Water Level Monitoring Plan

Merriam Junction Sands
Scott County, Minnesota

Prepared for
Merriam Junction Sands, LLC

December 2019

4300 MarketPointe Drive, Suite 200
Minneapolis, MN 55435
952.832.2600
www.barr.com

Water Level Monitoring Plan

December 2019

Contents

1.0 Introduction 4
1.1 Purpose of Plan and Intent of Monitoring 4
1.2 Scope 4
1.3 Project Area Geology 5
1.4 Hydrogeology and Hydrologic Conditions 5
1.5 Conceptual Basis for Monitoring Program 6
1.5.1 Alert Levels 7
1.6 Surface Water Resources 8
1.6.1 B4 Wetland 8
1.6.2 Seepage Wetland 8
1.6.3 Louisville Swamp and Gifford Lake 9
1.7 Water Supply Wells 9
2.0 Monitoring Plan 11
2.1 Monitoring Locations 11
2.2 Monitoring Schedule 12
2.2.1 Baseline Monitoring 12
2.2.2 Routine Monitoring Frequency 12
2.2.3 Timing of Surface Water Gage or Additional Well Installation 12
2.2.4 Criteria for Decreased Monitoring 13
2.3 Data Collection 13
2.3.1 Methods 14
2.3.1.1 Baseline Monitoring 14
2.3.1.2 Periodic Inspections and Manual Water Levels 14
2.3.1.3 Wetland Visual Monitoring 14
2.3.1.4 Public Data Resources 14
2.4 Alert Levels and Data Evaluation 15
2.4.1 Surface Water Alert Levels (for Protection of the B4, Seepage Wetland, Gifford Lake and Louisville Swamp Resources) 15
2.4.2 Groundwater Alert Levels for Protection of Private Wells 15
2.5 Response to Alert Level: Timing and Actions 17

2.5.1 Initial Alert and Verification of an Alert Level Trigger 18
2.5.2 Response to Verified Alert Level Trigger 18
2.5.3 Additional Response to Alert Level Trigger 19
2.5.4 Response to Public Data 20
2.5.5 Response to Qualitative Assessment of Visual (Photographic) Monitoring 20
2.6 Reporting 20
2.7 Post-Reclamation Monitoring 21
3.0 Mitigation Action Planning 22
3.1 Phased Mitigation and Adaptive Management 22
3.1.1 Phased Mitigation 22
3.1.2 Adaptive Management 22
3.1.3 Interim Mitigation Plan (IMP) 22
3.1.3.1 IMP for Surface Water Resources 22
3.1.3.2 Interim Mitigation Plan (IMP) for Private Supply Wells 23
3.2 Conceptual Action Plan Alternatives for the Seepage Wetland within the B4 Wetland Complex 23
3.2.1 Low Level of Mitigative Effort – Additional Direct Discharge to Seepage Wetland 23
3.2.2 Moderate Level of Mitigation – Infiltration Trenches 24
3.2.3 High Level of Mitigation – Infiltration Basin 24
4.0 Plan Summary 25
5.0 References 26

List of Tables

Table 1 Monitoring Network, Frequency, and Alert Levels

List of Figures

Figure 1 Site Location Map

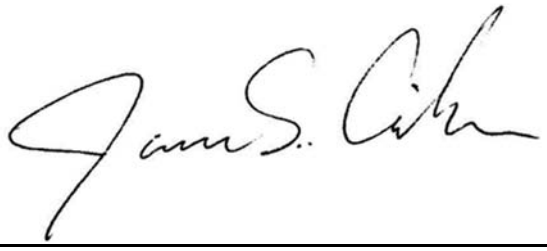
Figure 2 Groundwater Elevation Contours: November 2016

Figure 3 Proposed Monitoring Network

Figure 4 Alert Level Response Timeline and Monitoring Flow Chart

Certification

I hereby certify that this plan, document, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Geologist under the laws of the state of Minnesota.



12-27-2019

Name

Date

PG #: 30282

1.0 Introduction

This Groundwater and Surface Water Level Monitoring Plan (Plan) has been prepared for the Merriam Junction Sands non-metallic mineral mining and processing project (Project) in Louisville Township, Scott County, Minnesota (Site or Project Area; Figure 1). The Environmental Impact Statement (EIS) prepared for the Project includes an evaluation of the Project's potential impacts on groundwater quantity; this Plan is based on the findings of that evaluation.

As part of the EIS, Barr Engineering conducted groundwater modeling including predictive simulations related to the various mine alternatives (Barr 2017). The simulations were used to identify potential impacts to water resources and private well performance as a result of dewatering activity. The monitoring reflected in this plan represents precautionary measures that will be used to confirm the modeling report's conclusion of no significant impacts and to provide a strategy to address impacts should they occur unexpectedly.

In some cases, avoidance of impacts and impact-mitigation pre-planning (e.g. by mitigation and well owner agreements) are planned as a precautionary measure. The Plan provides a means for systematic data collection intended to monitor changes in water levels and provide a means to evaluate timing and implementation of those planned or other actions if necessary.

1.1 Purpose of Plan and Intent of Monitoring

This Plan is a draft water level monitoring plan that is provided for review and comment in the DEIS. It is anticipated that the Plan will be incorporated into the DNR Water Appropriation Permit for the Site. As such, the Plan is subject to modifications including additional requirements consistent with MDNR policy on similar sites and based on the water appropriations permitting process.

The purpose for conducting water monitoring is to document changes in water levels related to dewatering of a thin layer of rock that will be removed prior to wet mining of the underlying sandstone. Where appropriate, this Plan provides for the development of alert levels that will help guide adaptive mine management and implementation of mitigation strategies to protect water resources and private well performance in accordance with Minnesota Rules.

It is anticipated that the details of this plan will be finalized as part of the Water Appropriations Permit regulated by the Minnesota Department of Natural Resources (MDNR). The results of each year of monitoring will be included in annual report. The need for changes to the plan will be evaluated in the report and modifications to the plan will require approval from the appropriate regulatory entities.

1.2 Scope

The scope of this Plan includes the following:

- Describe the existing conditions regarding groundwater and surface water;

- Describe the procedures for monitoring surface water resources including wetlands and lakes near the Project Area;
- Describe the procedures for monitoring of groundwater water levels near private supply wells identified within the predicted area of potential impact;
- Establish a program for developing baseline (pre-mining and during non-dewatering periods of mining) monitoring program which will define background conditions that will serve as basis for alert levels;
- Define a monitoring network (location, schedule, reporting);
- Develop appropriate alert levels and a schedule for addressing conditions under which water levels fall below the alert level; and
- Identify potential contingency actions including mitigation that may be considered for developing a response to the alert condition.

The Plan has been organized as follows:

Section 1.0	Describes the Project in particular Project elements which pertain to groundwater and surface water; identifies potential impacts, as determined based on the evaluation in the EIS;
Section 2.0	Lists monitoring locations, schedule, and reporting;
Section 3.0	Describes conceptual mitigation measures; and
Section 4.0	Provides the references utilized to prepare this document.

1.3 Project Area Geology

The geology of the Project Area is described in Barr (2014). The Project Area is located on a glacial river terrace approximately 10 to 50 feet above the Minnesota River floodplain. Much of the Project Area has been mined down to the lower Prairie Du Chien known as "transition material" or the Coon Valley Member of the Oneota Formation, which is the basal member of the Prairie du Chien Group. The underlying Jordan Sandstone (Jordan) is the target bedrock unit for the proposed sandstone mining.

Where not previously mined, the Project Area is overlain by up to approximately 30 feet of alluvial terrace deposits, including areas with erosional valleys in the bedrock that are filled with floodplain alluvium and/or palustrine (wetland) deposits. Isolated remnants of glacial till have been found in the alluvial terrace deposits but are not laterally continuous across the Project Area.

1.4 Hydrogeology and Hydrologic Conditions

Existing conditions are shown on Figure 2. Groundwater occurs at about 0 to 50 feet below the ground surface over the Project Area. Because much of the area has been previously mined, groundwater is less than 20 feet below the ground surface over a large portion of the Project Area. Groundwater flow is westward toward the Minnesota River, which is a regional discharge area as shown on Figure 2.

A glacial outwash-filled bedrock valley is located under the northern portion of the Project Area that intercepts a portion of the Jordan and results in a northwestern component of groundwater flow in this

area. The elevation of the water table varies from approximately 724 feet above mean sea level (AMSL) in the eastern portion of the Project area to 702 feet AMSL in the northwestern portion of the Project Area. Below the Jordan, the St. Lawrence Formation acts as a confining unit on the Tunnel City Group. Strong upward vertical gradients are present between the Jordan and the underlying units. Groundwater flow in the Tunnel City Group is also westward toward the Minnesota River, which is a regional groundwater discharge area.

