Quality Assurance Project Plan

Feasibility Study for the Proposed Taneum Creek Managed Aquifer Recharge Pilot Project: Water Quality Components

June 2023

Publication Information

Each study conducted for the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan (QAPP). This QAPP describes the objectives of the Proposed Taneum Creek Managed Aquifer Project feasibility study components.

The final completed QAPP is available at
https://apps.ecology.wa.gov/publications/summarypages/2312011.html

Data for this project will be available on Ecology's Environmental Information Management (EIM) website: https://fortress.wa.gov/ecy/eimreporting/default.aspx; at www.data.wa.gov; and from Project Proponent Kittitas Reclamation District at 509-925-6158. In EIM, search Study ID: KRDMON2023B

Author and Contact Information

For more information contact:

Kat Satnik
Project Manager
Kittitas Reclamation District
315 N. Water St.
Ellensburg, WA 98926
kat@kcwp.org
509-925-6158

Prepared for:

Kittitas Reclamation District
315 North Water Street
Ellensburg, WA 98926

Prepared by:

EA Engineering, Science, and Technology, Inc., PBC
Seattle, WA

Gregory Geologic LLC
Spokane, WA

Jacobs Engineering
Yakima, WA

Cover photo: Kittitas Reclamation District

Accommodation Requests:

To request ADA accommodation, including materials in a format for the visually impaired, call Ecology at 360-407-6631 or visit https://ecology.wa.gov/accessibility. People with impaired hearing may call Washington Relay Service at 711. People with speech disability may call TTY at 877-833-6341.

Quality Assurance Project Plan

Feasibility Study for the Proposed Taneum Creek Managed Aquifer Recharge Pilot Project: Water Quality Components

June 2023

Approved by:

Signature: Urban Eberhart	Date: 7/5/2023
Kittitas Reclamation District – Secretary-Manager Urban Eberhart	
Signature: Kathleen Satnik	Date: 6/26/2023
Kittitas Reclamation District – Project Manager Kat Satnik	
Signature: Guy J Gregory	Date: 6/26/2023
Gregory Geologic LLC- Principal Guy Gregory	
Signature: Jennifer Bader	Date: 7/5/2023
Jacobs – Project Manager Jennifer Bader	
Signature:	Date: 7/7/2023
Office of Columbia River Project Manager and Quality Assurance Coordinator Scott Tarbutton	

*Signatures are not available on the Internet version.

1.0 Table of Contents

List of Figures

List of Tables

2.0 Abstract

This Quality Assurance Project Plan (QAPP) details the source water and receiving water monitoring requirements necessary to conduct a pilot study of the Kittitas Reclamation District's (KRD) proposed Managed Aquifer Recharge (MAR) project associated with Taneum Creek in the Yakima River Basin in Kittitas County, Washington, in support of the Yakima Basin Integrated Plan. The findings of this Pilot Study will be presented in the Taneum Creek MAR site assessment report, under Ecology grant WRYBIP-1921-KittRD-00017.

This characterization is designed to obtain empirical information to evaluate whether the proposed MAR project, when operational, will be protective of ground water quality and will effectively store water diverted to it and the degree to which that water will be retimed to return to Taneum Creek.

The QAPP ensures quality data collection, analysis, reporting, and management of the characterization effort. The pilot test was proposed and funded to determine the hydraulic properties of the alluvial aquifer and water quality response in site wells to project the timing and volume of return flows to Taneum Creek and assess likely water quality effects of managed recharge operations. The proposed MAR project pilot test will gather information on the ability of a permanent project to relieve low flow and high temperature impacts to lower Taneum Creek. Assuming the pilot test is successful, a permanent MAR project at this location has the potential to improve habitat conditions for anadromous fish within Taneum Creek.

3.0 Background

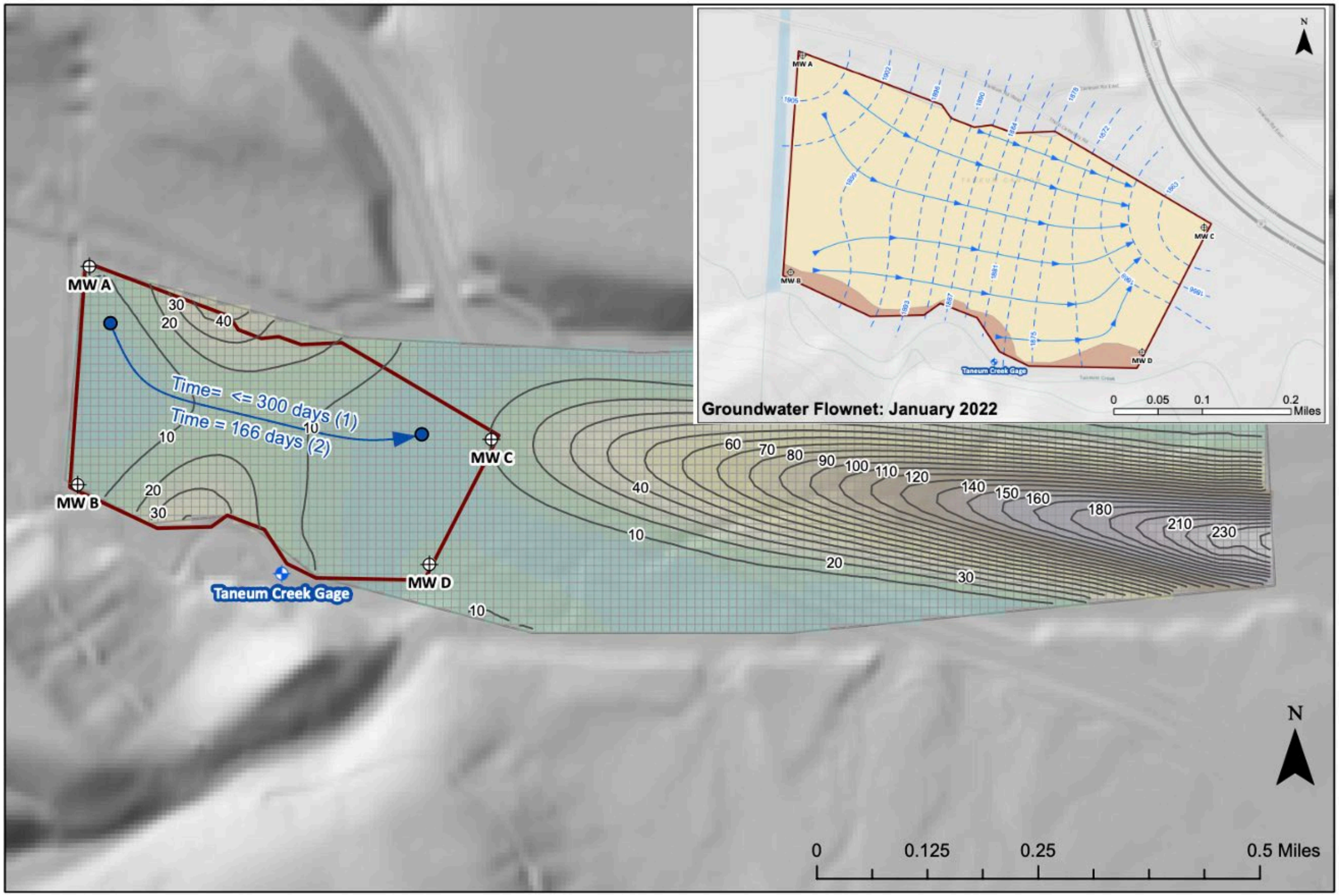
3.1 Introduction

Operational Managed Aquifer Recharge (MAR) projects augment low stream flows by capturing a portion of flood season stream flows or saved water in irrigation systems, then diverting that water to local spreading basins or other infiltration facilities. Once in those facilities, that water migrates through the surficial aquifer and discharges back to the stream later in the year. If timed properly, that water will augment low flows and mitigate high temperatures.

Taneum Creek is a Yakima River tributary located near Thorp in Kittitas County, WA. In 2020, this creek was identified as the highest-ranking site in the valley that is likely-suitable for Managed Aquifer Recharge (MAR) or Aquifer Storage and Recovery (ASR) Projects (EA et. al). Due to the 2020 ranking, KRD developed a project to quantify and assess MAR potential for the Taneum Creek Project Area, which was subsequently funded by a Washington Department of Ecology (Ecology) grant (Grant No. WRYBIP-1921-KittRD-00017; EIM study ID: KRDMON2023) (EA et al., 2022). The project conducts high frequency monitoring of surface flows in Taneum Creek on and near the project area, as well as well water table elevation in site monitoring wells on and near the project area (Figure 1). Surface and ground water measurements are synchronized to facilitate analysis.

During well installation, it became clear that the subsurface geology is a complex system of interbedded gravels, sands, silts, and clays. Traditional methods of hydraulic evaluation might not provide aquifer property information acceptable to the precision for long term decision making. A field-scale pilot test for the area was proposed using water sourced from the KRD canal infrastructure on site. A cursory analytical examination, using available data at the site in the ongoing assessment project, suggests groundwater flow paths, head values, and infiltration medium are adequate to recharge, retain, and retime flows. Flow paths suggest direction of groundwater is towards the Yakima River, rather than Taneum Creek (Figure 2). The potential storage volume of the recharge zone is estimated at greater than 140 acre-feet, based on soil infiltration rates for Soil Group A: Kayak-Weimer Complex, which covers most of the site (Inset map: Figure 2).

Figure 1. Taneum Creek study location



(1) Derived from groundwater gradient*n*k (n=0.27) (k=1.41)(method: Shilling and Wolter, 2006)

(2) Estimates were derived by grad*n*k (n=0.17) (k=0.014 ft/d)

⊕ Monitoring Wells

Site Boundary

Velocity Contour (ft/d)

Figure 2. Analytical evaluation of MAR at the site. Two analytical approaches (1) and (2) were used to estimate travel time of groundwater. Results indicate travel time within the site range up to 300 days (1) and 166 days (2). The inset map shows the groundwater flownet at the site, derived from January 2020 measurements.

