STATE OF COLORADO

Gagnon - DNR, Nikie <nikie.gagnon@state.co.us>

Henderson Development/Sandy Acres TR6 Review Letter M1980110

1 message

Gagnon - DNR, Nikie <nikie.gagnon@state.co.us> Fri, Apr 19, 2024 at 12:54 PM
To: Derek Slack <dslack@e-470.com>, Neil Thomson <Nthomson@e-470.com>

Hi Derek.
Please see the attached Request for Additional Information letter for Technical Revision 6 (TR6) for the Henderson/Sandy Acres site, permit no. M-1980-110. The letter contains a detailed overview of the ongoing hydrologic issues at Sandy Acres and requests additional information to be submitted for our review.

Please note, the decision date for TR6 is April 27, 2024. In all likelihood, you will need more time to respond to our request, and the Division will need sufficient time to review the information provided. Therefore, please submit a deadline extension request before April 27 and indicate in how much time you would like to respond to our review.

If you have any questions or concerns about the information we're asking for, please reach out to me. I'm happy to schedule a time for a phone or video call to go through the items in the letter.

Kind regards,

Nikie Gagnon
Environmental Protection Specialist

COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources

P 303.866.3567 x8126 | C 720.527.1640 | F 303.832.8106
Physical: 1313 Sherman Street, Room 215, Denver, CO 80203
Mailing: DRMS Room 215, 1001 E 62nd Ave, Denver, CO 80216
nikie.gagnon@state.co.us | https://www.drms.colorado.gov

M1980110 Henderson Development_TR6 Adequacy Review_04192024.pdf
2882K

April 18, 2024

Neil Thompson
E-470 Public Highway Authority
22470 E. 6th Parkway
Aurora, CO 80018

RE: Henderson Development/Sandy Acres, Permit No. M-1980-110, Technical Revision 6 (TR6), Request for Additional Information

Dear Mr. Thompson:

The Division of Reclamation, Mining and Safety (Division) completed our review of the information submitted in Technical Revision 6 and determined that the following issues of concern shall be adequately addressed before the revision can be considered for approval.

1) The Division approved Technical Revision No. 5 (TR-5) on January 24, 2022 to install a perimeter passive drainage system to address lingering water ponding issues at the site. This plan included installing a perimeter trench into the productive alluvial material outside of the fill material in the pit, at a slope of approximately 0.2%. This trench would include an 8-inch PVC or HDPE perforated pipe surrounded by gravel and enclosed in geotextile fabric, which would drain into a sump constructed into productive alluvial material on the downgradient end of the pit (near MW-6) to help discharge any captured inflow that is conveyed to the northern end of the pit. This drainage system would include cleanouts to allow for future maintenance of the pipe. In TR-5, it was recommended that a trench eventually be constructed around the outer edges of the entire pit, within approximately 5-10 feet of the fill material and in contact with the native alluvial material around the pit to allow for communication with the groundwater system. The existing stormwater drain should be plumbed into the perimeter trench.

   Before installing the entire perimeter trench system, it was recommended that an initial investigative trench be constructed along the eastern edge of the pit near the middle of the "Zone B" perimeter reach (just north of MW-2). This investigation should start with a shallow, open trench constructed to approximately 3 feet in depth with the intention of observing shallow groundwater conditions at the edge of the pit. If the initial trenching was dry at 3 feet, the trenching would be extended upgradient (to the south) until groundwater inflow is encountered and continued to the south to induce groundwater inflow to be captured by the trench. If the initial trenching was saturated at 3 feet, the trenching would be extended downgradient (to the north) to provide for conveyance and discharge of captured inflow. The trenching would then be expanded based on field observations, possibly up to 1,000 feet. If the results of this investigative trenching showed the trench could communicate with groundwater, could effectively convey water to the north, and the captured groundwater could be discharged into unsaturated material (outside of the fill area), the operator would continue expanding the trench around the entire perimeter of the pit and installing the sump into native gravel material at the northern edge of the pit as described in

TR-5.