1.5 Conceptual Basis for Monitoring Program

This Plan assumes that dewatering conducted for one growing season or less is unlikely to result in permanent adverse impact to wetlands or private water supplies as described below. The DEIS notes that there will likely be continuous dewatering for multiple consecutive years during development of the various project phases. Since dewatering may continue for longer periods, monitoring and/or mitigation may be necessary to avoid impacts to wetlands and private wells. Therefore, monitoring is optimized to be sensitive to early detection but flexible in implementing actions (including mitigation) over an extended period while dewatering continues. The supporting evidence for this approach is discussed below:

- **Results of groundwater modeling (Barr 2017)**. Groundwater simulations were performed to assess the potential effects of dewatering on the water resources and wells. The results were then compared by using a scoring system. The scoring system evaluated the potential impact of dewatering on each resource. While the modeling indicated that there are unlikely to be significant impacts from the proposed Project, the monitoring proposed adds an additional layer of protection to water resources.
- **Observation that water levels decline due to natural drought conditions.** Droughts have occurred in the past and will occur in the future. Natural systems are adapted to accommodate changes that may extend over more than one growing season. Biological harm can occur when there is a change of species that can invade a plant community over time. Due to plant reproductive processes, this change generally cannot occur in less than one growing season and may require more prolonged periods to effect change in wetland plant ecosystems.
- **Wells are located in a very transmissive aquifer**. Most of the private wells near the Project Area are open to the Jordan Aquifer which is considered very transmissive and therefore it yields significantly more water to wells on a daily basis than is typically consumed by households. Properly functioning wells can tolerate declines in water level without impact to performance.
- **Review of well construction records**. The DEIS includes an evaluation of private supply wells in the vicinity of the Project Area. The records indicate that the majority of wells within the area defined by the predicted 5-fooot drawdown contour in Barr (2017) are unlikely to become impaired in function under any of the modeled mining scenarios. Regardless, all of the well owners within the 5-foot contour will be offered a well owner agreement prior to mining activities that involve dewatering.
- **Existing water supplies protected by state law**. Adjacent water supply wells are protected by current state law which requires that adequate water supply be maintained to meet the needs of the household. By law, domestic water supply is given first priority in water allocation.

Dewatering for mining activity is given fifth priority. Protection of all the existing water well users is afforded by on-going regulatory authority of the Department of Natural Resources (DNR).

Therefore, the goals of water level monitoring are to:

1. Ensure that water resources are not subject to biological harm due to prolonged decline in water level; and to
2. Ensure that water supply and well performance of adjacent water supply wells is not negatively affected due to water level declines.

1.5.1 Alert Levels

The primary means for determining whether adverse conditions are occurring as a result of dewatering is by comparison of water levels observed during dewatering to baseline data. The lowest elevation of the baseline data will be used as the foundation for establishing "alert levels". Alert levels are conservative water levels that if reached at a given monitoring location, start the process of additional evaluation and/or response.

The alert level will include the lowest baseline water level with an additional offset that incorporates the likelihood that the baseline data set will under-represent low elevations and over-represent higher water levels. This is because flood conditions occur seasonally in this hydrologic setting and drought conditions occur much more rarely.

For water resources, the offset from baseline will include a pre-set number that may be modified as a result of on-going monitoring and collection of additional baseline data.

For monitoring wells that are not monitoring private wells, the offset from baseline will be based on anticipated "worst-case" simulated conditions. These offsets from baseline will be used as a check on the assumption that the modeling results are worst case because if the drawdown predicted occurs early in the Project, it would suggest that actual drawdown is greater than predicted by the groundwater model results (Barr 2017).

For monitoring wells that are used to monitor private water supply wells, the offset from baseline is determined by comparison of the recorded pump depth on well construction logs in the vicinity of the monitoring well. The offset is based on information from private wells called "comparison wells" because they are located near the monitoring wells and are believed to be typical of the construction of residential supply wells in the area.

An evaluation of the data trends will be completed as part of the annual reporting, with an assessment of the likelihood these trends may lead to an exceedance of a trigger. This will provide for proactive evaluation of the need for mitigation. This reporting of trends and observation will also provide the basis for recommendation for any changes to the plan and the associated Alert Levels.

The sections below describe each of the potentially affected areas near the Project. Alert levels are described in more detail in Section 2.4 and shown on Table 1.

1.6 Surface Water Resources

Prominent surface water features in the vicinity of the Project Area include the Minnesota River system along the western Project boundary, an elongated wetland complex in the south-central Project Area (Seepage wetland and B4 wetland), and Public Wetland Inventory (PWI) wetlands to the southwest (Louisville Swamp; public water #70-209) and northwest (Gifford Lake; public water #70-118P). Surface water features are shown on Figure 2.

1.6.1 B4 Wetland

The B4 wetland is a floodplain wetland complex that consists of two distinct wetland types that have been evaluated separately throughout the DEIS. Although the original wetland delineation labeled the entire wetland complex B4, there are two different wetland areas within the complex. Because the two areas of the wetland complex have distinctly different hydrologic components, for the purposes of this report the term "seepage wetland" includes the wet meadow and shrub Carr native plant community that is dominated by groundwater flow. The remainder of the wetland is referred to as the "B4 wetland".

The B4 wetland is river floodplain hydrology and receives most of its total flow from surface water and routine flooding based on water balance calculations described in Barr (2017). The wetland also receives ample surface water flow from water discharging from the seepage wetland. The seepage wetland is shown in Figure 2. A potential negative effect of the Project would be to decrease the amount of groundwater reaching the B4 wetland such that it permanently lowered water levels and negatively affected the wetland type and associated plant community. The first indication of reduction in flow to the B4 wetland would be indicated by a change in surface water level that is below historical baseline levels. Because these baseline levels are dominated by flood events, it is likely that the lowest baseline level will not fully account for natural declines. Therefore, an offset of an additional 2 feet of water level decline will be subtracted from the lowest baseline level to establish an alert level. Water level monitoring will be performed using surface water gages to evaluate changes in water levels in the B4 wetland.

1.6.2 Seepage Wetland

The southern portion of the B4 wetland is considered to be a native plant community referred to as a Southern Seepage Meadow/Carr (WMs83a) according to the MDNR classification (MDNR 2005), referred to herein as the seepage wetland. This community type is considered to be a "rare natural community" according to MDNR guidance information.

Groundwater modeling (Barr, 2017) demonstrated that groundwater discharge to the seepage wetland can be maintained through mitigation, by replacing a portion of the volume of groundwater removed through dewatering back into the wetland. Monitoring of surface water levels in the wetland will be used to determine if groundwater baseflow is reduced relative to historical baseline. If mitigation is initiated to replace a reduction in groundwater baseflow, subsequent monitoring will also be used to demonstrate the performance of the mitigation system.

Natural declines in water level are anticipated to occur seasonally and periodically over time in response to climatic trends. An impact to the seepage wetland would be indicated by a decrease in surface water

elevation strictly due to pumping. Natural declines are not considered an impact from the Project. Because the historical baseline data is relatively short, it is unlikely that the baseline water levels will account for natural declines. Therefore an additional one foot will be subtracted from the lowest baseline level to establish the alert level for this resource. Unlike the other surface water resources, the seepage wetland is less subject to flooding and therefore a lower offset to baseline is justified in determining the alert level.

Visual (routine photographic) monitoring of the seepage wetland during the growing season will be performed to verify no adverse changes and to evaluate the effect of potential declines relative to baseline.

1.6.3 Louisville Swamp and Gifford Lake

Two large water bodies are recognized near the Project. These include Louisville Swamp which receives significant surface water flow from Sand Creek (Figure 2) and Gifford Lake which is a floodplain lake connected to the Minnesota River hydrology during most of the year. Both waterbodies are frequently flooded surface water features that are not highly dependent on groundwater. Groundwater and surface water modeling have demonstrated that the Louisville Swamp and Gifford Lake are not likely to be significantly impacted by the Project (Barr, 2017). Because of the limited amount of baseline data and because the baseline levels recorded for these surface water features are typically dominated by flood events, it is likely that the lowest baseline level will not fully account for natural declines. Therefore, an offset of an additional two feet of water level decline will be subtracted from the lowest baseline level to establish an alert level.

