Water Protection Bureau
P.O. Box 200901
Helena, MT 59620-0901

MONTANA GROUND WATER POLLUTION CONTROL SYSTEM PERMIT FACT SHEET

Applicant:	Valley Construction of Helena, LLC
Permit Number:	MTX000268
Permit Type:	Domestic Wastewater
Application Type:	Modification
Facility Name:	Smith Subdivisions Wastewater Treatment Facility
Facility Location:	SWNE Section 20, Township 19 North, Range 25 West Latitude: 47.39492, Longitude: -114.805171 Lewis and Clark County
Facility Contact:	Kim Smith
Treatment Type:	Level 2
Receiving Water:	Class I Ground Water
Number of Outfalls:	1
Outfall / Type:	001 – Subsurface Pressure Dosed Drainfield
Effluent Type:	Domestic Wastewater
Mixing Zone:	Standard
Effluent Limits:	Total Nitrogen: 7.28 lbs/day
Flow Rate:	Design maximum: 21,500 gpd Design average: 32,000 gpd
Fact Sheet Date:	Modified - June of 2023

1.0 Permit Information

The following fact sheet outlines the basis for modifying the existing MGWPCS wastewater discharge permit for the Smith Subdivisions Wastewater Treatment Facility. The updated MGWPCS permit application and supplemental materials provide the information that serves as the basis for the development of the effluent limits and the monitoring requirements outlined within this fact sheet.

DEQ has identified the following as the major components of this modification request:

- The permittee is seeking to install a Recirculating Sand Filter treatment system to replace the Membrane Bioreactor system that was originally proposed (**Section 2.2**).
- The permittee completed a site-specific aquifer pumping test that updates the hydraulic conductivity value used for ground water dilution (**Section 4.0**).

This new information resulted in the following major permit modifications:

- Water Quality Based Effluent Limit was updated from 3.21 to 7.28 lbs/day for Total Nitrogen (**Section 5.0**).
- The Significance Determination Analysis was updated. The projection shows that the proposed project is not a significant activity (**Section 3.3**).
- The Reasonable Potential for Surface Water Degradation Analysis was updated. The projection shows that the proposed project is not a significant activity (**Section 3.4**).
- The Cumulative Impacts Analysis was updated. DEQ found that the proposed project has no significant adverse effects (**Section 3.6**).

The modifications are further addressed within this fact sheet.

DEQ issues MGWPCS permits for a period of five years. During the permit cycle, major modifications may be completed, however the original effective date (December 01, 2022) and expiration date (November 30, 2027) are maintained. The permit may be reissued at the end of the period, subject to reevaluation of compliance, water quality, and operations and maintenance.

The project is a collection of four subdivisions as proposed under the Sanitation in Subdivisions Act. They are as follows:

- Wordsmith Subdivision: EQ#22-1933 & EQ#22-1926 (wastewater connection).
- Coppersmith Subdivision: EQ#22-1932 & EQ#22-1925 (wastewater connection).
- Blacksmith Subdivision: EQ#22-1931 & EQ#22-1924 (wastewater connection).
- Arrowsmith Subdivision: EQ#22-1930 & EQ#22-1923 (wastewater connection).

A centralized collection, treatment, and disposal system has been proposed to encompass all listed subdivisions. The discharge permit will collectively refer to them as Smith Subdivisions.

1.1 Application

DEQ received an application to modify the existing permit on May 5, 2023. On May 18, 2023, applicable fees were also received. After review, DEQ determined completeness on May 25, 2023.

1.2 Facility Construction Status

The Subdivision's Wastewater Collection, Treatment, and Disposal systems have not yet been built at the time of this writing. The upgrades to the treatment system will need to undergo engineering design review by the DEQ Subdivision Program.

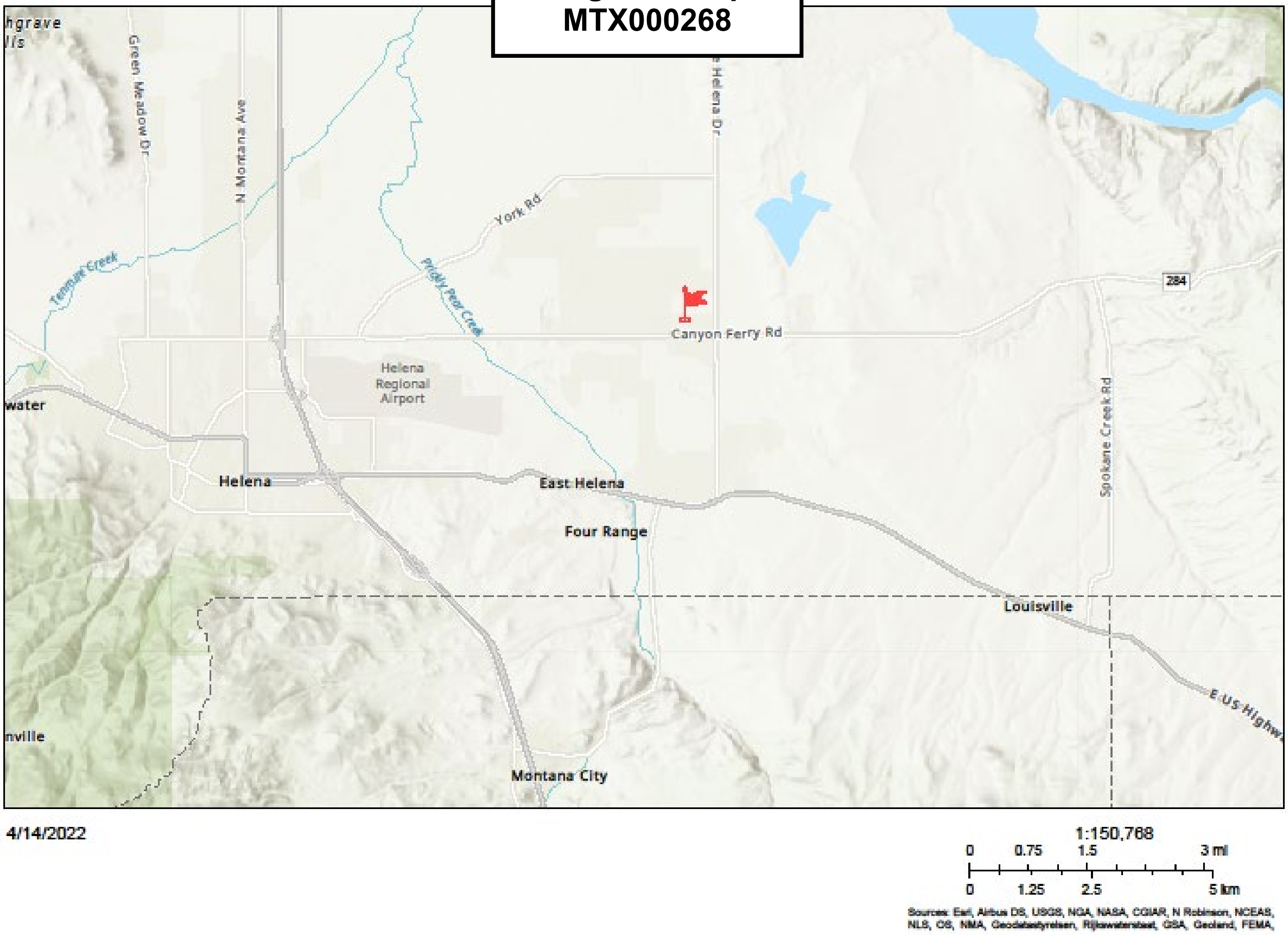
2.0 Facility Information

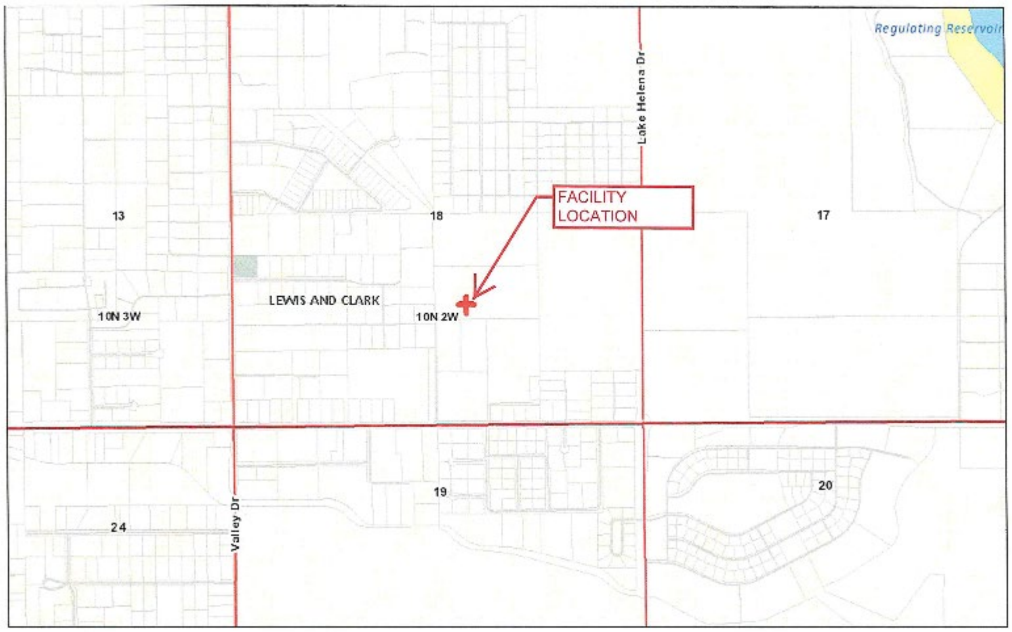
2.1 Location

The proposed subdivision is located in the Eastern portion of the Helena Valley, approximately 1.5 miles north of the Town of East Helena. The subdivision will be placed near the intersection of the existing Canyon Ferry Road and Sartori Street (**Figure 1, Figure 2**).

The location of the disposal system is shown in **Figure 2**. The subdivision will have individual water wells for each building lot.

Figure 1
Regional Map
MTX000268





Map created using the Digital Atlas April 7, 2021
http://msl.mt.gov/GIS/Atlas

Montana State Libary - Digital Library
(406) 444-5354 | geoinfo@mt.gov | http://msl.mt.gov

Figure 2
Vicinity Maps
MTX000268

• GWICWELLS

Map created using the Digital Atlas April 7, 2021
http://msl.mt.gov/GIS/Atlas

Montana State Libary - Digital Library
(406) 444-5354 | geoinfo@mt.gov | http://msl.mt.gov

2.2 OPERATIONS

The proposed facility is a centralized system that will collect, treat, and dispose of wastewater for the subdivision. The applicant has updated their proposal for the wastewater treatment design from a Membrane Bioreactor (MBR) system to a Recirculating Sand Filter (RSF) system. The RSF is a Level 2 system that is capable of removing approximately 100 to 162% more nitrogen than having individual septic (conventional) systems for each lot. Below is a summary of the proposed operations along with a wastewater system line diagram.

Table 1: Operations Summary
Sources and Treatment
Contributing Sources of Wastewater: Domestic-in-Nature, Residential Strength Standard Industrial Code(s) (SIC) of contributing sources: 4952, 7389 Treatment System: Recirculating Sand Filter (Level II) Location of System: Southeast Section 18, Township 10 North, Range 02 West Latitude: 46.624058, Longitude: -111.899654 Lewis and Clark County
Sampling/Monitoring
Wastewater System: EFF-001: Effluent wastewater sample collected from sample port located at the drainfield dose tank (proposed). FM-001: Effluent flow meters located in meter vault after the drainfield dose tank. Four meters have been proposed for four different drainfield zones. All meters shall be cumulatively recorded and reported (total flow to Outfall 001).
Disposal Operation
Outfall 001 - Subsurface Drainfield Method of Disposal: Pressure dosed subsurface infiltration to groundwater. Location: Southeast Section 18, Township 10 North, Range 02 West Latitude: 46.621243, Longitude: -111.902666 Lewis and Clark County Design Capacity: Average Daily Flow (gpd): 21,500 Maximum Daily Flow (gpd): 32,000