Based on the information provided in this revision, it is not clear whether the operator performed the initial investigative trenching proposed in TR-5 or whether the drainage system that was installed at the site was constructed in accordance with the plan approved in TR-5 (see enclosed). The Division has the following questions pertaining to the passive drainage system:

a) Please clarify whether the initial investigative trenching was conducted per TR-5. If so, please provide a construction timeline and describe the conditions observed during the project. Additionally, please specify whether BBA Water Consultants, Inc. was on site for any portion of this project as recommended in TR-5.

b) Based on the information provided, the trench and sump system installed along the northeastern edge of the pit does not appear to have been installed into native gravel material outside of the fill material in the pit as recommended in TR-5. Please explain.

c) Based on the information provided, it is not clear whether the trench and sump system installed along the northeastern edge of the pit was installed in accordance with the design guidelines outlined in TR-5. Please provide additional information demonstrating this system was installed in accordance with the approved plan or provide an explanation for any deviations.

d) The operator did not provide as-built drawings for the passive drainage system installed at the site. Please provide these drawings.

2) The Division requested survey data/elevations for the pit backfill. In this revision, the operator provided a topographic survey of the pit floor dated June 20, 2012, and a grading plan dated June 22, 2015, showing the proposed backfill elevations for the pit. However, the operator did not provide a survey of the backfilled pit showing final surface elevations after backfilling of the pit was completed in July of 2016. Please provide this survey data.

3) According to the 2012 topographic map provided, the groundwater level at that time was at an elevation of 5,006.8 feet. Please confirm this was the groundwater elevation used to calculate the required backfill levels for the pit.

4) The Division requested that a groundwater monitoring plan be submitted for the site. While some information on the existing monitoring wells, their locations, and historic water level data was included in the BBA Memorandum, a stand-alone groundwater monitoring plan with all required components was not included in the revision. Please include a separate groundwater monitoring plan for the site that includes a map showing all monitoring well locations, a table with construction data for each well (e.g., well name, coordinates, well installation date, elevation of top of casing, well material type, well depth in feet below ground surface, screened interval in feet below ground surface, screened unit), sampling method(s), monitoring parameter(s), monitoring frequency, and the reporting frequency and template to be used for reporting (e.g., well location map, tabulated water level data, graph of water level data, a narrative analysis of the data with trends and anomalies identified, field sheets).

5) Please provide an updated Reclamation Plan Map for the site that meets all requirements of Rules 6.2.1(2) and 6.4. This map must conform to the following criteria:
    a) Show the name of the operator.
    b) Must be prepared and signed by a registered land surveyor, professional engineer, or other qualified person.
    c) Give date prepared.
    d) Identify and outline the approved permit boundary.
    e) Be prepared at a scale that is appropriate to clearly show all elements that are required to be delineated. The acceptable range of map scales shall not be larger than 1 inch = 50 feet nor smaller than 1 inch = 660 feet. The map must also include a map scale, appropriate legend, map title (e.g., reclamation plan map), date, and north arrow.

    Additionally, please ensure the map includes the following:
    f) The expected physical appearance of the affected land including the proposed final topography of the area with contour lines of sufficient detail to portray the direction and rate of slope (horizontal:vertical) of all reclaimed lands.
    g) Portrayal of the proposed final land use for the affected lands.
    h) Indicate areas where vegetation will be established and the general area(s) for any shrub or tree planting.
    i) Outline the pit backfill areas.
    j) Label the names of owner(s) of record of the surface of the affected area and of the lands within 200 feet of the affected area.
    k) Show the owner's name, type of structure, and location of all permanent man-made structures (e.g., buildings, fences, above or below ground utilities, irrigation ditches, maintained or public roads, bridges, pipelines, water wells, water storage structures, discharge and conveyance structures) located on the affected land and within 200 feet of the affected land. Indicate which structures are proposed to remain on the affected land after reclamation.

6) Please provide a potentiometric surface map of the main aquifer system at the Henderson Development site and surrounding areas, showing groundwater elevations and flow directions.

