**DETERMINING DEPTH TO GROUNDWATER WORKSHEET**

Providing a conclusive and appropriate basis for estimated groundwater levels is required for an application to be determined complete and to have meaningful review by DEQ Opencut. Understanding that additional information may be required ahead of time gives the Operator an opportunity to gather the required data prior to submitting a permit application.

This document provides direction for Operators regarding methods to establish depth to seasonal high groundwater levels within the proposed permit boundary, as required by ARM 17.24.218(1)(g). Additionally, if it is determined that Opencut operations would result in a surface water feature for a postmining land use, the Plan must include a pond and/or wetland design and follow the requirements of the *Pond Guideline* in addition to this worksheet.

This form includes automated calculations that require Microsoft Word 2010 or newer. As data is entered into this form, auto calculate fields will auto populate (tab out of each field to ensure they auto calculate). Autocalculate fields contain red text. If an autocalculate field is blank, either: a) the required information was not entered, or b) the blank field does not pertain to this application.

# Site Specific Information

1. **Operator Name:**
2. **Site Name:**
3. **Opencut Number (if permitted):**
4. Proposed Maximum Depth of Mining (must be identical to mine depth in permit/amendment application):  feet below ground surface
5. **DETERMINING DEPTH TO Groundwater**

The following information assists in determining and designing appropriate postmining land uses within the proposed permit boundary;

The following estimated depths to groundwater are considered preliminary and would be reviewed by Opencut. Ensure documentation submitted supporting estimated groundwater levels is complete, accurate and conclusive as Opencut reserves the right to refute information included in this form if it is not accurately documented.

1. **Choose the method(s) below (minimum of one method must be chosen) that were used to determine seasonal high water levels for this site:**
2. **[ ]  Elevation of Nearby Surface Water:** The elevation of nearby surface water for ponds and potholes, etc., may provide supporting evidence of groundwater elevation if those features are created from groundwater. This method works best for nearby water features that were created by Opencut operations, or if there are prairie potholes containing surface water. This method requires accurate elevation data that establishes the elevation of surface water in existing nearby ponds and/or potholes, as well as the lowest elevation within the proposed permit boundary. It is recommended the elevation data be obtained by surveying the identified features/locations, although other forms of obtaining elevation information may be acceptable if adequate documentation is provided. (i.e. topographic maps, etc.) Provide the following information:
	* 1. Surface water feature(s) used to determine groundwater levels must be identified and labeled with their elevation on the Area Map and Site Map (if applicable).
		2. Enter the lowest elevation of the proposed mine site (i.e. actual surveyed, or other acceptable means of determining pre-disturbance elevation) where mining would occur to the proposed mining depth stated in A-4 above (i.e.  **0** feet).

Lowest Elevation where mining would occur to depth stated in A-4 above = feet

Note: If mining to the depth stated in A-4 above would not occur throughout the entire site, explain in detail any variations in mine depth across the site :

* + 1. Elevation of nearest applicable (most representative/closest) surface water feature (i.e. prairie potholes, wetlands, ponds, etc.):

feet **- Date Surveyed** (if applicable)**:       Water Feature** **(name, type):**

* + 1. Elevation of lowest proposed mining depth (Lowest elevation at site, part ii, minus Maximum depth of mining, part A-4)  **0** feet
		2. Is the elevation of the lowest proposed mining depth ( **0** feet) lower in elevation or within three feet of the Groundwater Elevation (i.e. elevation of nearby surface water, part iii) **( 0** **feet)? If 0** feet **- 0** feet **= 0** feet **< 3** feet then check **“Yes” [ ]  Yes [ ]  No**

If **Yes**, choose the appropriate water feature postmining land use in Section E and check the appropriate box on page 2 of the permit application, and complete the requirements of the *Pond and Wetland Design Worksheet*.

* + 1. Additional information:

1. **[ ]  Well Logs & GWIC Well Data:** Information can be used for existing wells within 1,000 feet of the permit boundary. If no wells are located within 1,000 feet, well data from existing wells further than 1,000 feet from the boundary may be used if they are applicable to the proposed site. In most cases, the wells that are located closest to the site and at the same approximate elevation are the most representative. Well logs can be accessed from the “Mapping DEQ’s Data” site located here: <https://deq.mt.gov/mining/Programs/opencut> (click on Mapping DEQ’s Data) tab. Wells displayed online are frequently located incorrectly, so the operator must “ground truth” the actual well locations to ensure applicability of the well log. The actual location of each well used to support the groundwater depth estimates must be displayed on the Area Map.

The Operator must use the closest and most applicable wells when determining seasonal high and low water depths. Up to three wells can be used to determine groundwater depth.