Additional funding for the pilot test, added through amendment to the above Grant (Grant no WRYBIP-1921-KittRD-00017), allows evaluation of hydraulic properties of the alluvial aquifer and potential water quality changes due to MAR. The pilot test approach, described in this QAPP, will allow for a scaled MAR response, and provide opportunity to project any potential water quality changes associated with implementing a future MAR project.

The findings of the MAR Pilot Test will provide the empirical information to help assess the feasibility of a MAR project at Taneum Creek, sourced from KRD Canal infrastructure or available spring freshet water from Taneum Creek. A water quality analysis described in this QAPP will also be used to evaluate whether a future proposed MAR project will protect quality of both groundwater and surface water.

Though water quality permits are not required for MAR projects at this time, both groundwater and surface waters of the state need to be protected during the MAR pilot test in accordance with WAC 173-200 and 173-201A. The selected approach to evaluate potential water quality impacts will follow guidance provided by Ecology. This includes characterizing source water quality and ambient groundwater quality. Existing groundwater and surface water quality and TMDL requirements will be evaluated at the project site to identify any potential water quality concerns at the site.

The pilot test QAPP has been prepared according to template provided in Publication 19-10-050, https://fortress.wa.gov/ecy/publications/documents/1910050.pdf.

3.2 Study area and surroundings

The project area is approximately 6 miles northwest of Thorp in Kittitas County, WA. The study location is along the north side of Taneum Creek in Section 5, Township 18 North, Range 17 East, Willamette Meridian (Figure 3).

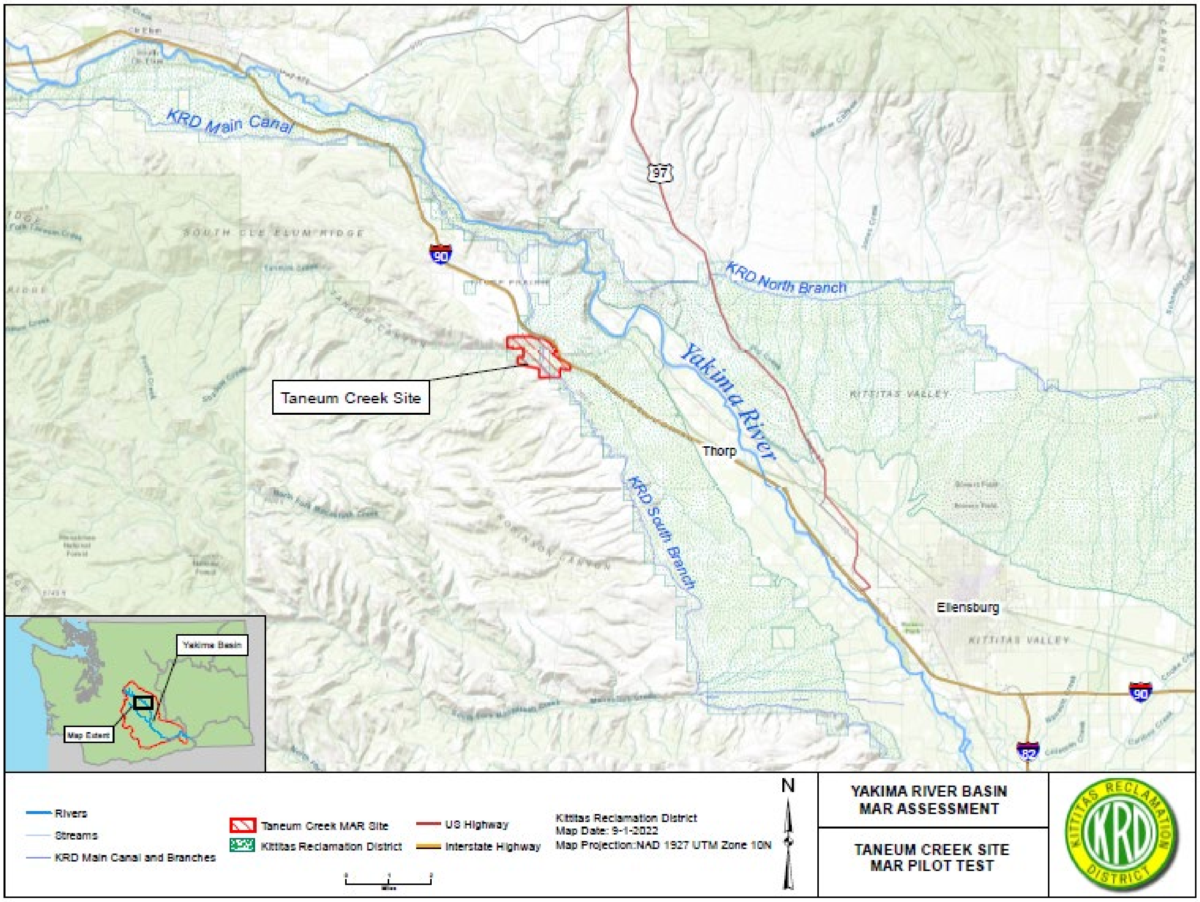


Figure 3. Map of larger study area

At the project site, there are currently 4 monitoring wells and one active stream monitoring station (Figure 1).

3.2.1 Summary of existing data

Previous studies of water quality and quantity in Taneum Creek and the Yakima River in the vicinity of the location of the proposed MAR project are described below. Existing data will be used as a baseline in conjunction with new measurements to assess the timing, volume, and water quality effects of MAR pilot activities in storing water at the project area. These data points, which include an active stream monitoring station and local water quality study locations obtained from Ecology's Environmental Information (EIM) database are shown in Figure 4.

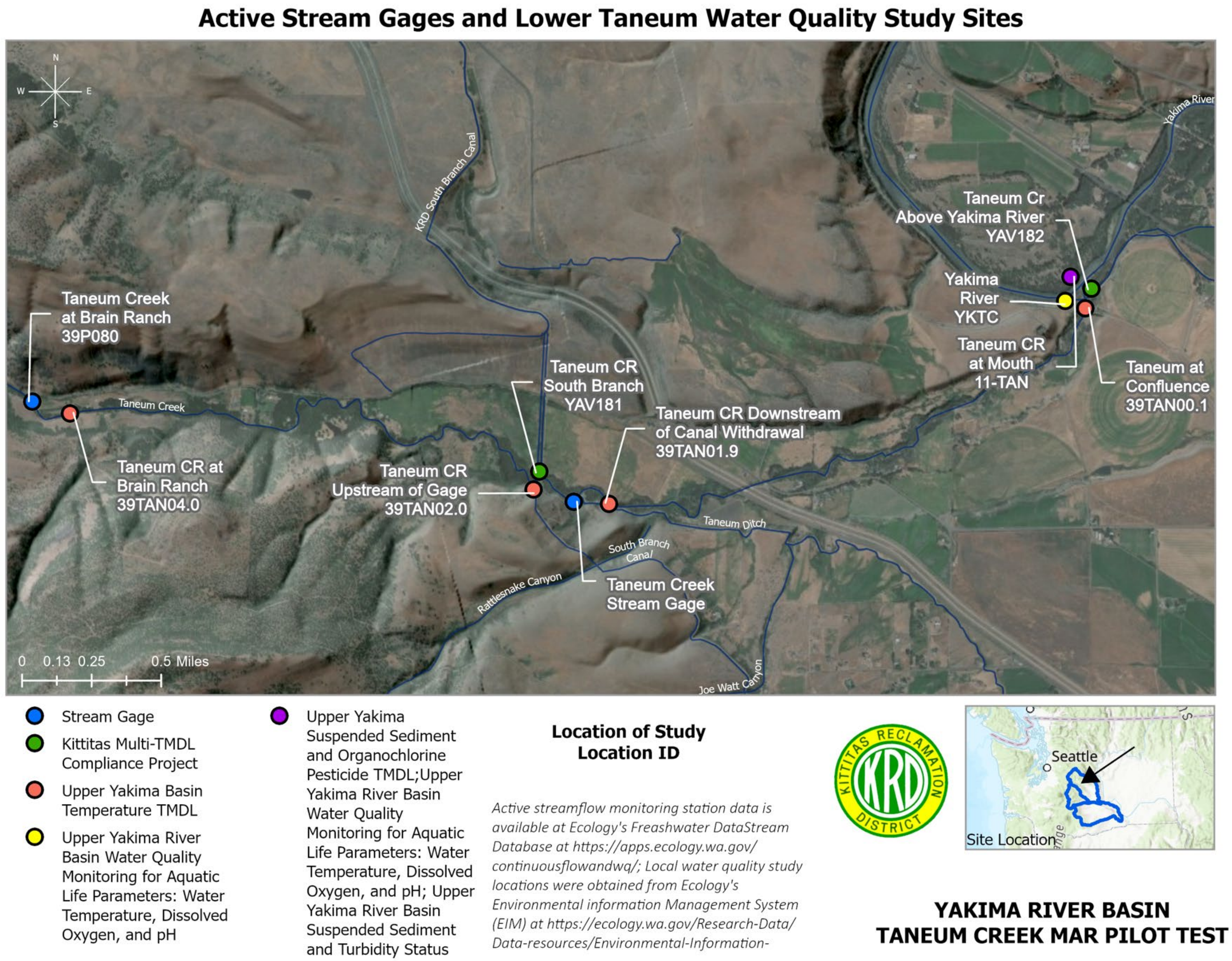


Figure 4. Local water quality studies identified in EIM and Active Surface Water Monitoring Stations (Taneum Creek at Brain Ranch and at Taneum Creek Study Site

3.2.1.1 Streamflow gaging and groundwater head information

Existing stream flow gaging stations in the project vicinity, including operator, general location, and data description are listed below. In addition, past or current studies which are gathering or have analyzed streamflow data in the project vicinity are included.