As requested by the County, water level monitoring is proposed for Louisville Swamp or Gifford Lake for a period of two years after dewatering is initiated near each water body to establish trends. That is, Gifford Lake monitoring will begin when dewatering in the Malkerson North mining phase is initiated and the Louisville Swamp monitoring will be initiated when dewatering Malkerson South mining is initiated. Surface water level monitoring is proposed for these areas. After a minimum of two years of monitoring, modification to the monitoring program may be proposed in the annual report. Placement of monitoring gage at Louisville Swamp is subject to third-party approvals which may limit monitoring near the swamp.

1.7 Water Supply Wells

The Plan includes groundwater level monitoring to monitor for potential impacts to private wells located near the Project Area. Groundwater modeling (Barr 2017) indicated that private water supply wells are not likely to be significantly impacted by the Project due to proximity, aquifer transmissivity, well construction, and well owner agreements that will be offered to well owners near the Project. These well owner agreements are part of on-going regulatory authority of the MDNR that requires that the Project not interfere with the needs of well owners.

Monitoring groundwater levels and evaluating the drawdown trends during dewatering are planned to provide an early indication of the need for mitigation, including lowering of well pump settings so that water supply to private wells is not affected by the Project. Well owner agreements will be offered to all

wells within the modelled five foot drawdown contour. The well agreements will include the Proposer's financial responsibility to institute mitigation measures such as lowering the pump setting in a well or redrilling a well to maintain water supply needs. Monitoring will be used as a way to identify the timing of implementation of mitigation measures if necessary to maintain private well water supply. The alert levels for baseline monitoring will use the lowest baseline elevation minus an offset that is one-half the average of the pump depth setting for the nearest private wells or wells. Comparison wells are shown on Figure 3 and Table 1.

2.0 Monitoring Plan

This Plan has been developed to determine if there are impacts to the potentially affected resources and wells identified in Section 1. Water level monitoring will also be used for mitigation monitoring if mitigation is needed, so that the effects of water being replaced either directly into a surface water body or indirectly by infiltration can be measured. The following subsections describe the monitoring protocol, including: monitoring locations, frequency, schedule, and reporting. Adjustments to the monitoring protocol may be necessary if monitoring wells are removed in the course of mining operations, or decreased monitoring is warranted.

2.1 Monitoring Locations

This Plan is for water level monitoring only. Monitoring locations are shown on Table 1 and on Figure 3. The monitoring locations were selected for the following purposes:

1. To monitor water levels in each phase during dewatering periods;
2. To monitor water levels near water resources and private wells which may be impacted by potential drawdown and/or decreased groundwater flow; and
3. To monitor post mining reclamation conditions for two years after mining is completed.

The assignment of proposed monitoring locations listed on Table 1 and shown on Figure 3 is based on the following elements:

- Monitoring locations at the B4 wetland will consist of monitoring stations at SW3, SW4, SWB4 and MW1-11
- Monitoring locations for the seepage wetland will consist of monitoring stations SW1 SW2 and MW17-11
- Monitoring locations at Gifford Lake will consist of SWGIFF and MW20-11.Monitoring locations at Louisville Swamp will consist of SWSWMP1 and MW-17-11
- Monitoring locations for private wells will consist of all of the monitoring points above to the extent that they contribute to water table contour mapping
- In addition wells MW7-11, MW4-11, MW9-11, W-114 (part of the Louisville Landfill monitoring system), MW-10 (part of the Dem-Con Landfill monitoring network) and a new well MW1-18 will also be monitored and used in water table contour mapping.

Permission for monitoring the Louisville/Dem-Con Landfill area wells will need to be obtained from the well or property owners. A new monitoring well, MW1-18 will be located on the bluff adjacent to private water supply wells with the final location to be determined based on access.

Public information will be obtained from the National Weather Service, the United States Geological Survey (USGS), Minnesota River stage levels, Minnesota DNR observation wells and used to track regional factors that may affect natural occurring changes in water levels within the Project Area.

2.2 Monitoring Schedule

2.2.1 Baseline Monitoring

Before dewatering begins, water level data will be collected from all locations on at least a quarterly basis and added to existing historical data to assess the range of water levels and to determine the lowest historical water level at each monitoring location that will be used as an alert level for future monitoring.

Water levels will also be collected during non-pumping periods to add to the baseline data set but will not be added to baseline until at least two weeks after pumping has stopped. In order to avoid normalizing the background data set, water levels will only be added to background after they have stabilized from the last round of pumping. For new monitoring locations, the baseline data will start at least one year prior to dewatering in the areas closest to the monitoring location.

2.2.2 Routine Monitoring Frequency

The water level readings at each of the on-site (e.g. within the Project boundary) monitoring locations will be recorded manually on a minimum weekly basis during active dewatering.

Four groundwater well locations (to be determined) will be instrumented with transducers collecting daily measurements. These locations will be uploaded twice a month and the two weeks of data from each upload will be plotted against the alert level. Likewise, the weekly manual readings will be plotted against the alert level for each of the wells not equipped with dataloggers such as the weekly manual measurements from SW1, SW2, SW3, and SW4.

Additional manual readings will be conducted monthly at offsite locations SWGIFF1, SWB4, and SWSMP1. A reduction in monitoring frequency can be proposed in the annual report with the associated basis for modification to the monitoring plan. Re-deployment of transducers into new areas can also be proposed if there are no observed effects for 90 days after pumping and/or the transducers can be better utilized in areas showing greater effects from dewatering. Any re-deployment of transducers will be discussed in the annual report. During non-pumping periods water levels will be collected at least quarterly.

2.2.3 Timing of Surface Water Gage or Additional Well Installation

This Plan is intended to cover water level monitoring that will occur once dewatering activity begins. The area and timing of the dewatering operations is defined by a series of alternatives that are not yet finalized in the mining plan. Monitoring in those areas farthest from dewatering during the early parts of the Project is not necessary or would be redundant based on the groundwater modeling simulations (Barr, 2017). Therefore the monitoring network will be completed in stages based on the following criteria:

- Water level monitoring in areas closest to the initial phases of dewatering in a mining area will begin within a minimum of one year (allowing for a minimum of 8 events) prior to start of dewatering.

- Those areas further from mining may be monitored at a minimum annual frequency but in all cases will have a minimum of eight monitoring events and at least one water level collected from each quarter prior to the start of dewatering once the dewatering begins in the phase nearest to the monitoring location.

2.2.4 Criteria for Decreased Monitoring

This Plan has been prepared based on results from past Project investigations and groundwater modeling simulations. The specifications for monitoring are based on interim mine plans. It is expected that as mining activities progress, monitoring trends will mature and the groundwater contours will reveal a stable area of influence. If a monitoring or surface water gage identified in the groundwater monitoring network is not affected by dewatering for two years, it may no longer be necessary to monitor water levels in that well or gage. If it is determined that monitoring requirement(s) should be reduced, a request will be presented to the appropriate regulatory entities (as applicable) for approval either through the annual report evaluation or under a separate submittal.

In areas that are dominated by river hydrology (e.g. Gifford Lake and Louisville Swamp), monitoring shall be conducted for a minimum of two years after dewatering is initiated in the mining area closest to that water body. A proposal to modify or discontinue monitoring after two years of monitoring may be made if there is no significant decline below the alert level. For example, Gifford Lake monitoring will be initiated once dewatering begins at Malkerson Sales North property and a recommendation to modify or discontinue may be made after two years if surface water gage data demonstrate that there is no significant impact to the lake. Likewise, monitoring at Louisville Swamp will be initiated once dewatering begins at Malkerson Sales South and a similar evaluation and recommendation may be made. Each monitoring point will be installed prior to dewatering so that 8 events covering at least one growing season are collected prior to dewatering. Monitoring at Louisville Swamp will be subject to approval of installation of monitoring gage by USFWS.

2.3 Data Collection

Water level data will be collected from either a monitoring well or a staff gage. The type of monitoring device will depend upon the location of the sampling station. Manual water levels will be collected with an electronic water level reader to the nearest 0.01 foot for monitoring wells used to monitor groundwater levels. Staff gages will be attached to a pipe or T-post grouted into the sand or bedrock substrate below the wetland. The staff gages will be used to monitor the elevation of the surface/groundwater water levels in the wetlands and Gifford Lake and will be read directly from the stage gage to the nearest 0.1 foot.

All transducers or dataloggers will be calibrated and if necessary corrected to a surveyed benchmark so that they read directly in feet above mean sea level (MSL). At least one barometric pressure data logger will be installed for the network.

Water level data will be reported as elevation above mean sea level datum for both the wells and staff gage monitoring locations.

2.3.1 Methods

2.3.1.1 Baseline Monitoring

Manual observations will be read directly from the surveyed gages and recorded on data forms or in a notebook that will be kept at the Project office. Dataloggers will be downloaded quarterly and combined with manual measurements in a spreadsheet program. Baseline data collection will be on-going during non-pumping periods to capture the lower range of water levels and post stabilization water levels after and between pumping periods. Baseline monitoring data will be appended to the historical data set as long as declining trends are not present due to pumping influence.

