

# PAISLEY PARK SUBDIVISION

*A major subdivision in Missoula, Montana*

## Water Engineering Report

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This design report provides the criteria used as a basis of design for the water distribution system to be constructed to serve Paisley Park Subdivision located in Missoula, Montana. This report is submitted in conjunction with the Preliminary Plat and preliminary construction plans. It is organized following the outline recommended in Department Circular DEQ-1, Chapter 1, Section 1.1.

### 1.1.1. GENERAL INFORMATION

#### A. DESCRIPTION OF EXISTING FACILITIES

The proposed major subdivision is in the Sx<sup>w</sup>tpqyen Master Planned area, which is northwest of downtown Missoula and immediately southeast of Missoula Montana Airport. The Sx<sup>w</sup>tpqyen Area is a rapidly developing neighborhood of Missoula, with a mixture of single-family and multifamily residential subdivisions in varying stages of development.

The Sx<sup>w</sup>tpqyen Area is served by the City of Missoula's municipal water distribution system. In 2020 and 2021, the City of Missoula undertook the Mullan BUILD Project, which prompted construction and upsizing of new water mains to serve anticipated development in the Sx<sup>w</sup>tpqyen Area. The BUILD Project installed a new 16-inch water main in Remington Drive, a City street in the first phase of the Remington Flats Subdivision, and a 12-inch water main in England Boulevard to the east of Paisley Park Subdivision. The Remington Flats Subdivision is immediately south of the proposed Paisley Park Subdivision; the water distribution system proposed to serve Paisley Park Subdivision will consist of 12-, and 8-inch main extensions from the existing water mains in the Remington Flats Subdivision and England Boulevard.

The existing water distribution infrastructure is shown in Figure 1. New water mains will be extended in Chuck Wagon Drive, an existing public right-of-way along the western boundary of Remington Flats, and England Boulevard, to serve Paisley Park Subdivision. This report will evaluate the existing conditions, discuss the design criteria, and fully explain the proposed design and constraints of the proposed water distribution system serving Paisley Park Subdivision.

#### B. MUNICIPALITY OR AREA SERVED

The proposed water main extensions will serve Paisley Park Subdivision, which will be annexed into the City of Missoula. The main extensions will be part of the City's existing water distribution system, which has a public water system identification number (PWSID) of MT20000294.