Ecology: Taneum Creek at Brain Ranch, Ecology Station 39P080, an active streamflow monitoring station, is located approximately 1 mile upstream of the project area (Figure 3-3). This station dataset contains telemetered data from April 2005- present. All data are available on Ecology's EIM webpage (https://apps.ecology.wa.gov/eim/search/default.aspx) or the station webpage (https://apps.ecology.wa.gov/continuousflowandwq/StationDetails?sta=39P080). Mean monthly discharge for Taneum Creek at this station is shown on Figure 5.

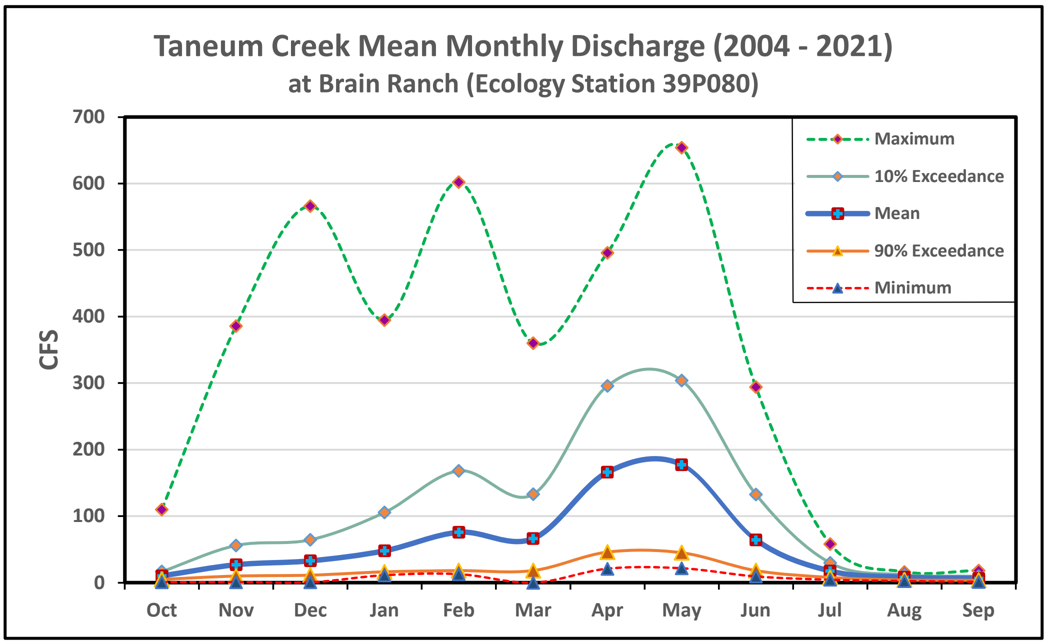


Figure 5. Mean monthly discharge, Taneum Creek at Brain Ranch

Ecology: Yakima River Near Horlick Siphon, Ecology Station 39A073, an active streamflow monitoring station, is located on the Yakima River approximately 2.5 miles upstream of the confluence of Yakima River and Taneum Creek (Figure 3-3). The station dataset contains flow measurements for the Yakima River since at least 2005. All data are available on Ecology's EIM Webpage (https://apps.ecology.wa.gov/eim/search/default.aspx) or the station webpage (https://apps.ecology.wa.gov/continuousflowandwq/StationDetails?sta=39A073).

KRD: Taneum Creek MAR Pilot Project: Datasets gathered from on-site wells and a stream gage established in early 2021. Dataset contains synchronized hourly data and confirmational hand measurements and gage ratings (Figure 1). Data is to be placed on EIM in the near future.

U. S. Bureau of Reclamation, Taneum Creek Study: The Bruton-KRD Water Exchange Project, 2009. Datasets gathered from existing gaging and diversion data. This is a project located downstream from the proposed pilot study. The final report is at https://www.usbr.gov/pn/programs/yrbwep/phase2/taneumcreek/taneumcreekstudy-final.pdf

3.2.1.2 Water Quality Information

The pilot test will focus on gathering historic water quality data. The following is a list of each study, the data that will be utilized in the pilot test, and the associated location ID and respective location information, also shown in Figure 3-3, unless otherwise noted.

Ecology: Studies and EIM Locations:

1. Upper Yakima River Tributaries Temperature Total Maximum Daily Load, Water Quality Improvement Report and Implementation Plan, Ecology publication 14-10-037 (**https://apps.ecology.wa.gov/publications/SummaryPages/1410037.html**)

Existing data within this body of research and pertinent to the project include, highest daily maximum temperatures and highest 7-day average of daily temperatures, and Turbidity Total Maximum Daily (TMDL) Load.

Relevant Location IDs:

- AKY482, instream piezometer installed for Upper Yakima River Tributaries Temperature Total Maximum Daily Load (Figure 3-1)
- 39TAN02.0 (Taneum Cr. upstream of canal withdrawal)
- 39TAN01.9 (Taneum Cr. downstream of canal withdrawal)
- 39TAN00.1 (Taneum Cr. at mouth)
- YAV181 (Taneum Cr. at South Branch),
- YAV182 (Taneum Cr. at Yakima River confluence)

2. Upper Yakima River Basin Suspended Sediment and Organochlorine Pesticides TMDL: 2019 Effectiveness Monitoring for TSS and Turbidity TMDL Targets, Ecology publication 21-03-013, (https://apps.ecology.wa.gov/publications/SummaryPages/2103013.html)

Existing data gathered from this project include Total Suspended Sediment (TSS) and Turbidity.

Relevant Location IDs (Figure #):

- YK-TC (Taneum Cr. at Yakima River confluence)
- 11-TAN (Taneum Cr. At mouth)

All data are available on Ecology's EIM Web database.

3. KRD/ Kittitas County Water Purveyors Dataset: Kittitas Multi-TDML Compliance Project

Existing data gathered for these sites include turbidity, sediment, temperature, water levels and streamflows.

Relevant Location IDs:

- YAV-181 (Taneum Cr. South Branch)
- YAV-182 (Taneum Cr. Above Yakima River)
- TCH (Taneum Chute shown in Figure 3-1)

These data have been collected under a grant and entered into EIM under an ECY-approved QAPP (EA et al., 2022) when funding was available to do so. Data collection has continued outside of those periods using the same standards and methods as described in the Ecology-approved QAPP, but without a currently approved QAPP in place. All samples, both inside and outside of Ecology-funded sampling seasons, were analyzed at an Ecology-accredited laboratory.

3.2.2 Established Total Maximum Daily Load Values

The reach of Taneum Creek where the proposed pilot test is located is not on the 303(d) list (https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-improvement/Assessment-of-state-waters-303d). Taneum Creek, both immediately upstream and downstream of the proposed project, is listed on the 303(d) list for temperature (Figure 6), while no other parameters were noted.

Table 1 contains those reaches for which 303(d) listing was adopted. Stream segments above and below the project have been shown at specific locations to have exceeded the criterion (16°C) of the 7-day average of daily maximum values (7DADmax) for this waterbody often in the summer. Maximum exceedances in these reaches during this period exceed 21°C for a 7-day period in July or August.

The reach of Taneum Creek downstream of the project area does not meet Water Quality Program Policy criteria for adequate instream flow and has been added to the 303d list. Minimum instream flow levels were recommended by the USFWS (Simmons, 1983). The minimum flows of 15 cubic feet per second (cfs) for July and August, and 10 cfs for September were not met on more than 95% of the days.

Table 1. 303(d) list details

Waterbody	Listing Category	Listing ID	Assessment Unit ID	Parameter
Taneum Cr	5 (303d listing)	7322	17030001000628	Temperature
Taneum Cr	5 (303d listing)	48467	17030001000616	Temperature
Taneum Cr	5 (303d listing)	39338	17030001000614	Temperature
Taneum Cr	5 (303d listing)	73016	17030001001554	Temperature
Taneum Cr	5 (303d listing)	79000	17030001000609	Temperature
Taneum Cr	5 (303d listing)	7321	17030001015351	Temperature
Taneum Cr	4C	5786	17030001015351	Instream Flow