2.3.1.2 Periodic Inspections and Manual Water Levels

During active dewatering, inspections will be performed once every two weeks to check piping, upload water level data (for those monitoring wells that have transducers) and check monitoring stations for damage. Manual (as opposed to automatic transducer) water levels measurements will also be obtained weekly during pumping periods, except during the winter months when the surface water gage locations are frozen. During non-pumping periods, inspections will be performed and water levels will be recorded at all monitoring locations quarterly. Quarterly inspections will be recorded on data forms or in a notebook that will be kept at the Project office.

2.3.1.3 Wetland Visual Monitoring

Photographic monitoring stations will be established to document vegetative conditions on an annual basis at the same time each year during the growing season for the seepage wetland and wetland B4. The photographic monitoring station locations will correspond to surface water monitoring locations SW1, SW2, SW3, and SW4. No visual monitoring is proposed at SWB4 in wetland B4, Louisville Swamp (SWMP1), and Gifford Lake (SWGIFF1) because of difficulty accessing these locations due to frequent inundation by flooding during the spring and summer. At each station, a photograph of the vegetation will be taken from the same direction and will focus on the same area perspective so that comparisons can be made between photographs. The photographs are intended to capture sufficient detail to compare the overall vegetative cover and if possible, depth of water observed. Additional more detailed monitoring may be required by the MDNR as part of the Water Appropriations Permit.

2.3.1.4 Public Data Resources

Precipitation data will be collected during the monitoring periods specified in this Plan from a local weather station with publicly-available data. Surface water data will be collected on the Minnesota River gage at Jordan, MN and will be corrected for elevation at Gifford Lake by interpolation from the flood insurance maps similar to river data included in Barr (2017). Data from a regional water level observation well will be evaluated quarterly. An MDNR observation well located near the Seminary Fen (located across the river by Chaska) will serve as check on regional drought and climatic changes that could influence long term trends to water levels in the Project Area. This area was selected because of its proximity to the

Site, long history of record, and similarities in the valley geometry relative to the Minnesota River. It is anticipated that drought conditions may require adjustment to some of the provisions of this Plan.

2.4 Alert Levels and Data Evaluation

During active dewatering, the most recent water levels will be compared to each well's own historical baseline every two weeks (14 days). An alert level is a predetermined water level elevation that serves as a trigger at which some additional data validation and evaluation occurs followed by some action (as needed) that will be taken to protect the resource or water supply. The alert will be triggered only if the alert level is exceeded continuously for 1 week (168 hours).

2.4.1 Surface Water Alert Levels (for Protection of the B4, Seepage Wetland, Gifford Lake and Louisville Swamp Resources)

The alert level for surface water resources will be the lowest recorded baseline elevation minus a pre-determined offset subtracted from the baseline elevation. This method has been used by the DNR for other mine sites. The offset for the seepage wetland will be one foot and two feet for the other surface water bodies. The extra two feet of offset is to account for the prevalence of flood events likely to result in an unrealistically high value for the lowest baseline water level. The seepage wetland has a smaller offset because it has not historically been subject to frequent flooding as the other surface water bodies have experienced (Barr, 2017). During dewatering, if the water level drops below the alert level continuously for at least one week (168 continuous hours), a response will be required as shown on Figure 4 and described in Section 2.5.

2.4.2 Groundwater Alert Levels for Protection of Private Wells

The baseline monitoring for all of the monitoring wells will incorporate the lowest recorded baseline water level elevation at each well. The elevations will be determined by either manual depth to water measurements or calibrated transducer referenced to the top of the well riser pipe. The monitoring well top of riser elevations will be determined based on surveying to be conducted upon permit approval and/or installation (e.g. MW1-18 is not yet installed).

As shown on Table 1, the alert level for each of the monitoring wells will be based on a decline relative to a baseline elevation. The alert level for monitoring wells will be determined by the lowest baseline elevation minus either of the following:

- The maximum simulated drawdown from the model (Barr 2017) nearest the monitoring well location; or
- One –half the pump depth based on well construction data collected from a nearby "comparison" water supply wells or the average pump depth where several supply wells are within a few hundred feet from the monitoring well location.

These comparison wells represent a subset of private wells near the Site that have known well construction data and/or have pump settings that may result in reduced performance if water levels decline. All of the private wells in the vicinity of the Site are believed to have sufficient depth to allow

good performance should the pumps need to be lowered in the future. A more detailed description of how alert levels are determined for monitoring wells is described below:

Groundwater Monitoring Wells That Are Not Located Near Private Wells

All of the water monitoring stations provide water level data useful for interpreting the current position of the water table. For all monitoring wells (except MW1-18, W10 and MW7-11 described below), the alert level will be converted to an approximate elevation that is equivalent to the lowest baseline elevation minus the maximum predicted modeling drawdown for that location. Estimates of the drawdown at each location are shown on Table 1. The water level trend analysis will provide an early warning that modeled conditions are being approached or are anticipated to be reached and further evaluation shall commence. None of these wells are located near potentially sensitive water supply wells. The alert level at these wells is intended to provide early warning that the model assumptions (and thus the predicted impacts from dewatering) are potentially greater than the model predictions.

Groundwater Monitoring Wells That Provide Monitoring for Private Wells

Alert levels for MW-7-11, MW1-18, and W10 are based on the reported pump depth shown on construction logs for comparison wells.

For monitoring wells intended to serve as sentry wells to prevent drawdown issues at private supply wells, the following procedure was used to assign alert levels:

1. The water levels for each well will be recorded to develop a baseline lowest recorded water level elevation.

2. The private wells closest to each monitoring well were evaluated with respect to their pump setting and total depths. All of these wells have adequate water in the well to avoid the effects of some dewatering except for one well (UID# 1955520) that indicates a pump depth of 0 feet below the water table. This is likely inaccurate well construction data and was not considered in the evaluation.

3. Most monitoring wells are located relatively close to the private supply wells with construction data as shown on Figure 3. At these monitoring well locations, the offset for the alert level was set to correspond to an alert level that is the lowest recorded baseline level minus approximately one-half the depth of the water column over the pump intake setting of the nearest supply well. For example, if the well construction record indicates that a well pump is set 12 feet below the static water level, the alert level will be the lowest baseline water level elevation minus six feet.

4. There are three private wells with construction data near proposed MW1-18. The shallowest pump depth below the water table from the three nearest comparison wells is four feet. The offset for this well from the lowest baseline elevation will be determined by subtracting two feet as shown on Table 1.

Note that in all of these cases, the alert levels are set conservatively and upon assumed elevations. Part of the alert response described in this Plan will be to evaluate applicable information including well construction logs, LIDAR data, and the surveyed elevation of monitoring wells. It may include contacting the owners to notify them of the early alert and implement appropriate actions under the well owner agreement so that they do not experience interruptions of their water supply.

2.5 Response to Alert Level: Timing and Actions

A summary of the timing and actions to an alert level consists of the following:

Timeline Of Response Actions From An Initial Alert

Days since Initial Alert/Action	Description of Action
0-14 Days: Initial Alert	Water levels evaluated every two weeks (14 days) – although the data may be collected at a minimum weekly frequency, the two week interval will be used to compare the water level data to the alert level.
	If no alerts are triggered, routine monitoring continues;
	If the water levels measured over two consecutive weeks show a drop below the alert level for one full week, an Initial Alert is triggered. The date of the Initial Alert is taken as the beginning of the two week water level data collection period.
14-30 Days: Alert Verification	If an Initial Alert is triggered, the next step is a two week Alert Verification Period to verify the result with comparison to the next two week interval of water level data.
30-60 Days: Desktop Review	If the Initial Alert trigger is verified, (below the alert level for 168 consecutive hours), a Desktop Review will be conducted to evaluate whether the declining levels are the result of natural conditions or dewatering.
	If the Initial Alert trigger is not verified, or if monitoring indicates that the water levels recover above the alert threshold, the alert is canceled, and routine monitoring continues as above;
60-90 Days: Interim Mitigation Plan	If the Desktop Review rules out other causes for the decline and the water levels have not otherwise reversed above the alert level in the preceding 60 calendar days, an Interim Mitigation Plan (IMP) will be prepared and implemented.
60-120 Days: Response Action Plan	A Response Action Plan will be developed to assess potential site specific actions (in addition to those included in the IMP) to restore water levels above the alert level.
120-210 Days: Implementation of Response Action Plan	If water levels have not otherwise recovered, the Response Action Plan will be implemented.
	Routine monitoring resumes if at any time the water levels recover to above the alert level.
	If water levels do not respond within 30 calendar days of the Response Action Plan implementation, additional mitigative measures will be reviewed and implemented.