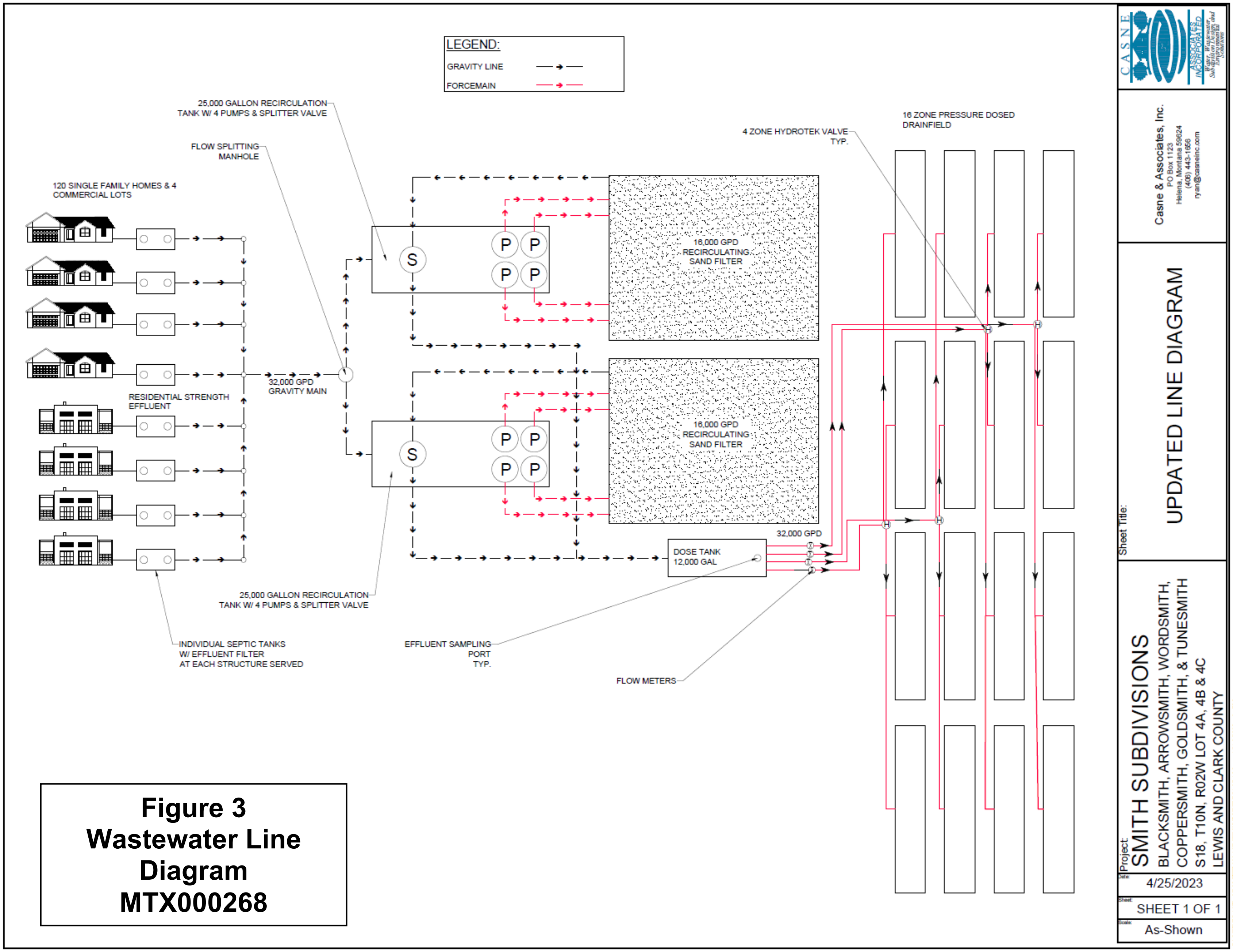


Figure 3
Wastewater Line Diagram
MTX000268

2.3 Geology/Hydrogeology

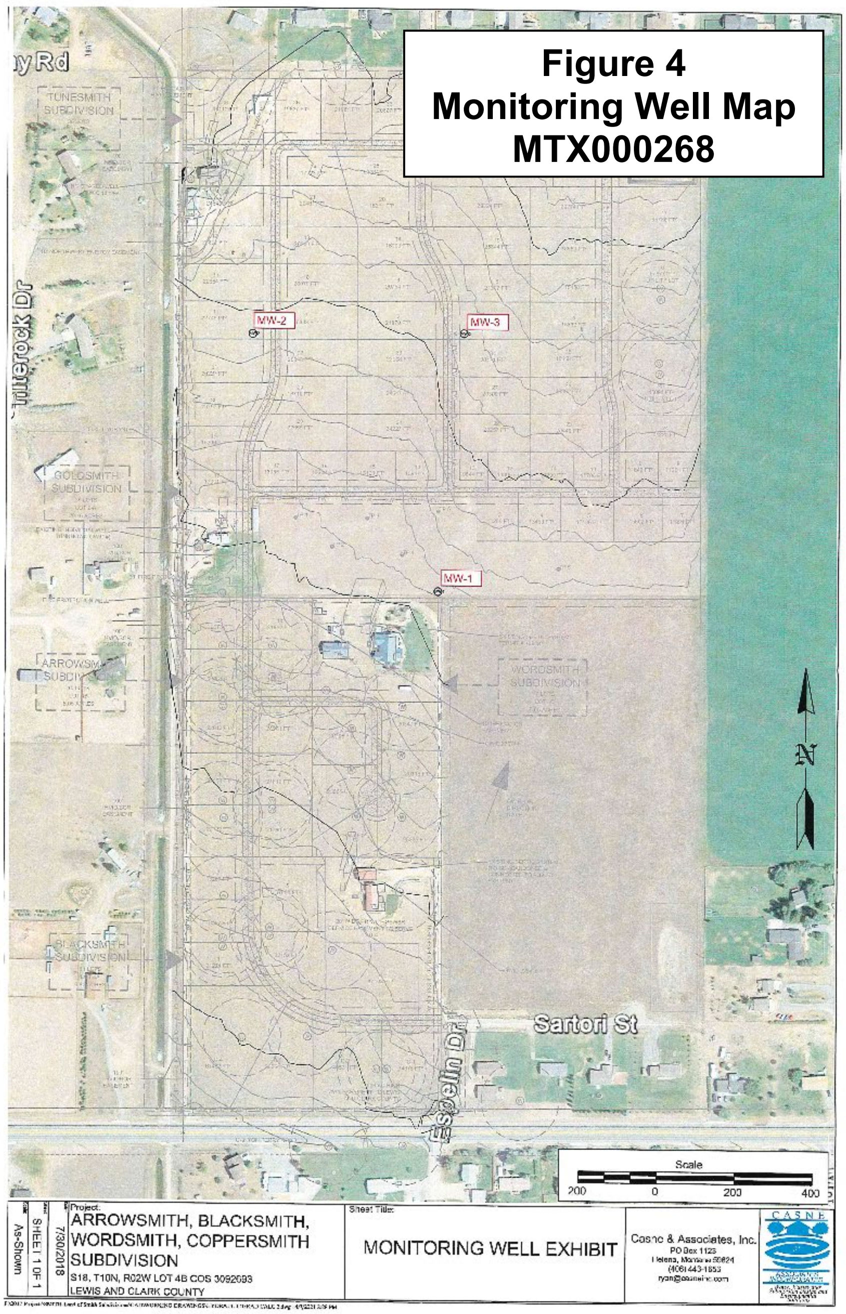
Table 2: Geology/Hydrogeology Summary	
Geology	The shallow subsurface is characterized as Quaternary alluvium. The upper 100 feet of the valley-fill material is best described as, "a sequence of complexly stratified lenses of cobbles, gravel, and sand" (Briar, 1992. USGS).
Hydrogeology	The primary aquifer of use is located in the shallow and unconsolidated alluvial deposits. Most water wells in the area are constructed in this aquifer. At the proposed facility, the top contact of the water bearing zone is approximately 45 feet below ground surface.
Ground Water Flow	Ground water flow direction was estimated to be North-Northeast (N20°E). This was determined by the triangulation of static water levels at the recently installed (on-site) monitoring wells. This site-specific direction is supported by a regional study (Briar, 1992. USGS).
Hydrology	Research indicates that the Helena Valley aquifer regionally flows toward the Lake Helena area (Briar, 1992. USGS). Lake Helena is located 4.5 miles to the North of the project area.

2.4 Ground Water Monitoring Network

Three monitoring wells and six test pits that were used to collect information on the soil, vadose zone, and the shallow ground water aquifer underlying the proposed facility. Well construction, lithologic log diagrams, and soil descriptions are attached as **Appendix A**. The well locations are shown on **Figure 4**.

Table 3: Monitoring Well Summary
Monitoring Well: MW-1
MBMG GWIC #: 302099
Use: Monitoring of the shallow unconfined ground water bearing zone upgradient of the drainfield.
Permit Status: Active. Constructed on June 26, 2018.
Location: Located approximately 120 feet South of the Eastern end of the proposed drainfield. Located 200 feet South of the road intersection of the proposed Lavender Drive and Forge Road. Latitude: 46.62087 Longitude: -111.90482
Representation: Upgradient of the outfall. The well as finished represents shallow ground water underlying the facility. Water samples collected are representative of the ambient quality of the aquifer. Water quality data collected from this well represents cumulative impacts from upgradient sources of pollutants.
Monitoring Well: MW-2
MBMG GWIC #: 302097
Use: Monitoring of the shallow unconfined ground water bearing zone sidegradient of the drainfield.
Permit Status: Inactive (but permanent). Constructed on June 27, 2018.
Location: Located approximately 436 feet to the North-Northwest of the center of the proposed drainfield. Located near Lot 1 on Anvil Drive. Latitude: 46.62262 Longitude: -111.90402
Representation: Sidegradient of the outfall. The well as finished represents shallow ground water underlying the facility. The well needs to be kept viable for future hydrogeologic data gathering.

Monitoring Well: MW-3
MBMG GWIC #: 302098
Use: Monitoring of the shallow unconfined ground water bearing zone downgradient of the drainfield.
Permit Status: Active. Constructed on June 26, 2018.
Location: Located approximately 500 feet to the North-Northeast of the center of the proposed drainfield. Located near Lot 4 on Lavender Drive. Latitude: 46.62268 Longitude: -111.90187
Representation: Downgradient of the outfall. The well as finished represents shallow ground water underlying the facility. Water samples collected represent ground water quality after dilution of the discharge occurs in the mixing zone.



2.5 QUALITY INFORMATION

The applicant has proposed a Level 2 treatment system that is capable of removing 60% of the raw wastewater nitrogen load. A comparative summary of the estimated effluent characteristics is provided in **Table 4**.

Ambient (pre-discharge) ground water quality characteristics of the shallow aquifer were collected from all three monitoring wells. A comparative summary is provided in **Table 4** and a full summary is provided in **Table 5**.

Table 4: Quality Summary

Analyte/Measurement	**units**	**Proposed Treatment System Wastewater Characteristics**	**Water Quality Standards** (see Table 7)	**Ambient Ground Water Quality**
Nitrogen, Kjeldahl, total [as N]	mg/L	10.8		1.9
Nitrogen, Nitrite + Nitrate [as N]	mg/L	14.9(1)	7.5	0.01
Nitrogen, Total [as N]	mg/L	25.7(1)(2)		1.9
Nitrogen, Total [as N]	lbs/day	4.61(3)		*
Phosphorus, Total [as P]	mg/L	5.6	see Table 7	*

Footnotes:
*Analyte was not required to be sampled in the application process, or not applicable.
The median value is displayed for the parameters that have a skewed, variable, or limited data set; otherwise average is listed.
A similar design system was used for estimated effluent characteristics (Golden Estates III).
(1) Prior to dilution within an authorized mixing zone, Section 4.0.
(2) The anticipated effluent concentration will be 24 mg/L or less with construction using the latest engineering design standards.
(3) Load based on the Average Design Capacity flows.

Table 5: Ground Water Monitoring Results

Monitor Source[1]	Parameter	Units	Reported Average Value	# of Samples	Source of Data
MW-1 MW-2 MW-3	Chloride (as Cl)	mg/L	26.6	3	APP
	Escherichia coli Bacteria	CFU/100 ml	<10	3	APP
	Nitrogen, Nitrate + Nitrite (as N)	mg/L	0.01	3	APP
	Nitrogen, Total Kjeldahl (as N)	mg/L	1.9	3	APP
	Organic Carbon	mg/L	0.93	3	APP
	Specific Conductivity (@ 25°C)	µS/cm	310	3	APP
	Static Water Level (SWL)	ft-bgs	45.4 - 49.0	3	APP
	Total Dissolved Solids (TDS)	mg/L	190	3	APP

Footnotes:
APP = Application Form
bgs = below ground surface
CFU = Colony Forming Units
(1) Refer to Section 2 of the Fact Sheet for the existing or proposed location of the monitoring wells.

3.0 WATER QUALITY STANDARDS

Part of DEQ's mission is to protect and sustain the quality of state waters. The receiving state water is Class I ground water which is a high quality water of the state. The current and future beneficial uses of the aquifer will be protected. The beneficial uses and water quality standards are listed below.

Beneficial uses:

- Public and private water supplies;
- Culinary and food processing purposes;
- Irrigation;
- Drinking water for livestock and wildlife; and,
- Commercial and industrial purposes.

Water quality standards are established to protect these beneficial uses. Standards are as follows:

- Ground water human health; and,
- Harmful, detrimental, or injurious activity.

In protecting the beneficial uses, DEQ identified parameters of interest which are further discussed in **Section 3.1**. The numeric water quality standards for these parameters are summarized in **Table 6.**

Table 6: Water Quality Standards.

Parameter(1)	Units	Ground Water Human Health Standards	Pollutant Category(2)	Nonsignificance Criteria(3)
Nitrogen, Nitrate + Nitrite [as N]	mg/L	10.0	T	7.5
Nitrogen, Total (TN)(4)	mg/L	10.0	-	7.5
Phosphorus, Total Inorganic	-	-	H	Surface water breakthrough time greater than 50 years(5)

Footnotes:

CFU = Colony Forming Unit

These standards establish the allowable changes in ground water quality and are the basis for limiting discharges to ground water.

(1) The list includes identified parameters of interest.

(2) Circular DEQ-7: Carcinogen (C), Harmful (H), and Toxic (T) parameter. Toxic pollutant with a Bioconcentrator (B) factor.

(3) Criteria indicates threshold for a significant activity that may lead to degradation.

(4) DEQ conservatively assumes all forms of nitrogen will convert to nitrates within the aquifer. DEQ recognizes that other nitrogen forms may be harmful to the beneficial uses therefore will use Total Nitrogen for projecting impacts and in formulation of compliance efforts (limitations).

(5) Changes in receiving ground water quality are not significant if water quality protection practices approved by the DEQ have been fully implemented and if the listed nonsignificance criteria is met.

3.1 Parameters of Concern

DEQ performed a characterization of all parameters typically associated with domestic wastewaters. DEQ identified parameters of interest based on application materials, research materials, beneficial use rules, Nondegredation criteria, and the Ground Water Human Health Standards of DEQ Circular-7. Parameters are summarized below.

Parameters of Concern: None identified.

Parameters of Interest: Nitrogen (spp.) and Phosphorus are both commonly found in domestic wastewaters.

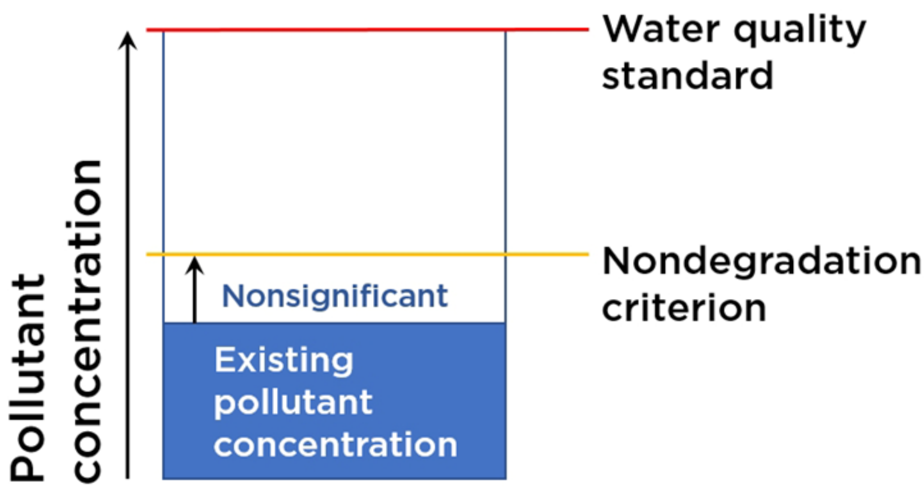
The proposed wastewater system has an advanced treatment design. The permit will require long-term monitoring and reporting for *Operations & Maintenance* and *Water Quality* purposes.

Discontinued/New Parameters: This is a new permit; therefore the permit only contains new monitoring and reporting conditions.

3.2 Nondegradation

Montana's nondegradation policy is intended to preserve the existing condition of high-quality state waters. Any water whose existing condition is better than the water quality standards must be maintained in that high quality. Nondegradation policy allows discharges to cause only nonsignificant changes in water quality.

Changes in water quality that are deemed significant require an authorization to degrade. An authorization to degrade is not an authorization to pollute; the water quality standard must not be exceeded. An authorization to degrade is not authorized for this activity.



As the proposed activity is new, DEQ has performed a Significance Determination Analysis that is summarized in the following sections.

3.3 Significance Criteria and Determination

For nitrogen, under Montana statute, total concentrations at or below 7.5 mg/L at the downgradient end of the mixing zone (**Section 4**) is a nonsignificant change in water quality. Using the nonsignificance criterion of 7.5 mg/L, DEQ will establish effluent limitations and long-term monitoring requirements for compliance at the end of the mixing zone (**Section 4**).

DEQ performed projections for predicting nitrate values downgradient of the mixing zone. Ground water at the downgradient edge of the mixing zone is projected to be 4.8 mg/L **(Appendix B)**. This is well below the nondegradation criterion.

For phosphorus, a surface water breakthrough time of greater than 50 years is a nonsignificant change in water quality. The phosphorus criterion requires an analysis to determine a breakthrough time based on the adsorption capacity of the soil. Breakthrough occurs when the subsurface soils lose their capability to adsorb any more phosphorus allowing phosphorus to reach surface water (Brady, 2004). DEQ conducted a phosphorus breakthrough analysis that estimates phosphorus discharged to ground water from Outfall 001 may reach surface water in 2,423 years. This breakthrough is nonsignificant as it is greater than 50 years; therefore, no phosphorus effluent limits are required. This updated projection is provided in **Appendix B**.

These analyses show that the discharge activity is not significant. The discharge permit requires that the permittee complies with these Nondegredation criteria on a long-term basis.

3.4 Reasonable Potential

DEQ evaluated the fate of nitrogen (in the form of nitrate) associated with the discharge of wastewater from the proposed facility. The phosphorus breakthrough analysis discussed above is based upon distance and time to nearest surface water, inherently addressing the potential for degradation of surface water. Therefore, the analysis of reasonable potential for surface water degradation in this section is limited to nitrogen.

DEQ recognizes that ground water and surface waters are hydraulically connected in the Helena Valley. Research indicates that the principal surface and ground water collection point is Lake Helena which is located approximately 4.7 miles downgradient from the proposed outfall.

DEQ performed an attenuation study to determine potential losses of nitrogen due to naturally occurring denitrifying conditions in the subsurface. Using Darcy's Law, it takes approximately 6 to 22 years for ground water to travel from the project site to Lake Helena (Freeze, 1979). During that time, nitrate naturally decays from biogeochemical processes that occur in the aquifer (McCray, 2005). DEQ estimates the following:

- Approximately 99 to 100% of nitrogen discharged will decay prior to reaching Lake Helena.
- Nitrate will decay to below the numerical surface water quality standard (0.3 mg/L) within 2,162 to 7,332 feet of the outfall, which is approximately 3.3 to 4.3 miles away from Lake Helena. [*At the time of drafting, numeric surface water standards were no longer in effect due to recent legislation. In order to preserve the analyses moving forward, DEQ will be conservative and temporarily use the former aquatic standard listed in 2019's Circular DEQ-7*.]
- Nitrate will decay to natural ambient levels (1 mg/L, conservatively) within 1,579 to 5,353 feet of the outfall. This occurs at approximately 3.7 to 4.4 miles away from Lake Helena.

DEQ was conservative in these predictions as it did not include additional reduction that occurs in the vadose and hyporheic zones. These updated projections are included within **Appendix B**.

These projections demonstrate that nitrate in ground water will not result in degradation of the nearest surface water. It also determined that measurable impacts to surface water is not expected.

3.5 Lake Helena Watershed

The Lake Helena Watershed encompasses most of the shallow aquifers and surface water streams that are located in the Helena Valley. US EPA provided water quality analysis and impairment determinations for the Lake Helena Watershed in the Water Quality Restoration Plan and Total Maximum Daily Loads (TMDLs) for the Lake Helena Watershed Planning Area: Volume I – Watershed Characterization and Water Quality Status Review (US EPA, 2004) (TMDL Volume 1). Source assessments, TMDLs and pollutant allocations were provided two years later in the Framework Water Quality Restoration Plan and Total Maximum Daily Loads (TMDLs) for the Lake Helena Watershed Planning Area: Volume II – Final Report (U.S. EPA, 2006) (the TMDL Volume 2). The TMDL Volume 1 identified water quality impairments resulting from the following pollutant categories: sediment, nutrients, metals, and temperature (see TMDL Volume 1 Table ES-1, page viii). The TMDL Volume 2 identified pollutant sources and provided TMDLs as needed for restoration of water quality (see TMDL Volume 2, page 14 for nutrients). Subsequently, Lewis & Clark County Water Quality Protection District and the Lake Helena Watershed Group released the 2016-2023 Lake Helena Watershed Restoration Plan ("the WRP") in 2015 (L&C, 2015). The WRP provides a plan to improve water quality in the subject waterbodies through best management practices. DEQ published the Lake Helena Watershed Nutrient TMDL Implementation Evaluation ("TIE") document in 2018 (DEQ, 2018). The TIE summarizes DEQ's assessment of progress made towards nutrient TMDL implementation. Sediment, metals, and temperature are not addressed in the TIE. Anthropogenic sources of nutrients include: fertilizer runoff, septic systems, agriculture crops, grazing, wastewater discharge, and storm water runoff. See the WRP at page 15 and the TIE at page 4. DEQ recommends best management practices (BMPs) to implement water quality restoration efforts of nonpoint sources.

Establishing centralized wastewater treatment systems in place of septic systems is one of the recommended BMP practices to reduce nutrient pollution from septic systems. See the TIE at Section 5.4 on page 7. As proposed, the subdivision will centralize 124 wastewater connections of residential homes and businesses. The proposed system has Level 2 treatment capabilities that exceeds the performance of conventional septic systems. The Plat at page 104.