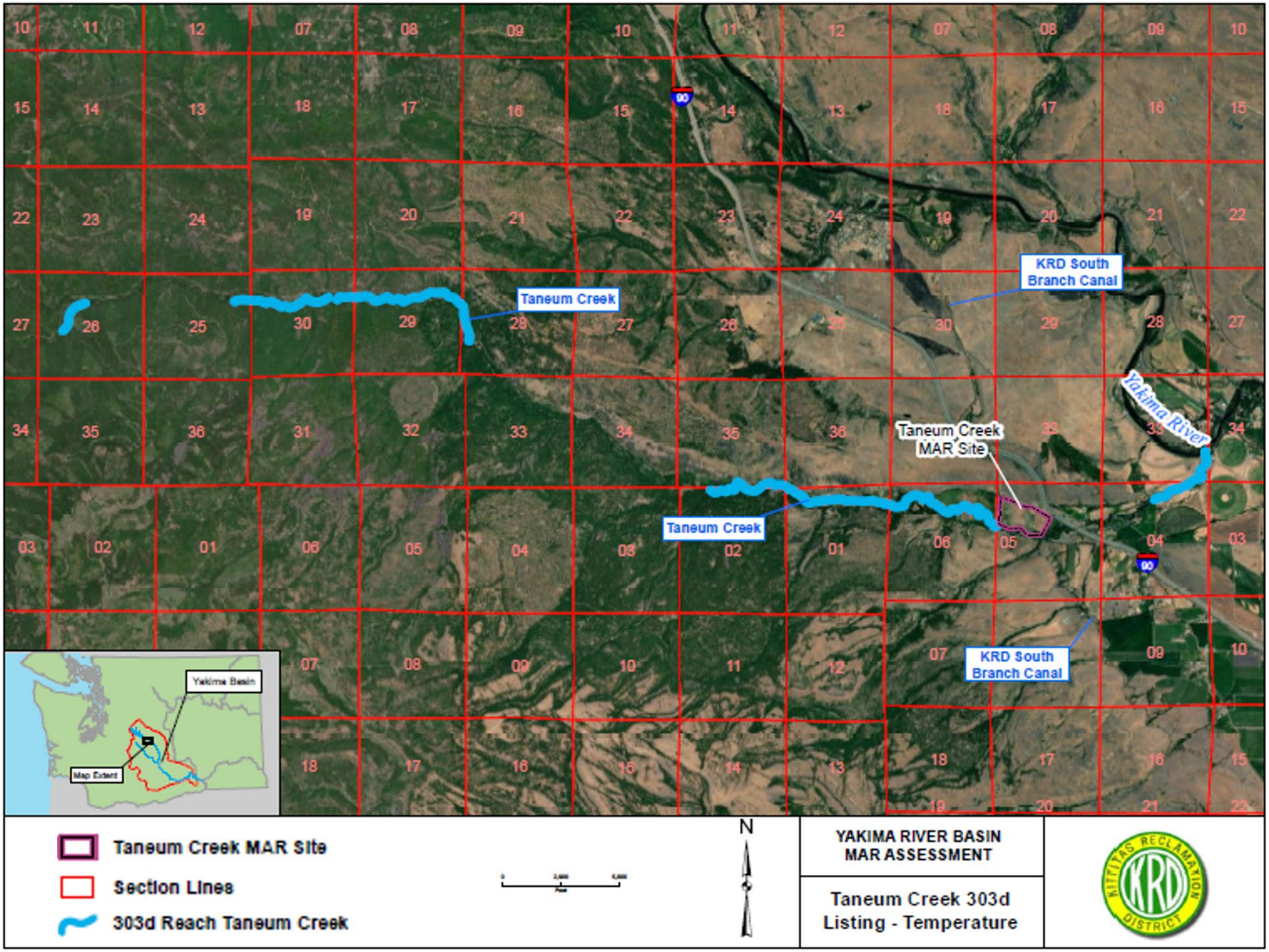


Figure 6. Location of 303d listed reaches of Taneum Creek

3.2.2.1 Anadromous Fish Conditions

The following discussion is derived from the Yakima Basin Subbasin Plan (Yakima Subbasin Planning Board, 2004). Good Coho runs existed in Taneum Creek until construction of the Taneum Ditch in 1910. Spring Chinook and summer steelhead stocks in the Yakima River are listed as depressed (SASSI, 1993), while the Coho stock has become extinct. The main constraint to restoration of spring Chinook in the Taneum system is low summer and fall flows due to diversions (Yakima/Klickitat Production Report, 1990). There are four main diversions on Taneum Creek, with the Taneum Ditch at RM 2.4 diverting most of the water from the mainstem Taneum Creek.

The proposed MAR project pilot test aims to gather empirical information on the ability of a permanent project to relieve low flow and high temperature impacts to lower Taneum Creek. Assuming the pilot test is successful, a permanent MAR project at this location has the potential to improve habitat conditions for anadromous fish within Taneum Creek.

3.2.3 Regulatory criteria or standards

Applicable regulatory criteria or standards for sampling parameters for surface and groundwater quality are listed in Table 2, along with the applicable water quality standards to which the samples collected during this pilot study will be compared. See **WAC 173-201A-200 and WAC 173-201A-240** for applicable surface water criteria and **WAC 173-200-040** for applicable ground water criteria. Surface water criteria are dependent on ambient water chemistry conditions, such as temperature, pH, or hardness. The summary report will include the necessary calculations to determine the proper criteria. Nitrate (NO3 as N) will be sampled for groundwater. As we are concerned with groundwater impacts, we chose the groundwater parameters in all samples; therefore, no additional parameters are necessary.

Table 2. Parameters and groundwater quality standards for completion

Indicator/Parameter	Surface Water Quality[1] Standard WAC 173-201A-200 WAC 173-201A-240	Groundwater Quality Standard WAC 173-200-040
Total Suspended Solids	NA	NA
Nitrate (NO3 as N)	NA	10 mg/L
Fecal coliform	100 CFU	1/100 cells/ml
Escherichia coli	100 CFU	NA
Dissolved Arsenic	190 ug/L	NA
Dissolved Cadmium	Hardness Dependent	NA
Dissolved Chromium	10 ug/L	NA
Dissolved Lead	Hardness Dependent	NA
Dissolved Zinc	Hardness Dependent	NA
Total Arsenic	NA	0.05 mg/L
Total Cadmium	NA	0.01 mg/L
Total Chromium	NA	0.05 m/L
Total Lead	NA	0.05 mg/L
Total Zinc	NA	5 mg/L
Water Temperature	17.5°C (63.5°F)	
Dissolved Oxygen	10 mg/L or 90% saturation	
pH	6.5 to 8.5	
Specific Conductance	N/A	N/A
Flow	N/A	N/A
Water Table Elevation	N/A	N/A

NA = not applicable. CFU = colony forming units. mg/L = milligrams per liter. ml = milliliter. ug/L = micrograms per liter.

[1] Freshwater aquatic life criteria for dissolved Cadmium, Lead and Zinc are hardness dependent and standard must be calculated for each sampling event. Ecology provides a spreadsheet that can be used to make those calculations.

4.0 Project Description

4.1 Project goals

The pilot test was proposed and funded to determine the hydraulic properties of the alluvial aquifer and water quality response in site wells to project the timing and volume of return flows to Taneum Creek and to assess likely water quality effects of managed recharge operations. The pilot test approach described in this QAPP will provide a scaled MAR response and an opportunity to evaluate any potential water quality changes associated with implementing a future MAR project at this site.

4.2 Project objectives

Objective 1 – Determine if water discharged to the project area from KRD Taneum Chute is resident in site aquifer materials.

- Measure:
    - flow out of Taneum Chute discharge facility onto project area over approximately 7 days.
    - water table elevation in site wells on an hourly basis for two weeks prior to, during, and as needed after the discharge.
    - area of inundation/saturation of project area daily until saturated conditions are no longer evident.
- Assess: using general methodologies outlined in section 8.2
    - bulk hydraulic conductivity of the subsurface at the Taneum Creek MAR site
    - soil infiltration capacity at the Taneum Creek MAR site
    - storage capacity of the subsurface at the Taneum Creek MAR site

Objective 2 – Determine if discharge of KRD Taneum Chute water affects groundwater quality.

- Measure:
- Water quality parameters (Table 3-2) in Taneum Chute prior to, during, and following discharge operations to the project area during normal ambient irrigation period conditions and compare these to applicable measured water quality parameters (Table 7) in groundwater within the proposed MAR project area prior to, during, and following discharge to the facility compare with groundwater quality standards.
- Assess if the proposed operational MAR affects groundwater quality in the project area.

Objective 3 – Evaluate operational aspects of the pilot test.

- Evaluate:
    - the performance of diversion operations to identify any issues or problems that may occur during the test that would need to be revised or corrected before implementation.
- Assess:
    - how water spreads across the site, including observing and correcting any undesirable impacts or issues.
    - the rate of application and the area of saturation
    - project effectiveness monitoring actions

4.3 Tasks Required

4.3.1 Prior to diversion operation

- Collect one (1) surface water quality sample during the 2023 irrigation season from the proposed MAR diversion location in the Taneum Chute
    - compare these surface water results with existing datasets and ground water quality standards.
- Collect one (1) water quality sample from groundwater monitoring wells screened in the surficial aquifer near the project site. No source and receiving water characterization will be conducted beyond that described in the QAPP.
    - compare the ground water result with water quality standards for surface water prior to discharge.
    - existing data will be used as described in sections 3.2.1 and 6.3.

4.3.2 During diversion operation

- Collect one (1) surface water quality sample from the operating MAR diversion location in the Taneum Chute
    - compare these surface water results with existing datasets and ground water quality standards.
    - existing data will be used as described in sections 3.2.1 and 6.3.
- Collect one (1) water quality sample from groundwater monitoring wells screened in the surficial aquifer near the project site.
    - compare the ground water result with water quality standards for surface water prior to discharge.
    - existing data will be used as described in sections 3.2.1 and 6.3.

4.3.3 Post diversion operation

Samples will be collected 2 weeks following cessation of diversion, and as deemed necessary by head response in site wells up to 6 months following cessation of diversion.

- Collect one (1) surface water quality sample from the proposed MAR diversion location in the Taneum Chute
    - compare these surface water results with existing datasets and groundwater quality standards.
    - existing data will be used as described in sections 3.2.1 and 6.3.
- Collect one (1) water quality sample from groundwater monitoring wells screened in the surficial aquifer near the project site.
    - compare the ground water result with water quality standards for surface water.
    - existing data will be used as described in sections 3.2.1 and 6.3.

4.3.4 From 2 weeks prior to discharge to 30 days following discharge, or as extended

- Collect hourly head measurements by transducers from the proposed MAR diversion locations, project area ground water monitoring wells.
- Collect hand measurements of flow in Taneum Creek and water table elevations in groundwater monitoring wells every day during the test; measurements are consistent with EA et al., (2022)
- Record discharge flow and total discharge measurements from the proposed MAR diversion daily.
- Observe through physical observation or drone collected imagery the amount of saturation/standing water on site daily until all water has infiltrated.