7) Assuming the grading plan was followed for the site, the pit was backfilled to an elevation of 5,012 feet along the outer edges of the pit and to 5,009 feet at the center of the pit. In Amendment No. 6 (AM-6; approved on September 3, 2014), the operator stated the pit would be backfilled a minimum of 2 feet above the static groundwater elevation. In recent correspondence, the operator indicated the pit was backfilled to 4 feet above the groundwater elevation. If the groundwater elevation used for the pit backfill was 5,006.8 feet and the minimum backfill elevation was 5,009 feet, it appears the pit was backfilled a minimum of 2.2 feet above the groundwater elevation at that time. This backfill elevation would have been in compliance with the approved plan in AM-6; however, it is not accurate to say the pit was backfilled to 4 feet above the groundwater elevation.

    In 2009, a slurry wall was installed at Pit 29 (Permit No. M-1980-183) directly west (and somewhat downgradient) of the Henderson Development pit. This installation occurred 6-7 years before the open groundwater pond at the Henderson Development pit was backfilled. However, in

2018, a leak was identified in this slurry wall which was repaired by the spring of 2019. As a result of these conditions, there would have been a localized drawdown in the groundwater table. Then after the slurry wall was repaired in 2018/2019, groundwater levels increased. Based on this information, the groundwater level used to backfill the Henderson Development pit in 2015/2016 would have been lower than the post-slurry wall repair groundwater level, possibly by up to 8-10 feet. Of course, without knowledge of the leaking slurry wall, it would have been difficult to predict that such a significant increase in groundwater levels would occur.

Based on the information provided, it appears the Henderson Development pit was not backfilled enough to sufficiently mitigate the exposed groundwater. In fact, it appears the current groundwater table daylights into the pit, at least along the southern and southeastern edges of the pit. Therefore, any additional efforts to mitigate the exposed groundwater may not be fully successful without additional backfill.

While the mitigation plan approved in TR-5 involved construction of the perimeter drainage system, some other conceptual options were listed. These options included:

- An active dewatering system either in or adjacent to the pit,
- The installation of additional fill to an elevation above the elevation of the neighboring groundwater system,
- Sealing of all or portions of the interior of the pit walls (such as by using a compacted clay liner), and/or
- A slurry wall system around the exterior of the pit.

Given that the passive drainage system installed has not been fully successful in mitigating the exposed groundwater at the site, please describe the new mitigation plan that will be implemented at the site. As mentioned above, based on the information provided thus far, the Division believes that placing additional fill material in the pit may be necessary, even if additional mitigation measures are pursued.

8) Rule 3.1.6(1) requires operators to minimize disturbances to the prevailing hydrologic balance of the affected land and of the surrounding area and to the quantity or quality of water in surface and groundwater systems both during and after the mining operation and during reclamation. This includes complying with applicable Colorado water laws and regulations governing injury to existing water rights.

The operator’s current Substitute Water Supply Plan (SWSP) approved by the Division of Water Resources (DWR), dated October 25, 2019, covers the period of October 1, 2019 through September 30, 2024. This SWSP only covers lagged depletions from evaporation associated with previously exposed groundwater at the site, prior to backfill of the pond being completed on July 1, 2016. This SWSP does not cover any exposed groundwater occurring at the site since July 1, 2016. Additionally, well permit no. 78820-F that was previously issued for the site was abandoned upon completion of backfilling.

Based on historical aerial imagery of the site and an inspection of the site conducted by the Division on December 21, 2017, there were no issues with ponded water for approximately 3 years after the pit was backfilled. Then during a site inspection conducted on July 17, 2019, the Division observed some ponded water in the southern portion of the pit. At that time, it was not clear whether the water was stormwater or groundwater. After this issue was investigated further by the operator's consultant, BBA Water Consultants, Inc., the primary source of the water was determined to be groundwater inflows. Based on this information, it appears that groundwater has been exposed at the site for at least as far back as July of 2019, meaning the site has been out of compliance with DWR for almost 5 years. The Division realizes the operator has made efforts since 2019 to investigate and mitigate the exposed groundwater. However, the mitigation efforts have not been fully successful, as exposed groundwater continues to occur at the site.