Well I.D. Static Water Ground Elev. Lineal ft from Water

 on Map Level (feet) of Well Permit BNDRY Elevation

Well #1 **0** feet

Well #2 **0** feet

Well #3 **0** feet

* + 1. Enter the lowest elevation of the proposed mine site (i.e. actual surveyed, or other acceptable means of determining pre-disturbance elevation) where mining would occur to the proposed mining depth stated in A-4 above (i.e.  **0** feet)*.*

Lowest Elevation where mining would occur to depth stated in A-4 above = feet

* + 1. Well #1: Lowest elevation of proposed mine site ( **0** feet) – mining depth ( **0** feet**)** = a mining elevation of  **0** feet**. 0** feet **- 0** feet= **0** feet**.**

If **0** feet< 3 feet, then check “Yes” **[ ]  Yes [ ]  No**

* + 1. Well #2: Lowest elevation of proposed mine site ( **0** feet) – mining depth ( **0** feet**)** = a mining elevation of  **0** feet**. 0** feet **- 0** feet = **0** feet**.**

If **0** feet < 3 feet, then check “Yes” **[ ]  Yes [ ]  No**

* + 1. Well #3: Lowest elevation of proposed mine site ( **0** feet) – mining depth ( **0** feet**)** = a mining elevation of  **0** feet**. 0** feet **- 0** feet= **0** feet**.**

If **0** feet < 3 feet, then check “Yes” **[ ]  Yes [ ]  No**

If **Yes** to any of the above, choose the appropriate postmining land use (e.g. pond, wetland, etc.) in Section E of the *Standard Opencut Mining Application*, and complete the requirements of the *Pond and Wetland Design Worksheet.*

If **No** to all of the above, choose an appropriate dryland postmining land use in Section E of the *Standard Opencut Mining Application*. Include a copy of this document and all supporting documentation with the application.

* + 1. Additional information:

1. **[ ]  Groundwater Observation/Monitoring Wells:** Groundwater observation/monitoring wells provide a viable method for determining the elevation of groundwater as well as for taking water samples. Refer to **Appendix A – Groundwater Observation Well Installation and Measuring Procedures** for the requirements to allow the use of this method of determining depth to groundwater.Ensure all data and measurements supporting the below information is provided with the application (i.e. Appendix A and other supporting data). Provide the following information:
	* 1. The estimated seasonal low water table level measurement (furthest from ground surface, deepest): feet**.**
		2. The estimated seasonal high-water table level measurement (closest to ground surface, shallowest): feet**.**
		3. Estimated seasonal high water table level measurement **( 0** feet**)** minus (-) proposed maximum mining **( 0** feet**)** depth = **( 0** feet**)**

Is this number **( 0** feet**)** < 3 feet?  **[ ]  Yes [ ]  No**

If **Yes**, choose the appropriate postmining land use (e.g. pond, wetland, etc.) in Section E of the *Standard Opencut Mining Application*, and complete the requirements of the *Pond and Wetland Design Worksheet*

If **No**, choose an appropriate dryland postmining land use in Section E of the *Standard Opencut Mining Application* and include a copy of this document and all supporting documentation with the application.

* + 1. Additional information:

1. **[ ]  Test Hole Observation:** Field observations by the operator, such as test pit information, may be acceptable in support of groundwater level estimates. Choose the method used at the proposed site and results below:
	* 1. **[ ]**  Groundwater or evidence of groundwater was observed in onsite test holes. Provide complete test hole information in the permit application supporting the seasonal high and low groundwater estimates.
			1. Choose the appropriate postmining land use (e.g. pond, wetland, etc.) in Section E of the Opencut *Standard Opencut Mining Application*, and complete the requirements of the *Pond and Wetland Design Worksheet.*

Additional information:

* + 1. **[ ]** Groundwater or evidence of groundwater was not observed in onsite test holes.
			1. Choose an appropriate dryland postmining land use in Section E of the *Standard Opencut Mining Application.* Include a copy of this document and the required report summarizing test pit results.

The following criteria must be met and included in the report to substantiate groundwater estimates based on this method:

* + - * 1. A minimum of 2-test pits must be located in low areas of the site and the test pits must be completed to a minimum of three feet deeper than the proposed maximum mining depth, and rationale and justification for the selected soil test pit locations must be provided.
	1. Test pits must be located and spaced to provide representative data for the entire proposed permit area, and must include the lowest elevations within the site.
	2. A professional soils expert must be hired to conduct a detailed soil profile of each test pit, specifically looking for indications of water (i.e. mottling, redoximorphic features, gleying, water, etc.).

Provide a report summarizing the results and describing how the seasonal high and low water levels were determined. Include a description of topography and how it interacts with the test pit locations and other pertinent supporting information. Complete the Soil Test hole table located in Section C of the permit application.

Note that this method is only applicable to sites where the groundwater flows through clay or soil horizons, not gravel.

 Additional information:

1. **[ ]  Other Methods to Determine Seasonal High and Low Water Levels (explain):**

**APPENDIX A - GROUNDWATER OBSERVATION WELL**

**INSTALLATION AND MEASURING PROCEDURES**

The Operator may be required to provide data identifying the existing water levels through the installation of observation wells and a consistent measurement of those wells in order to accurately determine the postmining land use(s). The observation well plan must be prepared by a competent professional for Opencut to review and include the information listed below. Field data must be accompanied by the names and addresses of the parties that collected and analyzed the data, and must include a description of the methodologies used to gather and analyze the data [ARM 17.24.222(2)].

