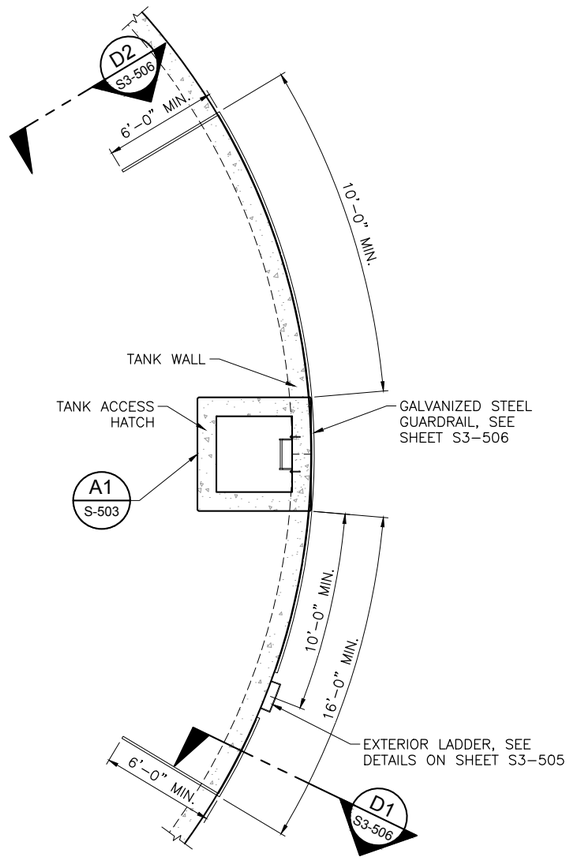
FILE : 81-18-013_S-101X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/23/2018

SHEET NUMBER:
S3-503

Plot Date:8/23/2018 9:02 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\GREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG



D1 SOUTHWEST SIDE TANK GUARDRAIL PLAN
SCALE: NOT TO SCALE



D2 NORTHEAST SIDE TANK GUARDRAIL PLAN
SCALE: NOT TO SCALE

Plot Date: 8/23/2018 9:03 PM Plotted By: Erick Christiansen
Date Created: 8/16/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG

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48706
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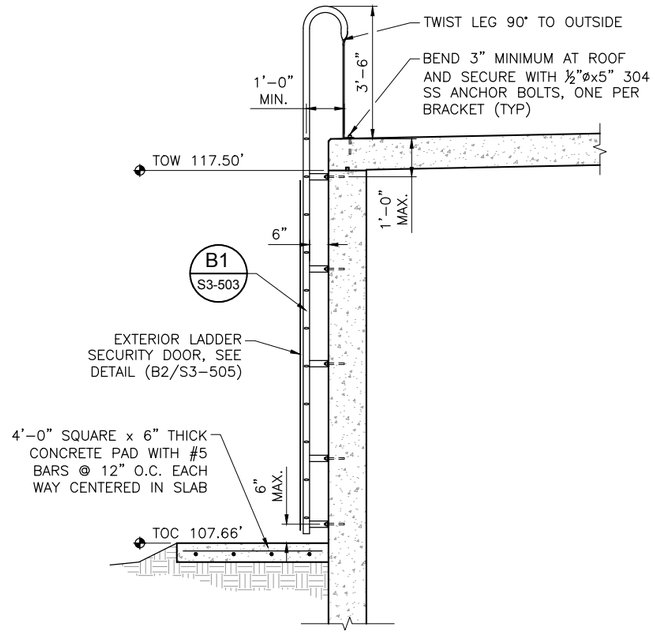
NO.	DESCRIPTION	BY	APR.	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
GUARDRAIL PLAN

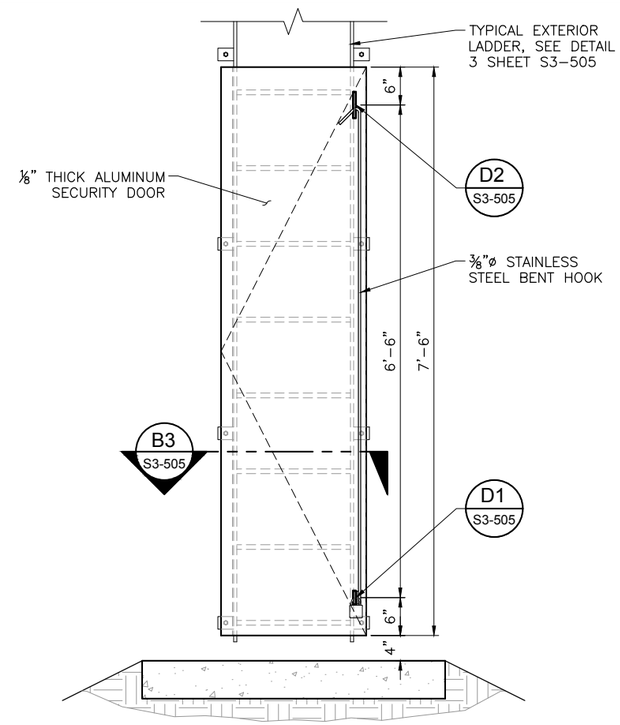
FILE : 81-18-013_S-101X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/23/2018

SHEET NUMBER:
S3-504



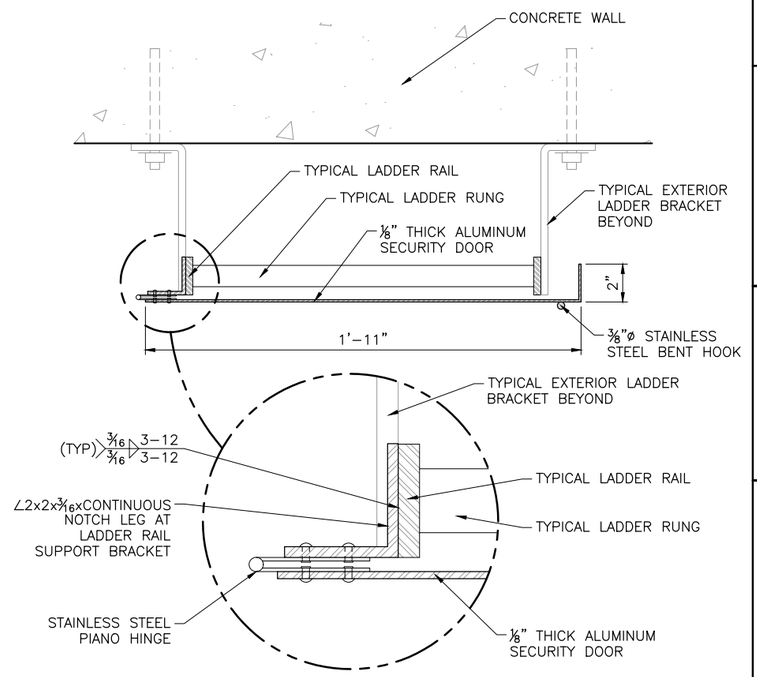
B1 EXTERIOR LADDER SECTION

SCALE: 1/4" □ 1=0"



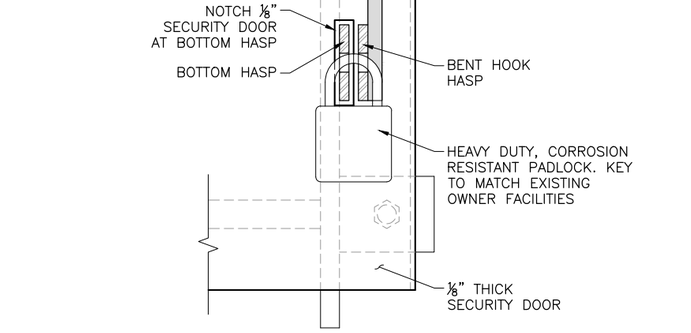
B2 EXTERIOR LADDER SECURITY DOOR DETAIL

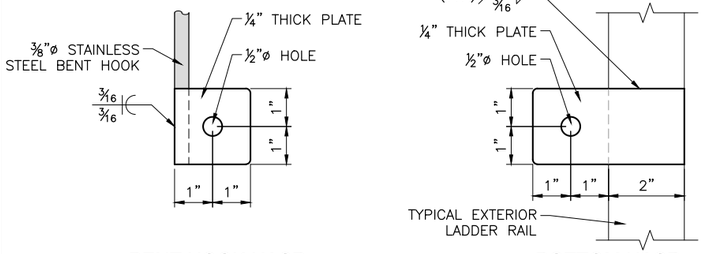
SCALE: 1/2" □ 1=0"