Please provide demonstration that the site is in compliance with DWR or show evidence that the operator is working with DWR to bring the site into compliance with regard to the exposed groundwater that has occurred at the site since 2019.

The decision date set for Technical Revision 6 is April 27, 2024. Please submit your response to the above listed issues prior to the decision date. If you need more time to respond, please submit a deadline extension request on or before April 27, 2024, and indicate how much time you would like to respond.

If you have questions or concerns, please feel free to contact me.

Sincerely,

Nikie Gagnon

Nikie Gagnon
Environmental Protection Specialist

Enclosure: Technical Revision 5 Plan for Installation of Passive Drain

Ec: Derek Slack, E-470 Highway Authority
Amy Eschberger, DRMS

COLORADO DIVISION OF RECLAMATION, MINING AND SAFETY
1313 Sherman Street, Room 215, Denver, Colorado 80203 ph(303) 866-3567

REQUEST FOR TECHNICAL REVISION (TR) COVER SHEET

File No.: M- 1980-110 Site Name: Henderson Development

County Adams TR# *(DRMS Use only)*

Permittee: E-470 Public Highway Authority

Operator (If Other than Permittee):

Permittee Representative: Derek Slack

Please provide a brief description of the proposed revision:
This technical revision consists of a modification for installation of a passive drainage sytem to transport ground water around the site. This is further described in the attachments.

As defined by the Minerals Rules, a Technical Revision (TR) is: "a change in the permit or application which does not have more than a minor effect upon the approved or proposed Reclamation or Environmental Protection Plan." The Division is charged with determining if the revision as submitted meets this definition. If the Division determines that the proposed revision is beyond the scope of a TR, the Division may require the submittal of a permit amendment to make the required or desired changes to the permit.

The request for a TR is not considered "filed for review" until the appropriate fee is received by the Division (as listed below by permit type). Please submit the appropriate fee with your request to expedite the review process. After the TR is submitted with the appropriate fee, the Division will determine if it is approvable within 30 days. If the Division requires additional information to approve a TR, you will be notified of specific deficiencies that will need to be addressed. If at the end of the 30 day review period there are still outstanding deficiencies, the Division must deny the TR unless the permittee requests additional time, in writing, to provide the required information.

There is no pre-defined format for the submittal of a TR; however, it is up to the permittee to provide sufficient information to the Division to approve the TR request, including updated mining and reclamation plan maps that accurately depict the changes proposed in the requested TR.

Required Fees for Technical Revision by Permit Type - Please mark the correct fee and submit it with your request for a Technical Revision.

Permit Type	**Required TR Fee**	**Submitted** (mark only one)
110c, 111, 112 construction materials, and 112 quarries	$216	☑
112 hard rock (not DMO)	$175	☐
110d, 112d(1, 2 or 3)	$1006	☐

Technical Revision
M-1980-110
Henderson Development (Sandy Acres)

This Technical revision is for the installation of a passive drainage system to transport ground water around the site.

The pit backfill was completed in July 2016. Water was first noted on the south end of the site in 2019. Water now covers a majority of the backfilled site. E-470 hired BBA Water Consultants and they determined that the ponded water is from ground water not from surface runoff. A series of test wells were installed to gather data on the ground water in the area. BBA has analyzed the data and developed a phased approach to eliminate ground water from ponding on the site. A passive drainage system will be used which consists of digging a trench and installing perforated pipe and rock. The initial installation of approximately 1,000 feet will be completed and the water levels monitored. If the system works to lower water levels it may then be extended in order to eliminate ground water ponding on the site. Once the system is completed as-built drawings will be submitted.

The attached report from BBA provides more detail on the analysis and the recommendations.

January 2022

MEMORANDUM

BBA Water Consultants, Inc.