Each of the key steps in the alert level determination and response to the alert is described in the following sections.

Note that the operator may choose to collect more frequent water level readings than required under the Plan during the alert level trigger and verification periods to be sure that the levels are not subject to daily or short term precipitation trends that would refute the assumption that the decline is continuously below the alert level.

2.5.1 Initial Alert and Verification of an Alert Level Trigger

Water levels are naturally subject to significant change over time. Historical average water levels based on decades of data are often subject to significant changes after a single very dry or very wet year as well as significant seasonal fluctuations. Natural declining trends in water levels are common and expected during the course of the Project. A key challenge to monitoring the effects of dewatering for this Project lies within distinguishing declines caused by dewatering from declines in water level resulting from other causes.

Normally, declining trends in water level are interrupted by precipitation events over the short term. Trends that last longer than a few weeks are more likely to represent either dewatering effects or emerging drought conditions. Therefore, a decline in both surface and groundwater levels should be continuously below some threshold level for a sufficiently long period of time in order to trigger an assessment of whether the dewatering is having a detrimental effect on water resources.

A two week "window" has been selected as the interval over which the determination of a potential alert level is evaluated. This allows comparison of the previous two weeks of measurement to the alert level for that monitoring location. If the water levels measured over two consecutive weeks show a drop below the alert level for one full week, an initial alert is triggered. For monitoring locations with once-per-week elevation readings, this means two consecutive weekly readings are below the alert level calculated for that location. Monitoring wells with dataloggers recording daily elevations (but downloaded weekly) may have more observations but in either scenario initial alert level will be triggered only after being below the alert level continuously for one week (7 days) during the observation period. Once an alert level has been triggered, the beginning of the Initial Alert is marked at the start of the two week interval of water levels falling below the alert level.

After the initial alert level is triggered, the first step is to verify the result with an independent sample. The basis for this is that scientifically valid conclusions require reproducible observations that are a statistically independent sample (EPA, 2009). This means that the verification observation occurs at the end of the next two week observation window or a total of 30 days after the initial alert.

2.5.2 Response to Verified Alert Level

If a water level compared to baseline data at a monitoring location has triggered an initial alert which has then been subsequently verified, a desktop review will be completed within 60 days after the initial alert. The desktop review will consult precipitation data, review additional pumping data and/or look at DNR observation well data to assess potential non-dewatering sources for the alert. The purpose of this action

is to rule out a false alert due to natural trends or cause other than dewatering. If it is determined that the initial alert level was due to natural causes, monitoring will revert back to routine monitoring.

Once natural declines have been ruled out, the actions will proceed to the next level of response following the alert level verification as applicable:

- Implement an Interim Mitigation Plan (IMP). The IMP for surface water resources is described in Section 3.1.3.1 and the IMP for private wells is described in Section 3.1.3.2. The IMP will be implemented to address the verified decline in water level until additional data collection and permanent adaptive mine strategies (additional responses) can be developed. The IMP will be developed and implemented within 90 days of the initial alert.

- Develop a Response Action Plan if necessary. The Response Action Plan will include an evaluation of additional potential mitigation alternatives that are viable for the location and timing of the area included in the current dewatering activity. The Response Action Plan will be prepared within 120 days of the initial alert.

- Evaluate pertinent private well construction data to evaluate mitigation measures and contact affected well owners.

- If, at any time after the verified alert the water level climbs above the alert level for 48 continuous hours, the alert will be cancelled and water level monitoring will return to routine monitoring status as above.

2.5.3 Additional Response to Alert Level Trigger

The following events will occur if after 210 continuous days below the alert level, and no alternative cause being evident, the following will occur:

- Implement the Action Plan within 210 days of the Initial Alert. Potential mitigation actions are described in Section 3.

- If water level monitoring (compared every two weeks) indicates that the water levels are in recovery or successful maintenance of water levels due to the IMP or other reason, the Action Plan will not be implemented unless or until a new alert level trigger is indicated.

- If the monitoring location is shown to be in recovery, and/or no dewatering is occurring, the IMP mitigation and any actions taken under the Action Plan will cease. If dewatering restarts, water level monitoring will continue as described in Section 2.4.

If, after implementation of the Response Action Plan, the water levels have not stabilized and a downward trend is still observed, additional mitigation actions will be considered and permanent adaptive mine strategies can be developed.

2.5.4 Response to Public Data

No response is required for changes in precipitation, river stage or DNR observation well monitoring. This information is for evaluation purposes only.

2.5.5 Response to Qualitative Assessment of Visual (Photographic) Monitoring

Visual review of surface water station photographic assessment will serve as an overall check on the effectiveness of the monitoring program in protecting surface water resources. Evidence of stressed vegetation, new invasive species coverage, and generally dry conditions are signals that the water resources may have become depleted and may need mitigation if not related to natural drought conditions.

2.6 Reporting

If an alert level and/or an alert trigger is observed, the operator will provide notice to the appropriate regulatory agency in accordance with the operating permits for the project. The notice will include a summary of the level or trigger that is observed, the actions to be taken in accordance with the Monitoring Plan, and any additional measures that will be taken to assess or respond to the condition. The notice will be for informational purposes, and approval is not anticipated to be required unless specifically required by the operating permit. Follow-up reporting of the findings of subsequent investigation or plans at critical junctures will also be reported to the appropriate parties. Critical junctures for progress reporting include:

- Initial Alert
- Alert Verification
- Desktop Review
- Interim Mitigation Plan development and Implementation
- Response Action Plan development and implementation
- Additional adaptive mitigation plans developed and implemented as needed
- Recovery thus cancelling the trigger exceedance actions

Water level data will be evaluated and summarized in an annual report and will be submitted to applicable regulatory entities as required by permits including the Water Appropriations Permit. The requirements of the plan may change based on the monitoring data collected and recommended changes to the plan will be subject to approval by the applicable regulatory entity. The water level data, a water-level trend analysis to assess whether triggers may be observed in the coming year, and details of mitigation, if triggered, will be included in the annual report. The adequacy of the monitoring plan will also be assessed. Recommendations for modifications of the Monitoring Plan may also be included in the annual report. Copies will be made available to Scott County and other government units as required by permit.

2.7 Post-Reclamation Monitoring

Quarterly monitoring will continue for a period of two years upon completion of mine dewatering activity. The primary goal of post-reclamation monitoring will be to verify the return of water levels to near pre-mining conditions adjacent to the mine site. Groundwater modeling (Barr 2017) predicted that the post-reclamation condition will result in lower water levels immediately upgradient of the mine area and no significant change from baseline in downgradient areas. The most notable effects would be related to private wells but post-reclamation water levels will be higher than experienced during mine operations. Any wells susceptible to dewatering impacts will have been mitigated during active dewatering operations. Mitigation measures implemented during active mining, such as lowering the pump setting will continue to be effective during the post-reclamation period.

3.0 Mitigation Action Planning

3.1 Phased Mitigation and Adaptive Management

The goal of the Project is to avoid impacts when possible and proactively implement mitigation before problems arise that may otherwise result in irreversible ecological harm. This means that where monitoring indicates that dewatering is causing significant changes in groundwater levels, options will be evaluated to determine if the mine phasing or planning can be modified to reduce impacts

3.1.1 Phased Mitigation

Where the effects cannot be avoided or there is no benefit to water resources from avoiding certain areas, a minimum mitigation plan (e.g. low option, below) may be established before the transition dewatering begins. Because initial dewatering volumes are lower than in later phases of mining, the need for initial mitigation is also expected to be less than in later phases. This means that small but scalable mitigation options are preferable to large scale efforts that would typically be needed only at the end of a mining phase when the largest open water dewatering area exists. Therefore, the volume and rates of return of groundwater for mitigation of affected areas will increase as dewatering volumes increase. In all cases, the modeling indicates that the rate of water needed for mitigation is less than the amount of water generated during dewatering.

3.1.2 Adaptive Management

While groundwater modeling is useful for predicting potential effects of mining, it is often overly conservative when used as an operational tool. Water monitoring provides real-time information to understand and modify actions in response to changes in water levels over time. Adaptive management is a structured, iterative process of robust decision-making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. This means that the process of implementing mitigation is an evolutionary one that relies on monitoring data to provide initial data and feedback to ensure that the mitigation is right-sized for the phasing and that it is sufficient to protect water resources.