Data gathered will be used to estimate:

- Aquifer characteristics
    - Storage Coefficient
    - Hydraulic Conductivity
- Facility soil infiltration capacity
- Ground water quality effects of recharge and storage
- Performance of site facilities for operation and monitoring

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 3. Organization of project staff and responsibilities

Staff	Title	Responsibilities
Scott Tarbutton Ecology Office of Columbia River	Ecology Grant Project Manager	Manages the grant project at Ecology. Receives periodic updates and final project deliverables.
Scott Tarbutton Ecology Office of Columbia River	QA Coordinator	Coordinates QA review, Ecology, Office of Columbia and reviews and approves project QAPP.
Kathleen Satnik Kittitas Reclamation District 509-925-6158 kat@kcwp.org	MAR Project Manager	Oversees all characterization study staff and serves as the project liaison to the Ecology MAR Project Manager. *May also serve as Principal Investigator.*
Guy Gregory (Gregory Geologic LLC)	MAR Project Principal Investigator and Project Field Lead	Finalizes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data. Analyzes and interprets data. Co-Author the draft report and final report. *May also serve as Field Lead.*
EA staff and Kat Satnik, KRD	MAR project Field Assistant(s)	Helps make field measurements, collect samples, and prepare them for shipping, manage continuous data, maintain instruments, and record field information. Reviews draft and final report.
Jen Bader Jacobs Engineering	MAR project Manager	Project lead, coordinates required responsibilities, including invoicing and oversees all tasks. Review draft and final report
Maria Daugherty EA Engineering	MAR project Data Manager	Coordinates upload of data to required databases with the Environmental Information Management database (EIM) Data Coordinator. Analyses and interprets data, field supervision, report writing and editing.

5.2 Special training and certifications

Field activities will consist of discharge measurements from the diversion equipment, groundwater level measurements, water quality sampling, and data retrieval. Field staff conducting these activities will be required to demonstrate proficiency on all equipment with respect to fieldwork parameters, including electrical tape to measure depth to groundwater within the data quality objectives. They will also be required to be able to retrieve data using the latest version of Win-Situ Software. A licensed hydrogeologist will oversee and audit physical parameter data gathering.

Chemical data gathering will consist of surface and ground water sampling procedures. Staff conducting these activities will be required to proficiently and safely acquire surface water samples using standard sampling equipment, and groundwater sampling will be conducted with standard disposable bailers. Staff must also collect and organize samples in the field for shipping under chain of custody procedures to the laboratory.

Drone pilots (if used) will conduct drone monitoring following the rules outline in **eCFR :: 14 CFR Part 107 -- Small Unmanned Aircraft Systems (FAR Part 107)** (e.g., FAA certified pilot, registered drone less than 50 lbs., etc.).

5.3 Proposed project schedule

The project proponent will prepare and submit each of the reports and deliverables listed below in Table 4. The reports and deliverables will clearly articulate the results and related procedures. Written reports will be submitted electronically to the Ecology Designated WQP Regional Contact and MAR Grant Manager.

Table 4. Proposed schedule for completing data entry into EIM and required reports.

Report Type/Title	Target date	Description
Monitoring preparation reports		
Final QAPP	6/1/2023	Revised completed QAPP, responsive to all comments from Ecology's Project Grant Contact and QA Coordinator.
Data entry or upload		
Entry of Study ID and monitoring locations into EIM	1/31/2024	Sampling location coordinates and descriptions entered.
Entry of laboratory results into EIM	1/31/2024	All quality assured and quality-controlled lab data and modified version for data analysis if necessary.
Summary report		
Report summarizing results of characterization monitoring, including tables of data comparing concentrations to applicable standards.	7/1/2024	Submit to Ecology's Project Grant Manager.

6.0 Quality Objectives

6.1 Data quality objectives

The data quality objectives (DQO) for chemical sampling is to obtain water samples representative of irrigation water from the Taneum Chute, and on-site ground water monitoring wells within the project area (Figure 1) and to have them analyzed. The analysis will use standard methods to obtain data that meet the measurement quality objectives (MQOs) described below and that are comparable to previous study results.

The objective is to determine any effect on groundwater chemical characteristics attributable to discharge from the Taneum Chute.

The DQO for physical measurements gathered in the field is to obtain flow and head measurements in Taneum Chute water discharge, and wells before, during, and after the discharge of water from the Taneum Chute. These measurements will be obtained using standard methods to obtain data that meet MQO's that are described below and that are comparable to previous study results. The objective is to determine if field data can demonstrate protection of ground water quality and obtain an estimate of subsurface storage and retiming of return to lower Taneum Creek.

6.2 Measurement quality objectives

Field measurement data, including water well levels, streamflow temperature locational data, and gauge height will be gathered to manufacturers' specifications in Table 5. Field duplicates for measurements will be taken in accordance with the referenced measurement standard operating procedure (Table 7) to evaluate and demonstrate measurement quality. The reporting limits of the methods listed in Table 8 are appropriate for the expected range of results and the required level of sensitivity to meet project objectives.

Table 5. Manufacturers' specifications, also described in (EA et al., 2022)

Equipment	Model	Data gathered	Accuracy/Resolution
Garmin GP	Vista Etrex	Latitude and Longitude	+/- 3 meters 95% confidence
In-Situ RuggedTROLL® Loggers	RT100	Water Well Levels	+/- 0.01% of full scale or better
		Water Pressure	+/- 0.01% of full scale or better
		Water Temperature	+/- 0.3oC / 0.01oC or better
In-Situ Rugged BaroTROLL	Baro	Barometric Pressure	+/- 0.01% full scale or better
		Air Temperature	+/- 0.05% from -5o to 50o C
Slope Indicator Water Level Indicator (E-Tape)	300 ft.	Depth to water	0.01 foot
Micrometer Flow Meter	M0300 Strap-on Saddle Flow Meter	Instantaneous and totalized flow	+/- 2% of reading over full range (max flow 6000 gpm)

6.2.1 Targets for precision, bias, and sensitivity

Laboratory MQOs for project results, expressed in terms of acceptable precision, bias, and sensitivity, are described in this section and summarized in Table 6.

Table 6. Laboratory Measurement Quality Objectives

Parameter	LCS[2](Recovery)	Lab duplicates (RPD)[3]	Method Blanks	Matrix Spike (Recovery)	Matrix Spike Duplicates
TSS	NA	5%	±0.3 mg/L	NA	NA
Metals	85 – 115%	<20%	<LOQ	75 – 125%	<20%
Total Nitrogen	80-120%	<20%	<MDL	75-125%	<20%
Fecal coliform	NA	40%	<MDL	NA	NA
E. coli	NA	40%	<MDL	NA	NA

[2] Relative percent difference

[3] Lab Control Samples

Field chemical sampling precision will be addressed by submitting replicate samples. The Ecology-accredited LabTest will conduct tests using standard procedures. The laboratory will assess precision and bias in the laboratory using duplicates and blanks.

Table 8 outlines expected precision of sample duplicates and method reporting limits. This table contains all laboratory determinations with the possible exception of pH. The reporting limits of the methods listed in the table are appropriate for the expected range of results and the required level of sensitivity to meet project objectives.

Precision is the degree of agreement among repeated field measurements of the same indicator and gives information about the consistency of your methods. It is typically defined as relative percent difference (RPD).

The precision of water well levels for e-tape measurements are based on SOP within Ecology Publication: No.17-11-005 (p. 22), which states the following:

1) +/- 0.02 feet for depths of less than or about 250 feet

2) +/- 0.04 feet for depths between 250 and 500 feet

3) +/- 0.1 feet for depths in excess of 500 feet

Unless otherwise referenced in Ecology Publication: No.17-11-005, all other water well measurements will be considered acceptable as stated in Freeman et al. (2004) which includes, “The measurement error and accuracy standard for most situations are 0.1 feet, 0.1 percent of range in water-level fluctuation, or 0.01 percent of depth to the water above or below a measuring point, whichever is least restrictive.” Turbidity measurements will be conducted under USEPA 180.1 Rev2 (USEPA, 2993)

Accuracy is a measure of confidence that describes how close a measurement is to its “true” or expected value.

Representativeness is the extent to which measurements represent the true environmental condition. Parameters such as site selection (including location of sampling point within the water column), time, and frequency of sample collection can all play a role in determining how representative a sample is.

The goal of this effort is to collect data representative of the height of the water table over time in wells on site.

Taking enough measurements to construct a valid temporal head curve for each well increases the likelihood the station will provide representative head information. Coupling the individual well measurements with data from pressure transducers over the monitoring period increases confidence in the representativeness of the project measurement program.

Discharge measurements from the diversion facility

The goal of this effort is to document instantaneous rates and project duration volume of water applied to the project area.

Totalizing flow meter data will provide continuous measurement of rates and total flow of water applied on a moment-to-moment basis, which is in fact representative.

Comparability is the extent to which data can be compared between sample locations or periods of time within a project, or between different projects.

The standard operating procedures (SOP) for deriving aquifer properties and water level data include manual well measurements and datalogger/barometer installation. The SOPs in this QAPP for aquifer information, and soil infiltration are listed in Table 7.

Table 7. Standard Operating Procedures for aquifer information and obtaining water level data.

Aquifer Information and Water Well Data	Standard Operating Procedure
Datalogger/Barometer Installation	EAP074, version 1.2
Manual Measurements	EAP052, version 1.2
Instrument Drift	EAP082, version 1.2
Log/Record Management	ECY Publication: No.17-11-005

Completeness is the comparison between the amounts of valid or usable data the program originally intended to collect versus how much was actually collected. This study will be considered complete if data can be gathered over 95% of the proposed project duration.

Bias

Bias will be addressed by calibration of the equipment in Table 8. Calibration will be conducted to manufacturer specifications. Static water levels will be recorded on every visit to download data from each monitoring well. These field measurements will be used to assess drift in the transducer measurements.