To: Derek Slack, P.E. and Neil Thomson, P.E.
E-470 Public Highway Authority (E-470)

From: Timothy A. Crawford

Subject: E-470 – Sandy Acres Pit – Ponding Water Mitigation Efforts

Job: 9607.00

Date: October 21, 2021

This memorandum presents information to assist E-470 with mitigating the current ponding water issues at the E-470 Sandy Acres Pit. We understand that the ponding water issues need to be addressed before closing the mining permit for the pit. Based on conversation with E-470, the investigation of mitigation options has been discussed in a stepwise manner to allow for confirmation of options, approaches and efficacy of potential solutions before designing and installing a full system to address the issues.

General Background

The Sandy Acres Pit is currently a backfilled, inactive, unlined gravel pit located on one of E-470's properties near Henderson, Colorado. The former gravel pit was permitted by the Colorado Division of Reclamation, Mining and Safety (DRMS) as the "Henderson Development" under Permit No. M-1980-110. DRMS approved Amendment No. 6, AM-06 on September 3, 2014 and Technical Revision No. 3 on May 12, 2015, allowing E-470 to backfill the Sandy Acres Pit with washed fines from a neighboring gravel pit. The approved backfilling was completed on July 1, 2016.

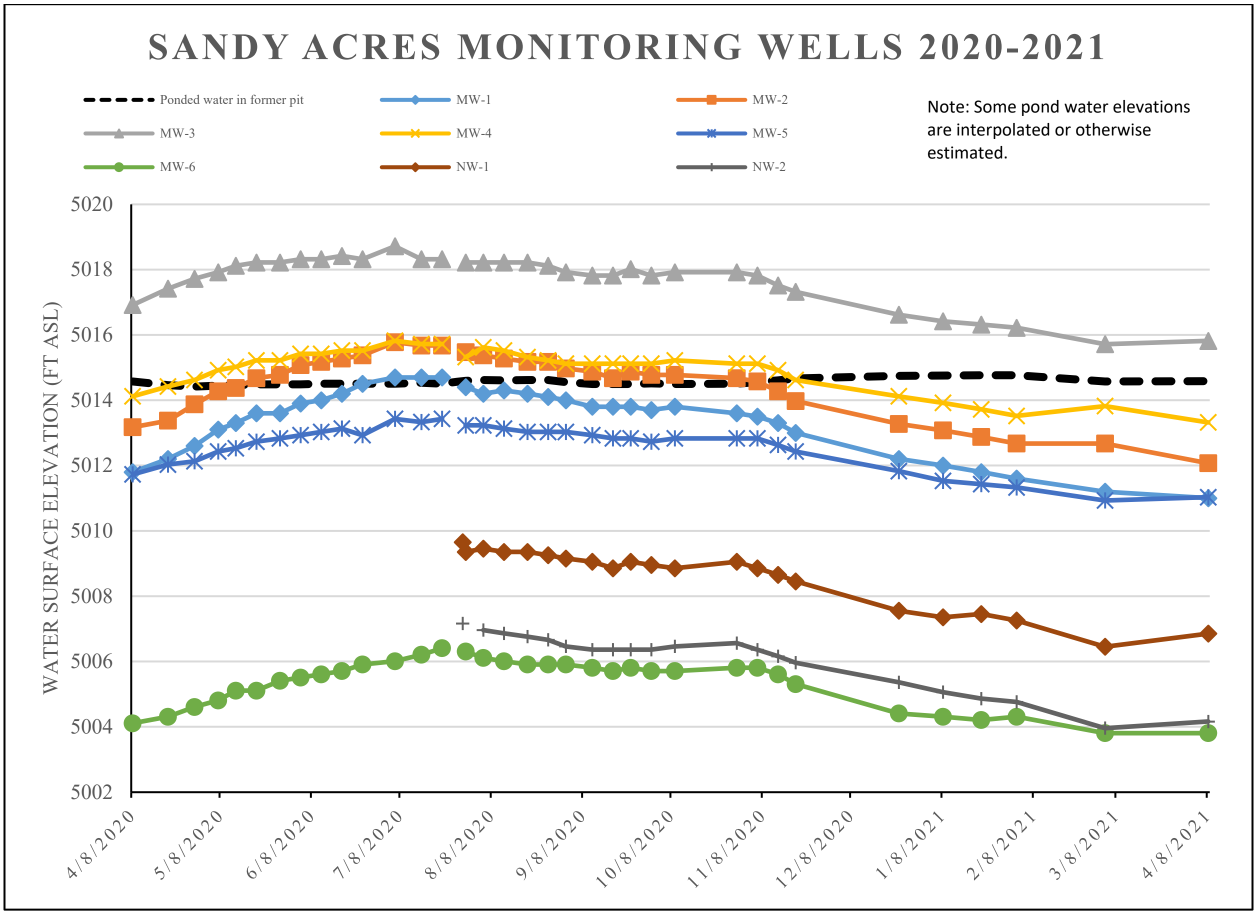
During a 2019 site inspection, DRMS staff noted ponding water at the base of the (backfilled) pit at the southern end of the site. Representatives from E-470 and BBA Water Consultants, Inc. (BBA) visited the site and confirmed the presence of the observed ponded water in the Sandy Acres Pit.