3.1.3 Interim Mitigation Plan (IMP)

The IMP is a temporary response that is intended to immediately address a verified decrease in water levels at a surface water resource or at a particular private well while longer term mitigation plans are developed within the action plan. The IMP will consist of materials, resources, and equipment that are readily available and can be mobilized relatively soon after a verified alert while other more detailed feasibility studies, engineering, or contracting is being evaluated.

3.1.3.1 IMP for Surface Water Resources

The IMP for surface water resources will provides a basic level of mitigation that can be constructed prior to dewatering near sensitive areas so it is ready to be immediately activated once an alert level is confirmed based on monitoring. For example, water levels in most portions of surface water receptors can be augmented by direct discharge of dewatered groundwater via pipes laid down adjacent to (but not in) the wetland areas. Standard erosion and sediment control will be designed into the outlet structures

adjacent to the surface water bodies so that the discharge does not cause erosion or sedimentation at the receiving water. Subsequent monitoring may prove that the IMP in itself may prove to be all that is needed to prevent a decline in water levels. However, the monitoring will also provide information needed to size additional remediation effort as well as prevent further decline in water volume. The monitoring data will also be useful for design of long-term measures that will be evaluated in creating the Action Plan as the IMP proceeds as shown in Figure 4.

3.1.3.2 Interim Mitigation Plan (IMP) for Private Supply Wells

An IMP for private wells includes notifying well owners adjacent to the monitoring wells that have reached a verified alert level based on well records or location that could be impacted by further decrease in water levels. Arrangements will be made to verify well construction including depth of well and elevation of pump setting. Actions in the IMP include ensuring a water supply is maintained while long term plans are being developed with continued monitoring to look for improvements that eliminate the need for further action. Long term actions included in the well owner agreements may include replacing well or pump parts, lowering pump setting, or drilling a new well.

3.2 Conceptual Action Plan Alternatives for the Seepage Wetland within the B4 Wetland Complex

This section describes the types of mitigation that may be included in the Action Plan that will start after a verified alert level decline and the start of the IMP. As shown on Figure 4, if the IMP is successful or the water levels are no longer in decline, the work on the Action Plan may cease or, if completed, will not be implemented until monitoring shows conditions that are likely of an impact.

3.2.1 Low Level of Mitigative Effort – Additional Direct Discharge to Seepage Wetland

The lowest level of mitigation for the Action Plan is to increase the amount of groundwater discharge directed to the potentially affected resource via direct discharge of groundwater at rates of about 500 to 1500 gallons per minute (gpm). This level of mitigation can be added to the IMP and includes placing additional pipe or pipes on the ground surface at the nearest reach of the water resource so that water is placed directly back into the resource to maintain water levels at baseline levels or slightly higher levels than those observed during periods of no dewatering. Water would then be pumped from the mine areas to the discharge pipes. Multiple discharge points could be deployed. Verification of mitigation would come from surface water gages placed into the seepage wetland to demonstrate that adequate water is available.

The next level of complexity for this alternative would be to add pipe and discharge pipes, add pipe in deeper trenches or infiltration galleries to increase seepage of groundwater and route the water over larger lengths of the affected water resource. This method would work well for any of the surface water resources near the mined areas.

If monitoring data indicates that pre-pumping water levels are not being maintained, additional mitigation efforts will be instituted.

3.2.2 Moderate Level of Mitigation – Infiltration Trenches

This mitigation option would include a series of trenches excavated or blasted into the rock in an area between the seepage wetland and the active mining areas. A single trench would be excavated through the transition zone but not significantly into the Jordan Sandstone. The trench could be bounded on either side at the surface by a clay berm on one or both sides of the trench to allow for additional head to be applied above the trench. Infiltration rates would be around 1500 to 5000 gpm. A variation of this alternative would be to excavate the rock into the Jordan Sandstone and create open ditches to increase the flow into the trenches. This option could also be combined with additional trenches and/or deeper injection wells to focus on areas of the wetland that, based on monitoring, are not receiving adequate water. For comparison, the infiltration trench tested by Unimin at the Kasota, Minnesota mine is about 100 feet wide, 400 feet long and about 20 feet deep. This trench concept (or injection wells) was approved by the MDNR for the Unimin mine in 2017.

As above, if monitoring data indicates that pre-pumping water levels are not being maintained, additional mitigation efforts will be continued. Cold weather operations also may present challenges for this method; however if the trenches are long and deep enough, there should be adequate flow to keep the lower reaches of the trench flowing, even if the surface were to freeze. In addition, this condition would not coincide with the growing season.

3.2.3 High Level of Mitigation – Infiltration Basin

This option would consist of a large but relatively narrow basin excavated into the Jordan Sandstone located between the seepage wetland and the mining area similar to that modeled in Barr (2017). The basin would be much deeper than the trenches above, extending at least through the upper portion of the Jordan Sandstone. As above, clay berms can be added to either side of the basin to increase the head available to drive infiltration. Typical infiltration rates would generally be above 5000 gpm. In practice, this option would be a larger version of the Unimin infiltration trench. This method also could be used with variants of the other two options (described above) and could be implemented as an expanded version of the above options as the pumping rates increase near the end of each mining alternative.

4.0 Plan Summary

This Plan provides a phased approach to groundwater and surface water level monitoring for the Project. The monitoring locations were selected to provide information that will verify the conclusions of previous work completed for the DEIS that indicates that the Project will not have significant impact on private wells or water resources. The monitoring proposed in this Plan represents precautionary measures that will help to demonstrate compliance and document the lack of impact to the environment from the Project.

The criteria used in this Plan for protection of water resources is that the Plan will identify and reverse declines in surface water level caused by dewatering so that they do not last for more than one growing season. For private wells, the criteria is to intervene before water levels result in declines that impact the well owner's household water needs. All of the private wells that might potentially be affected by the Project will be covered under well-owner protection agreement. The monitoring is also intended to provide documentation that mitigative measures are effective in protecting wells and resources should they prove necessary.

The Plan describes a routine monitoring program that assigns alert levels that will be developed for each location. These levels will be derived from the lowest baseline elevation collected during non-dewatering periods with appropriate offsets based on site-specific or groundwater model-derived factors. The offsets are intended to allow a simple comparison of the latest round of water levels to these pre-established alert levels. The Plan also addresses the potential for water levels to be influenced by naturally-occurring seasonal, regional, and longer term declines requires provides appropriate time intervals needed to evaluate the data and avoid erroneously conclusion that a decline in water level is due to dewatering when there are naturally-occurring declining trends present.

The alert levels provide a stepwise, and carefully considered approach that addresses the need for verification of the results with implementing timely actions that are appropriate for the resources/wells that are most likely to be impacted if there are dewatering effects. The approach includes an Interim Mitigation Plan that will be initiated relatively soon after the first alert is triggered, followed by additional more intensive response actions as necessary. Dewatering operations will be calibrated to the monitoring data on an adaptive basis, and if changes are needed to avoid impacts, those changes can be phased in over a time period that is likely to prevent declines in surface water and/or declines that might impact the function of private wells.

Although it is premature to establish which additional response actions may be appropriate, the Plan provides a discussion of differing levels of mitigative effort that may be required if initial mitigation appears to be inadequate in avoiding lowering trends in groundwater.

5.0 References

Barr, 2014. Groundwater Assessment Report: Resource Document for Environmental Impact Statement and Groundwater Appropriations Permit Application. Prepared for Merriam Junction Sands, LLC. November 14, 2014.

Barr, 2015. Wetland Hydrology Monitoring Report 2014, Prepared for Merriam Junction Sands, LLC. April 2015.

Barr, 2017. Draft Groundwater Modeling of Mine Plan Alternatives Predictive Simulations Report. Prepared for Merriam Junction Sands, LLC. Revised May, 2017.

EPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance; EPA Document 530/R-09-007, March 2009.

MDNR. 2005. Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. St. Paul, MN. (http://www.dnr.state.mn.us/npc)

MDNR, 2017. Personal communication with Garry Bennett of MDNR and Barr Engineering regarding the Unimin Kasota site infiltration system.

Scott County, 2014. Scoping Environmental Review Assessment Worksheet. Prepared for Sunde Engineering, PLLC. (Proposer), June 3, 2014.