The plan must include:

* + Observation well plan to determine actual seasonal high and low water levels within the proposed permit boundary.
	+ Installation of a minimum of three (3) groundwater observation wells at the lowest elevations of the site. Refer to “Where to Install” and “Installation Process” sections below for more detailed information.
	+ Measurement of groundwater for a sufficient period of time to determine a peak and a sustained decline in the groundwater level. Refer to the Observation Schedule below for further guidance.
	+ A report summarizing observation results including a description of topography, a map showing well locations, well logs, a table summarizing groundwater data collected, and actual seasonal high and low groundwater levels based on the collected data. The report must include total precipitation for the previous year and snowpack equivalent compared to the 30-year historical average. The results must be submitted for analysis and review with the application and prior to permit approval.

**Observation Schedule**

Observation wells must be installed before or during the time when groundwater levels are highest. This is typically during spring runoff and/or during the irrigation period, but may also occur at some other time during the year. Observation measurements must be made weekly or more frequently during the appropriate periods of suspected high groundwater. Observation measurements must be made at a minimum of once a week for a minimum of four weeks when groundwater is at its highest to accurately determine high groundwater level. More complex sites must include at least two weeks of observation measurements prior to and two weeks of observation measurements after the groundwater peak. Failure to meet these criteria would likely result in the Opencut Section rejecting the results. The applicant is encouraged to submit a Pre-Application Meeting Request to seek guidance on any groundwater observation well plan and installation prior to implementing the plan or submitting a permit application. The monitoring and measurements of the observation wells must be completed by a qualified site evaluator such as a soil scientist, professional engineer, hydrogeologist, or geologist who has experience and knowledge on how to properly take and record measurements from an observation well.

Surface water levels may be indicative of the groundwater levels that could peak several weeks

after spring runoff and the irrigation season.

Local conditions may indicate that there is more than one geologic horizon that can become seasonally saturated. Observation wells must be installed to the depth of mining and preferably three feet deeper than the proposed mining depth. The wells should be placed in, but not extended through, the horizon that is to be monitored.

The Opencut Section may refuse to accept seasonal high groundwater data when the total precipitation for the previous year, defined as May 1 of the previous year to April 30 of the current year, if April 1 snowpack equivalent, measured at the nearest officially recognized observation station, is more than 25 percent below the 30-year historical average. This is based upon the definition of drought conditions created by the National Drought Mitigation Center. The Opencut Section may consider soil morphology and data from nearby groundwater observation sites with similar soil, geology, and proximity to streams or irrigation ditches, if available, to determine seasonal high groundwater elevation during periods of drought.

**Where to Install**

The observation wells must be installed in locations representative of typical groundwater conditions at the site. At least two of the wells should be in low lying areas of the site and the wells should be spread out to represent conditions across the site. Larger sites or sites with highly variable conditions and/or topography may require the installation of additional wells. Opencut may require additional observation wells if the wells installed by the Operator are not installed properly and/or are not in locations considered representative of the site.

**Installation Process**

The following criteria must be met for installed observation wells:

* The observation wells must be installed vertically into a dug or drilled hole.
* A slotted water well pipe should be used that is wide enough in diameter to install a measuring device.
* The slotted water well pipe must be installed a minimum of three feet deeper than the proposed mining depth.
* Slotted pipe (PVC is the most common material) with slot sizes between 0.04 and 0.10 inches wide is suggested. Slots should be horizontal and spaced at intervals less than or equal to 0.5 inches. Refer to ARM 36.21.650 for additional information on casing perforations. Alternate well materials are acceptable if they meet the requirements of ARM 36.21.640 (DNRC well casing requirements).
* The pipe must be perforated from 1 foot below the ground surface to 3 feet below the proposed maximum mining depth.
* The casing must be unperforated 1 foot below the ground surface to the top of the observation well. The observation well must extend at least 2 feet above the ground surface.
* The top of the observation well must be sealed with a watertight cap.
* The area around the well must be backfilled with native material to 1 foot below the ground surface.
* The observation well must be sealed in such a manner that prevents surface runoff from running along the outside of the well casing. The well should be sealed from 1 foot below the ground surface to slightly above grade to allow for subsidence and to maintain a positive ground slope away from the well casing. The material used to seal the well can be either fine-grained material or bentonite.
* Each observation well should be flagged to facilitate locating the well and labeled with a well number, operator name, and site name.

**Measuring Procedures**

Lower a measuring tape or stick to the water level and measure the distance from the water level to the top of the pipe (refer to example on last page). Water levels should be measured to the nearest inch. A plunking device or electronic water sensor can also be used. Data should be submitted in a similar form to that of the example.

Measure the distance from the top of the pipe to the natural ground surface (B distance) (refer to example). Then measure the distance from the top of the pipe to the water level (A distance) (refer to example). Subtract B from A. This value equals the actual separation between the water table and the natural ground surface.

**Decommissioning**

If observation wells were installed deeper than 10 feet below the proposed mine depth, the operator may be required to follow the standards in ARM 36.21.810.