We understand that E-470 is seeking to close the mining permit for the Sandy Acres Pit and that the ponding water issue must be resolved before the permit can be closed.

Geologic and Hydrogeologic Background

The Sandy Acres Pit was constructed into and mined the South Platte Alluvium which, based on the available geologic mapping, is quaternary alluvial material that consists of sand, gravel, silt and clay with deposits potentially as thick as 60 feet. Test drilling efforts completed to investigate the ground water system as it relates to ponding water issues indicate that the alluvium at the Sandy Acres Pit ranges in depth from 32 to 45 feet and consists of gravels, sand, silt and clay, generally consistent with the mapped geology. The test drilling efforts included the installation of monitoring wells, located as presented in Figure 1, which indicate the alluvium is saturated. Water level data has been collected from the wells since installation. The water level data collected in 2020 and 2021 indicate that water levels around the pit fluctuate with a general gradient from south to north with the highest ground water elevations consistently measured in the MW-3 well (southernmost well) and the lowest ground water elevations consistently measured in the MW-6 well (northernmost well).

A comparison of water level elevations, as presented below, indicates that ground water is a contributing source of inflow to the pit. In areas and at times where / when the ground water around the pit is at a higher elevation than the standing water in the pit, the ground water system is discharging to the pit. Data suggests that inflow to the pit occurs along the southern and eastern portions of the pit and may occur year-round near the MW-3 location, for portions of the year around the MW-2 and MW-4 locations and for a brief portion of the year near the MW-1 location. We note that the water level data period of record available to review is limited to 1 year. While we would expect similar conditions to the data below, future ground water conditions will be a factor of local steam flow and precipitation.



The fill material in the pit may exacerbate the interaction between ground water and the pit due to the lower permeability of the fill material by forcing ground water to mound upgradient from the pit resulting in artificially higher ground water elevations.

The monitoring well data suggest that the ground water elevation is below the elevation of the standing water in the pit in the northwestern portions of the pit around the NW-1, NW-2 and MW-6 locations.

Figure 2 presents 3 perimeter zones around the Sandy Acres Pit representing reaches of the pit perimeter that have differing pit inflow conditions. In "Zone A", the water level data indicate that ground water inflow to the pit occurs year-round. In "Zone B", the water level data indicate that water level conditions vary and ground water inflow to the pit occurs at some times of the year. In “Zone C”, the water level data indicate that no ground water inflow occurs at any time of the year.

It is conceptualized that ground water inflow occurs around the edge of the pit with the inflow being perched on top of the fill material in the pit and flowing to the north.

Potential Pit Inflow

The ground water in the general vicinity of the Sandy Acres Pit has been identified as one potential source for the standing water in the pit indicating that the ground water is discharging to the pit at some rate.