The proposed centralized system will be covered under a Montana Ground Water Pollution Control System (MGWPCS) Permit that provides a regulatory mechanism for protecting water quality by applying limitations, requiring long-term wastewater and aquifer monitoring, ongoing reporting, qualified maintenance, compliance, and technical support.

There are six nutrient-impaired surface water bodies located throughout the Lake Helena Watershed (Lake Helena, AUID 41I007_010; Prickly Pear Creek, AUID MT41I006_030; Prickly Pear Creek, AUID MT41003_020; Sevenmile Creek, AUID MT41I006_160; Spring Creek, AUID MT41I006_080; Tenmile Creek, AUID MT41I006_143). These creeks all flow into Lake Helena. The expectant load reductions listed for nutrients are for Lower Prickly Pear Creek and Tenmile Creek. The portion of the Helena Valley Alluvial aquifer underlying the project site flows toward Lake Helena and not toward the other surface waters in the Lake Helena Watershed.

Establishment of a Level 2, centralized system, will prevent the creation of multiple stand-alone septic systems and, by requiring regular monitoring and reporting, provide for significant reduction in the overall nitrogen load. It is estimated that the proposed Level 2 system will remove approximately 100 to 162% more nitrogen compared to constructing individual septic systems (conventional).

Wider adoption of centralized advanced treatment systems is an important step towards reducing septic systems and achieving the nitrogen reduction goals in the WRP. DEQ's proposed permitting action is consistent with the WRP and further recommendations within the TIE.

3.6 Cumulative Effects

DEQ considered the direct, secondary, and cumulative environmental impacts of the construction and operation of the facility and found no significant adverse effects on water quality, the human environment, and the physical environment. The DEQ analysis included the cumulative impact from other past and present actions.

DEQ evaluated the fate of nitrogen (in the form of nitrate) associated with the discharge of wastewater from the proposed facility (**Section 3.4**). DEQ predicts that nitrate will decay to natural ambient levels within 1,579 to 5,353 feet of the outfall. This occurs at approximately 3.7 to 4.4 miles away from Lake Helena. DEQ was conservative in this prediction as it did not include additional reduction that may occur in the vadose and hyporheic zones. This updated projection is included in **Appendix B**.

DEQ analyzed Montana Bureau of Mines and Geology Ground Water Information Center (MBMG-GWIC) records for available ground water quality data collected between the outfall and Lake Helena. The average of these nitrate samples is 1.12 mg/L which falls within the range generally considered to be naturally occurring background conditions (Lamond, 1999).

DEQ considered the direct, secondary, and cumulative environmental impacts of the construction and operation of the facility and found no significant adverse effects on water quality, the human environment, and the physical environment. The DEQ analysis included the cumulative impact from other past and present actions.

All major discharge permitting actions, including the current action and any future actions, will include any substantive information derived from public input relating to potential impacts on the human environment and on water quality. All future actions related to this current action will be addressed by DEQ through additional discharge permitting process procedures. Any actions that are outside the prevue of the discharge permit may not be addressed by DEQ until the next permitting action takes place.

To protect beneficial uses, there shall be no increase of a pollutant to a level that renders the waters harmful, detrimental, or injurious. Therefore, no wastewaters may be discharged such that the wastewater either alone or in combination with other wastes will violate or can reasonably be expected to violate any standard.

The allowable discharge will be derived from a mass-balance equation that determines the assimilative capacity of the receiving aquifer. This factors in the cumulative impacts of all existing upgradient discharges in the receiving aquifer.

Testing of the aquifer was completed to determine the existing impacts of all upgradient discharge sources. The resulting ambient nitrogen levels were used to determine the assimilative capacity to ensure limitations were achieved that factors in these existing sources.

A ground water monitoring network has been established that will provide for long-term monitoring of the aquifer. The ground water data collected will provide continual monitoring of the health of the aquifer including the impacts of any upgradient dischargers. This data is made available to the public for their viewing and will be used by DEQ to update future permit limitations. In addition, any update to limitations, including cumulative effect analyses, will be noticed to the public and will undergo public comment.

Long-term monitoring and reporting, continual analysis, updating of permit conditions, and public notice procedures is a benefit of having a system that is covered under a discharge permit.

4.0 MIXING ZONE

A mixing zone is an area of the receiving shallow ground water where the aquifer is able to assimilate wastewater pollutants. The availability of dilution is based on the site-specific aquifer characteristics and the drainfield dimensions. The allowable level of dilution is limited by the permit to ensure that water quality standards are met at the end of the mixing zone.

DEQ will propose to reauthorize the existing standard mixing zone. Mixing Zone characteristics are summarized in **Table 7** and a layout is provided in **Figure 5**.

Geologic information is provided in **Section 2.3**. The hydraulic conductivity has been updated in use of an onsite aquifer pump test resulting in 257 ft/day. The test report is included as **Appendix C**.

Information below provides details on how DEQ calculates the available dilution of the receiving aquifer. The cross-sectional area (A) is the area of the ground water flux boundary at the maximum width of the mixing zone.

Based on the dimensions of the mixing zone, and the hydrogeologic characteristics (**Section 2**), the volume of ground water (**Q_{GW}**) available to mix with the wastewater is calculated using Darcy's Equation below, and has been summarized in **Table 7**:

$$Q_{GW} = K\ I\ A$$

Where:
Q_{GW} = ground water flow volume (ft^3/day)
K = hydraulic conductivity (ft/day)
I = hydraulic gradient (ft/ft)
A = cross-sectional area (ft^2) of flow at the downgradient boundary of the mixing zone.

Table 7: Hydrogeologic and Mixing Zone Information - Outfall 001		
Parameter	**Units**	**Value**
Mixing Zone Type	-	Standard
Authorized Parameters	-	Nitrogen
Ambient Ground Water Concentrations, Nitrate + Nitrite	mg/L	0.01
Ground Water Flow Direction	azimuth/bearing	N20°E
Length of Mixing Zone	feet	500
Thickness of Mixing Zone	feet	15
Outfall Width, Perpendicular to Ground Water Flow Direction	feet	522
Width of Mixing Zone at Down Gradient Boundary	feet	609.5
Cross Sectional Area of Mixing Zone (A)	ft^2	9142.5
Hydraulic Conductivity (K)	feet/day	257
Hydraulic Gradient (I)	ft/ft	0.0054
Volume of Ground Water Available for Mixing (Q_{gw})	ft^3/day	12,688

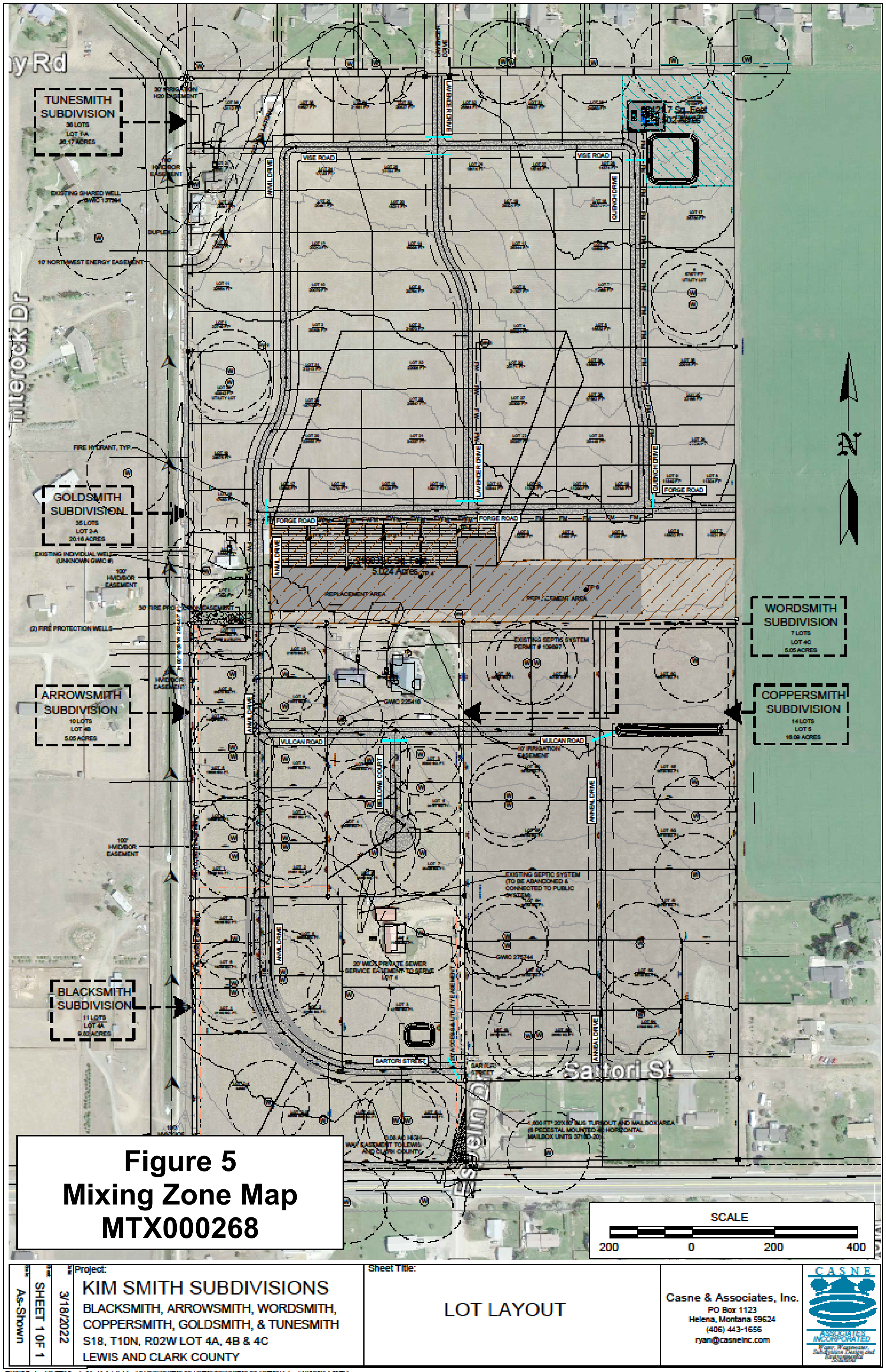


Figure 5
Mixing Zone Map
MTX000268

5.0 Limitations

To protect beneficial uses, there shall be no increase of a pollutant to a level that renders the waters harmful, detrimental, or injurious. Therefore, no wastewaters may be discharged such that the wastewater either alone or in combination with other wastes will violate or can reasonably be expected to violate any standard. DEQ will establish an effluent limitation for nitrogen within this permit. The limit will conservatively be based on the projection that the entire nitrogen load in the wastewater stream may ultimately be converted to nitrate.

The allowable discharge will be derived from a mass-balance equation which is a simple steady-state model that determines the assimilative capacity of the receiving aquifer. The equation factors in cumulative impacts of existing upgradient discharges in the receiving aquifer and any available dilution within the mixing zone. The mass-balance equation derived for ground water is as follows:

$$Q_{gw}C_{gw} + Q_{eff}C_{eff} = Q_{comb}C_{proj}$$

Where:

Q_{gw}	=	ground water available for mixing
C_{gw}	=	ambient receiving ground water concentration
Q_{eff}	=	design capacity of wastewater system
C_{eff}	=	effluent pollutant concentration
Q_{comb}	=	combined ground water and effluent ($Q_{comb} = Q_{gw} + Q_{eff}$)
C_{proj}	=	projected pollutant concentration (after available dilution)

The mass-balance equation has been arranged to calculate the maximum amount of nitrogen that can be added to the aquifer without causing or contributing to an exceedance of the water quality standard.

$$C_{lmt} = C_{std} + D(C_{std} - C_{gw})$$

Where:
C_{lmt} = effluent limitation concentration
C_{std} = water quality standard concentration
C_{gw} = ambient receiving ground water concentration
D = dilution ratio (Q_{gw}/Q_{eff})

Numeric effluent limits are often expressed as loads which inherently regulates both volume and strength of the discharge. The load limit ensures compliance with the ground water standard at the end of the mixing zone.

$$L_{lmt} = (CON)(C_{eff})(DC_{eff})$$

Where:
L_{lmt} = effluent limitation-load
C_{eff} = allowable effluent concentration
DC_{eff} = design capacity of wastewater treatment system (gpd)
CON = conversion factor [$8.34(10^{-6})$]

The updated calculated effluent limitation for nitrogen is:

7.28 lbs/day
C_{lmt} = 40.57 mg/L
Design Capacity = 21,500 gpd

The effluent limitation for this permit is summarized in **Table 8.**

Table 8: Effluent Limitations – Outfall 001		
Parameter	**Units**	**Quarterly Average**
Nitrogen, Total [as N]	lbs/day	7.28
Quarterly load calculation: The quarterly average of all individual daily concentrations and the quarterly flow total must be used in the load calculations. Calculation rules are provided within the Wastewater Monitoring Tables.		

DEQ prohibits the connection of wastewater sources that are not domestic-in-nature. Wastewater generators typically associated with domestic activities include: sinks, toilets, showers, and laundry.

6.0 MONITORING AND REPORTING

Long-term monitoring and reporting of wastewater and ground water will be established as a condition of the permit. Monitoring wastewater characteristics will help to ensure proper operation and maintenance of the treatment system and in compliance with the established effluent limitation. Wastewater monitoring and reporting requirements are provided in **Table 9**.

Ground water monitoring will provide DEQ with information on the current and future health of the aquifer. Ground water monitoring and reporting requirements are provided in **Table 10**. The permittee must develop and implement a Ground Water Monitoring, Analysis, and Reporting Operational Manual (**Section 7**).

Reporting must be completed in use of Discharge Monitoring Reports (DMRs). The permittee or operator will file DMRs electronically in use of the online NetDMR program. Information and contacts for this program can be found here: https://deq.mt.gov/water/assistance.

Table 9: Effluent Monitoring and Reporting Requirements

Analyte/Measurement	Monitor Location	Units	Sample Type[(1)]	Minimum Sample Frequency	Reporting Requirements[(1)(2)]	Report Frequency
Flow Rate, Effluent[(3)]	FM-001	gal/day	Contin-uous	Contin-uous	Quarterly Average[(4)]	Quarterly
	FM-001	gal/quarter	Contin-uous	Contin-uous	Quarterly Total	Quarterly
Nitrogen, Nitrite+Nitrate [as N]	EFF-001	mg/L	Grab	1/Quarter	Quarterly Average	Quarterly
Nitrogen, Total Ammonia [as N]	EFF-001	mg/L	Grab	1/Quarter	Quarterly Average	Quarterly
Nitrogen, Total Kjeldahl (TKN)[as N]	EFF-001	mg/L	Grab	1/Quarter	Quarterly Average	Quarterly
Nitrogen, Total [as N][(5)]	EFF-001	mg/L	Calculate	1/Quarter	Quarterly Average	Quarterly
		lbs/day[(6)]	Calculate	1/Quarter	Quarterly Average	Quarterly
Phosphorus, Total [as P]	EFF-001	mg/L	Grab	1/Quarter	Quarterly Average	Quarterly

Footnotes:
EFF-001: Description provided in Table 1 of the Fact Sheet document.
FM-001: Description provided in Table 1 of the Fact Sheet document.

"No Discharge" shall be recorded on the wastewater Discharge Monitoring Report (DMR) report forms only when no discharge takes place throughout the entire reporting period.

Parameter analytical methods shall be in accordance with the Code of Federal Regulations, 40 CFR Part 136, unless specified above or within a deviation authorized by DEQ.

(1) See definitions in Part V of the permit unless defined within this table or by a permit condition.

(2) Quarterly Average: The average of all individual daily concentrations (mg/L) analyzed during the quarterly reporting period.

(3) Requires recording device and/or totalizing meter. Equipment must be capable of recording daily and quarterly effluent volumes.

(4) Quarterly Average Flows: Determine total flows (gal/quarter) that occurred during the quarterly reporting period. Divide total flow by the number of calendar days in the Quarterly reporting period to get a unit of daily flow (gal/day).

(5) Total Nitrogen is the sum of Nitrate + Nitrite and Total Kjeldahl Nitrogen.

(6) Quarterly Load Calculation. Determine concentration (mg/L): Use the average of all individual daily concentrations (mg/L) analyzed during the quarterly reporting period. Determine totalized quarterly flows (gal/quarter): Total flow that occurred during the quarterly reporting period. Convert to a daily flow average (gal/day): Divide the total quarterly flow (gal/quarter) by the total calendar days (days) of the quarterly reporting period. Calculate quarterly load (lbs/day): Concentration (mg/L) x Flows (gal/day) x [8.34×10^{-6}].

Table 10: Ground Water Monitoring and Reporting Requirements

Analyte/Measurement	Monitor Location	Units	Sample Type[(1)]	Minimum Sampling Frequency	Reporting[(2)] Requirements	Report Frequency
Chloride [as Cl]	MW-1 MW-3	mg/L	Grab	1/Quarter	Quarterly Average	Quarterly
Nitrogen, Nitrite+Nitrate [as N]	MW-1 MW-3	mg/L	Grab	1/Quarter	Quarterly Average	Quarterly
Nitrogen, Total Ammonia [as N]	MW-1 MW-3	mg/L	Grab	1/Quarter	Quarterly Average	Quarterly
Nitrogen, Total Kjeldahl (TKN)[as N]	MW-1 MW-3	mg/L	Grab	1/Quarter	Quarterly Average	Quarterly
Nitrogen, Total [as N][(3)]	MW-1 MW-3	mg/L	Calculate	1/Quarter	Quarterly Average	Quarterly
Specific Conductivity @ 25°C	MW-1 MW-3	µS/cm	Grab or Instant-aneous	1/Quarter	Quarterly Average	Quarterly
Temperature	MW-1 MW-3	°C	Instant-aneous	1/Quarter	Quarterly Average	Quarterly
Static Water Level (SWL)[(4)]	MW-1 MW-3	ft-bmp	Instant-aneous	1/Quarter	Quarterly Average	Quarterly
Well Depth[(4)]	MW-1 MW-3	ft-bmp	Instant-aneous	1/Quarter	Quarterly Average	Quarterly

Footnotes:
CFU = Colony Forming Units
ft-bmp = feet below measuring point
Monitoring for MW-1 and MW-3 commences upon the permit effective date.
At no time shall the permittee mark or state "no discharge" on any monitoring well DMR form.
Each monitor well to be individually monitored and sampled for the analyte and measurements respectively listed.