B3 EXTERIOR LADDER SECURITY DOOR SECTION

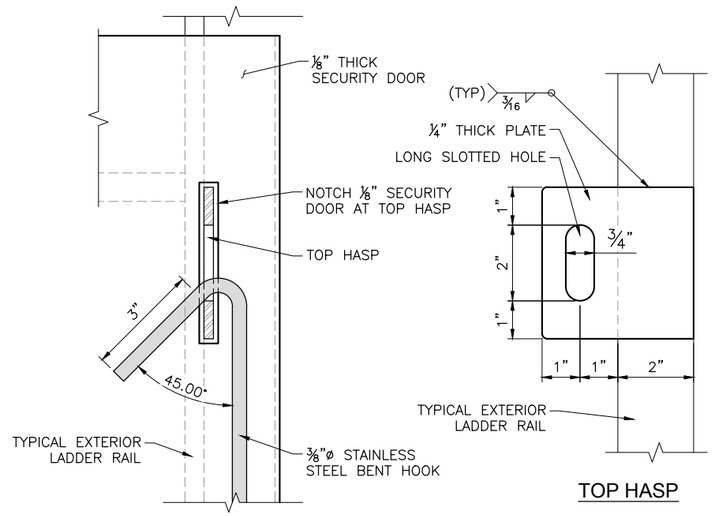
SCALE: 1 1/2" □ 1=0"





D1 BOTTOM HASP DETAIL

SCALE: 3" □ 1=0"

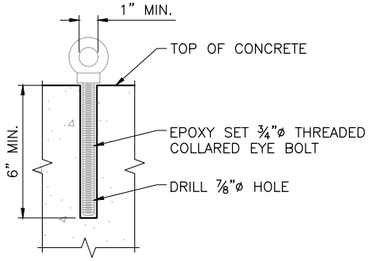


D2 TOP HASP DETAIL

SCALE: 3" □ 1=0"

NOTES:

1. USE 316 GRADE STAINLESS STEEL COLLARED EYE BOLTS (fy = 75 ksi MIN.) AND CLIPS CONFORMING TO ASME B18.15.
2. USE STRUCTURAL EPOXY IN ACCORDANCE WITH ACI 318 APPENDIX D, ACI 355.2. CURRENT ICC CERTIFICATION REQUIRED. USE SIMPSON SET–XP, HILTI RE–500 SD, POWERS PE 100+ OR APPROVED EQUAL.



C3 FALL PROTECTION ANCHOR DETAIL

SCALE: NOT TO SCALE

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Palisade, CO 81526
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STEPHEN E. ROBERTS
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NO.	DESCRIPTION	BY	APR	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
EXTERIOR LADDER DETAILS

FILE :	81-18-013_S-101X
JUB PROJ. # :	81-18-013
DRAWN BY:	JMM
DESIGN BY:	----
CHECKED BY:	----

ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY

LAST UPDATED: 8/23/2018

SHEET NUMBER:

S3-505

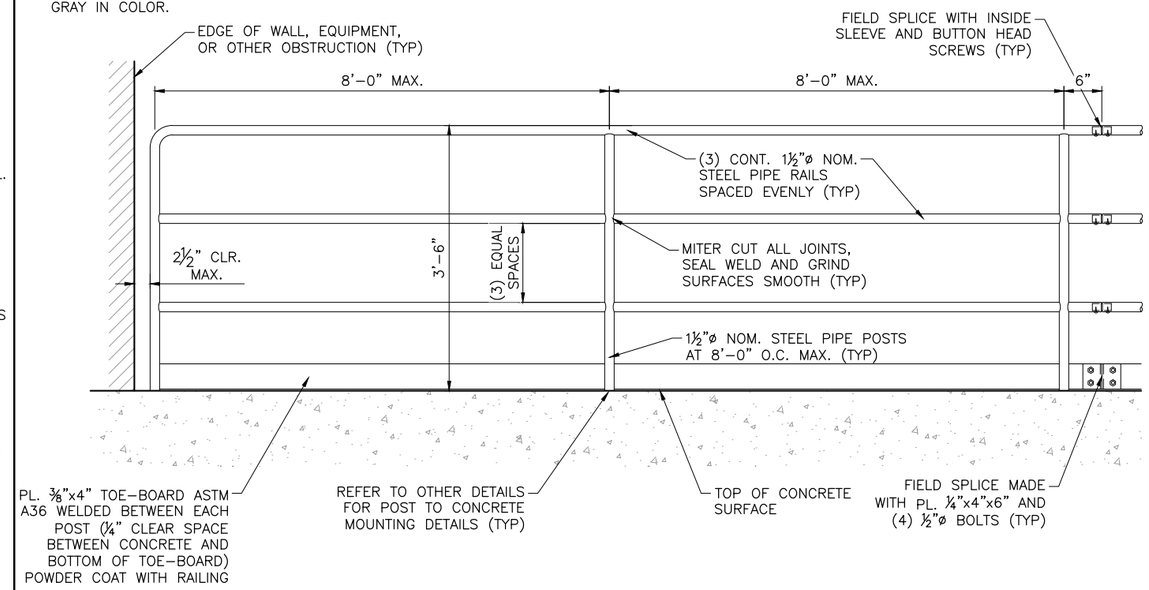
Plot Date:8/23/2018 9:05 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG

GENERAL CONSTRUCTION NOTES FOR GALVANIZED STEEL FABRICATIONS

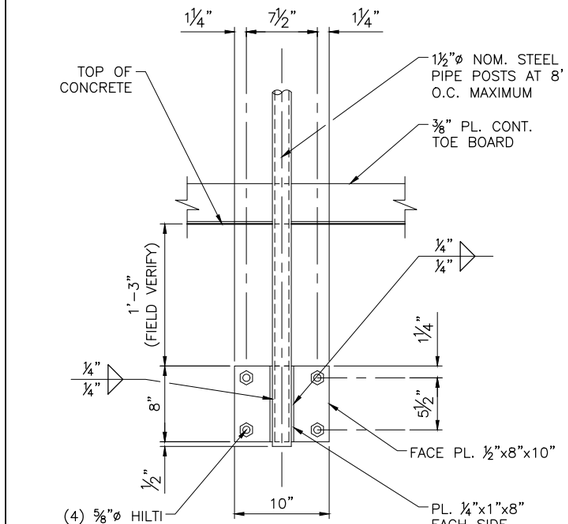
1. STEEL PIPE TO BE ASTM A53 GRADE B STEEL WITH Fy = 35 KSI
2. STEEL PLATE, CHANNELS, AND ANGLES TO BE ASTM A36 STEEL WITH Fy = 36 KSI
3. ALL WELDING TO CONFORM TO CURRENT AWS D1.1 REQUIREMENTS.
4. COMPLETE ASSEMBLY OR SUB-ASSEMBLIES, BRACKETS, RAILING, AND MISCELLANEOUS STEEL PIECES SHALL BE HOT-DIP GALVANIZED AFTER FABRICATION.
5. STRUCTURAL BOLTS, NUTS & WASHERS SHALL BE HOT-DIP GALVANIZED OR STAINLESS STEEL.
6. EXPANSION ANCHORS TO BE HILTI KWIK-BOLT II OR APPROVED EQUAL. INSTALL EXPANSION ANCHORS PER MANUFACTURER'S WRITTEN INSTRUCTIONS.
7. EXPANSION ANCHOR BOLTS, NUTS & WASHERS SHALL BE STAINLESS STEEL.
8. REFER TO OTHER DETAILS FOR CONCRETE REINFORCING REQUIREMENTS.
9. COORDINATE REBAR PLACEMENT IN CONCRETE TO MISS ANCHOR BOLTS AND INSERTS.
10. FIELD SPLICES SHALL BE MADE UTILIZING GALVANIZED STEEL PIPE SLEEVE INSERTS AND HOT-DIP GALVANIZED OR STAINLESS STEEL BOLTS, NUTS & WASHERS.
11. GALVANIZED AREAS THAT ARE DAMAGED DURING CONSTRUCTION SHALL BE REPAIRED WITH AN APPROVED COLD-GALVANIZING COMPOUND.
12. EPOXY SET ANCHORS SHALL UTILIZE HILTI HIT HY 150 CONSTRUCTION ADHESIVE AND HAS GALVANIZED OR STANLESS STEEL THREAD RODS.
13. CROSS REFERENCE ASSOCIATED STANDARD DETAILS AS NECESSARY FOR STEEL FABRICATIONS.

B1 GENERAL NOTES FOR GALVANIZED STEEL FABRICATIONS
SCALE:NOT TO SCALE

NOTE:
1. REFER TO GENERAL CONSTRUCTION NOTES FOR GALVANIZED STEEL FABRICATIONS.
2. ALL RAILING COMPONENTS TO BE POWDER COATED GRAY IN COLOR.