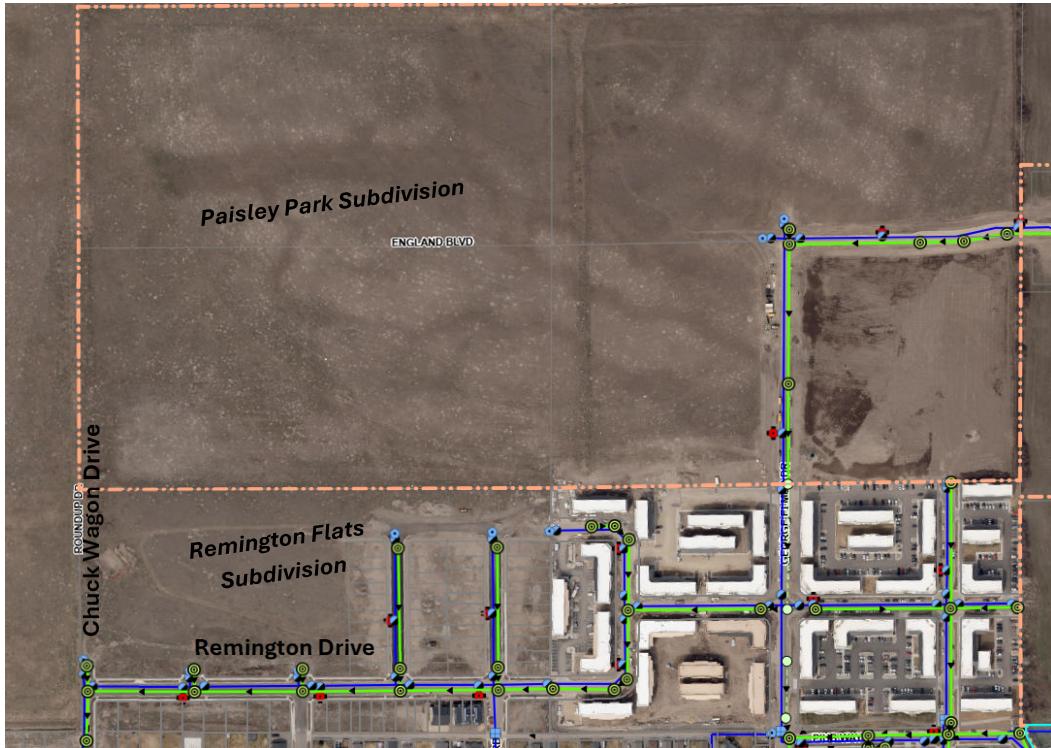


Figure 1. Existing Water Distribution Infrastructure South of Paisley Park Subdivision.

### C. PARTY IDENTIFICATION

Table 1. Identification of Involved Parties.

PARTY	IDENTIFICATION	MAILING ADDRESS
System Owner	City of Missoula	435 Ryman Street, Missoula, MT 59802
Developer	RYN Built Homes	16309 East Marietta Avenue, Spokane Valley, WA 99216
Custodian	Woith Engineering	3860 O'Leary Street, Suite A, Missoula, MT 59808

### D. ENGINEER'S SEAL

The imprint of the professional engineer's seal will be provided on the cover sheet of this report at the time of its submittal for Department of Environmental Quality review for each phase of the project.

## 1.1.2. EXTENT OF WATER WORKS

### A. NATURE AND EXTENT OF AREA SERVED

The area to be served by the main extensions includes 40 acres in the Sx<sup>w</sup>tpqyen master-planned area of Missoula. The water main extensions will expand the City's existing water supply network through the installation of new pipelines. These extensions are being driven by the development of a new residential neighborhood.

### B. PROVISIONS FOR EXTENSION

The new water mains will be equipped with stubs and blowoffs at terminal points in streets to facilitate future extensions to neighboring properties. In addition, the City plans for an eventual new water supply well on neighboring land to the west. Refer to Section 1.1.14 of this report.

### C. FUTURE SERVICE REQUIREMENTS

For a full assessment of future service requirements in the City's broader water distribution system, please refer to the City's Water Facility Master plan (HDR, Inc., 2018), or PWS (MT20000294) information on file. In the immediate project vicinity, the proposed 8" and 12" water main extensions, along with the blowoffs provided to facilitate future extensions, will be sufficient to accommodate the future service requirements of adjacent properties.

## 1.1.3. ALTERNATE PLANS

Alternative water supply systems were not considered for Paisley Park subdivision due to the adjacency of the City of Missoula's existing municipal water supply system.

## 1.1.4. SITE CONDITIONS

### A. SOIL CHARACTERISTICS

The project site is entirely devoid of significant topographic features; it is a flat plain which slopes from an elevation 3,154 feet above mean sea level (MSL) in the southeast corner to 3,146 feet MSL in the northwest corner. This equates to an average topographic slope of 0.42%, with almost no variation across the site. The site has historically been used for agriculture: hay production and cattle grazing.

In general, silty sand and sandy silt overlie high-quality sand and gravel aggregates across the site. Geologically, this area is mapped on the Missoula West 30' x 60' Quadrangle Geologic Map (MBMG Open File Report 373) as Quaternary period Alluvium of Alluvial Terrace Deposits (Qat). These deposits are characterized as well-rounded cobbles, gravel, and sand in deposits with flat topped surfaces that are 10 to 30 feet above the present flood plain. Bedrock was not encountered in the geotechnical investigation and is sufficiently deep beneath the site to not be a consideration in the design of the water distribution system.

#### **B. FOUNDATION CONDITIONS**

The soils encountered onsite are generally expected to support construction of foundations using typical means and methods.

#### **C. HYDROLOGY**

In preparation for a project to realign Grant Creek, which is northwest of Paisley Park, Newfields prepared a Groundwater Modeling Study for the City of Missoula in 2023. According to the study, seasonal high groundwater rises to within 6'-15' of the ground surface on the property.

Groundwater may be encountered during the deep sanitary sewer installations in Chuck Wagon Drive and Somerset Way, along with the installation of water mains in areas where they must be installed at a depth sufficient to pass under sanitary sewers; the construction plans will include provisions to address groundwater if encountered during construction.