If any monitoring well(s) are abandoned, destroyed or decommissioned, or are no longer able to be sampled due to fluctuations in the ground water table; the permittee shall install a new well to replace the abandoned, destroyed, decommissioned, or non-viable well(s).

Parameter analytical methods shall be in accordance with the Code of Federal Regulations, 40 CFR Part 136, unless specified above.
Samples must not be collected until after the well casing is properly purged.

Submittal of discharge monitoring report forms (DMRs) will be required, regardless of the operational status of the facility or of each individual monitoring well.

(1) See definitions in Part V of the permit unless defined within this table or by a permit condition.

(2) Quarterly Average: The average of all individual daily concentrations (mg/L) analyzed during the quarterly reporting period.

(3) Total Nitrogen is the sum of Nitrate + Nitrite and Total Kjeldahl Nitrogen.

(4) Measuring point (point of reference) for SWL measurements shall be from top of inner casing (or as established by an Operational Manual) and measured to within 1/100th of one foot.

7.0 Special Conditions

7.1 Ground Water Monitoring, Analysis, and Reporting Operational Manual

The permittee shall use Best Management Practices (BMPs) in developing SOPs (Standard Operating Procedures) for sampling, analyzing, and reporting ground water characteristics. The SOP manual must be site-specific and result in monitoring and reporting that is representative of the nature of the shallow ground water bearing zones. The manual must provide for consistent identification, development, monitoring, sampling, calculating, recording, and reporting of the monitoring wells. The manual must provide for guidance on: determining and documenting dry-well occurrences; and determining future well viability. DEQ recommends using the Montana Bureau of Mines and Geology Open-File Report 746 titled Standard Procedures and Guidelines for Field Activities (MBMG, 2022) as a reference in developing a site-specific operational manual.

The completion and submittal date of the manual is listed in **Section 8**. The manual must be reviewed and approved by DEQ prior to implementation. The permittee shall maintain a copy of the manual, monitoring well development records, dry well occurrence records, sampling records, and calibration records at the facility at all times. Ground water monitoring requirements are discussed in **Section 6**. All subsequent amended manuals must be reported to DEQ.

7.2 Special Conditions – Monitoring Well Viability

The permittee shall monitor and collect representative ground water samples from the shallow water bearing zones. If any of the monitoring wells are abandoned, destroyed, decommissioned, or non-viable; or are no longer able to be monitored due to obstructions or fluctuations in the ground water table; the permittee shall rehab the non-viable well or replace with the installation of a new well.

8.0 COMPLIANCE SCHEDULE

The actions listed in **Table 11** must be completed on or before the respective scheduled completion date. The action dates of the existing permit have been maintained within this major modification. A report documenting each respective action must be received by DEQ on or before the scheduled reporting date. Unless otherwise stated, completion of all actions or deliverables must be reported to DEQ in accordance with Part II.D and Part IV.G of the permit.

Table 11: Compliance Schedule

Action	Frequency	Completion Date of Action	Reporting Due Date
Develop and implement a **Ground Water Monitoring, Analysis, and Reporting Operational Manual.**	Single event	June 01, 2023	June 28, 2023

PUBLIC NOTICE

Legal notice information for water quality discharge permits are listed at the following website: http://deq.mt.gov/Public/notices/wqnotices. Public comments on this proposal are invited any time prior to close of business on **August 09, 2023**. Comments may be directed to:

DEQWPBPublicComments@mt.gov

or to:

Montana Department of Environmental Quality
Water Protection Bureau
PO Box 200901
Helena, MT 59620

All comments received or postmarked prior to the close of the public comment period will be considered in the formulation of the final permit. DEQ will respond to all substantive comments pertinent to this permitting action and may issue a final decision within thirty days of the close of the public comment period.

All persons, including the applicant, who believe any condition of the draft permit is inappropriate, or that DEQ's tentative decision to deny an application, terminate a permit, or prepare a draft permit is inappropriate, shall raise all reasonably ascertainable issues and submit all reasonably available arguments supporting their position by the close of the public comment period (including any public hearing). All public comments received for this draft permit will be included in the administrative record and will be available for public viewing during normal business hours.

Copies of the public notice are mailed to the applicant, state and federal agencies, and interested persons who have expressed interest in being notified of permit actions. A copy of the distribution list is available in the administrative record for this draft permit. Electronic copies of the public notice, draft permit, fact sheet, and draft environmental assessment are available at the following website: http://deq.mt.gov/Public/notices/wqnotices.

Any person interested in being placed on the mailing list for information regarding this permit may contact the DEQ Water Protection Bureau at (406) 444-5546 or email DEQWPBPublicComments@mt.gov. All inquiries will need to reference the permit number (MTX000268), and include the following information: name, address, and phone number.

During the public comment period provided by the notice, DEQ will accept requests for a public hearing. A request for a public hearing must be in writing and must state the nature of the issue proposed to be raised in the hearing.

References

40 CFR § 136. Guidelines Establishing Test Procedures for the Analysis of Pollutants. 2011.

Administrative Rules of Montana, Title 17, Chapter 30, Water Quality:

- Subchapter 2 - Water Quality Permit Fees.
- Subchapter 5 – Mixing Zones in Surface and Ground Water.
- Subchapter 7 – Nondegradation of Water Quality.
- Subchapter 10 – Montana Ground Water Pollution Control System.
- Subchapter 13 – Montana Pollutant Discharge Elimination System.

Bauder, J.W., et. al. 1993. Physiographic and land use characteristics associated with nitrate nitrogen in Montana ground water: Journal of Environmental Quality, v. 22, 99. 255-262.

Brady, N.C. and R. R. Weil. 2004. Elements of the Nature and Properties of Soils 2nd Edition. Prentice Hall. Upper Saddle River, NJ.

Briar, D., and Madison, J., Hydrogeology of the Helena Valley-Fill Aquifer System, West-Central Montana, 1992. Water-Resources Investigations Report 92-4023.

Crowley et al., 2017. Montana Bureau of Mines and Geology (MBMG), Principal Aquifers of Montana, MBMG Hydrogeologic Map 11.

Department of Environmental Quality, Water Quality Circulars:

- Circular DEQ-2 – Design Standards for Wastewater Facilities.
- Circular DEQ-4 – Montana Standards for On-Site Subsurface Sewage Treatment Systems.
- Circular DEQ-7 – Montana Numeric Water Quality Standards, Required Reporting Values, and Trigger Values.

Montana Department of Environmental Quality, Lake Helena Watershed Nutrient TMDL Implementation Evaluation, August 2018.

Montana Department of Environmental Quality, Montana Pollutant Discharge Elimination System Permit Fact Sheet, City of Helena Wastewater Treatment Plant, May 2021. MT0022641.

Driscoll, F.G. 1986. Groundwater and Wells 2nd Edition. Johnson Division. St. Paul, Minnesota.

Fetter, C.W., Applied Hydrogeology, 1994.

Freeze, R., and Cherry, J., Groundwater, 1979.

Kendy, E. and R.E. Tresch. 1996. Geographic, Geologic, and Hydrologic Summaries of Intermontane Basins of the Northern Rocky Mountains, Montana. USGS Water-Resources Investigations Report: 96-4025.

Kirkland, S.L. 2001. Coupling site-scale fate and transport with watershed-scale modeling to assess the cumulative effects of nutrients from decentralized onsite wastewater systems. M.S. thesis, Department of Geology and Geological Engineering: Colorado School of Mines.

Lamond, Ray E., G. Morgan Powell, and Dan Devlin, Nitrate and Groundwater, Kansas State University, April 1999.

L&C, Lake Helena Watershed Restoration Plan, December 2015. Lewis & Clark County Water Quality Protection District, Helena, MT.

Lonn, J., et al. 2007. Geologic Map of the Plains Quadrangle, Western Montana. Montana Bureau of Mines and Geology. Open-File Report 554.

McCray, John E., S. L. Kirkland, Robert L. Siegrist, and Geoffrey D. Thyne. 2005. Model Parameters for Simulating Fate and Transport of On-Site Wastewater Nutrients. Ground Water.

McCray, John E., Geza Mengistu, Kyle E. Murray, Eileen P. Poeter, and David Morgan. 2009. Modeling Onsite Wastewater Systems at the Watershed Scale: A User's Guide. Water Environment Research Foundation.

Montana Bureau of Mines and Geology, Ground-Water Information Center, GWIC state well database, http://mbmggwic.mtech.edu.

Montana Bureau of Mines and Geology, Standard Procedures and Guidelines for Field Activities, Open-File Report 746, p.96. http://www.mbmg.mtech.edu/mbmgcat/catmain.asp

Montana Code Annotated, Title 75, Chapter 5, *Montana Water Quality Act*, 2011.

National Research Council, 1996. Use of Reclaimed Wastewater. Chapter 5, Public Health Concerns About Infectious Disease Agents, Use of Reclaimed Water and Sludge in Food Crop Production. Washington, DC: The National Academies Press. https://doi.org/10.17226/5175.

Ohio Environmental Protection Agency, Technical Guidance Manual for Ground Water Investigations. 2007. http://www.epa.ohio.gov/ddagw/gw_support.

U.S. Environmental Protection Agency, Effluent Limitation Guidelines, http://water.epa.gov/scitech/wastetech/guide/, 2013.

U.S. Environmental Protection Agency, Guidance Manual for Developing Best Management Practices http://www.epa.gov/npdes/pubs/owm0274.pdf>, 1993.

U.S. Environmental Protection Agency, 2018. Exposure Pathways to High-Consequence Pathogens in the Wastewater Collection and Treatment Systems. EPA/600/R-18/221. Office of Research and Development, Homeland Security Research Program, Cincinnati, OH 45268.

U.S. Environmental Protection Agency, 1991. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. EPA160014-891034. Office of Research and Development, Las Vegas, NV.

U.S. Environmental Protection Agency, 2013. Monitoring for Microbial Pathogens and Indicators. Tech Notes 9, National Nonpoint Source Monitoring Program. Developed for U.S. Environmental Protection Agency by Tetra Tech, Inc., Fairfax, VA.

U.S. Environmental Protection Agency, 2010. NPDES Permit Writers' Manual, 833-K-10-001.

U.S. Environmental Protection Agency. Protecting Underground Sources of Drinking Water from Underground Injection. Large-Capacity Cesspools. https://www.epa.gov/uic/large-capacity-cesspools.

U.S. Environmental Protection Agency, 2002b. Onsite Wastewater Treatment Systems Manual, 625/R-00/008, Office of Research and Development and Office of Water. Washington, DC.

U.S. Environmental Protection Agency, 1991. Suggested Operating Procedures for Aquifer Pumping Tests. EPA-540/S-93/503. Office of Research and Development, Washington, DC.

U.S. Environmental Protection Agency, 1991. Technical Support Document for Water Quality-Based Toxics Control (TSD). EPA-505/2-90-001. Office of Water, Washington, DC. www.epa.gov/npdes/pubs/owm0264.pdf

U.S. Environmental Protection Agency, 2009. Unified Guidance: Statistical Analysis of Ground Water Data. EPA-530/R-09-007. Office of Resource Conservation and Recovery, Washington, DC.

U.S. Geological Survey, Basic Ground Water Hydrology, http://pubs.usgs.gov/wsp/2220/report.pdf, 2016.

U.S. Geological Survey, Groundwater Basics, http://water.usgs.gov/ogw/basics.html, 2016.

U.S. Geological Survey, Hydrogeology of the Helena Valley-Fill Aquifer System, West-Central Montana. Briar, D., and Madison, J. 1992. Water-Resources Investigations Report 92-4023.

Woessner, W., and Poeter, E. 2020. Hydrogeologic Properties of Earth Materials and Principles of Groundwater Flow. Groundwater Project, Guelph, Ontario, Canada.

Woessner, W., Troy, T., Ball, P. and D.C. DeBorde. 1998. Virus Transport in the Capture Zone of a Well Penetrating a High Hydraulic Conductivity Aquifer Containing a Preferential Flow Zone: Challenges to Natural Disinfection. In Proc. Source Water Protection Int., Dallas, TX. 28–30 Apr. 1998. National Water Research Inst., Fountain Valley, CA.

Vuke, et al., Montana Bureau of Mines and Geology, Geologic Map of Montana, Geologic Map 62, 2007.

APPENDIX A – WELL CONSTRUCTION, LITHOLOGIC LOG DIAGRAMS, AND SOIL DESCRIPTIONS

MONTANA WELL LOG REPORT	Other Options
This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.	Return to menu Plot this site in State Library Digital Atlas Plot this site in Google Maps View scanned well log (7/17/2019 8:19:21 AM)

Site Name: KIM SMITH PROPERTIES
GWIC Id: 302099

MW1
(1)

Section 1: Well Owner(s)
1) KIM SMITH PROPERTIES (MAIL)
7510 APPLEGATE DR
HELENA MT 59602 [06/26/2018]

Section 2: Location

Township	Range	Section	Quarter Sections
10N	02W	18	SW¼ NW¼ SE¼

County	Geocode
LEWIS AND CLARK	

Latitude	Longitude	Geomethod	Datum
46.62201294925	-111.9031098525	TRS-SEC	NAD83

Ground Surface Altitude	Ground Surface Method	Datum	Date

Addition	Block	Lot
		2-A

Section 3: Proposed Use of Water
MONITORING (1)

Section 4: Type of Work
Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date
Date well completed: Tuesday, June 26, 2018

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	25	10
25	82	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.5	80	6	0.25		WELDED	STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
60	80	6	18	0.25 X 3	TORCH OR PLASMA CUTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	0	BENTONITE	Y

Section 7: Well Test Data

Total Depth: 80
Static Water Level: 52
Water Temperature:

Air Test *

_15_ gpm with drill stem set at _80_ feet for _1_ hours.
Time of recovery _1_ hours.
Recovery water level _52_ feet.
Pumping water level _ feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log

Geologic Source
Unassigned

From	To	Description
0	77	SANDY GRAVEL
77	82	SANDY CLAY

Driller Certification
All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name:	JACK CLARK
Company:	WESTERN WATER WELLS
License No:	WWC-697
Date Completed:	6/26/2018

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View scanned well log (7/17/2019 8:18:30 AM)

Site Name: KIM SMITH PROPERTIES
GWIC Id: 302097

MW2

2

Section 1: Well Owner(s)

1) KIM SMITH PROPERTIES (MAIL)
7510 APPLEGATE DR
HELENA MT 59602 [06/27/2018]

Section 2: Location

Township	Range	Section	Quarter Sections
10N	02W	18	SW¼ NW¼ SE¼

County	Geocode
LEWIS AND CLARK	

Latitude	Longitude	Geomethod	Datum
46.62201294925	-111.9031098525	TRS-SEC	NAD83

Ground Surface Altitude	Ground Surface Method	Datum	Date

Addition	Block	Lot
		2-A

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Wednesday, June 27, 2018

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	25	10
25	100	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.5	97.5	6	0.25		WELDED	STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
80	100	6	18	0.25 X 3	TORCH OR PLASMA CUTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	0	BENTONITE	Y

Section 7: Well Test Data

Total Depth: 100
Static Water Level: 50
Water Temperature:

Air Test *

30 gpm with drill stem set at 100 feet for 1 hours.
Time of recovery 1 hours.
Recovery water level 50 feet.
Pumping water level _ feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	100	SANDY GRAVEL

Driller Certification

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: JACK CLARK
Company: WESTERN WATER WELLS
License No: WWC-697
Date Completed: 6/27/2018

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View scanned well log (7/17/2019 8:19:03 AM)

Site Name: KIM SMITH PROPERTIES
GWIC Id: 302098

Section 1: Well Owner(s)

1) KIM SMITH PROPERTIES (MAIL)
7510 APPLEGATE DR
HELENA MT 59602 [06/26/2018]

Section 2: Location

Township	Range	Section	Quarter Sections
10N	02W	18	SW¼ NW¼ SE¼

County	Geocode
LEWIS AND CLARK	

Latitude	Longitude	Geomethod	Datum
46.62201294925	-111.9031098525	TRS-SEC	NAD83

Ground Surface Altitude	Ground Surface Method	Datum	Date

Addition	Block	Lot
		2-A

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Tuesday, June 26, 2018

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	25	10
25	80	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.5	78.5	6	0.25		WELDED	STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
60	80	6	18	0.25 X 3	TORCH OR PLASMA CUTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	0	BENTONITE	Y

Section 7: Well Test Data

MW3
(3)

Total Depth: 80
Static Water Level: 49
Water Temperature:

Air Test *

20 gpm with drill stem set at 80 feet for 1 hours.
Time of recovery 1 hours.
Recovery water level 49 feet.
Pumping water level _ feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