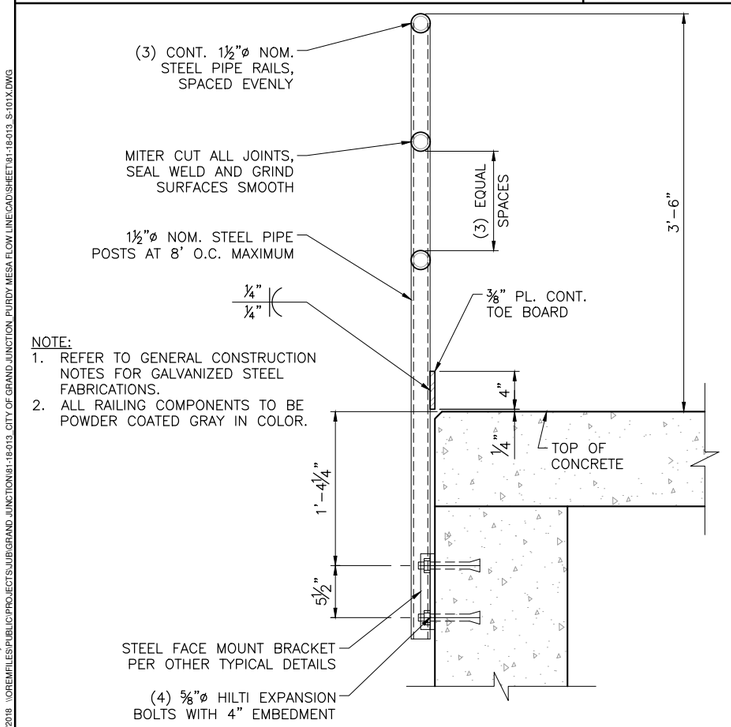


B2 TYPICAL GALVANIZED STEEL GUARDRAIL
SCALE:NOT TO SCALE



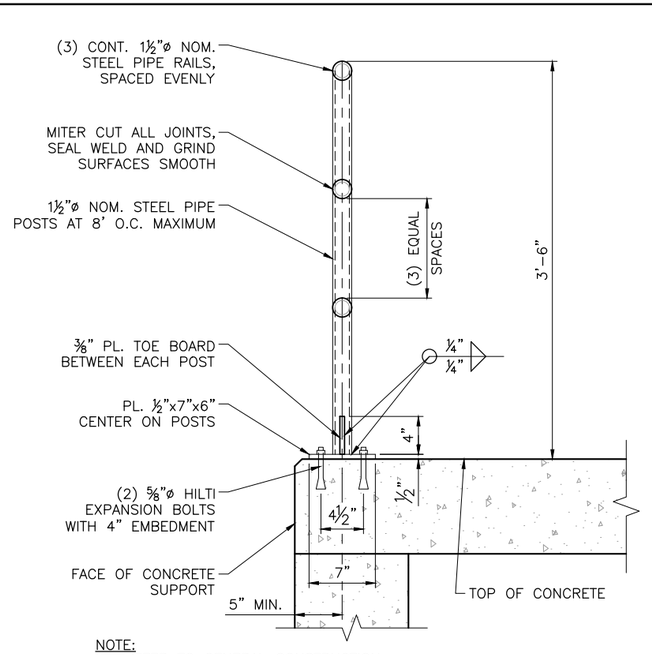
NOTE:
1. REFER TO GENERAL CONSTRUCTION NOTES FOR GALVANIZED STEEL FABRICATIONS.
2. ALL RAILING COMPONENTS TO BE POWDER COATED GRAY IN COLOR.

B4 TYPICAL WALL BRACKET FOR VERTICAL SURFACE RAIL MOUNTING DETAIL
SCALE:NOT TO SCALE



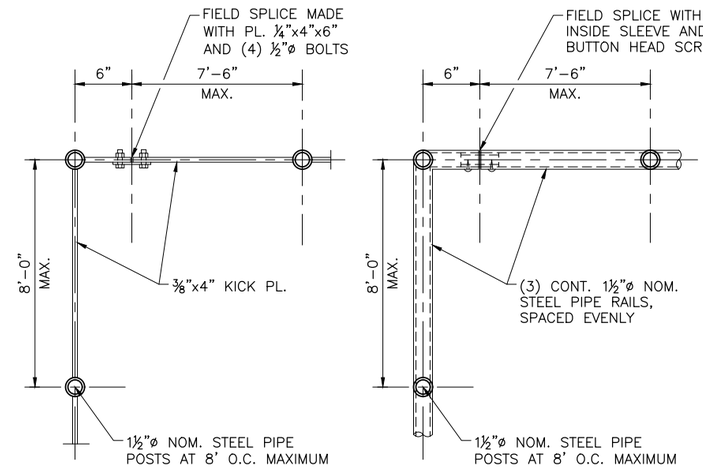
NOTE:
1. REFER TO GENERAL CONSTRUCTION NOTES FOR GALVANIZED STEEL FABRICATIONS.
2. ALL RAILING COMPONENTS TO BE POWDER COATED GRAY IN COLOR.

D1 TYPICAL VERTICAL SURFACE MOUNT STEEL RAILING DETAIL
SCALE:NOT TO SCALE



NOTE:
1. REFER TO GENERAL CONSTRUCTION NOTES FOR GALVANIZED STEEL FABRICATIONS.
2. ALL RAILING COMPONENTS TO BE POWDER COATED GRAY IN COLOR.

D2 TYPICAL HORIZONTAL SURFACE MOUNT STEEL RAILING DETAIL
SCALE:NOT TO SCALE



NOTES:
1. REFER TO GENERAL CONSTRUCTION NOTES FOR GALVANIZED STEEL FABRICATIONS.
2. DETAIL IS SIMILAR FOR CORNER ANGLES OTHER THAN 90°.
3. ALL RAILING COMPONENTS TO BE POWDER COATED GRAY IN COLOR.

D3 TYPICAL GALVANIZED STEEL PIPE RAILING CORNER DETAILS
SCALE:NOT TO SCALE

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J-U-B ENGINEERS, INC.
305 Main Street
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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

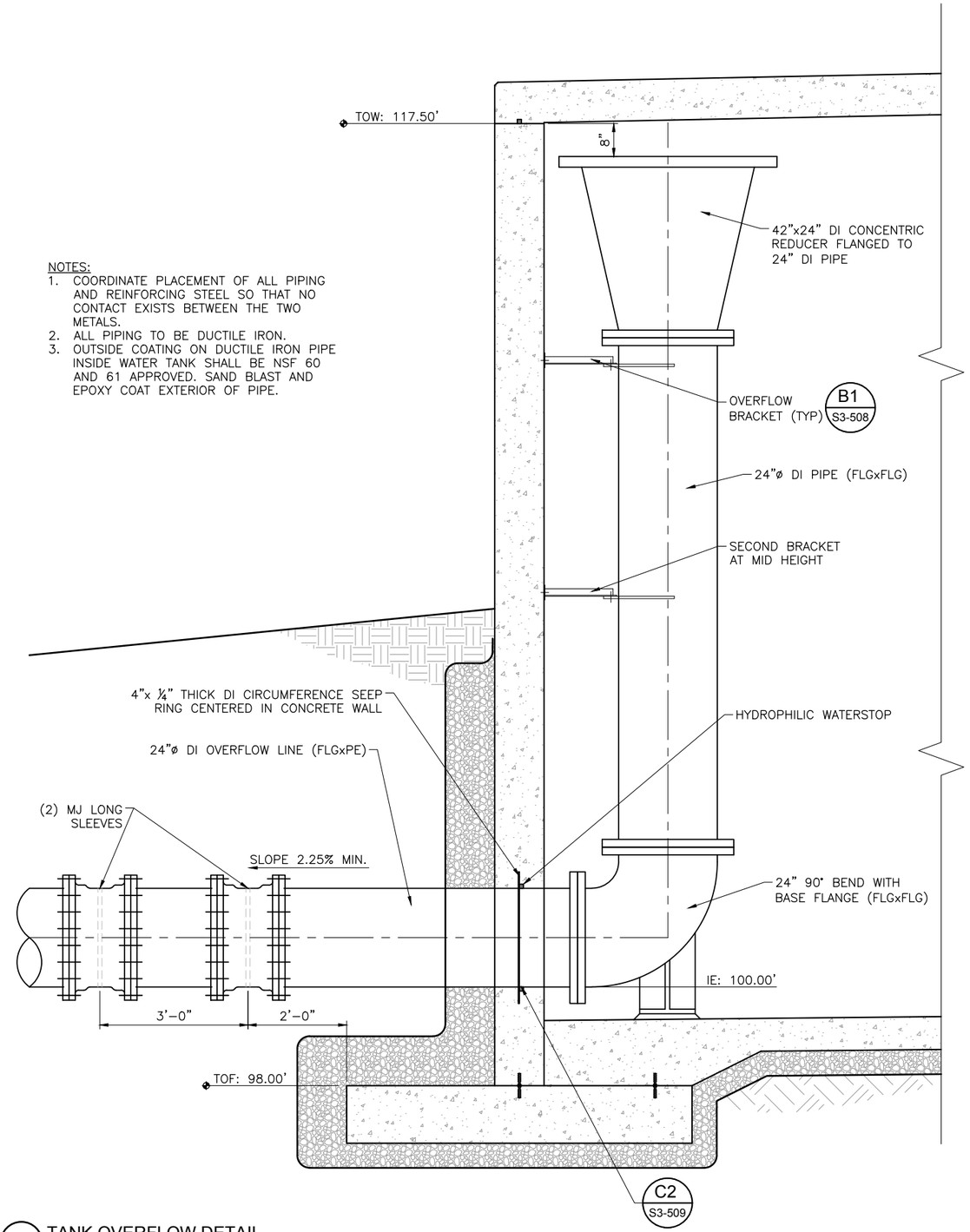
BID ALTERNATIVE 3
TYPICAL RAILING DETAILS

FILE : 81-18-013_S-101X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/23/2018