A simplified Darcy calculation with Dupuit assumptions designed to calculate inflows to a linear feature, such as a drainage ditch or the perimeter of a pit, indicates that inflows to the pit may be as high as approximately 1,600 gallons per minute (gpm) in the middle of the summer when water levels are at their highest in the aquifer around the pit. During the early spring months, when water levels around the pit are deeper and there is less interaction with the ground water system, inflows to the pit may only be on the order of 200 gpm. This estimation of inflow is sensitive to the inputs which have been assumed based on the best information available, but can vary significantly. These estimates should be considered rough planning estimates of potential ground water inflow to the pit.

A second method to estimate pit inflow is a simplified water balance approach focusing on potential evaporation and infiltration, which indicates a potential pit inflow of approximately 700 gpm.

These basic investigations indicate that ground water inflow to the pit may be as high 700 to 1,600 gpm at certain times of the year. We would expect for inflows to vary throughout the year and from year to year based on water level conditions in the alluvial aquifer surrounding the pit.

We also understand that there are storm drain outlets that discharge to the pit and also directly contribute to ponding water in the pit when flowing.

Options

As mentioned above, we understand that E-470 is seeking to remedy the ponding water conditions in the Sandy Acres Pit as part of the closure of the DRMS permit for the pit. There are several conceptual options that can be implemented at the Sandy Acres Pit to remedy the ponding water conditions although we understand E-470 is interested in passive solutions. The conceptual options available to E-470 include:

- An active dewatering system either in or adjacent to the pit,
- The installation of additional fill to an elevation above the elevation of the neighboring ground water system,

- Sealing of all or portions of the interior of the pit walls (such as by using a compacted clay liner),
- A slurry wall system around the exterior of the pit, and / or
- A passive drainage system (French drain system) in or adjacent to the pit.

These options could be implemented individually or in tandem and each have inherent advantages and disadvantages. As mentioned above, we understand that E-470 is most interested in a passive system, specifically a passive drainage system, as it should provide a remedy that can be installed and allow the pit to be closed without significant cost or ongoing operating and maintenance requirements.

Generalized Passive Drainage System Conceptual Design

A passive drainage system will include a lateral trench(es) that intercept(s) ground water before it enters the pit or collect(s) standing water in the pit and convey(s) that water to a discharge point. More specifically, a passive drainage system will include:

- Excavated trenches that intercept the ground water system,
- Conducting layers to allow the system to communicate with the ground water system and screen fine grained material from drainage water entering the system,
- Collector pipes to efficiently convey drainage water,
- Geotextile fabric to minimize system sedimentation, and
- Outlet structures.

For the Sandy Acres Pit, E-470 can consider either a perimeter trench or a trench(es) inside the pit to collect and convey water.

<u>Perimeter Trench Vs. Interior Trench Considerations</u>

The benefit of a perimeter trench is that the trench would intercept ground water before it enters the pit and contributes to the standing water. This option may have a better potential to remedy the ponding water conditions to the DRMS' satisfaction if the ground water is discharging along the edges of the pit and becoming perched on the fill material.

An interior trench system could reduce the total linear length of trench required; however, water would still need to flow into the pit and then to the collection system before being captured and conveyed by the system. An interior system could successfully move water and lower the water level of standing water in the pit, but may not fully address the ponding water issue as desired to achieve closure of the permit for the pit. An interior system would provide for efficient conveyance of captured water by utilizing the apparent low permeability of the fill material in the pit.

Surface drainage into the pit can be captured and directed to either trench system to effectively convey and discharge surface drainage contributions to the pit along with any captured ground water.

Once outside contributions to the pit are controlled, direct precipitation to the pit should not be a concern as any precipitation will be consumed though natural evapotranspiration.

Due to the greater potential for success, we recommend a perimeter trench design of the Sandy Acres Pit.