The MQOs for project chemical results, expressed in terms of acceptable precision, bias, and sensitivity, are described in Table 8.

Table 8. Measurement Quality Objectives for Chemical Results

Analysis	Method	Accuracy[4]	Precision RPD [5]	Bias [6]	Reporting Limits
pH	SM 4500-H	0.05 standard units	0.0-5 standard units	0.10 standard Units	1-14 standard units
Water Temperature	SM 25508	0.1 degree C	0.025 degree C	0.05 degree C	0 to 50° C
Dissolved Oxygen	SM 4500-	15%	<5%	+/-5%	0.1-15 mg/l
Specific Conductance	SM 25018	10%	<10%	+/-5%	1 umhos/cm
Laboratory Analysis					
Total Suspended Solids	USEPA 160.2	N/A	N/A	+/-15%	0.5 mg/L for a 1-L sample
Nitrate as NO3	USEPA 352.2	85 to 115%	85-115%	85-115%	0.29 mg N/L
Dissolved Metals					
Arsenic	USEPA 200.7	85 to 115%	85 to 115%	85 to 115%	0.008 mg/L
Cadmium	USEPA 200.7	85 to 115%			0.001 mg/L
Chromium	USEPA 200.7	85 to 115%	85 to 115%	85 to 115%	0.004 mg/L
Lead	USEPA 200.7	85 to 115%	85 to 115%	85 to 115%	0.01 mg/L
Zinc	USEPA 200.7	85 to 115%	85 to 115%	85 to 115%	0.002 mg/L
Total Metals					
Arsenic	USEPA 200.7	85 to 115%	85 to 115%	85 to 115%	0.0005 mg/L
Cadmium	USEPA 200.7	85 to 115%			0.0005 mg/L
Chromium	USEPA 200.7	85 to 115%	85 to 115%	85 to 115%	0.000007 mg/L
Lead	USEPA 200.7	85 to 115%	85 to 115%	85 to 115%	0.0005 mg/L
Zinc	USEPA 200.7	85 to 115%	85 to 115%	85 to 115%	0.0005 mg/L
Biologic Constituents					
Fecal Coliform	USEPA 1604	100%	N/A	N/A	20 to 80 colonies
E. Coli	USEPA 1103.1	Recovery interval 2-2s to R+2s	40.5%	-2%	<10 e.coli/100mL

[4] Accuracy is % of laboratory control spike concentration for laboratory samples; direct unit of measurement for metered determinations.

[5] Precision is % of field duplicate concentration for laboratory samples, direct unit of measurement for metered determinations.

[6] Bias is % of matrix spike concentration for laboratory samples, direct unit of measurement for metered determinations.

6.3 Acceptance criteria for quality of existing data

All previous data used in this study will be Level 4--that is the data will have been assessed and verified for usability in a formal study report. Existing data in the specific study area will be evaluated for precision, accuracy, and completeness in accordance with this QAPP and any quality assurance documentation governing it's gathering. Existing data will be incorporated into the analysis as appropriate when necessary and available to evaluate conclusions.

7.0 Study Design

7.1 Study boundaries

This study will focus on describing key chemical water quality attributes of MAR in the Kittitas Reclamation District Flume and receiving groundwater. Sampling locations are presented below and shown in Figure 1

A diversion will be established on the Taneum Chute at GPS coordinates -120.75028, 47.08628, within the west half of the northwest quarter of Section 5, Township 18 North, Range 17 East, Willamette Meridian. The diversion placement is approximately 30 feet south of Taneum Road and diverted water will be used to flood the site (Figure 7).

The actions to achieve this goal requires diverting water from the KRD operated irrigation canal (Taneum Chute near the KRD Flume in Figure 7) adjacent to the project site at a controlled rate of 4 cfs and for a measured time period. Estimates of infiltration area will include walking the location during the recharge test while marking GPS coordinates or by flying a drone overhead to image the extent of flooding. Postprocessing and Geographic Information System (GIS) mapping will be used to estimate the flooded area. Surface assessments either by drone or walking the site will continue after pumping ceases to provide information on the time it takes for water to infiltrate across the site. Any aerial imagery will be made available for documentation purposes. The test will occur over a seven-day period between September 1st and October 31st. Permission has been granted from all landowners involved and copies of the users Unmanned Aircraft Systems (UAS) license, drone Federal Aviation Administration (FAA) registration, and landowner permissions will be available for review. The proposed flight area is within the Taneum Creek Site (Figure 7).

Well head monitoring will be conducted to assess any change in storage due to water application. While surface water monitoring was originally suggested to estimate return flows to Taneum Creek, it was determined these flows could be within the margin of error of the measuring equipment and were therefore removed from the proposed study design. However, current studies along Taneum Creek measure surface flows and are available for use. Bulk aquifer parameters will be estimated from the volume and timing data and used to evaluate the potential for a future project.

Water quality will be monitored in water applied to the site prior to, during, and following application. Water quality will be monitored in site wells prior to, during, and following the application. Data will be used to assess any changes to water quality in site groundwater due to application of water from Taneum Chute. Once synthesized, the pilot test information will inform future actions on the site, potentially including a feasibility study necessary to permit a production scale MAR facility.

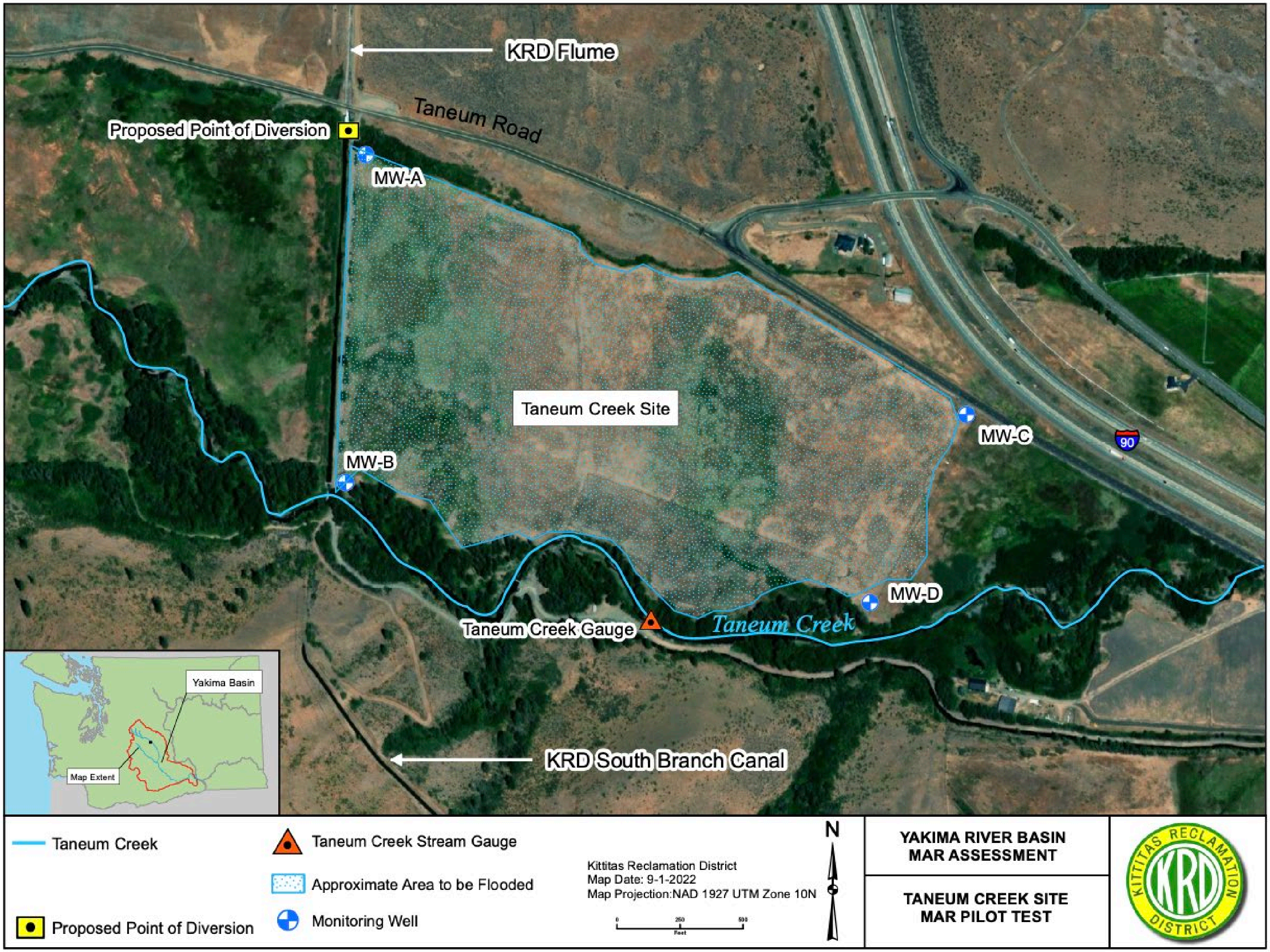


Figure 7. Proposed diversion and saturation area

7.2 Field data collection

7.2.1 Sampling locations and frequency

Following the protocols in this QAPP, surface water quality grab samples will be collected during irrigation season prior to operations and one groundwater quality sample will be collected from each groundwater well on site (sampling locations are shown in Figure 1). Locations and descriptions are summarized in Table 9.