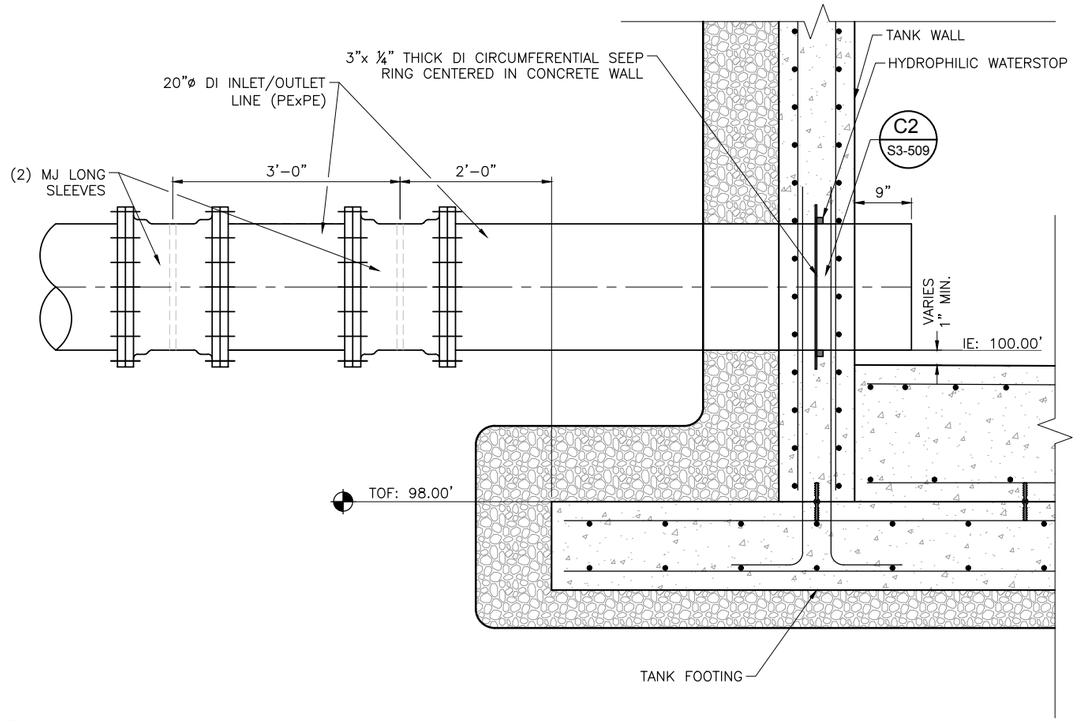
SHEET NUMBER:
S3-506

Plot Date:8/23/2018 9:06 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG

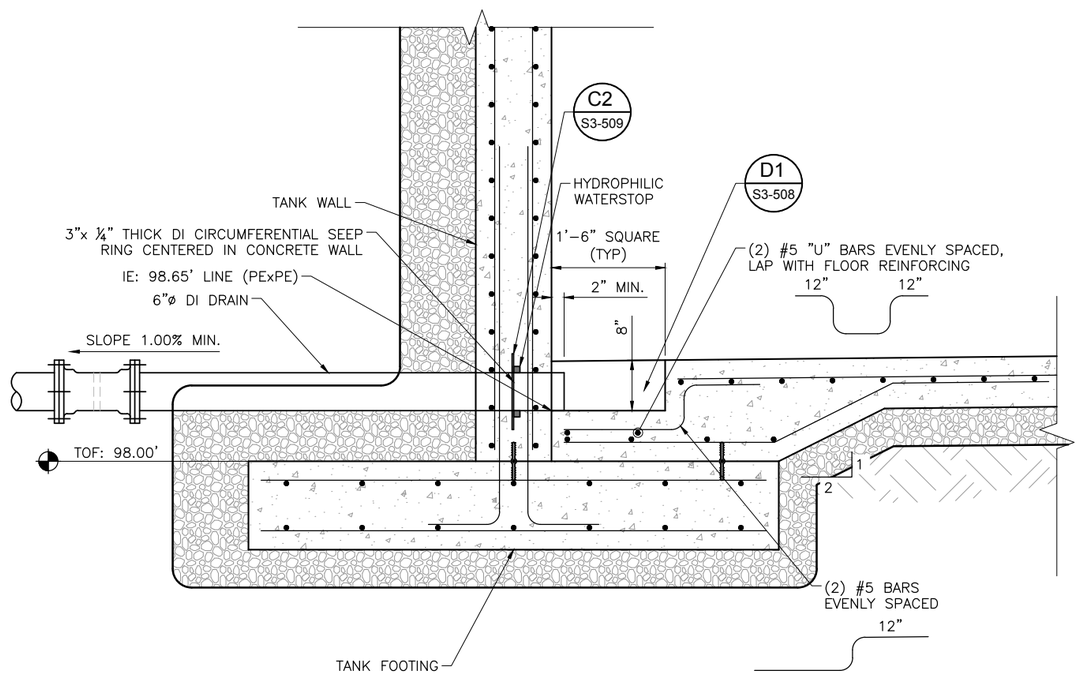
NOTES:
1. COORDINATE PLACEMENT OF ALL PIPING AND REINFORCING STEEL SO THAT NO CONTACT EXISTS BETWEEN THE TWO METALS.
2. ALL PIPING TO BE DUCTILE IRON.
3. OUTSIDE COATING ON DUCTILE IRON PIPE INSIDE WATER TANK SHALL BE NSF 60 AND 61 APPROVED. SAND BLAST AND EPOXY COAT EXTERIOR OF PIPE.



D1 TANK OVERFLOW DETAIL
SCALE:NOT TO SCALE



B3 TANK INLET/OUTLET DETAIL
SCALE:NOT TO SCALE



D3 TANK DRAIN DETAIL
SCALE:NOT TO SCALE

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	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
TANK PIPING DETAILS

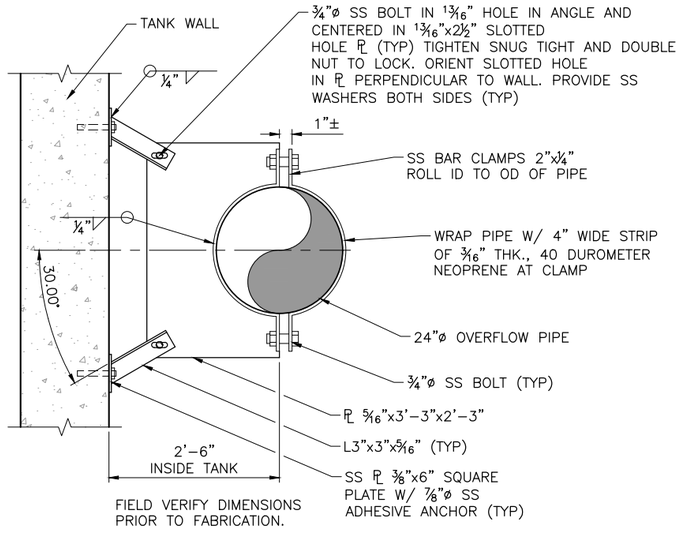
FILE :	81-18-013_S-101X
JUB PROJ. # :	81-18-013
DRAWN BY:	JMM
DESIGN BY:	----
CHECKED BY:	----

ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY

LAST UPDATED: 8/23/2018

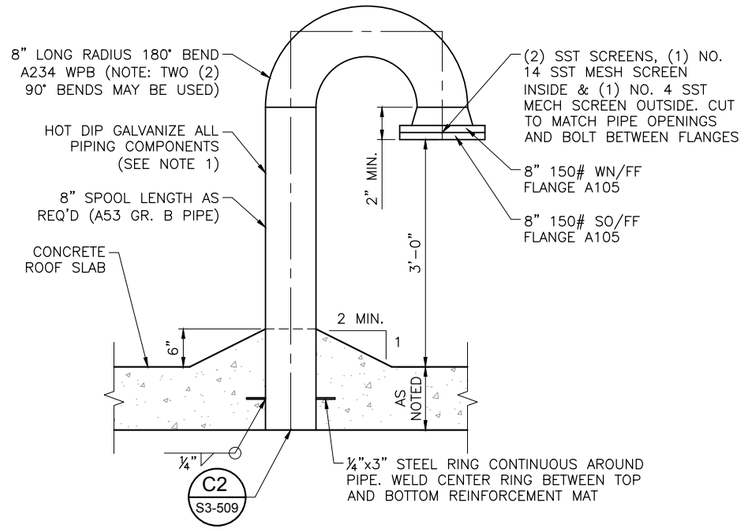
SHEET NUMBER:
S3-507

Plot Date:8/23/2018 9:07 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG



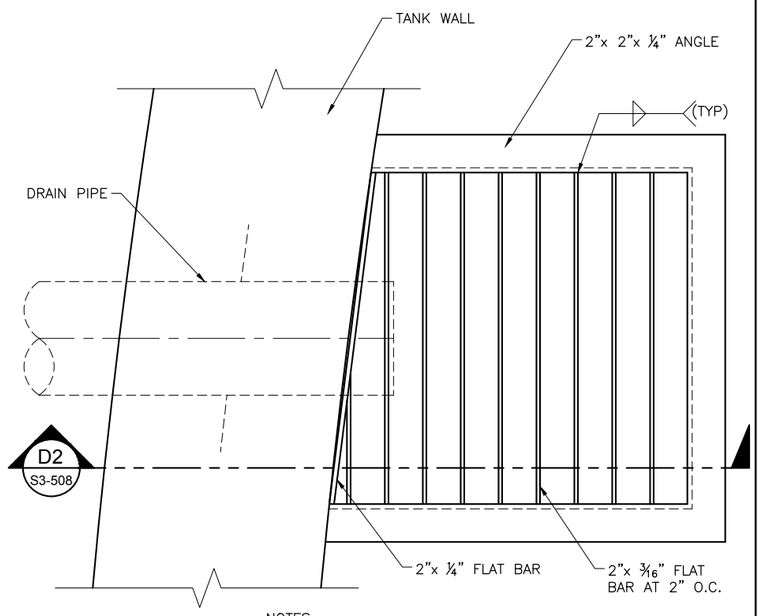
NOTES:
1. LOCATE BRACES TO BE CLEAR OF OPENING ABOVE. ADJUST OVERFLOW LOCATION IF NECESSARY.
2. FIELD LOCATE ANCHOR TO MISS REINFORCING BY 3" MIN (TYP EACH SIDE).
3. ALL BRACKET MATERIALS SHALL BE FABRICATED FROM 316 GRADE STAINLESS STEEL. ALL MATERIALS AND ANY APPLIED COATINGS SHALL BE NSF 61 APPROVED.

B1 OVERFLOW BRACKET DETAIL
SCALE:NOT TO SCALE



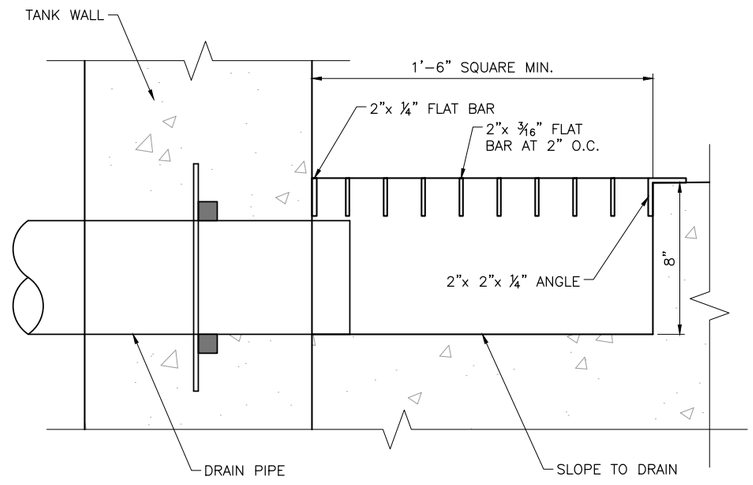
NOTES:
1. VENT PIPING SHALL BE HOT DIPPED GALVANIZED (INTERIOR AND EXTERIOR) TOUCH UP AFTER INSTALLATION USING NSF 61 APPROVED GALVANIC PAINT.
2. SLAB REINFORCEMENT NOT SHOWN FOR CLARITY, REFER TO OTHER DETAILS FOR REINFORCEMENT REQUIREMENTS.
3. REFER TO ROOF PLAN FOR VENT LOCATIONS.
4. STEEL PIPE SHALL BE MINIMUM STANDARD SCHEDULE 40 PIPE.
5. FLANGES SHALL BE WELD NECK AND SLIP-ON FLANGES RATED TO 150 LB. AS SHOWN ON DETAIL. USE SST BOLTS A182 TP304.

B2 AIR VENT DETAIL
SCALE:NOT TO SCALE



NOTES:
1. CONTRACTOR TO VERIFY DIMENSIONS PRIOR TO FABRICATION.
2. ALL SCREEN MATERIALS SHALL BE FABRICATED FROM 316 GRADE STAINLESS STEEL. ALL MATERIALS AND ANY APPLIED COATINGS SHALL BE NSF 61 APPROVED.

D1 SUMP SCREEN PLAN
SCALE:NOT TO SCALE



D2 SUMP SCREEN SECTION
SCALE:NOT TO SCALE

J-U-B ENGINEERS, INC.
J-U-B ENGINEERS, INC.
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Palisade, CO 81526
Phone: 970.208.8508
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STEPHEN E. KINNEY
48706

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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

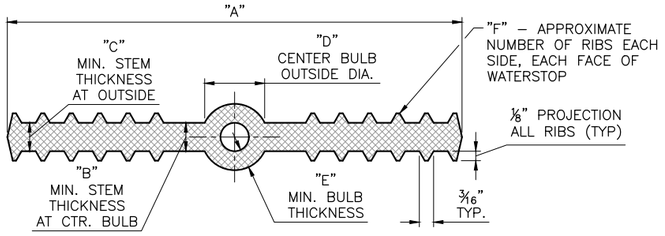
PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
TANK PIPING DETAILS

FILE : 81-18-013_S-101X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/23/2018

SHEET NUMBER:
S3-508

Plot Date:8/23/2018 9:07 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION, PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG

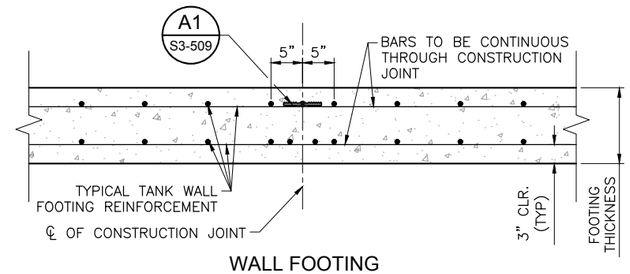


SIZE	A	B	C	D	E	F
6"x⅜"	6"	⅜"	⅜"	⅞"	¼"	6

NOTE:
SEE SECTION 03 15 16 OF THE SPECIFICATIONS FOR WATERSTOP REQUIREMENTS

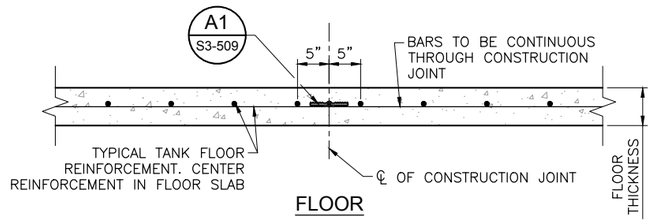
NOTES:
1. PROVIDE PREFABRICATED INTERSECTION PIECES AND FULLY WELD ALL WATERSTOP PIECES TOGETHER AT INTERSECTIONS PER MANUFACTURER'S REQUIREMENTS.
2. INSTALL WATERSTOP PER MANUFACTURER'S RECOMMENDATIONS. WATERSTOP SHALL BE ENVELOPED WITH CONCRETE FREE OF AIR POCKETS AND DEBRIS. PRIOR TO CONSTRUCTION, THE CONTRACTOR WILL DEMONSTRATE THE METHOD OF PLACEMENT OF THE CONCRETE AROUND THE WATERSTOP TO THE ENGINEER.

A1 PVC WATERSTOP DETAIL
SCALE:NOT TO SCALE



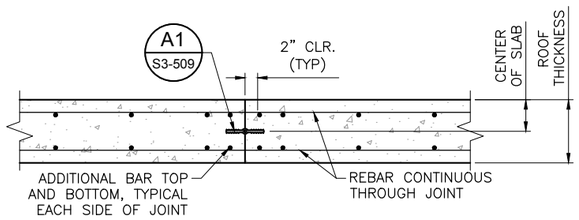
WALL FOOTING

NOTES:
1. MODIFICATIONS TO FLOOR SLAB CONSTRUCTION JOINT LOCATIONS MUST BE APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION.