According to FEMA Flood Insurance Rate Map 30063C1190E, the proposed subdivision is not within a FEMA-designated 100-year or Shaded Zone X floodplain. The project site does not feature any major drainageways, receiving channels, or surface waters. The nearest surface water is Grant Creek, approximately 650 feet northwest of the project site.

### **1.1.5. WATER USE DATA**

#### **A. POPULATION TRENDS**

Paisley Park Subdivision will include 51 single-family residential units and 620 multi-family units. For the purposes of this analysis, duplex, triplex, and townhome units are considered as single-family dwellings. To produce a conservative estimate of water demands, single-family dwellings are considered to have an average of three bedrooms, with 3.5 residents per unit, and multi-family living units are assumed to have an average of 2.5 residents per unit. The total population of the

Subdivision is anticipated to be approximately 1,729 individuals. This population is not anticipated to change over time, as the land will be fully developed.

For further information on population trends within the City's broader system, please refer to the City's Water Facility Master plan (HDR, Inc., 2018), or PWS (MT20000294) information on file.

## B. DAILY DEMAND ESTIMATES

Water in Paisley Park Subdivision will be consumed through domestic and irrigation usage. The demand assumptions which form the basis of the calculations presented in this section are shown in Table 2.

Table 2. Base Assumptions for Water Demand Calculations.

USE CATEGORY	BASE DEMAND	DEMAND UNIT	DATA SOURCE
Single-family Residential (Domestic plus Irrigation)	490	Gallons per Day	City of Missoula Public Works Standards and Specifications; Section 4.2.3(B)
Multi-family (Domestic)	250	Gallons per Day	MDEQ Circular 4; Section 3.1.2
Multi-family (Irrigation)	2.5	Acre-feet per Acre per Year	ARM Rule 36.12.115(2)(a)
Open Space (Irrigation)	2.5	Acre-feet per Acre per Year	ARM Rule 36.12.115(2)(a)

The irrigation demand per acre, in gallons per day, is calculated using Equation 1. Equation 1 assumes a four-month irrigation season, beginning in May and ending in September.

$$\text{Equation 1. } MDD_{IRR} = \frac{2.5 \frac{\text{ac-ft}}{\text{ac-yr}} * 325,900 \frac{\text{gal}}{\text{ac-ft}}}{4 \text{ months} * 30 \frac{\text{days}}{\text{month}}} = 6,790 \frac{\text{gallons}}{\text{day-acre}}$$

Where  $MDD_{IRR}$  = Maximum Daily Demand for Irrigation (gallons per acre per day)

According to the City's Public Works Standards and Specifications, the design of new water main extensions should use a Maximum Day Demand (MDD) peak factor of 5.0 and a Peak Hour Day (PHD) peak factor of 1.5 times Maximum Day Demand. Using the number of units, the base assumptions listed in Table 2, and these peaking factors, the Average Day Demand, Maximum Day Demand, and Peak Hour Demands for Paisley Park Subdivision can be calculated. Equation 2 and Equation 3 show the calculation of Average Day Demand.

$$\text{Equation 2. } ADD_S = DU_{SF} * BD_{SF}$$

Where  $ADD_S = \text{Average Day Demand for Single-Family Units (gallons per day)}$   
 $DUSF = \text{Number of Single-family Dwellings Proposed}$   
 $BD_{SF} = \text{Base Demand for Single-family Dwellings}$

**Equation 3.**  $ADD_M = DU_{MF} * BD_{MF}$

Where  $ADD_M = \text{Average Day Demand for Multi-family Units (gallons per day)}$   
 $DUM = \text{Number of Multi-family Dwellings Proposed}$   
 $BD_M = \text{Base Demand for Multi-family Dwellings}$

Table 3 shows the calculated Average Day Demand for Paisley Park Subdivision. Due to the limitations of the meter data used in the base assumptions, the Average Day Demand of the single-family land use includes irrigation.

Table 3. Calculated Average Day Demands.

USE CATEGORY	AVERAGE DAY DEMAND (GALLONS PER DAY)
Single-family Residential	24,990
Multi-family Residential	155,000
Total	179,990

Next, Equation 4, Equation 5, and Equation 6 show the calculation of Maximum Day Demand for single-family, multi-family, and open space uses, respectively.