Unassigned

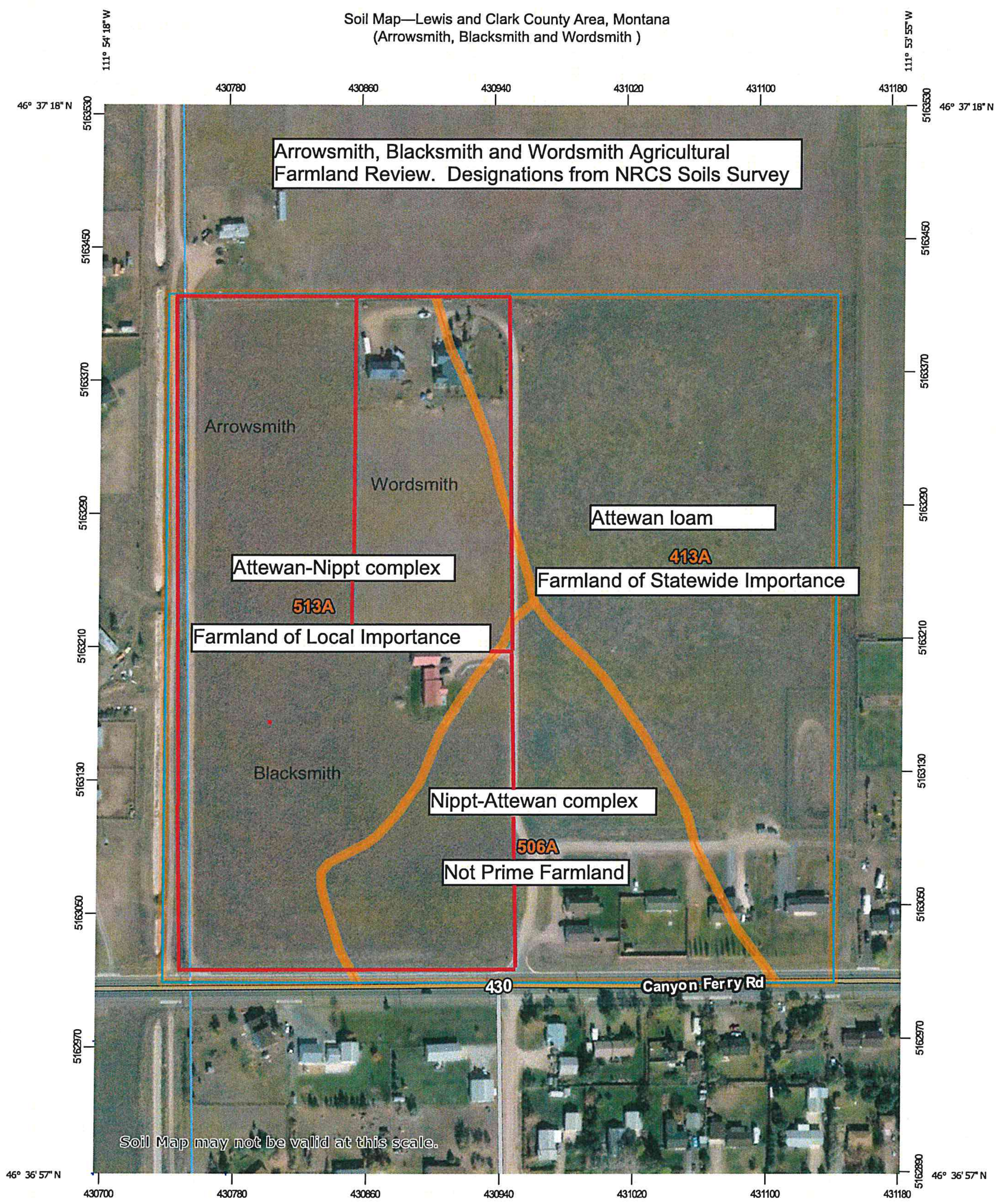
From	To	Description
0	80	SANDY GRAVEL

Driller Certification

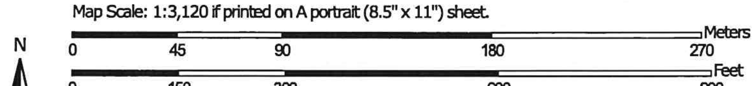
All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: JACK CLARK
Company: WESTERN WATER WELLS
License No: WWC-697
Date Completed: 6/26/2018

Soil Map—Lewis and Clark County Area, Montana
(Arrowsmith, Blacksmith and Wordsmith)



Map Scale: 1:3,120 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Lewis and Clark County Area, Montana
Survey Area Data: Version 11, Sep 28, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 4, 2013—Nov 12, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
413A	Attewan loam, 0 to 2 percent slopes	15.4	37.3%
506A	Nippt-Attewan complex, 0 to 2 percent slopes	8.8	21.2%
513A	Attewan-Nippt complex, 0 to 2 percent slopes	17.2	41.5%
Totals for Area of Interest		**41.3**	**100.0%**

APPENDIX B – NONDEGREDATION PROJECTIONS

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)

PHOSPHOROUS BREAKTHROUGH ANALYSIS

SITE NAME: Smith Subdivisions
COUNTY: Lewis and Clark
Permit #: MTX-261
NOTES: Variables used are based on conservative measurements
Design Capacity = 21,500 gpd = 2,840 ft³/day

VARIABLES	DESCRIPTION	VALUE	UNITS
Lg	Length of Primary Drainfield as Measured Perpendicular to Ground Water Flow	522	ft
L	Length of Primary Drainfield's Long Axis	600	ft
W	Width of Primary Drainfield's Short Axis	500	ft
B	Depth to Limiting Layer from Bottom of Drainfield Laterals*	45	ft
D	Distance from Drainfield to Surface Water	23760	ft
T	Phosphorous Mixing Depth in Ground Water (0.5 ft for coarse soils,	0.5	ft
Ne	1.0 ft for fine soils)**		
Sw	Soil Weight (usually constant)	100	lb/ft3
Pa	Phosphorous Adsorption Capacity of Soil (usually constant)	200	ppm
#l	Number of proposed wastewater treatment systems	1	
CONSTANTS			
Pl	Phosphorous Load per proposed wastewater treatment system	366.5	lbs/yr
X	Conversion Factor for ppm to percentage (constant)	1.0E+06	
EQUATIONS			
Pt	Total Phosphorous Load = (Pl)(#l)	367	lbs/yr
W1	Soil Weight under Drainfield = (L)(W)(B)(Sw)	1350000000	lbs
W2	Soil Weight from Drainfield to Surface Water = [(Lg)(D) + (0.0875)(D)(D)] (T)(Sw)	3089988000	lbs
P1	Total Phosphorous Adsorption by Soils = (W1 + W2)[(Pa)/(X)]	887998	lbs
SOLUTION			
BT	**Breakthrough Time to Surface Water = P / Pt**	2423	years

BY: C. Boe
DATE: Updated 05/24/2023

NOTES: ** Depth to limiting layer is typically based on depth to water in a test pit or bottom of a dry test pit minus two feet to account for burial depth of standard drainfield laterals.*

REV. 04/2000

MASS BALANCE EQUATION

ALLOWABLE DISCHARGE CONCENTRATION DETERMINATION

$$C_2 = \frac{C_3(Q_1 + Q_2) - C_1 Q_1}{Q_2}$$

C1	Ambient ground water (background) concentration (mg/L)	0.01
C2	**Allowable discharge concentration (mg/L)**	**40.57**
C3	Ground water concentration limit for pollutant (from Circular WQB-7) at the end of the mixing zone.	7.50
Q1	Ground water volume (ft^3 / day)	12688
Q2	Flow of discharge (average design capacity of system in ft^3/day)	2874

The volume of ground water that will mix with the discharge (Q_s) is estimated using Darcy's equation: Q1=K I A

Q1	**Ground water flow volume (ft^3 / day)**	**12688**
K	hydraulic conductivity (ft/day)	257
I	hydraulic gradient (ft/ft)	0.0054
A	cross-sectional area (ft^2) of flow at the down-gradient boundary of a standard 500-foot mixing zone.	9142.5

Outfall 001 - Smith Subdivisions, 05/2023

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

Projected Downgradient Nitrates in Ground Water

SITE NAME: Smith Subdivisions
COUNTY: L&C
Permit #: MTX000268
NOTES: Projected nitrates in receiving ground water downgradient from discharge structure
Projected to be lower than the most restrictive surface water significance criteria and trigger value (see notes)

Distance from Discharge Structure	(K) Hydr. cond. (ft/day)	(I) Hydr. grad. (ft/ft)	(D) Mix zone thick (feet)	(L) Down grad. distance (feet)	(Ng) Back-ground nitrate (mg/l)	(Y) Drain-field width (feet)	(Ql) Effluent per source (ft3/day)	(Ne) Effluent TN conc. (mg/l)	(W) Down-grad. width (feet)	(Am) Mix zone area (ft^2)	(As) Mix. zone surface area (ft^2)	(Qg) Ground water flow (ft3/day)	(Qe) Effluent flow (ft3/day)	Nt Projected nitrate (N) (mg/l)
Outfall 001														
500 feet	257	0.005400	15	500	0.01	522	2874	26.0	610	9143	304750	12688	2874	**4.81**

REV. 10/2015

NOTES:

Circular DEQ 7: Ground Water Human Health Standard = 10 mg/L
Circular DEQ 7: Trigger Value in determining significant activities = 5 mg/L
ARM 17.30.715: Significance Criteria for determining nonsignificant changes in surface water = 7.5 mg/L

BY: C. Boe
DATE: 05/17/23

= Projected downgradient nitrates
= Projection data adjustments
= Wastewater treatment system and drainfield data
= Hydrogeology and mixing zone data
= Auto calculations

Hydr. cond. =	*K*	Hydraulic Conductivity
Hydr. grad. =	*I*	Hydraulic Gradient
Mix zone thick =	*D*	Thickness of Mixing Zone (Standard mixing zone is typically 15ft)
Down grad. distance	*L*	Mixing Zone Length, or if less, the distance to the nearest downgradient source.
Drainfield width =	*Y*	Width of Drainfield Perpendicular to Ground Water Flow
Background nitrate =	*Ng*	Background Nitrate (as Nitrogen) Concentration
Nitrate in precip. =	*Nr*	Nitrate (as Nitrogen) Concentration in Precipitation (usually constant at 1.0 mg/L)
Effluent Nitrate conc.	*Ne*	Total Nitrogen concentration in treated effluent
# single family home:	*#I*	Number of Single Family Homes on the Drainfield (leave as 1 if effluent volume in next column is adjusted to equal total effluent from drainfield)
Effluent per drain. =	*Ql*	Quantity of Effluent from drainfield
Annual precip. =	*P*	Annual local Precipitation
Percent precip recha	*V*	Percent of Precipitation Recharging Ground Water (usually constant at 0.2)
Down grad. width =	*W*	Width of Mixing Zone Perpendicular to Ground Water Flow = (0.175)(L) + (Y)
Mix zone area =	*Am*	Cross Sectional Area of Aquifer Mixing Zone = (D)(W)
Mix zone surface are	*As*	Surface Area of Mixing Zone = (L)(W)
Ground water flow =	*Qg*	Ground Water Flow Rate = (K)(I)(Am)
Recharge flow =	*Qr*	Recharge Flow Rate = (As)(P/12/365)(V)
Effluent flow =	*Qe*	Effluent Flow Rate = (#I)(Ql)
Resulting nitrate (N)	*Nt*	Nitrate (as Nitrogen) Concentration at End of Mixing Zone = ((Ng)(Qg) + (Nr)(Qr) + (Ne)(Qe)) / ((Qg) + (Qr) + (Qe)) (or nitrate concentration to use as background nitrate for next downgradient drainfield when determining cumulative effects)

GW Velocity and Travel Time

GW_v= K*I/n Darcy's Law

K =	257	ft/day		
I =	0.0054	ft/ft		
n =	0.13	low (range)		
	0.44	high		
Distance =	24816	ft		
GW_v =	**3.15**	**to**	**10.68**	**ft/day**
t =	**7868**	**to**	**2325**	**days**
	22	**to**	**6**	**years**

t	*travel/residence time*
GW_v	*ground water velocity*
K	*Hydraulic Conductivity*
I	*Hydraulic Gradient*
n	*Porosity (effective)*

Effective Porosity (Woessner)		
Type of Bedrock/ Unconsolidated Sediment Type	Range of n	
Limestone/Dolomite	0.01	0.24
Sandstone	0.10	0.30
Siltstone	0.21	0.41
Clay	0.01	0.18
Silt	0.01	0.39
Sand, fine	0.01	0.46
Sand, medium	0.16	0.46
Sand, course	0.18	0.43
Gravel	0.13	0.44

Notes:

Conservative, equation considers only horizontal movement

Distance = feet to downgradient (gaining) surface water

Time = travel/residence time in the aquifer

Effective porosity is based on aquifer lithology

Choose porosity based on the primary (major) sediment of the matrix

Use both the low and high porosity values (when a range is provided)

Brady and Weil, 2002

Woessner and Poeter, 2021

Lake Helena is 4.7 miles away

GRAVEL sandy

First-Order Denitrification Rate for Nitrogen (Horizontal Flow)

0.004 to 2.27	1/day	McCray, Kirkland
0.0065	1/day @ 25th percentile	DEQ, Regensburger

0.30 mg/L Typical N standard for surface water (future beneficial uses)
0.01 mg/L Typical detection level (LRL/RRV)

Time for Reduction to 0.3 mg/L		
$[A]_o$	26	mg/l
$[A]_t$	0.3	mg/l
k	0.0065	1/day
t	**686**	days
Distance for Reduction to 0.3 mg/L		
GW_v min	3.15	ft/day
GW_v max	10.68	ft/day
Distance min	**2162**	**ft**
Distance max	**7332**	**ft**

Time for Reduction to 1.0 mg/L		
$[A]_o$	26	mg/l
$[A]_t$	1.0	mg/l
k	0.0065	1/day
t	**501**	days
Distance for Reduction to 0.01 mg/L		
GW_v min	3.15	ft/day
GW_v max	10.68	ft/day
Distance min	**1579**	**ft**
Distance max	**5353**	**ft**

Notes:
LRL = lab reporting level
RRV = DEQ Circular 7 required reporting value
Conservative, equation considers only horizontal movement

Brady and Weil, 2002
Kirkland, 2001
Martin and Focht, 1977
McCray et al., 2005
McCray et al., 2009
Parry et al., 2000
Woessner and Poeter, 2020

26 mg/L Comparable Level 2 (capable of 24)
1.0 mg/L Conservative ambient nitrates in aquifer

TIME/DISTANCE FOR REDUCTION FROM 24 TO 0.3 mg/l			
frequency from CFD plots	First-Order Denitrification Rate (1/day)	Time (days)	Distance (@ velocity = 1 ft/d) (ft)
10th	0.0021	2086	2086
25th	0.0065	674	674
50th	0.0415	105	105

Total Reduction		
$[A]_o$	26	
$[A]_{t\text{-}max}$	0.3	
$[A]_{t\text{-}min}$	1	
Range of Reduction %		
	98.85	**96.2**

Integrated Rate Law - First Order Reaction

$\ln[A]_t - \ln[A]_o = -kt$

$(\ln[A]_t - \ln[A]_o) / -k = t$

ln *natural log*
$[A]_o$ *Initial concentration*
$[A]_t$ *Future concentration*
$[A]_{tr}$ *Estimated downgradient concentration*
t *travel/residence time*
k *decay rate constant*
GW_v *ground water velocity*

Rearranged to graph line
First order decline = straight line
y = mx + b
$\ln[A]_t = -kt + \ln[A]_o$

Exempt Conventional Systems - In Comparison to Existing Project Proposal

Current Proposal: Centralized wastewater system with advanced treatment capabilities.

Alternative Proposal: A decentralized subdivision with multiple smaller wastewater systems containing conventional (septic) treatment.[(1)]

Design of Current Centralized Project		
Average Design Capacity	21,500	gpd
Estimated Effluent Concentration	26	mg/L
Equivalent Discharge Load	4.66	lbs/day
	1702	lbs/year

Alternative Permit Excluded Systems - Cumulative			
21,500	gpd		
min		max	
52	mg/L	68	mg/L
9.32	lbs/day	12.19	lbs/day
3403	lbs/year	4450	lbs/year

Comparison - Alternative Increase in Nitrogen		
100	**% Min**	*double*
162	**% Max**	*approaching tripple*
4.66	**lbs/day Min**	
7.53	**lbs/day Max**	
1,702	**lbs/year Min**	
2,749	**lbs/year Max**	

Household Characteristics

300	*gpd*	*Design average household flow (DEQ Circular 4, average 3 bedroom house)*		
54	*mg/L*	*maintained septic system, general DEQ estimate*		
52	*mg/L*	*68 mg/L*		*Range provided by McCray (Kirkland, 2001)*
(8)	*%*	*Comparison of proposed treatment to a Level 2 system*		
26	*mg/L*	*Comparable Level 2 (capable of 24)*		

Notes:

(1) Smaller wastewater systems with a design of less than 5,000 gpd are excluded from obtaining permit coverage under the Ground Water Pollution Control System program.

USEPA, EPA/625/R-00/008 lists effluent N at 40-100 mg/L.