Table 9. Proposed sampling locations

Location ID	Site ID	Location Description	Latitude	Longitude
Taneum Chute at Diversion	TCH	Taneum Chute at MAR Diversion	47.08627	-120.75028
MW-A	MW-A	Well MW-A	47.08610	-120.74995
MW-B	MW-B	Well MW-B	47.08265	-120.75011
MW-C	MW-C	Well MW-C	47.08327	-120.74036
MW-D	MW-D	Well MW-D	47.08119	-120.74201

7.2.2 Field parameters and laboratory analytes to be measured

See Table 6-6 in Section 6.3. Field parameters to be analyzed are flow rate and volume (diversion), water table elevation, pH, temperature, dissolved oxygen, and specific conductivity in wells. All water quality samples will be analyzed for total suspended solids, Nitrate as Nitrogen, dissolved and total metals (arsenic, cadmium, chromium, zinc, and lead) and fecal coliform and E. coli bacteria.

7.3 Assumptions underlying design

This study assumes the target analytes will be representative of water quality conditions during the period of time when the MAR project will be operational and that the analytical and reporting limits for the laboratory analysis are appropriate for the water quality standards comparisons.

7.4 Possible challenges and contingencies

The study design was developed to achieve the desired goals and objectives of this project. However, logistical problems, practical constraints, and scheduling limitations do exist, which presents some challenges.

Potential problems associated with sampling logistics include the following:

- Variability and uncertainty in third party shipping schedules, etc. causing delay and in violation of holding times.

- Weather related difficulties reaching sampling locations.
- Recording instrument failure due to on-board battery failure or faulty deployment
- Rainfall or other anticipated inclement weather may cause unmeasured response in site wells.

Operation of the diversion from the Taneum Chute is planned to be done at a constructed diversion structure. Construction timing is uncertain, so if the structure is unavailable a portable pump capable of pumping the projected flows will be used. Potential problems with pump use include:

- Mechanical breakdown of the pump and/or associated pump power equipment
- Interruptions in pump operation due to required maintenance or fueling.
- Fluctuations in pumping rate due to variability in power systems

8.0 Field Procedures

8.1 Invasive species evaluation

Assess the possibility of invasive species contamination of both protective gear and sampling equipment. Ecology's SOP EAP070 addresses invasive species transport and contamination. This document is at Ecology's QA website: Published SOPs.

8.2 Sampling and Measurement procedures

Metal samples will be collected following guidance outline in *Standard Operating Procedure EAP029, Version 1.6: Collection and Field Processing of Metals Samples* (EAP029, 2018) and *Standard Operating Procedure EAP098, Version 1.1: Collecting Groundwater Samples for Metals Analysis from Water Supply Wells (EAP098)*. Fecal coliform and e. coli will be collected following guidance outlined in *Standard Operating Procedure for the Collection of Fecal Coliform Bacteria Samples* (EAP030, 2017). All other groundwater samples will be collected following *Standard Operating Procedure EAP099, Version 1.0: Purging and Sampling Monitoring Wells for General Chemistry Parameters (EAP099).* Field data will be gathered using the SOPs Table 10.

Table 10. Standard Operating Procedures for field logs and records of measurement requirements

Logs and Records of Measurements	Standard Operating Procedure
Data Download	EAP074
Observation Well Field Measurements	ECY Publication No.17-11-005 (p. 30-31) EAP052
Datalogger/Barometer Installation	EAP074 (p.48)
Pipe flow Meter	McCrometer 24517-11

8.2.1 Field Measurements:

Discharge measurements will be taken using the McCrometer pipe flow meter measuring discharge to the area on a frequent basis, flow will be maintained at or near 4 cubic feet per second throughout the test period. Measurements in site wells will be taken from the existing dataloggers, supplemented with frequent field measurements using an etape. Area of inundation will be determined daily by observation and mapping of saturated/inundated soils using field walks and gps recordings. At completion, the dataset will contain information in discharge to the facility, depth to groundwater and area of inundation over time. This dataset will be analyzed analytically using a Theis-derived method, or numerically using a peer-reviewed and referenced numerical solution.

8.3 Containers, preservation methods, holding times

Table 11. Sample containers, preservation, and holding times

Parameter	Matrix	Container	Holding Time	Preservative
Total Suspended Solids (TSS)	Water	1000 mL w/m poly bottle	7 days	Cool to ≤4°C
Total Metals	Water	500 mL poly bottle with Teflon or polypropylene lid	6 months	adjust pH to <2 with HNO3, cool to ≤6°C
Dissolved Metals	Water	500 mL poly bottle with Teflon or polypropylene lid	6 months	Filter (0.45 um) within 15 minutes of collection; then add HNO3[8] to pH <2 , Cool to ≤6°C
Fecal Coliform	Water	100 mL plastic bottle	24 hours	Fill bottle to shoulder, Cool to ≤4°C
Escherichia coli	Water	1000 mL w/m poly bottle	24 hours	Cool to ≤6°C

8.4 Equipment decontamination

No analytes are expected to contain high levels of contaminants. Sampling equipment will be single use or dedicated to the well in question. However, to obtain accurate, representative samples, sampling equipment must be free from residual contamination. Quality assurance measures as described in Ecology SOP EAP090 are to be implemented after cleaning to ensure equipment is sufficiently decontaminated.

Metals sample equipment not prepared from the laboratory will be washed in a dilute liquinox-tap water solution and then visually inspected for cleanliness. Once acceptable, a nitric acid rinse followed by a deionized water rinse will be performed. Clean and dry equipment will be wrapped in foil.

Bacteriologic sample equipment not prepared from the laboratory will be washed in a dilute liquinox-tap water solution and rinsed with tap water. Once visually clean, it will be rinsed with isopropyl alcohol, followed by a deionized water rinse, and once dry wrapped in foil.

All clean containers will be handled by gloved personnel.

8.5 Sample ID

Samples will be labeled with the following, or as modified to meet specific environmental lab protocol.

Samples will be labeled in accordance with EA Science, Engineering and Technology Standard Operating Procedure for Sample Labels. As each sample is collected/selected, a sample label will be filled out. Enter the following information on each label:

- Project name
    - Project Number (or Case Number, as applicable)
    - Location/site identification—the media type (i.e., well number, surface water, soil, etc.)
    - Sampling number, and other pertinent information concerning where the sample was taken)
    - Date of sample collection
    - Time of sample collection
    - Analyses to be performed (NOTE: Due to number of analytes, details of analysis should be arranged with laboratory prior to start of work)
    - Filtered or unfiltered (water samples only)
    - Preservatives (water samples only)
    - Number of containers for the sample (e.g., 1 of 2, 2 of 2).

8.6 Chain of custody

Chain of custody will be maintained for all samples for laboratory analysis throughout the project. Samples will be stored in a cooler and an accredited laboratory) chain of custody form will be used for documentation of shipment to laboratories.

9.0 Laboratory Procedures

9.1 Lab procedures table

All lab-analyzed samples will be analyzed using an Ecology-accredited water quality laboratory. Methods for all lab procedures are described in Table 6. Quality assurance and quality control (QA/QC) protocols are discussed in the *Quality Control* section of this plan.

9.2 Sample preparation method(s)

Sample preparation methods are listed in standard operating procedures for lab analyses or in analytical methods (Table 12).

Table 12. Measurement methods (laboratory)

Analyte	Sample Matrix	Expected Range of Results	Method	Method Reporting Limit	Analytical Instrument
Total Suspended Solids (TSS)	Water	<1 – 2,000 mg/L	USEPA 160.2	1 mg/L	Weight scale
Nitrate as N	Water	0.5-50 mg/L	USEPA 352.2	0.013 mg/L	Ion Chromatograph
Fecal Coliform	Water	1-15,000 cfu	USEPA 1604	1 cfu/100 mL	Membrane Filtration
Escherichia coli	Water	1-15,000 cfy	USEPA 1103.1	1 MPN	Multitube
Arsenic	Water	0.01-50 mg/L	USEPA200.7	0.01 ug/L	Inductively coupled plasma mass spectrometry
Cadmium	Water	0.008 – 10 mg/L	USEPA 200.7	0.008 ug/L	Inductively coupled plasma mass spectrometry
Chromium	Water	0.007 – 10 mg/L	USEPA200.7	0.007 ug/L	Inductively coupled plasma mass spectrometry
Lead	Water	0.007 – 10 mg/L	USEPA200.7	0.007 ug/L	Inductively coupled plasma mass spectrometry
Zinc	Water	0.2 – 10 mg/L	USEPA200.7	0.2 ug/L	Inductively coupled plasma mass spectrometry

9.3 Laboratories accredited for methods

All chemical analysis performed at LabTest, located in Yakima, which is accredited for all methods, if changes to the lab become necessary, an accredited lab by Ecology will be used.

9.4 Table of field and laboratory quality control

Table 13. Quality control samples, types, and frequency

Parameter	Field Replicates	LCS[71]	Method blanks	Matrix spikes	Matrix spike duplicates	Laboratory duplicates
Total Suspended Solids (TSS)	1/batch	1/batch	1/batch	N/A	N/A	1/batch
Metals	1/batch	1/batch	1/batch	1/batch	1/batch	-
Nitrate as NO3	1/batch	1/batch	1/batch	1/batch	1/batch	1/batch
Fecal Coliform	1/batch	N/A	1/batch	N/A	N/A	1/batch
Escherichia coli	1/batch	N/A	1/batch	N/A	N/A	1/batch

Each type of QC sample listed above will have MQOs associated with it (Section 6.2) that will be used to evaluate the quality and usability of the results.

9.4.1 Field Quality Control Procedures

These field quality control procedures for this project also described in EA et al., (2022).

9.4.1.1 Groundwater monitoring

Groundwater monitoring will use the following quality control measures are

- Duplicate groundwater level measurements during every field visit.
- If available, comparison of manual measurements to other agencies' data.
- Duplicate water sample for groundwater temperature and conductivity at approximately 5% of the sites.

[7] Lab Control Samples

9.4.1.2 Discharge flow monitoring

Discharge flow monitoring will use the following quality control measures:

The McCrometer Flow Meter Model M0300 will be installed in accordance with factory specifications. The factory calibrated and certified meter will be tested using the following steps.