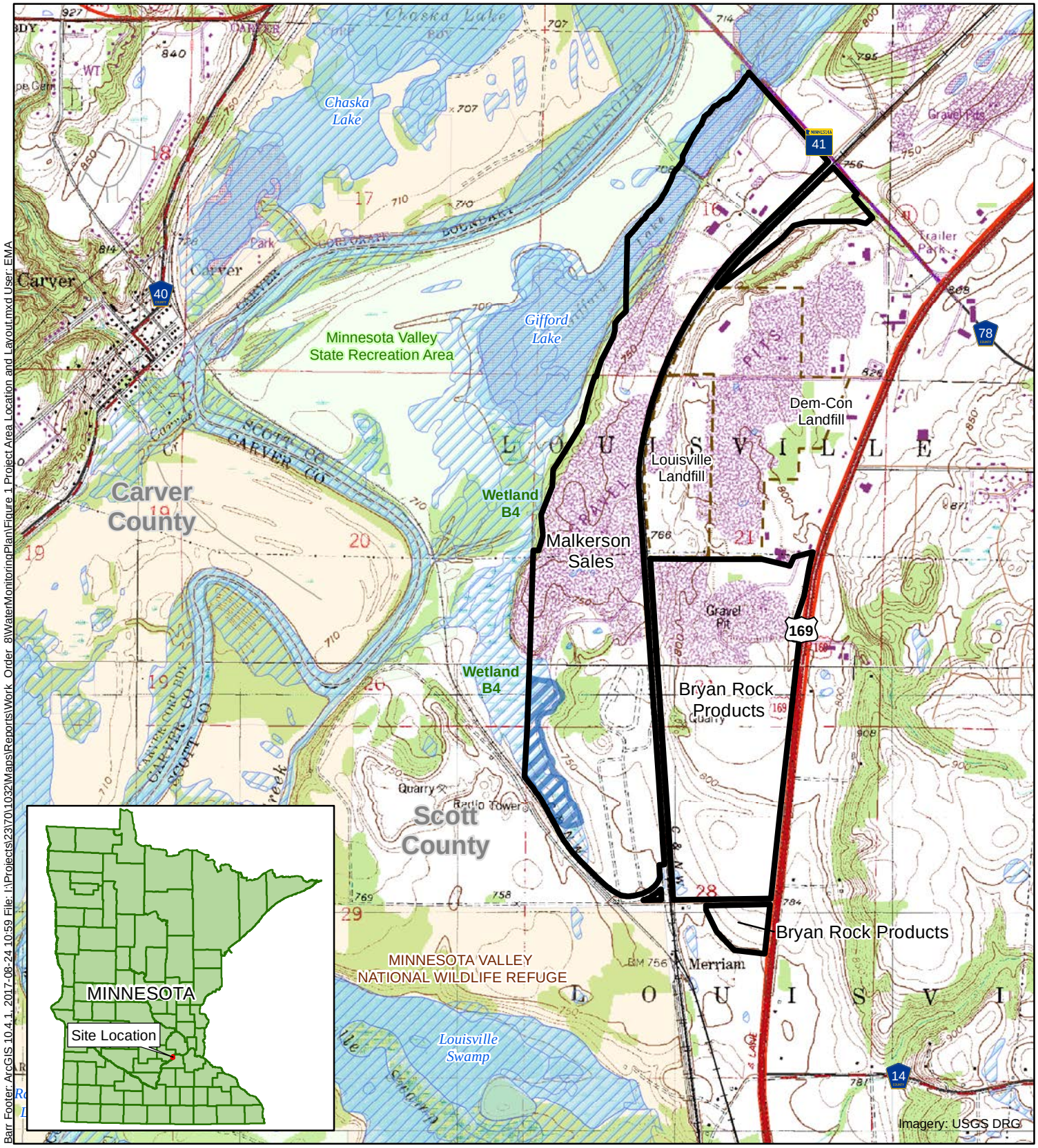
Tables

Table 1
Proposed Monitoring Frequency and Thresholds
Water Level Monitoring Plan
Merriam Junction Sands

Monitoring Target and Location ID	Media	Frequency (during active dewatering)	Alert Level Source	Approximate Alert Threshold Offset from Baseline Elevation (ft)	Note
Seepage Wetland					
SW1	Surf water	weekly	Lowest Baseline Elevation -1 foot	-1	will be based on historical and baseline water level elevations
SW2	Surf water	weekly	Lowest Baseline Elevation -1 foot	-1	will be based on historical and baseline water level elevations
W17-11	Groundwater	quarterly	Lowest Baseline Elevation minus the max. model-simulated drawdown	-20	frequency will increase to weekly if alert threshold exceeded
Wetland B4					
SW3	Surf water	weekly	Lowest Baseline Elevation -2 feet	-2	will be based on historical and baseline water level elevations
SW4	Surf water	weekly	Lowest Baseline Elevation -2 feet	-2	will be based on historical and baseline water level elevations
SWB4	Surf water	monthly	Lowest Baseline Elevation -2 feet	-2	will be based on historical and baseline water level elevations
W1-11	Groundwater	quarterly	Lowest Baseline Elevation minus the max. model-simulated drawdown	-27	frequency will increase to weekly if alert threshold exceeded
Gifford Lake					
SWGIFF1	Surf water	monthly	Lowest Baseline Elevation -2 feet	-2	will be based on historical and baseline water level elevations
MW20-11	Groundwater	quarterly	Lowest Baseline Elevation minus the max. model-simulated drawdown	-5	frequency will increase to weekly if alert threshold exceeded
Louisville Swamp					
SWSWMP1	Surf water	monthly	Lowest Baseline Elevation -2 feet	-2	will be based on historical and baseline water level elevations
MW-17-11	Groundwater	quarterly	Lowest Baseline Elevation minus the max. model-simulated drawdown	-20	frequency will increase to weekly if alert threshold exceeded
Wetland Visual Monitoring					
SW1, SW2, SW3, SW4	Vegetation	quarterly	Visual estimate of cover	NA	SW-B4 not included due to no access during most spring and/or flood events
Minnesota River	River Stage	daily	USGS Gage at Jordan	NA	
Precipitation Data	Rainfall	quarterly	National Weather Service	NA	data collected from Flying Cloud Airport
DNR Observation Wells	Groundwater	quarterly	DNR observation well network	NA	Will use representative well to compare climate trends to background for wells near the Seminary Fen.
Private Wells					
W-114	Groundwater	weekly	Lowest Baseline Elevation minus the max. model-simulated drawdown	-25	
MW4-11	Groundwater	weekly	Lowest Baseline Elevation minus the max. model-simulated drawdown	-20	
MW9-11	Groundwater	weekly	Lowest Baseline Elevation minus the max. model-simulated drawdown	-25	
MW7-11	Groundwater	weekly	Lowest Baseline Elevation minus one-half the depth of pump intake in nearest comparison private well #759599	-9	
MW10	Groundwater	weekly	Lowest Baseline Elevation minus-one half the depth of pump intake in nearest comparison private well #573107	-6	
MW1-18 (New Proposed)	Groundwater	weekly	Lowest Baseline Elevation minus the one-half the shallowest depth of pump intake in nearest comparison private wells #678856, #589960, and 587553	-2	

NOTES:
All Alert Threshold Elevations will be the lowest baseline elevation minus the offset shown above. All historical data will be incorporated into baseline (if available).
Up to four wells will be equipped with transducers for daily water levels (downloaded weekly) and at least one barometric transducer. All other measurements will be collected manually on weekly basis during dewatering.
W or MW = monitoring well
SW = Surface water gage, to be set in concrete at least 48" below surface.
AMSL = above mean sea level
TBD = historical data and baseline data will be used to calculate the lowest previous water level elevation. Baseline monitoring will continue during non-pumping periods.
Bold - indicates off property location that is not owned by proposer and will require an access agreement to install and/or monitor
Weekly monitoring will default to quarterly during non-dewatering periods; a request for monitoring to be decreased or eliminated if far from location or two years of no observed effect. This request is as described in 1.6.3

Figures



Barr Footer: ArcGIS 10.4.1, 2017-08-24 10:59 File: I:\Projects\23\70\1032\Maps\Reports\Work_Order_8\WaterMonitoringPlan\Figure 1 Project Area Location and Layout.mxd User: EMA

- Property Boundary
- Seepage Wetland
- Landfill Location
- Railroad
- Delineated Wetland B4
- Seepage Community
- Wetlands (National Wetlands Inventory)
- Public Waters Inventory (PWI) Basin
- MN State Park
- USFWS National Wildlife Refuge
- County Boundary