**Equation 4.**  $MDD_S = ADD_S * MHF$

Where  $MDD_S = \text{Maximum Day Demand for Single-Family Units (gallons per day)}$   
 $ADD_S = \text{Average Day Demand for Single-Family Units}$   
 $MDF = \text{Maximum Day Factor; 5.0}$

**Equation 4.**  $MDD_M = (ADD_M * MHF) + (MDD_{IRR} * A_{IRR, MF})$

Where  $MDD_M = \text{Maximum Day Demand for Multi-Family Units (gallons per day)}$   
 $ADD_M = \text{Average Day Demand for Multi-Family Units}$   
 $MDF = \text{Maximum Day Factor; 5.0}$   
 $MDD_{IRR} = \text{Maximum Day Demand for Irrigation (gallons per acre per day)}$   
 $A_{IRR, MF} = \text{Land Area Irrigated for Multi-Family Development (acres)}$

**Equation 5.**  $MDD_{OS} = MDD_{IRR} * A_{IRR, OS}$

Where  $MDD_{OS} = \text{Maximum Day Demand for Open Space Irrigation (gallons per day)}$

$MDD_{IRR}$  = Maximum Day Demand for Irrigation (gallons per acre per day)

$A_{IRR, MF}$  = Land Area Irrigated for Open Space (acres)

The land area irrigated for multi-family development is calculated using the total area of multi-family lots depicted on the Master Site Plan of Paisley Park Subdivision, assuming 20% of the lot area will be irrigated to meet the landscaping standards of Missoula Title 21. The land area irrigated for open space is the area of open space shown on the plat of Paisley Park Subdivision. Table 4 shows the calculated maximum daily demands for the Subdivision.

Table 4. Calculated Maximum Day Demands.

USE CATEGORY	MAXIMUM DAY DEMAND (GALLONS PER DAY)
Single-family Residential	124,950
Multi-family Residential	793,848
Open Space	34,899
Total	953,697

Finally, Equation 6 shows the calculation of Peak Hour Demand, in gallons per minute, for the Subdivision. Table 5 shows the calculated Peak Hour Demand for the Subdivision.

**Equation 6.**  $PHD = \frac{MDD * PHF}{1,440}$

Where  $PHD$  = Peak Hour Demand (gallons per minute)

$MDD$  = Maximum Day Demand (gallons per day)

$PHF$  = Peak Hour Factor; 1.5

Table 5. Calculated Peak Hour Demands.

USE CATEGORY	PEAK HOUR DEMAND (GALLONS PER MINUTE)
Single-family Residential	130.2
Multi-family Residential	826.9
Open Space	36.4
Total	993.4

## C. SOURCE YIELD

The Missoula aquifer is the primary source of the City's drinking water system. The Missoula aquifer is composed primarily of a 100- to 150-foot-thick sequence of sand, gravel, and cobbles that were deposited as a result of the glacial Lake Missoula flooding about 12,000 to 20,000 years ago. Groundwater generally flows from east to west and the Clark Fork River leaks water to the aquifer in the eastern portion of the valley and gains water from the aquifer in the west. As of June 2017, the City extracted water from the aquifer through 40 wells. The wells are capable of producing 74 million gallons per day, or 56 million gallons per day with the largest well in each pressure zone out of service. For more information on source yield, please refer to the City's Water Facility Master plan (HDR, Inc., 2018), or PWS (MT20000294) information on file.

#### **D. UNUSUAL OCCURRENCES**

For more information on unusual occurrences within the City's existing system, such as power outages, please refer to the City's Water Facility Master plan (HDR, Inc., 2018), or PWS (MT20000294) information on file. Unusual occurrences within the main extensions constructed to serve Paisley Park Subdivision will be managed in the same manner as in the City's broader system.

#### **E. WATER LOSSES**

Water losses, such as from leakage at joints and service taps, within the proposed water main extensions are expected to be minimal, since the proposed mains will be constructed with Class 350 ductile iron pipe, with mechanical joints to minimize potential leakage. The mains will be constructed with new materials and pressure tested in accordance with the City of Missoula Public Works Standards and Specifications. Modern ductile iron pipes and fittings are expected to have a service life of well over 50 years with minimal leakage issues.