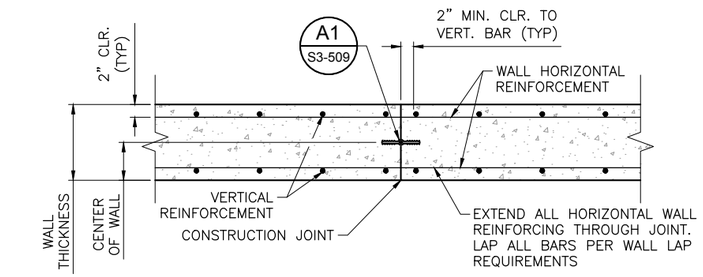


FLOOR

A2 TANK WALL FOOTING AND FLOOR SLAB CONSTRUCTION JOINT DETAIL
SCALE:NOT TO SCALE

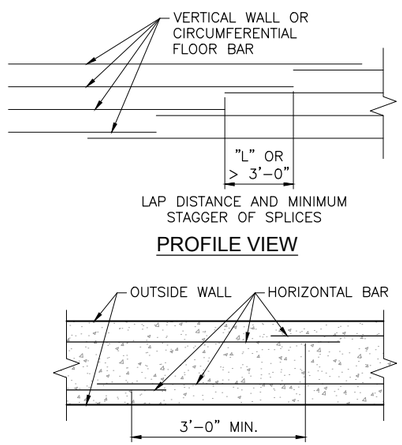


B1 TYPICAL ROOF SLAB CONSTRUCTION JOINT DETAIL
SCALE:NOT TO SCALE



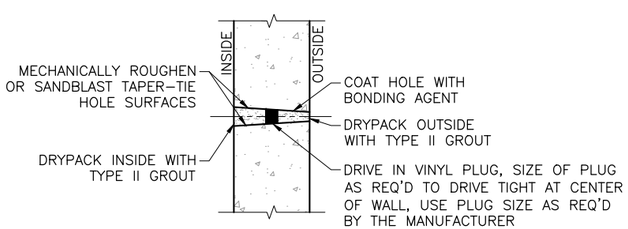
B2 TYPICAL TANK WALL VERTICAL CONSTRUCTION JOINT DETAIL
SCALE:NOT TO SCALE

NOTES:
1. USE SPLICE LENGTH ON DETAIL (B1/S3–510), UNLESS A SPECIFIC SPLICE LENGTH IS CALLED OUT ELSEWHERE ON THE PLANS.
2. SPLICES IN HORIZONTAL WALL REINFORCEMENT SHALL BE STAGGERED HORIZONTALLY (CENTER OF LAP BELOW TO CENTER OF LAP ABOVE) BY NO LESS THAN ONE LAP LENGTH NOR 3'–0" AND SHALL NOT COINCIDE IN VERTICAL ARRAYS MORE FREQUENTLY THAN EVERY THIRD BAR.
3. HORIZONTAL WALL SPLICES ON EACH FACE IN THE SAME HORIZONTAL PLANE SHALL BE SEPARATED HORIZONTALLY BY NOT LESS THAN ONE LAP LENGTH NOR 3'–0" FROM CENTER TO CENTER



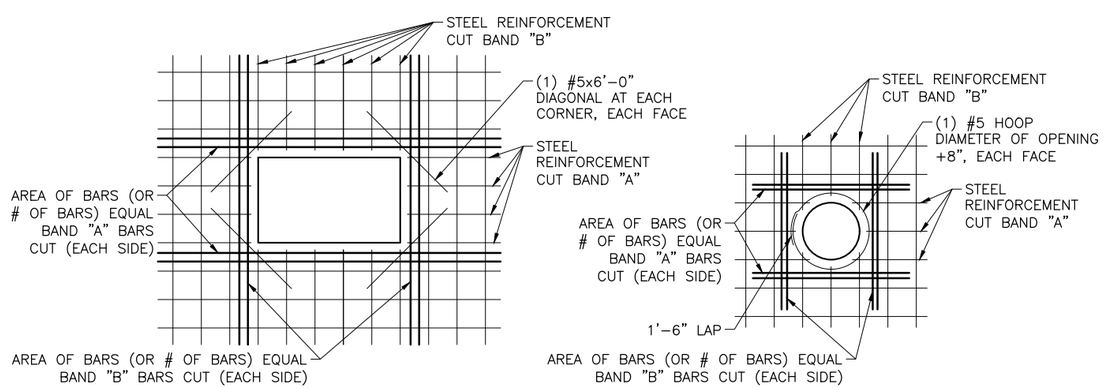
B3 TYPICAL SPLICE DETAIL
SCALE:NOT TO SCALE

CONSTRUCTION STEPS:
1. SANDBLAST OR MECHANICALLY ROUGHEN WITH ELECTRIC EQUIPMENT.
2. DRIVE IN VINYL PLUG.
3. COAT INSIDE AND WHILE BONDING AGENT IS TACKY, DRYPACK INSIDE.
4. COAT OUTSIDE AND WHILE BONDING AGENT IS TACKY, DRYPACK OUTSIDE.



NOTE:
MINIMUM DIAMETER AT OUTSIDE = 1"
TAPER HOLE SO THAT MINIMUM INSIDE DIAMETER = 1¼"

C1 FORM TIE THROUGH BOLT SEAL DETAIL
SCALE:NOT TO SCALE



GENERAL NOTES:
1. TYPICAL FOR ALL OPENINGS IN CONCRETE WALLS AND SLABS UNLESS INDICATED OTHERWISE ON PLANS.
2. DO NOT WELD REINFORCEMENT TO PIPE SLEEVES, INSERTS OR EMBEDMENTS.
3. PROVIDE A MINIMUM OF TWO (2) "A" BARS AND TWO (2) "B" BARS EACH SIDE OF OPENING (1 EACH FACE).
4. SPACE BARS AT 3 BAR DIAMETERS (OR 3" MIN) ON CENTER.
5. IF OPENING REINFORCING TERMINATES AT THE EDGE OF THE SLAB PROVIDE A STANDARD HOOK ON THE "EDGE" SIDE OF THE REINFORCING.
6. EXTEND BARS REQUIRED SPLICE LAP LENGTH BEYOND EDGE OF OPENING, SEE TABLE ON DETAIL (B1/S3–510).
7. AT CIRCULAR OPENING PIPE PENETRATIONS, CONTRACTOR SHALL CAST PIPE IN SEEP RING.

NOTE:
COORDINATE PLACEMENT OF ALL PIPING AND REINFORCING STEEL SO THAT NO CONTACT EXISTS BETWEEN THE TWO METALS.

C2 OPENING REINFORCING DETAIL
SCALE:NOT TO SCALE

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NO.	DESCRIPTION	BY	APR.	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
TYPICAL CONCRETE DETAILS

FILE : 81-18-013_S-101X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE. IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/23/2018

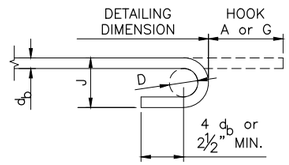
SHEET NUMBER:
S3-509

Plot Date:8/23/2018 9:09 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\OREMFILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION, PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG

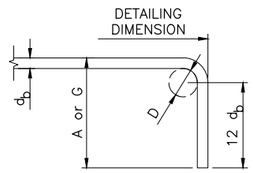
TYPICAL LAP SPLICE LENGTHS IN INCHES, PER ACI 318 / 350									
BAR SIZE	LAP CLASS	f'c 3,000 psi		f'c 4,000 psi		f'c 4,500 psi		f'c 5,000 psi	
		CAT. 1	CAT. 2	CAT.1	CAT. 2	CAT. 1	CAT. 2	CAT. 1	CAT. 2
#4	A	22	33	19	28	18	27	17	25
	B	28	43	25	37	24	35	22	33
#5	A	27	41	24	36	23	34	21	32
	B	36	53	31	46	30	44	28	41
#6	A	33	49	28	43	27	41	25	38
	B	43	64	37	55	36	53	33	50
#7	A	48	72	42	62	40	59	37	56
	B	62	93	54	81	51	77	48	72
#8	A	55	82	47	71	45	68	42	64
	B	71	106	61	92	58	88	55	83
#9	A	62	92	53	80	51	76	48	72
	B	80	120	69	104	66	99	62	93

NOTES:
1. FOR GRADE 60 REINFORCING STEEL BARS.
2. ALL LAP SPLICES SHALL BE CLASS B, UNLESS NOTED OTHERWISE.
3. CATEGORY 1: CLEAR COVER $\geq d_b$ AND CLEAR SPACING $\geq d_b$, AND STIRRUPS OR TIES THROUGHOUT L_d ARE PROVIDED.
   CATEGORY 1: CLEAR COVER $\geq d_b$ AND CLEAR SPACING $\geq 2d_b$.
   CATEGORY 2: CLEAR COVER $< d_b$ OR CLEAR SPACING $< 2d_b$.
4. FOR TOP BARS, MULTIPLY LAP LENGTH LISTED BY 1.30. TOP BARS ARE HORIZONTAL BARS WITH MORE THAN 12" OF CONCRETE CAST BELOW THE BARS.
5. FOR EPOXY COATED BARS, LAP LENGTHS SHALL BE MULTIPLIED BY 1.20.