Kirkland, 2001
McCray et al., 2005
McCray et al., 2009
Woessner and Poeter, 2020

APPENDIX C – AQUIFER PUMP TEST

HydroSolutions

MEMORANDUM

Date: January 10, 2023

To: Ryan Casne, P.E., Casne and Associates

From: David Baldwin, Sr. Hydrogeologist and Rye Svingen, Environmental Scientist
HydroSolutions Inc

Subject: Kim Smith Canyon Ferry Road Site, Aquifer Testing, Data Analysis, and Hydraulic Conductivity Determination

Introduction

HydroSolutions, Inc (HydroSolutions) conducted an aquifer test at the Kim Smith Canyon Ferry Road Site located at S18, T10 N, R02 W NW4SE4 near East Helena, Montana. The pumped well was GWIC well #302097 (MW2) and the Observation well was GWIC well #302098 (MW3). The observation well is located about 450 feet east of the pumping well as shown on the attached Figure 1 Site Map. Well logs are provided in Attachment A.

This memorandum presents the methods and results of HydroSolutions' aquifer test and analysis of aquifer test data to determine hydraulic conductivity (K) at the site. This work was authorized by Kim Smith through Casne and Associates.

Summary of Testing and Analysis

A submersible pump was set in the pumping well at a depth of approximately 75 feet below the top of casing (btoc) and a transducer was placed near the top of the pump. The 24.4-hour aquifer test was initiated on November 30, 2022, at 11:48 AM.

Water levels were measured and recorded in the pumping well using an In-Situ Level TROLL 500 100 psi and in the observation well using an In-Situ Level TROLL 500 100 psi data-logging pressure transducers. Pumping rate was measured and recorded using a 2-inch SeaMetrics magnetic flow meter. Discharge water was conveyed via flexible 2-inch hose approximately 100 feet west of the well head (Figure 1) where it flowed on the ground which was frozen at the time. The pumping well was pumped for 24.4 hours at an average rate of 10.8 gallons per minute (gpm). During this test, drawdown in the pumping well was 1.45 feet with 0.06 feet of drawdown in the observation well. Results are summarized in Table 1. The drawdown data are included in Attachment D.

After the pump was turned off water level in the pumping well recovered to 90%.. A second pumping test was initiated in MW2 on December 1, 2022, at 12:47 PM. The same water level and discharge measurement equipment listed above was utilized in the second test. The pumping well was pumped for 4.8 hours at an average rate of 33.9 gpm.

The second pumping test at an increased pumping rate was initiated in an attempt to gain a greater response in the observation well. Response in the observation well was minimal with no clear drawdown curve to match. Data from this second pumping test was not used to determine hydraulic conductivity at the site.

The observation well (MW3) is located approximately 450 feet east of the pumping well (MW2). The well logs indicate the pumping well is completed at a total depth of 100 feet and the observation well is completed at a total depth of 80 feet. Both wells are completed with torch cuts in the bottom 20 feet, in the same gravel aquifer. The observation well responded to pumping with a maximum of 0.0.06 feet of drawdown.

Aquifer test data were analyzed with AQTESOLV (Duffield, 2007) aquifer test analysis software. Based well completions in a sand and gravel layer in the Helena Valley Aquifer, the aquifer is determined to be unconfined. Based on this determination, the Theis (Theis, 1935) drawdown method for unconfined aquifers and the Cooper-Jacob solution (1935) residual drawdown solutions were utilized. Additionally, the Theis and Copper-Jacob recovery solutions were utilized. At the start of the pumping test, the static water level was 46.8 feet, giving an aquifer thickness (b) of 53.2 feet. Static water level measured in the observation well prior to pumping was 44.2 feet.

Aquifer Test Analysis Results

A summary of test results and estimated parameters are presented in Tables 1 and 2. Due to very little response and no clear drawdown curve in the observation well, storativity was not determined. Hydrographs covering the testing period are included in Attachment A and graphical curve matching results are provided in Attachment B.

Table 1. Summary of aquifer testing results.

Well	Pumping Duration (hours)	Maximum Drawdown (feet)	Rate (gpm)	Specific Capacity (gpm/ft)
Pumping Well (GWIC #302097)	24.4	1.45	10.8	7.45
Observation Well (GWIC #302098)		0.06		

gpm: gallons per minute

Table 2. GWIC #302097 well estimated aquifer parameters.

Solution	Saturated thickness [a] (feet)	Transmissivity ($feet^2$/day)	Hydraulic Conductivity (feet/day)	Storage Coefficient/Specific Yield
Theis (unconfined)	53.2	12,650	238	Not Estimated
Cooper-Jacob (unconfined)	53.2	9,027	170	Not Estimated
Theis Recovery (unconfined)	53.2	18,310	344	Not Estimated
Cooper-Jacob Agarwal Recovery (unconfined)	53.2	14.800	278	Not Estimated
Average		13,697	257	

[a] Estimated from drillers log.

As shown, average transmissivity (T) is 13,697 ft^2/day. A high T value reflects the low drawdown and rapid recovery seen in the pumping well (Attachment A). The average K value is 257 ft/day and is within the range of typical hydraulic conductivities for fine to coarse gravel (Driscoll, 1989, pg. 75).

References

Cooper, H.H., and C.E. Jacob, 1946. Solution for a Pumping Test in an Unconfined Aquifer

Driscoll, Fletcher G., 1989, Groundwater and Wells, Johnson Filtration Systems, St. Paul MN.

Duffield, Glenn M. 2007. AQTESOLV for Windows. HydroSolve, Inc.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

Attachments

Attachment A: Hydrograph showing groundwater level at site during testing period.

Attachment B: Aquifer test analysis curve matches.

Attachment C: Well logs

Attachment D: Groundwater level data during testing period (Excel File)

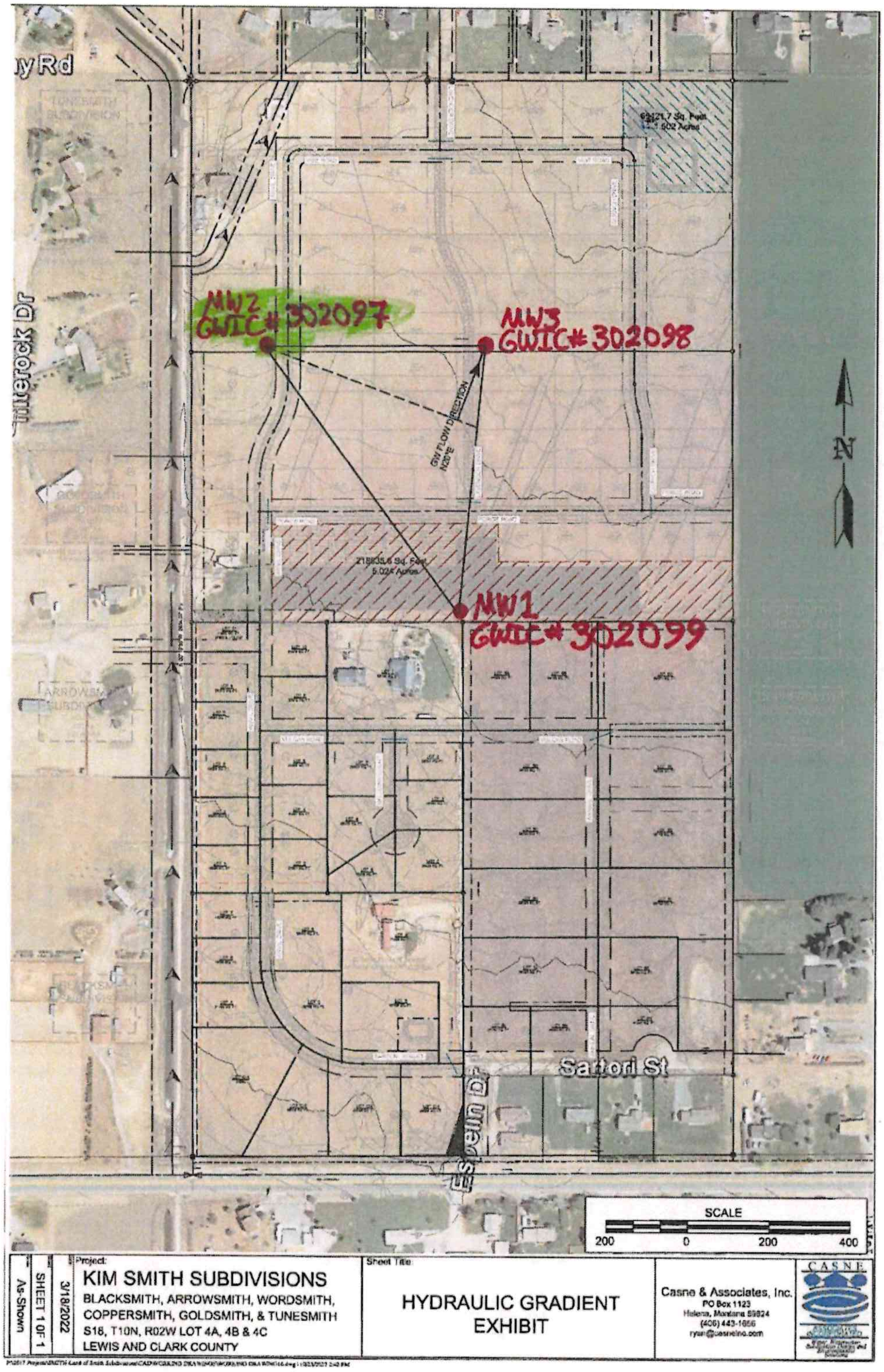
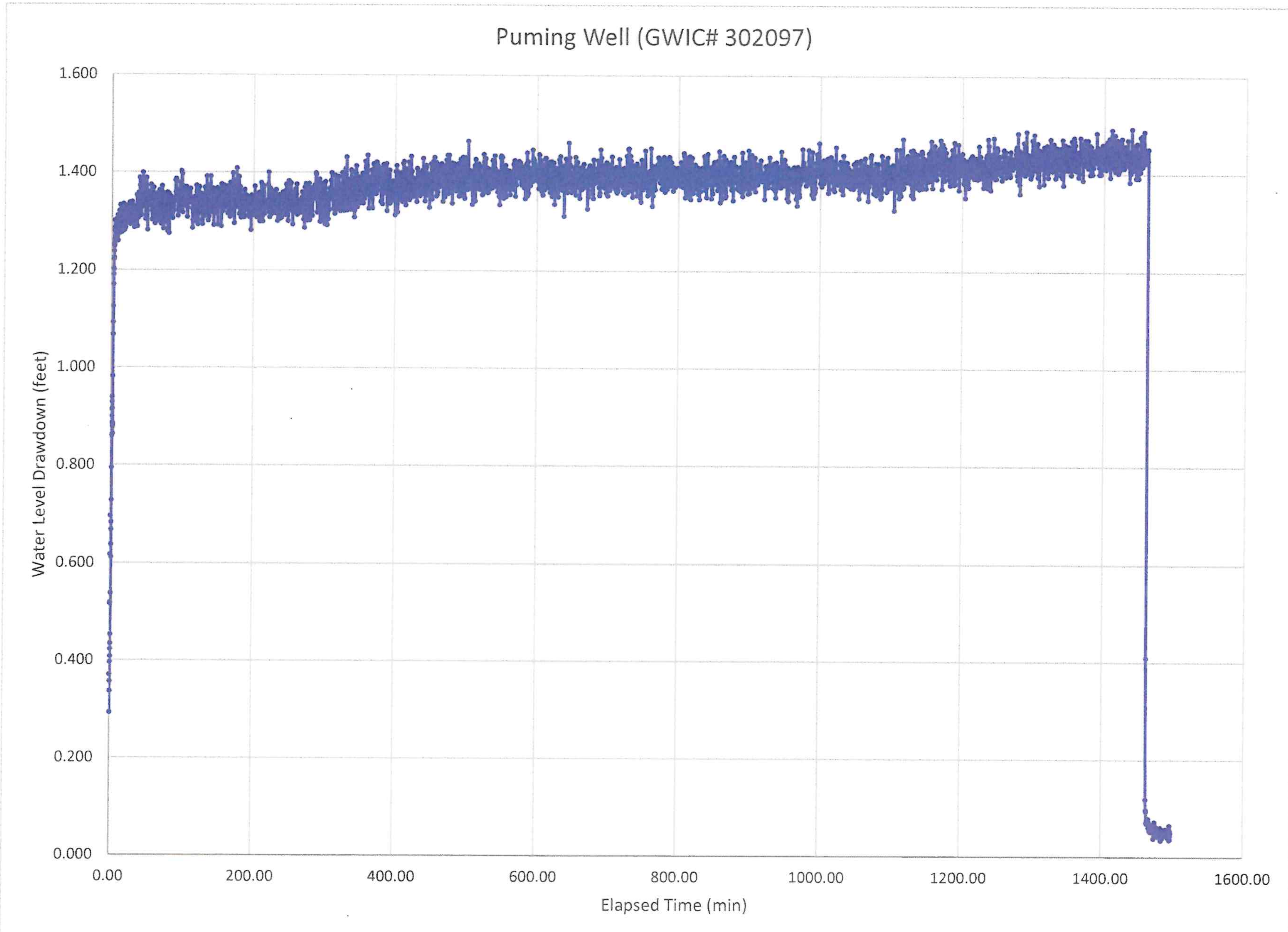


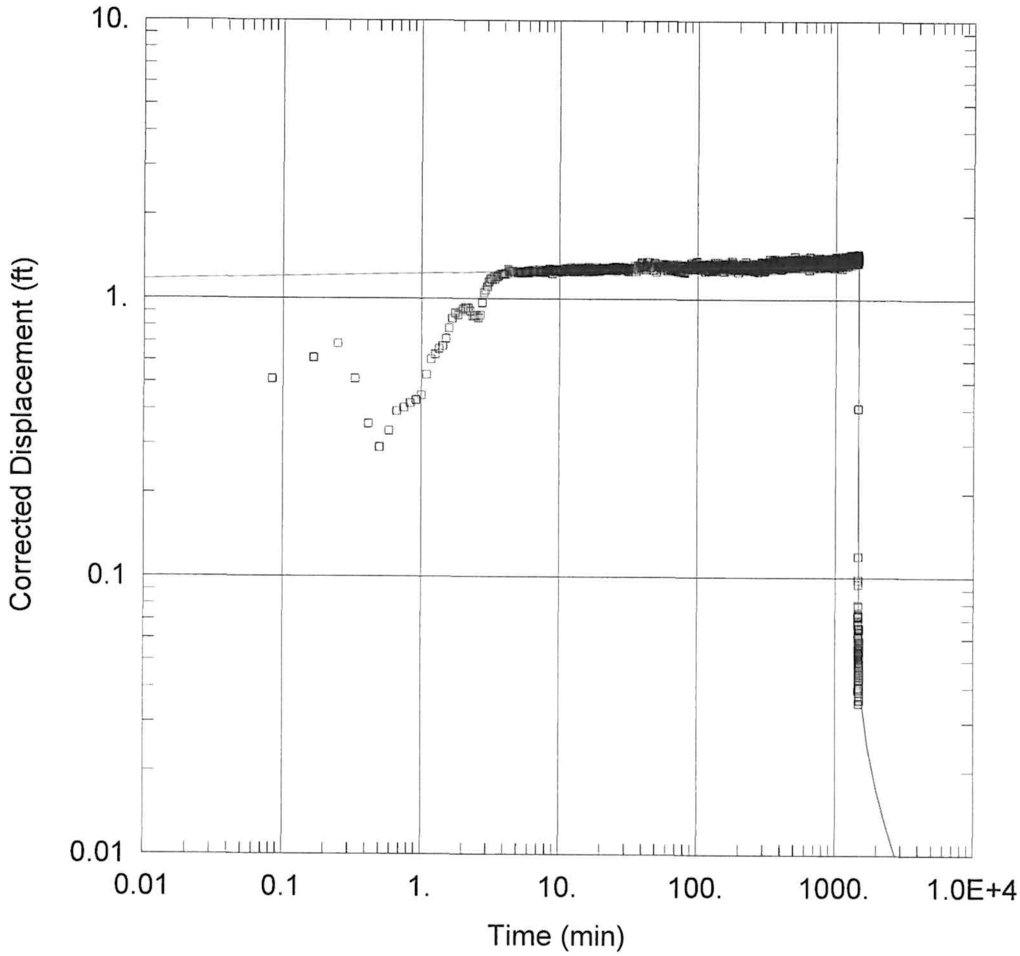
Figure 1. Site Map

Attachment A: Hydrograph showing groundwater level at site during testing period.



Puming Well (GWIC# 302097)
Water Level Drawdown (feet)
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
0.00
200.00
400.00
600.00
800.00
1000.00
1200.00
1400.00
1600.00
Elapsed Time (min)

Attachment B: Aquifer test analysis curve matches.