For more information on water losses within the City's broader system, please refer to the City's Water Facility Master plan (HDR, Inc., 2018), or PWS (MT20000294) information on file.

### **1.1.6. FLOW REQUIREMENTS**

#### **A. HYDRAULIC ANALYSIS**

The City will review the daily demand estimates calculated in Section 1.1.5.B in the context of their system model at the time of requests for platting and approval of construction plans for each phase of the project. This analysis will inform any additional main upsize requirements and ensure that the proposed main extensions can supply both the peak hour demand and fire flow demands,

while maintaining the minimum system pressures specified in MDEQ Circular 1. This analysis will determine the City's decision to provide capacity certification letters for each phase of Paisley Park subdivision at the time of their construction and platting.

## **B. FIRE FLOWS**

The City of Missoula fire department will review and approve of the proposed arrangement of fire hydrants as part of the subdivision preliminary plat approval process. The specified fire flow for Paisley Park Subdivision is 1,500 gallons per minute.

### **1.1.7. SOURCES OF SUPPLY**

As of June 2017, the City extracted water from the Missoula Aquifer through 40 wells. The wells are capable of producing 74 million gallons per day, or 56 million gallons per day with the largest well in each pressure zone out of service. For more information on source yield, please refer to the City's Water Facility Master plan (HDR, Inc., 2018), or PWS (MT20000294) information on file.

### **1.1.8. TREATMENT PROCESSES**

No treatment processes are proposed as part of the proposed distribution system serving Paisley Park Subdivision.

### **1.1.9. SEWAGE SYSTEM**

Paisley Park Subdivision will be served by extensions of the City of Missoula's existing gravity sanitary sewer system. The proposed water distribution and sanitary sewer collection systems in the Subdivision will meet the separation requirements set forth in the City of Missoula Public Works Standards and Specifications Manual.

### **1.1.10. WASTE DISPOSAL**

For more information on waste disposal, please refer to the City's Water Facility Master plan (HDR, Inc., 2018), or PWS (MT20000294) information on file.

### **1.1.11. AUTOMATION**

No automated equipment or processes are proposed as part of the proposed distribution system serving Paisley Park Subdivision.

### 1.1.12. PROJECT SITES

#### A. SITES CONSIDERED

Alternative sites were not considered for the project. The proposed system does not include any new supply wells, finished water storage, pump stations, or other appurtenances other than distribution main extensions.

#### B. LAND USES

Land uses in the vicinity are primarily residential, with a mixture of housing types. The land to the west and north is owned by the Missoula Montana Airport. To the east, land is either vacant or used for growing hay but is expected to develop into residential or commercial uses in the next few decades.

#### C. SOURCES OF POLLUTION

The project does not include any new sources of supply. There are no nearby sources of pollution, such as sewage absorption systems, septic tanks, privies, cesspools, sink holes, sanitary landfills, refuse and garbage dumps, that could interfere with the effective operation of the water main extensions.

### 1.1.13. FINANCING

Construction of the proposed water main extensions will be privately financed in conjunction with the development of Paisley Park Subdivision. The Subdivision, and water main extensions, will be developed and constructed in phases.

### 1.1.14. FUTURE EXTENSIONS

Provisions for future extensions to the east, north, and west of Paisley Park Subdivision will be included in the design of the extensions. Water mains installed in streets will terminate at the Subdivision boundary with the blowoff installed in accordance with City of Missoula standard drawing STD-409.

In addition to the basic provisions for future extensions above, the City plans two future public water supply wells on airport property to the west of Chuckwagon Drive. Thus, the City has requested upsizing to 16-inch water mains in Chuck Wagon Drive and England Boulevard.

Additionally, a 16-inch stub is provided by the BUILD Project at the intersection of England Boulevard and George Elmer Drive.

### **1.1.15. OPERATION AND MAINTENANCE**

Construction of the proposed water main extensions will be privately funded. Ultimately, these water main extensions will be owned, operated, and maintained by the City of Missoula.

### **1.1.16. PLANS**

Preliminary construction drawings are attached to the subdivision application as Attachment 15.

### **1.1.17. REFERENCES**

HDR, Inc. (2018). *2018 Water System Master Plan*. Missoula: City of Missoula.