- The flow will pass through the meter and be increased to a relatively high, steady rate.
- A specific increment of the totalizer wheel will be timed.
- The rate of flow over that period of time should be within 2% of the indicated totalizer reading. Discrepancies will be evaluated with the local McCrometer representative or the factory.

9.4.1.3 Water temperature monitoring

Water temperature monitoring will use the following quality control measures:

- Pre and Post data logger accuracy testing.
- Manual field checks during deployment and data recovery.

9.5 Corrective action processes

The project manager will work closely with the contract laboratory staff reviewing preliminary results to identify any data that fall outside of QC criteria. The project manager will determine whether data should be re-analyzed, rejected, or used with appropriate qualification

10.0 Data Management Procedures

10.1 Data recording and reporting requirements

Projects funded by or submitting data to Ecology must submit the data formatted for entry into Ecology's Environmental Information Management database IM data system.

All field data and observations will be recorded on waterproof paper kept in field notebooks. Staff will transfer information contained in field notebooks to Excel spreadsheets after they return from the field. Data entries will be independently verified for accuracy by another member of the project team. Field and laboratory data for the project will be entered into Ecology's EIM database. Laboratory data will be uploaded into EIM using the EIM XML results template under EIM Study ID: KRDMON2023B

10.2 Laboratory data package requirements

Laboratory data will be sent to the MAR Project Principal Investigators and Project Field Leads directly from each laboratory following completion of each set of analyses for a sampling event. Reporting times may vary depending on holding time and analytical methods but should not exceed six months from the documented sampling date. Laboratory reports will be reviewed by the Data Manager for errors or missing data. The Data Manager and Project Manager will implement corrective actions if needed. Finalized electronic laboratory data will be loaded to Ecology's EIM database by the project staff with the assistance of Ecology's EIM Data Coordinator.

10.3 Electronic transfer requirements

Analytical laboratory will deliver case narratives (in PDF format) and electronic data deliverables of contract laboratory data (in Excel spreadsheet format) to the project manager. Finalized electronic laboratory data will be loaded to Ecology's EIM database by the Data Manager with the assistance of Ecology's EIM Data Coordinator.

11.0 Audits and Reports

11.1 Reporting

MAR Project Principal Investigators and Project Field Leads will prepare a water characterization technical memorandum. The Pilot Test results (including the technical memorandum) will be included in the MAR Assessment of Taneum Creek Site Technical Report. The technical memorandum will include all laboratory data presented in a table. Groundwater quality standards for all applicable parameters will also be included in the table for comparison purposes.

12.0 Data Verification

Throughout field sampling, the field lead and all crew members are responsible for carrying out station positioning, and sample collection as specified in the QAPP and SOPs. Additionally, technicians systematically review all field documents (such as field logs, chain-of-custody sheets, holding times, and sample labels) to ensure data entries are consistent, correct, and complete, with no errors or omissions. A second staff person always checks the work of the staff person who primarily collected or generated data results.

12.1 Field data verification, requirements, and responsibilities

Field notes will be verified by MAR Project Principal Investigators and Project Field Leads, and field data gathered including water level and flow will be noted and verified by the sampling personnel and checked by the field supervisor for consistency with existing measurements.

12.2 Laboratory data verification

Data verification involves examining the data for errors, omissions, and compliance with QC acceptance criteria. Analytical laboratory staff will perform laboratory verification following standard laboratory practices (MEL, 2016). Staff will provide a written report of their data review, which will include a discussion of whether:

1. MQOs were met.
2. Proper analytical methods and protocols were followed.
3. Calibrations and controls were within limits.
4. Data was consistent, correct, and complete, without errors or omissions.

The project manager is responsible for the final acceptance of the project data. The complete data package along with laboratory's written report will be assessed for completeness and reasonableness. Based on these assessments, the data will either be accepted, accepted with qualifications, or rejected and re-analysis considered.

13.0 Data Quality (Usability) Assessment

13.1 Process for determining project objectives were met

After the project data have been reviewed and verified, the principal investigator/project manager will determine if the data are of sufficient quality to make determinations and decisions for which the study was conducted. The data from the laboratory's QC procedures will provide information to determine if MQOs have been met. Laboratory and QA staff familiar with assessment of data quality may be consulted. The project final report will discuss data quality and whether the project objectives were met. If limitations in the data are identified, they will be noted.

Some analytes will be reported near the detection capability of the selected methods. MQOs may be difficult to achieve for these results. Best professional judgment will be used in the final determination of whether to accept, reject, or accept the results with qualification. The assessment will be based on a review of laboratory QC results. This will include assessment of laboratory precision, contamination (blanks), accuracy, matrix interferences, and the success of laboratory QC samples meeting MQOs.

13.2 Treatment of non-detects

Laboratory data will be reported down to the method detection limit, with an associated "U" (not detected) or "UJ" (not detected and estimated) qualifier for non-detected results. If averaging concentrations, non-detects will be assigned a value of half the detection limit while a value of zero will be assigned for other parameters.

14.0 References

EA Engineering, Science and Technology, Inc., Gregory Geologic LLC, and Jacobs, 2020: Yakima Basin Managed Aquifer Recharge Assessment Final Report, prepared for Kittitas Reclamation District

EA Engineering, Science and Technology, Inc., Gregory Geologic LLC, and Jacobs, 2020: Quality Assurance Project Plan Field Assessments of High-Priority Managed Aquifer Recharge Sites in the Upper Yakima River Basin. EIM Study ID: KRDMON2023

Ecology, 2014: Upper Yakima River Tributaries Temperature Total Maximum Daily Load, Water Quality Improvement Report and Implementation Plan, Ecology publication 14-10-037

Ecology, 2019: Water Quality Program Quality Assurance Project Plan (QAPP) Template for Water Quality Components of Required Feasibility Studies for Managed Aquifer Recharge (MAR) Projects Publication 19-10-050

Ecology, 2021: Upper Yakima River Basin Suspended Sediment and Organochlorine Pesticides TMDL: 2019 Effectiveness Monitoring for TSS and Turbidity TMDL Targets, Ecology publication 21-03-013

Environmental Protection Agency (USEPA): Determination of Turbidity by Nephelometry Method 180 Rev 2. Available at https://www.epa.gov/sites/default/files/2015-08/documents/method_180-1_1993.pdf

U.S. Bureau of Reclamation, 2009: Taneum Creek Study: The Bruton-KRD Water Exchange Project Final Report https://www.usbr.gov/pn/programs/yrbwep/phase2/taneumcreek/taneumcreekstudy-final.pdf

Yakima Subbasin Planning Board, 2004, Yakima Sub basin Plan, prepared for the Northwest Power Planning Council, , https://www.nwcouncil.org/subbasin-plans/yakima-subbasin-plan/

15.0 Appendices

15.1 Appendix A: Standard Operating Procedures

Standard Operating Procedure EAP011, Version 2.0: Instantaneous Measurement of Temperature in Water, Ecology 19-03-202, February 2019: https://apps.ecology.wa.gov/publications/SummaryPages/1903202.html

Standard Operating Procedure EAP029, Version 1.6: Collection and Field Processing of Metals Samples, Ecology 18-03-204, March 2018: https://apps.ecology.wa.gov/publications/SummaryPages/2103203.html

Standard Operating Procedure EAP030, Version 2.1: Collection of Fecal Coliform Bacteria Samples in Surface Water, Ecology 18-03-239, December 2018: https://apps.ecology.wa.gov/publications/SummaryPages/1803239.html

Standard Operating Procedures EAP031, Version 1.5, Collection and Analysis of pH Samples, Ecology 17-03-205, July 2017: https://apps.ecology.wa.gov/publications/SummaryPages/2103204.html

Standard Operating Procedures EAP032, Version 2.3, Collection and Analysis of Conductivity Samples, Ecology 17-03-206, July 2017: https://apps.ecology.wa.gov/publications/SummaryPages/2203209.html

Standard Operating Procedure EAP052, Version 1.2: Standard Operating Procedure for Manual Well-Depth and Depth-to-Water Measurements, Ecology 18-03-215, April 2018: https://apps.ecology.wa.gov/publications/SummaryPages/1803215.html

Standard Operating Procedure EAP070, Version 2.2: Minimize the Spread of Invasive Species, Ecology 18-03-201, March 2018: https://apps.ecology.wa.gov/publications/SummaryPages/1803201.html

Standard Operating Procedure EAP074, Version 1.2: Use of Submersible Pressure Transducers During Groundwater Studies, Ecology 19-03-205, January 2019: https://apps.ecology.wa.gov/publications/SummaryPages/1903205.html

Standard Operating Procedure EAP090, Version 1.2: Decontaminating Field Equipment for Sampling Toxics in the Environment, Ecology 21-03-202, March 2021: https://apps.ecology.wa.gov/publications/SummaryPages/2103202.html

Standard Operating Procedure EAP098, Version 1.1: Collecting Groundwater Samples for Metals Analysis from Water Supply Wells, Ecology 19-03-204, January 2019: https://apps.ecology.wa.gov/publications/SummaryPages/1903204.html

Standard Operating Procedure EAP099, Version 1.0: Purging and Sampling Monitoring Wells for General Chemistry Parameters, Ecology 18-03-214, April 2018: https://apps.ecology.wa.gov/publications/SummaryPages/1803214.html

Integrated Statewide Groundwater Monitoring Strategy, Ecology 17-11-005, April 2017: https://apps.ecology.wa.gov/publications/SummaryPages/1711005.html

McCrometer, 2022, Mc Propeller Flow Meters: Installation, Operation and Maintenance Manual 24517-11 Rev. 4.7 July 11, 2022, https://www.mccrometer.com/library

15.2 Appendix B: Previous data

Please refer to section 3.2