PRELIMINARY EVALUATION

Data Set: S:\Projects\Casne\KimSmith\CanyonFerryRd\mm\DB\Smith CF_Rd_Theis_DB.aqt
Date: 01/10/23 Time: 11:58:22

PROJECT INFORMATION

Company: HydroSolutions
Client: Casne & Assoc
Project: Kim Smith
Location: Canyon Ferry Rd
Test Date: 11/30/22

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW (#302099)	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ PW (#302099)	0	0

SOLUTION

Aquifer Model: Unconfined

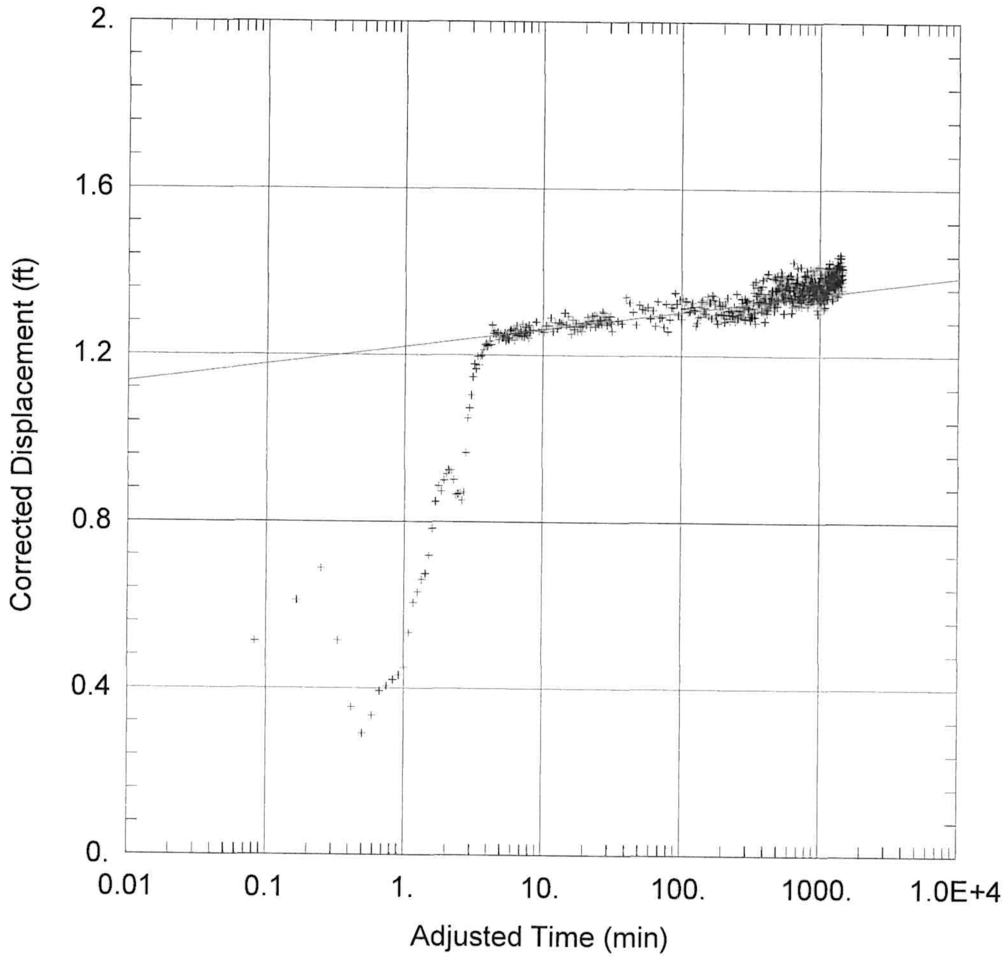
Solution Method: Theis

T = 1.265E+4 ft^2/day

Kz/Kr = 0.1

S = 2.4E-40

b = 30. ft



HYDRAULIC CONDUCTIVITY EVALUATION

Data Set: S:\Projects\Casne\KimSmith\CanyonFerryRd\mm\DB\Smith CF_Rd_CJ_DB.aqt
Date: 01/10/23 Time: 11:57:01

PROJECT INFORMATION

Company: HydroSolutions
Client: Casne & Assoc
Project: Kim Smith
Location: Canyon Ferry Rd
Test Date: 11/30/22

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW (#302099)	0	0

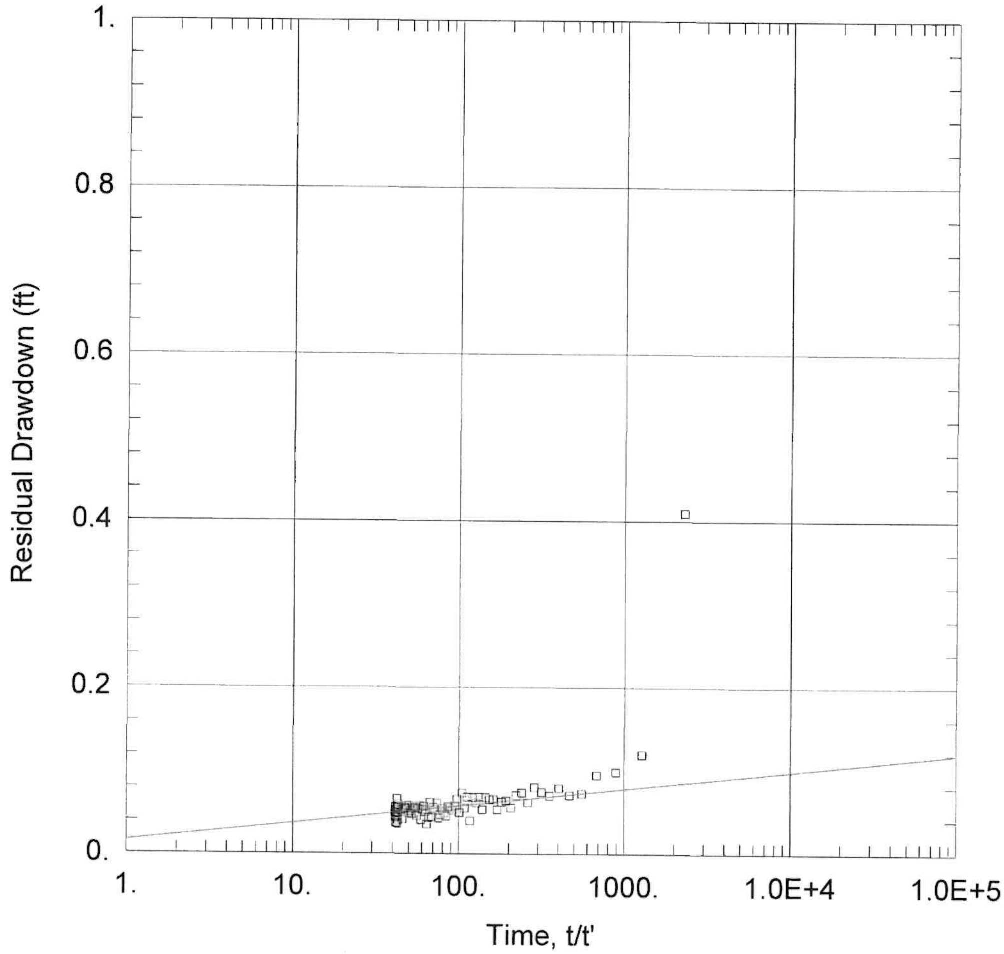
Observation Wells

Well Name	X (ft)	Y (ft)
+ PW (#302099)	0	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 9020.7 ft^2/day S = 1.796E-28



HYDRAULIC CONDUCTIVITY EVALUATION

Data Set: S:\Projects\Casne\KimSmith\CanyonFerryRd\mm\DB\Smith CF_Rd_Theis Recov_DB.aqt
Date: 01/10/23 Time: 11:57:39

PROJECT INFORMATION

Company: HydroSolutions
Client: Casne & Assoc
Project: Kim Smith
Location: Canyon Ferry Rd
Test Date: 11/30/22

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW (#302099)	0	0

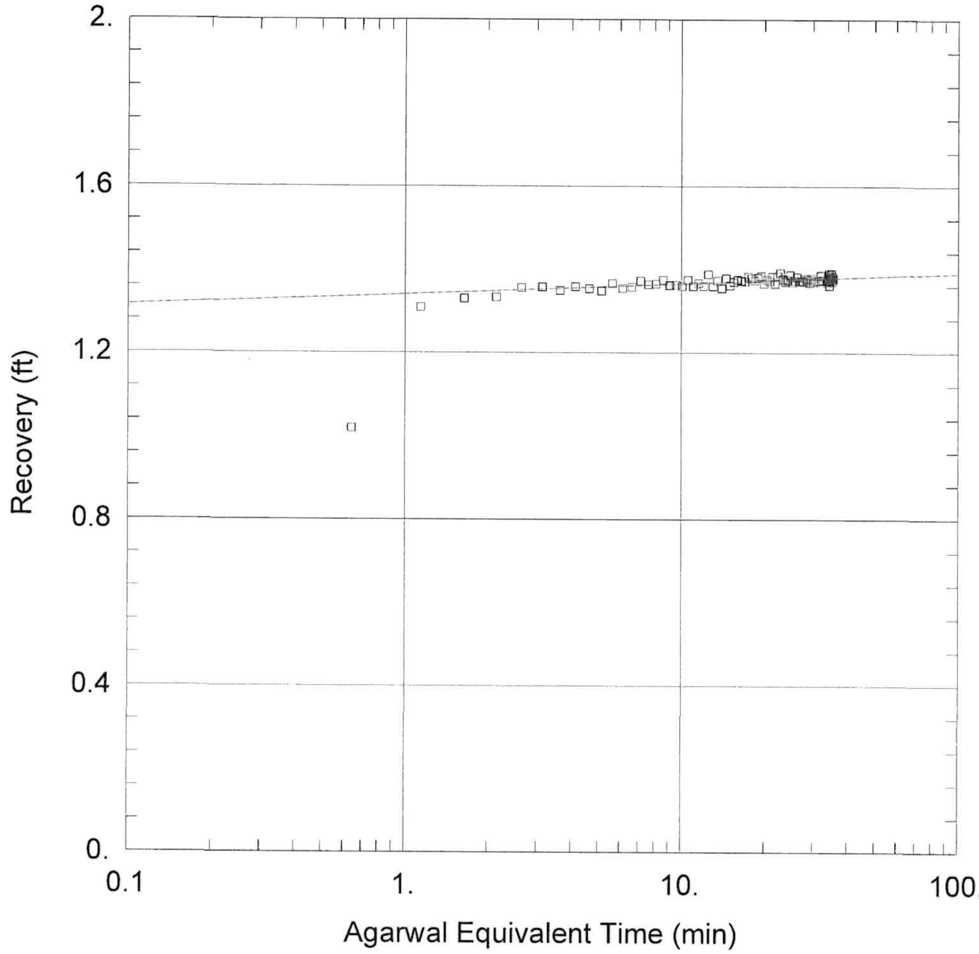
Observation Wells

Well Name	X (ft)	Y (ft)
□ PW (#302099)	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 1.831E+4 ft^2/day S/S' = 0.1745



HYDRAULIC CONDUCTIVITY EVALUATION

Data Set: S:\Projects\Casne\KimSmith\CanyonFerryRd\mm\Smith CF_Rd_recov_ararwal.aqt
Date: 01/10/23 Time: 11:59:32

PROJECT INFORMATION

Company: HydroSolutions
Client: Casne & Assoc
Project: Kim Smith
Location: Canyon Ferry Rd
Test Date: 11/30/22

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW (#302099)	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ PW (#302099)	0	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 1.48E+4 ft^2/day S = 1.99E-51

Attachment C: Well logs

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View scanned well log (7/17/2019 8:19:21 AM)

MW1

(1)

Site Name: KIM SMITH PROPERTIES
GWIC Id: 302099

Section 1: Well Owner(s)
1) KIM SMITH PROPERTIES (MAIL)
7510 APPLEGATE DR
HELENA MT 59602 [06/26/2018]

Section 2: Location

Township	Range	Section	Quarter Sections
10N	02W	18	SW¼ NW¼ SE¼

County	Geocode
LEWIS AND CLARK	

Latitude	Longitude	Geomethod	Datum
46.62201294925	-111.9031098525	TRS-SEC	NAD83

Ground Surface Altitude	Ground Surface Method	Datum	Date

Addition	Block	Lot
		2-A

Section 3: Proposed Use of Water
MONITORING (1)

Section 4: Type of Work
Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date
Date well completed: Tuesday, June 26, 2018

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	25	10
25	82	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.5	80	6	0.25		WELDED	STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
60	80	6	18	0.25 X 3	TORCH OR PLASMA CUTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	0	BENTONITE	Y

Section 7: Well Test Data

Total Depth: 80
Static Water Level: 52
Water Temperature:

Air Test *

15 gpm with drill stem set at 80 feet for 1 hours.
Time of recovery 1 hours.
Recovery water level 52 feet.
Pumping water level _ feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log

Geologic Source
Unassigned

From	To	Description
0	77	SANDY GRAVEL
77	82	SANDY CLAY

Driller Certification

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: JACK CLARK
Company: WESTERN WATER WELLS
License No: WWC-697
Date Completed: 6/26/2018

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View scanned well log (7/17/2019 8:18:30 AM)

Site Name: KIM SMITH PROPERTIES
GWIC Id: 302097

MW2

(2)

Section 1: Well Owner(s)

1) KIM SMITH PROPERTIES (MAIL)
7510 APPLEGATE DR
HELENA MT 59602 [06/27/2018]

Section 2: Location

Township	Range	Section	Quarter Sections
10N	02W	18	SW¼ NW¼ SE¼

County	Geocode
LEWIS AND CLARK	

Latitude	Longitude	Geomethod	Datum
46.62201294925	-111.9031098525	TRS-SEC	NAD83

Ground Surface Altitude	Ground Surface Method	Datum	Date

Addition	Block	Lot
		2-A

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Wednesday, June 27, 2018

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	25	10
25	100	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.5	97.5	6	0.25		WELDED	STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
80	100	6	18	0.25 X 3	TORCH OR PLASMA CUTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	0	BENTONITE	Y

Section 7: Well Test Data

Total Depth: 100
Static Water Level: 50
Water Temperature:

Air Test *

30 gpm with drill stem set at 100 feet for 1 hours.
Time of recovery 1 hours.
Recovery water level 50 feet.
Pumping water level _ feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log

Geologic Source
Unassigned

From	To	Description
0	100	SANDY GRAVEL

Driller Certification

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: JACK CLARK
Company: WESTERN WATER WELLS
License No: WWC-697
Date Completed: 6/27/2018

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View scanned well log (7/17/2019 8:19:03 AM)

Site Name: KIM SMITH PROPERTIES
GWIC Id: 302098

MW3
(3)

Section 1: Well Owner(s)

1) KIM SMITH PROPERTIES (MAIL)
7510 APPLEGATE DR
HELENA MT 59602 [06/26/2018]

Section 2: Location

Township	Range	Section	Quarter Sections
10N	02W	18	SW¼ NW¼ SE¼

County	Geocode
LEWIS AND CLARK	

Latitude	Longitude	Geomethod	Datum
46.62201294925	-111.9031098525	TRS-SEC	NAD83

Ground Surface Altitude	Ground Surface Method	Datum	Date

Addition	Block	Lot
		2-A

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Tuesday, June 26, 2018

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	25	10
25	80	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.5	78.5	6	0.25		WELDED	STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
60	80	6	18	0.25 X 3	TORCH OR PLASMA CUTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	0	BENTONITE	Y

Section 7: Well Test Data

Total Depth: 80
Static Water Level: 49
Water Temperature:

Air Test *

_20_ gpm with drill stem set at _80_ feet for _1_ hours.
Time of recovery _1_ hours.
Recovery water level _49_ feet.
Pumping water level _ feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	80	SANDY GRAVEL

Driller Certification

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: JACK CLARK
Company: WESTERN WATER WELLS
License No: WWC-697
Date Completed: 6/26/2018

Attachment D: Groundwater level data during testing period (Excel File)

Scale	Sheet	Date	Project:	Sheet Title:		
As-Shown	SHEET 1 OF 1	7/30/2018	ARROWSMITH, BLACKSMITH, WORDSMITH, COPPERSMITH SUBDIVISION S18, T10N, R02W LOT 4B COS 3092693 LEWIS AND CLARK COUNTY	MONITORING WELL EXHIBIT	Casne & Associates, Inc. PO Box 1123 Helena, Montana 59624 (406) 443-1656 ryan@casneinc.com	CASNE ASSOCIATES INCORPORATED Water, Wastewater, Subdivision Design and Environmental Solutions

P:\2017 Projects\SMITH-Land of Smith Subdivisions\CAD\WORKING DRAWINGS\HYDRAULIC GRAD CALC 2.dwg 4/7/2021 2:28 PM

Hydraulic Gradient Three Point Solution Worksheet

Instructions to determine groundwater (GW) gradient and flow direction based on static water elevations (SWE) of 3 wells.

SITE NAME: LAND OF SMITH

A. Record elevation difference and horizontal distances (HD) between the wells:

Well	Topographic Elevation (ft)		Depth to Static Water (ft bgs*)		SWE (ft)	Wells		HD (ft)
#1	3780.73	-	49	=	3731.73	#1 to #2	=	809.73
#2	3777.48	-	46.8	=	3730.68	#2 to #3	=	541.04
#3	3775.62	-	45.4	=	3730.22	#3 to #1	=	662.56

* bgs = below ground surface

B. Plot the well locations on a scaled diagram

SCALE: ______" = ______'

C. Perform the following calculations:

1. Calculate the position between the High Static Water Elevation (HSWE) well and the Low Static Water Elevation (LSWE) well where the SWE is the same as the Intermediate Static Water Elevation (ISWE).