B1 TYPICAL REBAR LAP SPLICE SCHEDULE FOR CONCRETE
SCALE:NOT TO SCALE



180° HOOKS



90° HOOKS

TYPICAL HOOK DIMENSIONS				
BAR SIZE	D	180° HOOKS		90° HOOKS
		A or G	J	A or G
#3	2¼"	5"	3"	6"
#4	3"	6"	4"	8"
#5	3¾"	7"	5"	10"
#6	4½"	8"	6"	1'–0"
#7	5¼"	10"	7"	1'–2"
#8	6"	11"	8"	1'–4"
#9	9½"	1'–3"	11¾"	1'–7"
#10	10¾"	1'–5"	1'–1¼"	1'–10"
#11	12"	1'–7"	1'–2¾"	2'–0"

NOTES:
d_b = NOMINAL BAR DIAMETER.
D = FINISHED INSIDE BEND DIAMETER.
MINIMUM D = 6 d_b FOR #3 TO #8 BARS.
MINIMUM D = 8 d_b FOR #9 TO #11 BARS.
MINIMUM D = 10 d_b FOR #14 AND #18 BARS.

B2 TYPICAL REBAR HOOK DETAILS FOR CONCRETE
SCALE:NOT TO SCALE

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NO.	DESCRIPTION	BY	APR.	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
TYPICAL CONCRETE DETAILS

FILE : 81-18-013_S-101X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY
LAST UPDATED: 8/23/2018

SHEET NUMBER:
S3-510

Plot Date:8/23/2018 9:09 PM Plotted By: Erick Christiansen
Date Created:8/16/2018 \\OREMFILES\PUBLIC\PROJECTS-JUB\GRAND_JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_S-101X.DWG

APPROXIMATE EASEMENT BOUNDARY

NEW 20" C905 DR-25 PVC WATERLINE, SEE CIVIL SHEETS

20" 45° BEND

SLOPE

20" 45° BEND

20" TEE

20" GATE VALVES

SLOPE

NEW 20" C905 DR-25 PVC WATERLINE, SEE CIVIL SHEETS

20" OUTLET LINE, SEE DETAIL (B1/M3-102)

SLOPE

NEW 20" C905 DR-25 PVC WATERLINE, SEE CIVIL SHEETS

WATERLINE PAY ITEM LIMITS | TANK PAY ITEM LIMITS

NEW 20" WATERLINE, SEE CIVIL SHEETS

SLOPE

10'-0"

CONNECT WITH 20" 45° BEND TO NEW WATERLINE WHEN READY TO PUT NEW LINE INTO SERVICE

SLOPE

EXISTING WATERLINE, SEE CIVIL SHEETS

TEMPORARY CONNECTION TO EXISTING LINE TO ALLOW FOR CONSTRUCTION OF TANK BEFORE NEW LINE IS PUT INTO SERVICE.

CONNECT OVERFLOW LINE TO EXISTING LINE AFTER NEW WATERLINE HAS BEEN PUT INTO SERVICE, CONTRACTOR TO VERIFY EXISTING LINE HAS A MINIMUM SLOPE OF 2.25%. IF SLOPE DOES NOT MEET REQUIREMENTS, CONTRACTOR IS TO RUN PARALLEL 20" PIPE DOWNSTREAM UNTIL CONNECTION CAN BE MADE, OR REMOVE AND REPLACE EXISTING PIPE WITH THE SPECIFIED SLOPE.

SLOPE 2.25% MIN.

6" DRAIN LINE, SEE DETAIL (C1/M3-102)

NEW 20" C905 DR-25 PVC DRAIN LINE

20"x24" ECCENTRIC REDUCER

(2) 24" 45° VERTICAL BENDS

24" 90° BEND

24" OVERFLOW LINE, SEE DETAIL (C1/M3-102)

20" INLET LINE, SEE DETAIL (A1/M3-102)

SLOPE

FUTURE 20" WATERLINE

20" 45° BEND

EXISTING WATERLINE TO BE REMOVED BETWEEN NEW CONNECTIONS FOR CONSTRUCTION OF TANK

CONNECT TO EXISTING WATERLINE

20" GATE VALVES

20" TEE

EXISTING WATERLINE, SEE CIVIL SHEETS

SLOPE

N

NOTES:

1. SEE CIVIL SHEETS FOR CONTINUATION OF PIPING.
2. ALL COMPONENTS WITHIN THE TANK INTERIOR, ASSOCIATED WITH PIPING, OR IN CONTACT WITH WATER, SHALL BE NSF 61 APPROVED.
3. UNLESS OTHERWISE NOTED, ALL PIPING WITHIN TANK PAY ITEM LIMITS SHALL BE DUCTILE IRON PIPE.

APPROXIMATE EASEMENT BOUNDARY

TANK MECHANICAL PIPING PLAN

SCALE:3/16" = 1'-0"

J-U-B ENGINEERS, INC.

J-U-B ENGINEERS, INC.
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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
FLOW CONTROL TANK MECHANICAL PIPING PLAN

FILE : 81-18-013_M-101X
JUB PROJ. # : 81-18-013
DRAWN BY: JMM
DESIGN BY: ----
CHECKED BY: ----

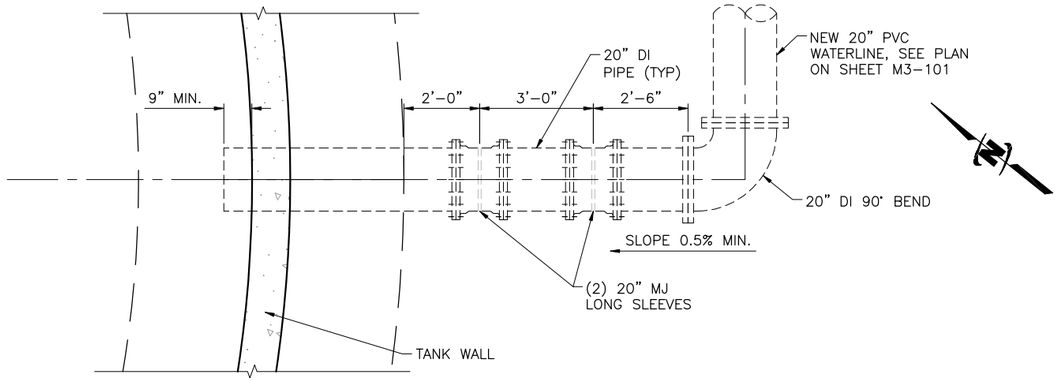
ONE INCH
AT FULL SIZE, IF NOT ONE INCH, SCALE ACCORDINGLY

LAST UPDATED: 8/16/2018

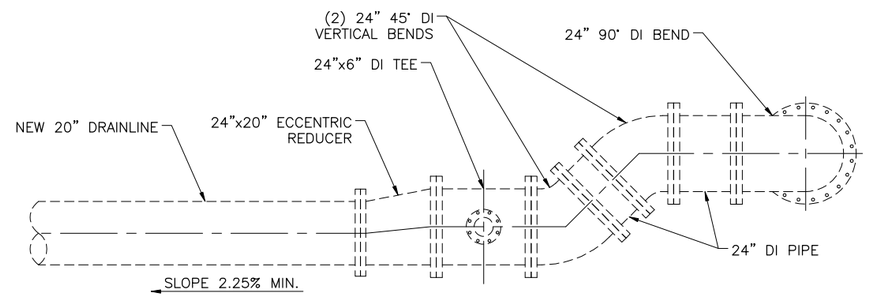
SHEET NUMBER:

M3-101

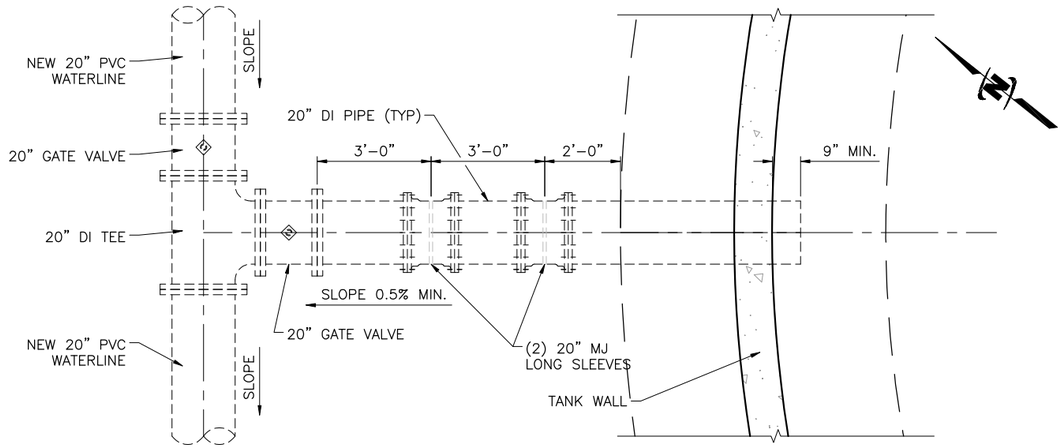
Plot Date: 8/20/2018 8:24 AM Plotted By: Jubal Myers
Date Created: 8/15/2018 I:\OREM\FILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION, PURDY MESA FLOW LINE\CAD\SHEETS\81-18-013_M-101X.DWG



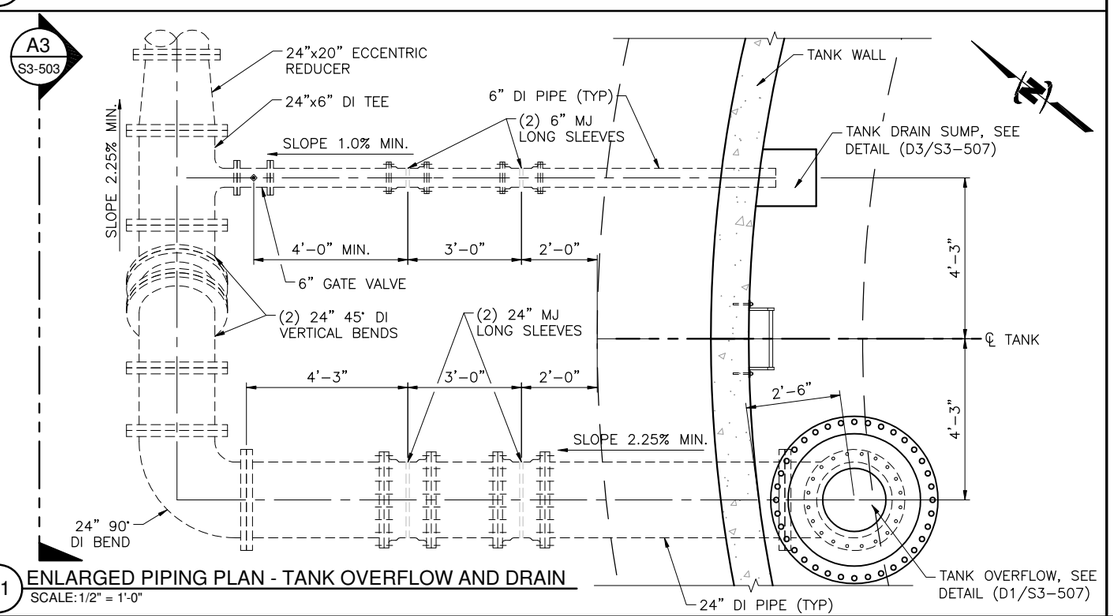
A1 ENLARGED PIPING PLAN - TANK INLET
SCALE: 1/2" = 1'-0"



A3 ENLARGED PIPING PLAN - TANK OVERFLOW AND DRAIN PROFILE
SCALE: 1/2" = 1'-0"



B1 ENLARGED PIPING PLAN - TANK OUTLET
SCALE: 1/2" = 1'-0"



C1 ENLARGED PIPING PLAN - TANK OVERFLOW AND DRAIN
SCALE: 1/2" = 1'-0"

NOTES:
1. SEE CIVIL SHEETS FOR CONTINUATION OF PIPING.
2. ALL COMPONENTS WITHIN THE TANK INTERIOR, ASSOCIATED WITH PIPING, OR IN CONTACT WITH WATER, SHALL BE NSF 61 APPROVED.

J-U-B ENGINEERS, INC.
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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

PURDY MESA FLOWLINE REPLACEMENT
CITY OF GRAND JUNCTION

BID ALTERNATIVE 3
ENLARGED MECHANICAL PIPING PLANS

FILE:	81-18-013_M-101X
JUB PROJ. # :	81-18-013
DRAWN BY:	JMM
DESIGN BY:	---
CHECKED BY:	---
ONE INCH	AT FULL SIZE. IF NOT ONE INCH, SCALE ACCORDINGLY.
LAST UPDATED:	8/16/2018

SHEET NUMBER:
M3-102

Plot Date: 8/20/2018 8:24 AM Plotted By: Jubal Myers
Date Created: 8/15/2018 I:\OREM\FILES\PUBLIC\PROJECTS\JUB\GRAND JUNCTION\81-18-013_CITY OF GRAND JUNCTION_PURDY MESA FLOW LINE\CAD\SHEET\81-18-013_M-101X.DWG

RESOLUTION NO. 81-19
A RESOLUTION ADOPTING RATES, FEES, AND CHARGES FOR WATER, WASTEWATER AND SOLID WASTE UTILITIES

Recitals:

The City of Grand Junction establishes rates, fees, and charges for Water, Wastewater and Solid Waste services, and by this resolution, the City Council establishes these rates, fees, and charges to implement decisions made in the long-term financial plans for the Utilities.

Now, therefore, be it resolved that:

Effective January 1, 2020 rates for Water, Wastewater and Solid Waste utility services change according to the following schedule:

Water Rates			
City Water System Monthly Service Charge	**2019**	**2020 Proposed**	**Change**
0 - 3,000 Gallons	$ 20.14	$ 20.54	$ 0.40
3,000 – 10,000 Gallons (per 1,000)	$ 2.92	$ 3.12	$ 0.20
10,000 - 20,000 Gallons (per 1,000)	$ 3.45	$ 3.69	$ 0.24
> 20,000 Gallons (per 1,000)	$ 4.03	$ 4.31	$ 0.28
Ridges Irrigation System			
Single Family	$ 17.56	$ 18.96	$ 1.68
Multiple Family (per unit)	$ 12.57	$ 13.57	$ 1.00
Bulk Water (Fill Stations)			
Per 1,000 Gallons	$ 7.00	$ 7.50	$ 0.50

Water Fees			
City and Kannah Creek Water Systems	**2019**	**2020 Proposed**	**Change**
Administrative Fees			
Disconnect Fee	$ 30.00	$ 40.00	$ 10.00
Availability Fee (Monthly)	$	$ 14.10	$ 14.10
Final Payoff Cancellation Fee	$	$ 50.00	$ 50.00

Wastewater Rates			
201 Sewer System	**2019**	**2020 Proposed**	**Change**
Monthly Service Charge (per EQU)	$ 22.40	$ 22.62	$ 0.22

Wastewater Fees			
Description	2019	2020 Proposed	Change
Plant Investment Fee	$ 4,776.00	$ 4,919.00	$ 143.00
Trunk Line Extension Fee			
Developer			
1 unit/acre	$ 1,280.00	$ 1,306.00	$ 26.00
>1-3 units/acre	$ 1,153.00	$ 1,176.00	$ 23.00
>3 units/acre	$ 854.00	$ 871.00	$ 17.00
Builder			
1 unit/acre	$ 2987.00	$ 3,047.00	$ 60.00
>1-3 units/acre	$ 2,560.00	$ 2,610.00	$ 50.00
>3 units/acre	$ 1,706.00	$ 1,740.00	$ 34.00

Solid Waste Rates			
Automated Monthly Container Prices	2019	2020 Proposed	Change
1-64 Gallon Container	$ 13.00	$ 13.00	$ 0.00
1-96 Gallon Container	$ 17.00	$ 17.50	$ 0.50
2-64 Gallon Container	$ 20.25	$ 21.50	$ 0.75
1-64, 1-96 Gallon Container	$ 23.75	$ 25.00	$ 1.25
2-96 Gallon Container	$ 27.50	$ 29.00	$ 1.50
Commercial Monthly Dumpster Prices			
1-2 Cubic Yard - Pick-Up 1 Time Per Week	$ 70.46	$ 72.57	$ 2.11
1-4 Cubic Yard - Pick-Up 1 Time Per Week	$ 114.12	$ 117.54	$ 3.42
1-6 Cubic Yard - Pick-Up 1 Time Per Week	$ 154.40	$ 159.03	$ 4.63
1-8 Cubic Yard - Pick-Up 1 Time Per Week	$ 194.19	$ 200.02	$ 5.83

PASSED and ADOPTED this 4th day of December, 2019.

President of the Council

Attest:

City Clerk