N

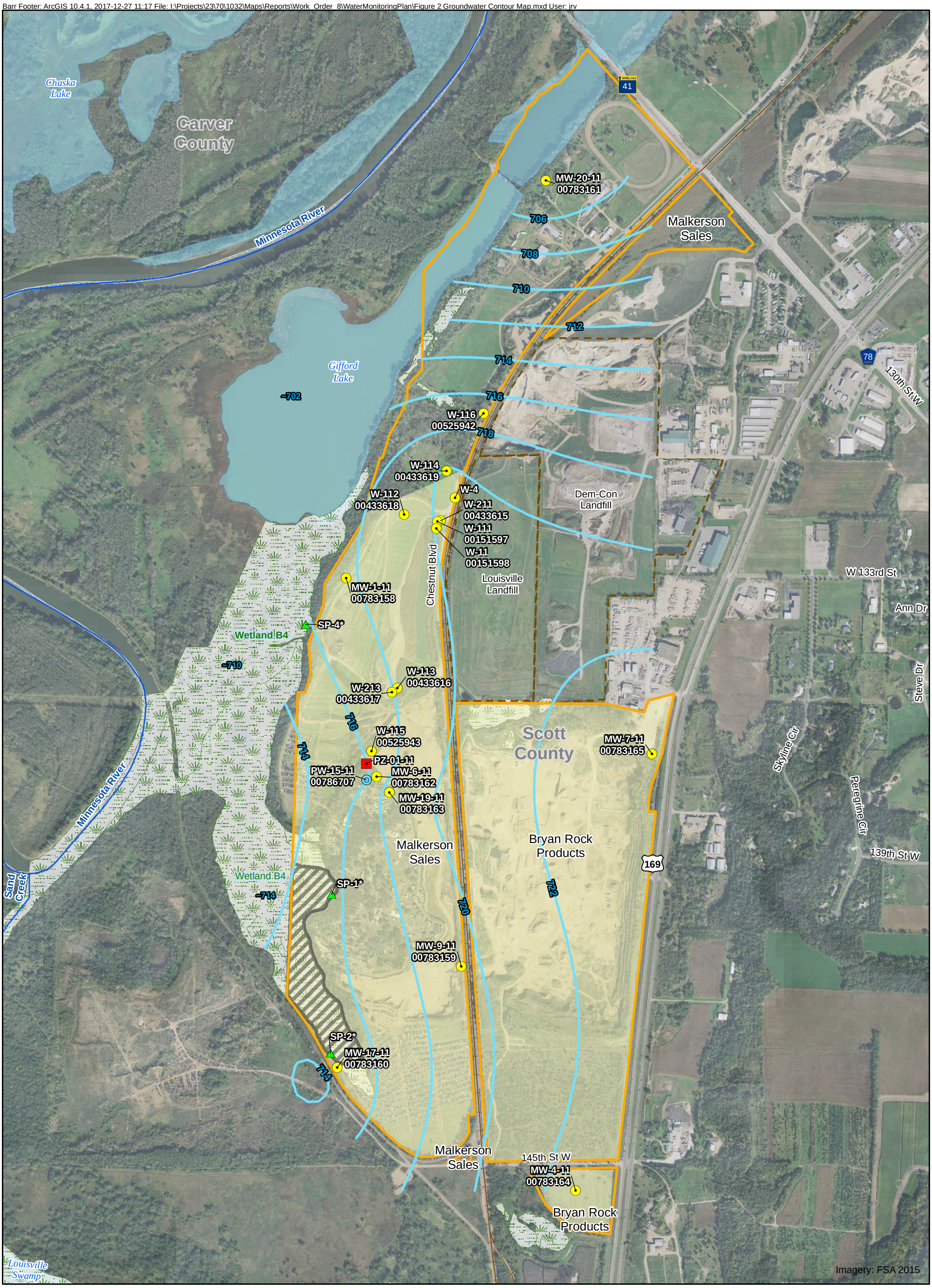
Feet

2,000 1,000 0 2,000

Figure 1

PROJECT AREA LOCATION AND LAYOUT
Water Monitoring Plan
Merriam Junction Sands
Scott County, MN

Barr Footer: ArcGIS 10.4.1, 2017-12-27 11:17 File: I:\Projects\23\70\1032\Maps\Reports\Work_Order_8\WaterMonitoringPlan\Figure 2 Groundwater Contour Map.mxd User: jrv



Monitoring Network Locations

- Monitoring Well
- Pumping Well
- Vibrating-Wire Piezometer
- Wetland Piezometer
- Groundwater Elevation Contours, November 2015
- Property Boundary
- Seepage Wetland
- Proposed Mining Area
- Landfill Location
- County Boundary
- Public Waters Inventory (PWI)
- Public Water Inventory Watercourses
- Delineated Wetlands

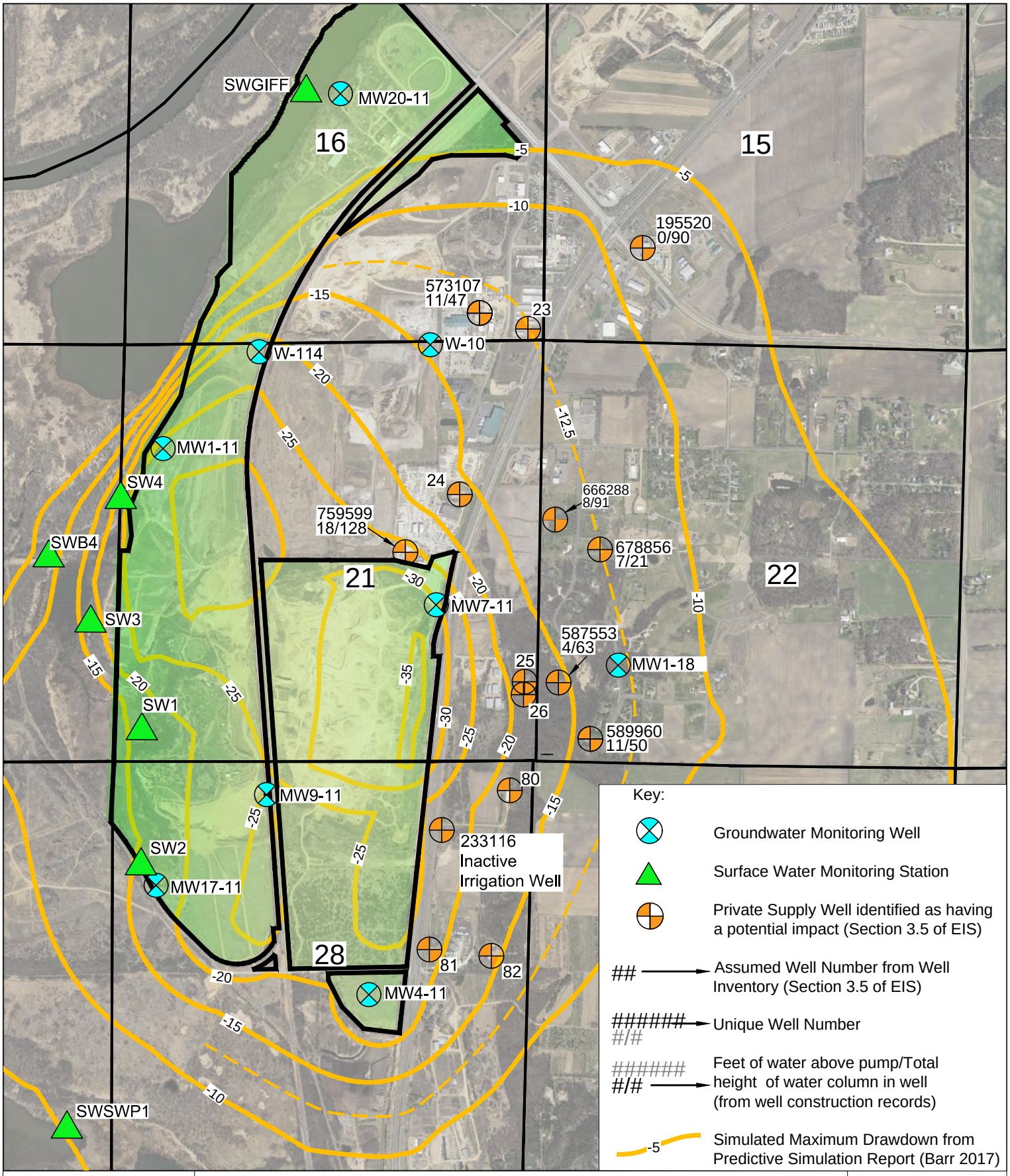
*SP-1, SP-2, and SP-4 are Seasonal Temporary Piezometers (to be Replaced with Permanent Level Gauges)

N

Feet
1,000 0 1,000

Figure 2

GROUNDWATER ELEVATION CONTOURS: NOVEMBER 2016
Water Monitoring Plan
Merriam Junction Sands
Scott County, MN



N

0 800 1600

SCALE IN FEET

Figure 3
Water Level Monitoring Network

Merriam Junction Sands

DEIS

Sunde Engineering, PLLC.