(a) HSWE 3731.73 minus LSWE 3730.22 = (a) 1.51 (ft)

(b) Horizontal distance between HSWE well and LSWE well 662.56 divided by (a) 1.51

= (b) 438.78 (ft/ft)

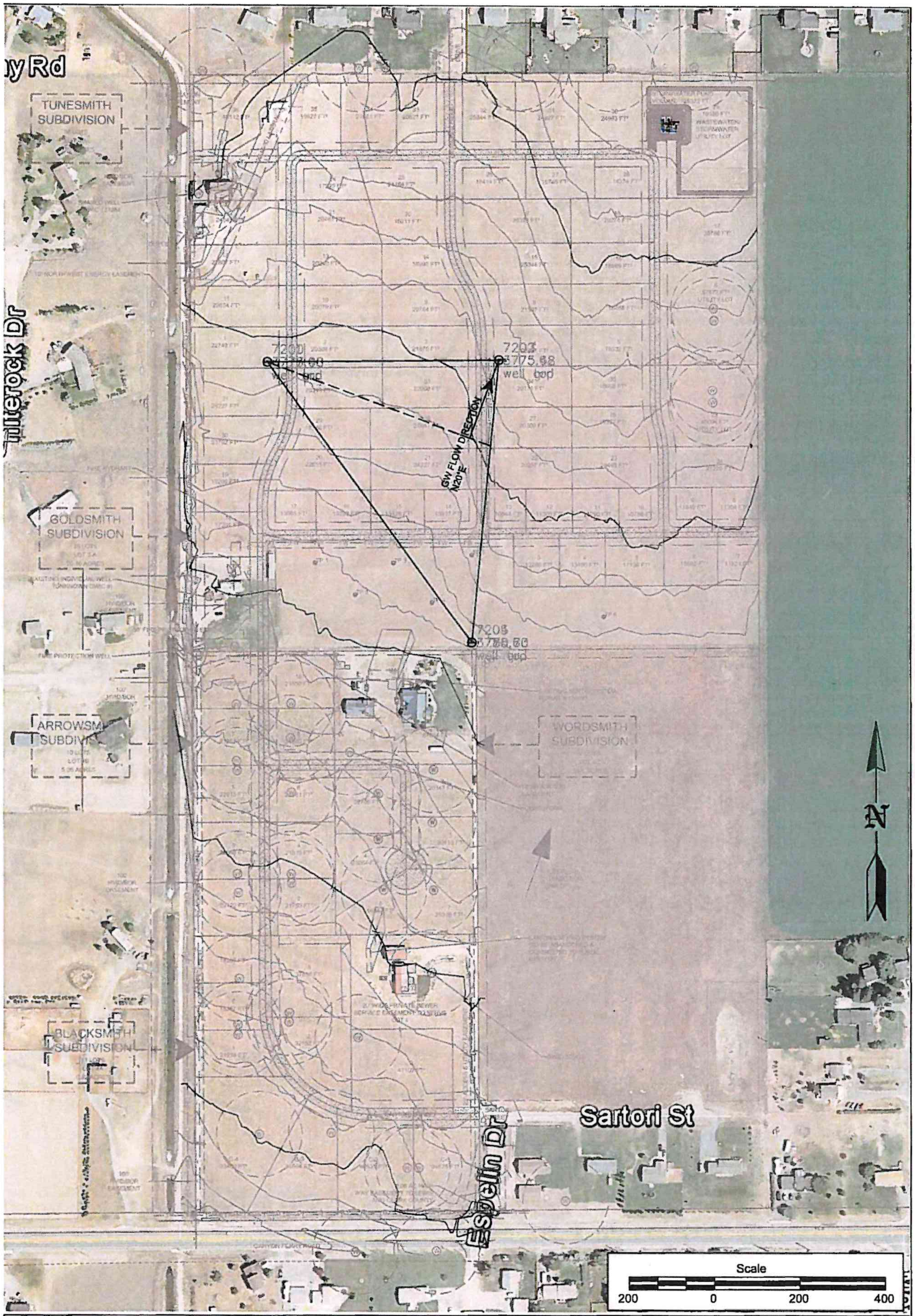
(c) HSWE 3731.73 minus ISWE 3730.68 = (c) 1.05 (ft)

(d) (b) 438.78 x (c) 1.05 = (d) 460.71 (ft) (= the horizontal distance between the HSWE well and LSWE well that is equal to the ISWE).

2. Measure the distance (d) from the HSWE well along the line between it and the LSWE well, and plot that position on the diagram.
3. Draw a straight line from the ISWE well to position (d) on the well location diagram. This represents the water level contour line along which the SWE is the same as the ISWE well.
4. Draw a line perpendicular to the ISWE contour line through the HSWE well location on the well location diagram. This is the ground water flow direction (high to low). The distance along this groundwater flow line from the HSWE well to the ISWE contour line is (e).

D. Calculate the Hydraulic Gradient (HG) of the groundwater by dividing (c) by (e).

(c) 1.05 divided by (e) 194.94 = HG 0.005386 (ft/ft)



7/30/2018

SHEET 1 OF 1

As-Shown

Project:

ARROWSMITH, BLACKSMITH, WORDSMITH, COPPERSMITH SUBDIVISION

S18, T10N, R02W LOT 4B COS 3092693

LEWIS AND CLARK COUNTY

Sheet Title:

HYDRAULIC GRADIENT EXHIBIT

Casne & Associates, Inc.
PO Box 1123
Helena, Montana 59624
(406) 443-1656
ryan@casneinc.com

Appendix E

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

NITRATE SENSITIVITY ANALYSIS

REVISED JANUARY 2023

SITE NAME: Smith Subdivisions - LCC
COUNTY: Lewis & Clark
LOT #: All Lots
NOTES: CENTRALIZED LEVEL 2 WASTEWATER TREATMENT SYSTEM (RSF)
HYDRALIC CONDUCTIVITY BASED UPON 24HR PUMP TEST (GWIC#302097)
SEE ATTACHED MEMORANDUM DATED 1-10-2023 FROM HYDROSOLUTIONS
HYDRAULIC GRADIENT AND FLOW DIRECTION VIA. THREE ONSITE WELLS

VARIABLES	DESCRIPTION	VALUE	UNITS
K	Hydraulic Conductivity	257.00	ft/day
I	Hydraulic Gradient	0.0054	ft/ft
D	Mixing Zone Thickness (usually constant)	15.0	ft
L	Mixing Zone Length (see ARM 17.30.517(1)(d)(viii)	500	ft
Y	Width of Drainfield Perpendicular to Ground Water Flow	522	ft
Ng	Background Nitrate (as Nitrogen) Concentration	0.29	mg/L
Nr	Nitrate (as Nitrogen) Concentration in Precipitation (usually constant)	1.0	mg/L
Ne	Nitrate (as Nitrogen) Concentration in Effluent	24.00	mg/L
#I	Number of Single Family Homes on the Drainfield	160.0	
QI	Quantity of Effluent per Single Family Home	26.70	ft3/day
P	Precipitation	12.6	in/year
V	Percent of Precipitation Recharging Ground Water (usually constant)	0.20	

EQUATIONS			
W	Width of Mixing Zone Perpendicular to Ground Water Flow = (0.175)(L)+(Y)	609.50	ft
Am	Cross Sectional Area of Aquifer Mixing Zone = (D)(W)	9142.50	ft2
As	Surface Area of Mixing Zone = (L)(W)	304750.00	ft2
Qg	Ground Water Flow Rate = (K)(I)(Am)	12655.07	ft3/day
Qr	Recharge Flow Rate = (As)(P/12/365)(V)	175.34	ft3/day
Qe	Effluent Flow Rate = (#I)(QI)	4272.00	ft3/day

SOLUTION

Nt	**Nitrate (as Nitrogen) Concentration at End of Mixing Zone =((Ng)(Qg)+(Nr)(Qr)+(Ne)(Qe)) / ((Qg)+(Qr)+(Qe))**	**6.22**	**mg/L**

BY:
DATE: May 4, 2023

REV. 03/2005

Appendix N

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

PHOSPHOROUS BREAKTHROUGH ANALYSIS

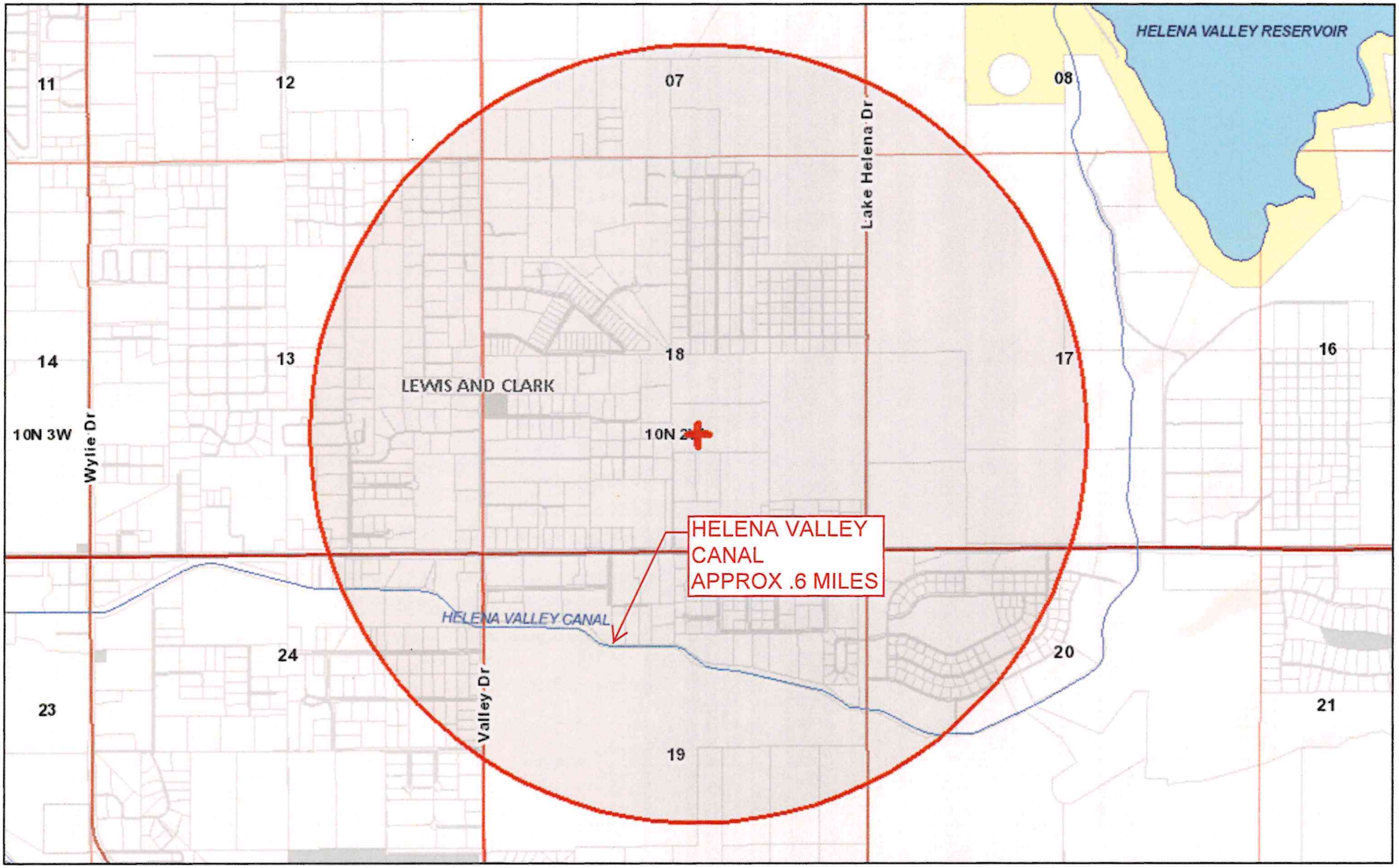
SITE NAME: Smith Subdivisions - LCC
COUNTY: Lewis & Clark
LOT #: All Lots
NOTES: Nearest Surface Water (non-irrigation canal) is Lake Helena
Irrigation canals in the area are losing water bodies as evidenced by the SWL of the shallow ground water (45') versus the surface of the water in the canals

VARIABLES	DESCRIPTION	VALUE	UNITS
Lg	Length of Primary Drainfield as Measured Perpendicular to Ground Water Flow	522.0	ft
L	Length of Primary Drainfield's Long Axis	545.0	ft
W	Width of Primary Drainfield's Short Axis	99.0	ft
B	Depth to Limiting Layer from Bottom of Drainfield Laterals*	5.0	ft
D	Distance from Drainfield to Surface Water	24800.0	ft
T	Phosphorous Mixing Depth in Ground Water (0.5 ft for coarse soils, 1.0 ft for fine soils)**	0.5	ft
Sw	Soil Weight (usually constant)	100.0	lb/ft3
Pa	Phosphorous Adsorption Capacity of Soil (usually constant)	200.0	ppm
#I	Number of Single Family Homes on the Drainfield	160.0	
CONSTANTS			
PI	Phosphorous Load per Single Family Home (constant)	6.44	lbs/yr
X	Conversion Factor for ppm to percentage (constant)	1.0E+06	
EQUATIONS			
Pt	Total Phosphorous Load = (PI)(#I)	1030.40	lbs/yr
W1	Soil Weight under Drainfield = (L)(W)(B)(Sw)	26977500.0	lbs
W2	Soil Weight from Drainfield to Surface Water = [(Lg)(D) + (0.0875)(D)(D)] (T)(Sw)	3338080000.0	lbs
P	Total Phosphorous Adsorption by Soils = (W1 + W2)[(Pa)/(X)]	673011.5	lbs
SOLUTION			
BT	**Breakthrough Time to Surface Water = P / Pt**	653.2	years

BY:
DATE: April 7, 2021

NOTES: ** Depth to limiting layer is typically based on depth to a limiting layer (such as clay, bedrock or water) in a test pit or bottom of a dry test pit minus two feet to account for burial depth of standard drainfield laterals.*
*** Material type is usually based on test pit. A soil that can be described as loam (e.g. gravelly loam, sandy loam, etc.) or finer according to the USDA soil texture classification system is considered a "fine" soil.*

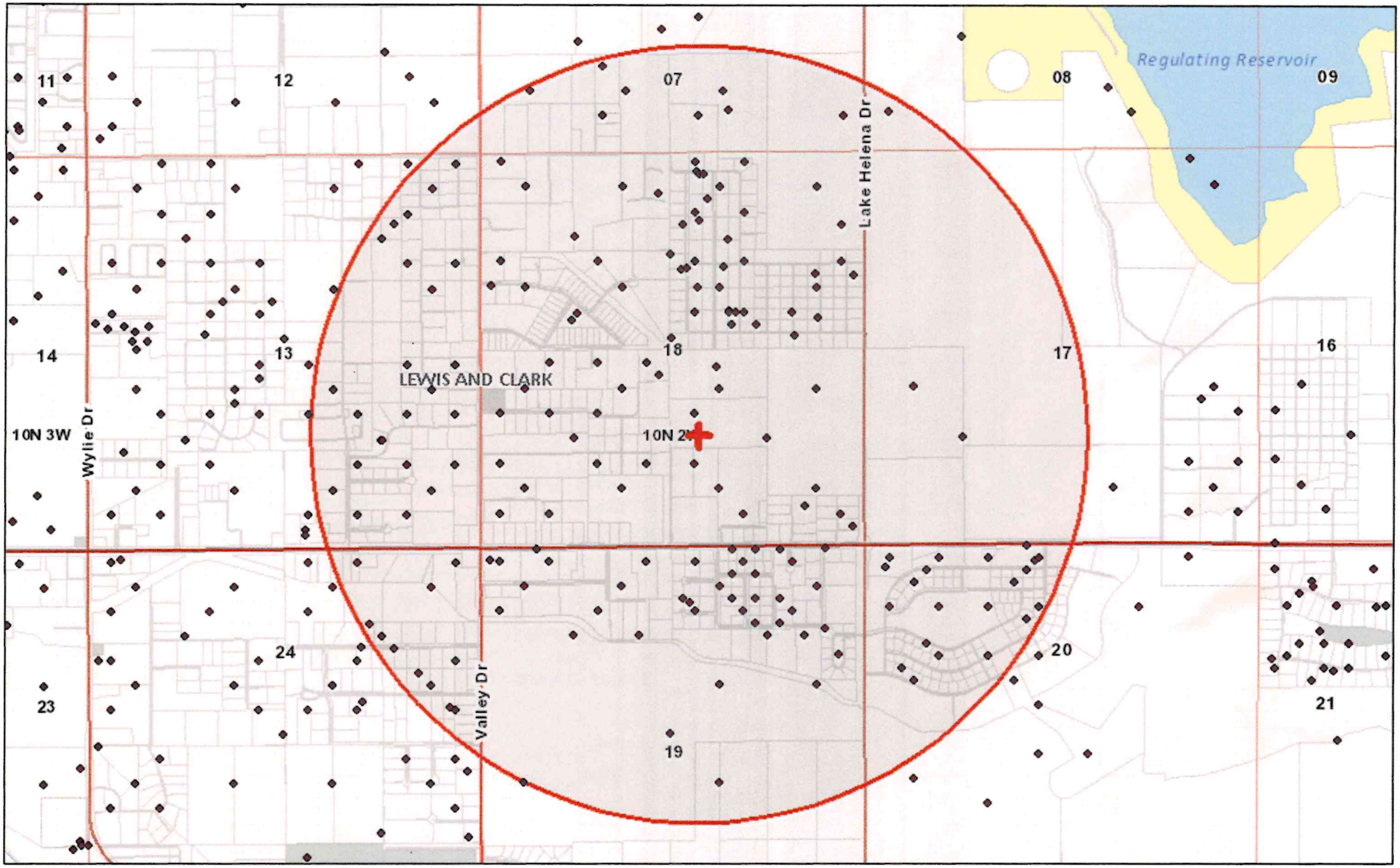
REV. 12/2007



Lakes24K_NamedOnly
Streams24K_NamedOnly

Map created using the Digtal Atlas April 7, 2021
http://msl.mt.gov/GIS/Atlas

Montana State Libary - Digital Library
(406) 444-5354 | geoinfo@mt.gov | http://msl.mt.gov



◆ GWICWELLS

Map created using the Digtal Atlas April 7, 2021
http://msl.mt.gov/GIS/Atlas

Montana State Libary - Digital Library
(406) 444-5354 | geoinfo@mt.gov | http://msl.mt.gov