Trench Underdrain System Conceptual Design

The trenching for an underdrain system at the Sandy Acres Pit will be at least 24-inches wide, will be excavated to establish a positive grade in the trench and allow for the installation of perforated pipe. A perimeter trench will be constructed to interact with productive alluvial material outside the fill material in the pit and to maintain a slope of approximately 0.2% across the system. In the southern portions of the pit, the trench and piping will be shallow (2 to 3 feet), but in the northern portions of the pit, the recommended trench and piping may be up to 6 to 8 feet deep. The elevations of the pit and the neighboring ground water do not allow for a system that would meet a recommended system slope of 0.5% but should accommodate the minimum recommended slope of 0.2%.

The trench will be backfilled with gravel material as bedding material before perforated pipe is installed. Additional gravel will be backfilled around and on top of the pipe to the ground surface. There should be a minimum of 6 inches of gravel beneath the perforated pipe. We recommend 8-inch PVC perforated pipe with a slot size of 0.05 inches (50-slot) for installation, but high-density polyethylene pipe (HDPE) can also be considered. The PVC pipe or HDPE pipe will provide for corrosion resistance in the system in case of aggressive ground water quality. The 8-inch diameter pipe is recommended to provide capacity and to minimize sedimentation issues within the system since the system will have horizontal pipe over 500 feet in length. A geofabric textile material will also be installed around the gravel to minimize fine grained material from entering the system. A generalized cross section of the trench construction has been presented in Figure 3.

The perforated pipe installed within the conducting layer of the trench will collect water from the trench layer and help convey it more efficiently to the system's outlet(s). The perforated pipe will provide for a safety factor in this essential portion of the drainage system.

A passive drainage system typically discharges to the surface at a location away from its collection areas. Due to the closed surface drainage condition of the Sandy Acres Pit, surface discharge is not feasible without pumping or substantial infrastructure modifications. Accordingly, a sump structure should be constructed into the productive alluvial material on the downgradient end of the pit (northern end near MW-6) to help discharge any captured inflow that is conveyed to the northern end of the pit.

The drainage system should include cleanouts to allow for future maintenance in case of silting of the pipe.

The trench will act as a collector trench wherever the elevation of the trench is lower than the elevation of the neighboring ground water system. Anywhere the trench is located above the ground water elevation, it will act to convey the captured water as well as discharge the captured water into unsaturated alluvium beneath those reaches of the trench.

Sandy Acres Passive Drainage System Conceptual Design

The most important design component for a passive dewatering system at the Sandy Acres Pit is the trench system installed to capture and convey the ground water inflow. We recommend a perimeter trench encircling the entire pit. As mentioned above, reaches of the trench that are below the elevation of the neighboring ground water will capture ground water and any reaches that are above the elevation of the neighboring ground water will convey and discharge captured ground water. The entire length of the trenching will need to be outside, but within approximately 5 to 10 feet, of the fill material of the pit and in contact with the native alluvial material around the pit to allow for communication with the ground water system.

For the Sandy Acres Pit, the trench should be at least 24-inches wide, but could be wider if available equipment does not allow for such a narrow width.

The trench will be constructed to depths necessary to maintain positive grade through the system. Required trenching depths may range up to 6 to 8 feet in some areas. A final trench design including trench and pipe elevations can be finalized based on the findings the initial investigation described below.

The proposed Sandy Acres Pit dewatering system will utilize the trench system to discharge captured water to unsaturated alluvial material generally present along the northern perimeter of the pit. While the ultimate trench system is anticipated to have sufficient capacity to discharge captured water to the alluvium along its length, the system should also include a sump to help discharge water as a safety factor. The system should include an over excavated and gravel backfilled sump at the northern end of the pit that is connected to receive flow from the perimeter trenching. This sump feature should be approximately 20 feet by 20 feet in size and excavated to at least 10 feet of depth into the native gravel material.

The existing storm drain should be plumbed into the perimeter trench such that the drainage system captures the flow from the storm drain before it enters the pit and contributes to ponding water conditions in the pit.

Initial Steps for System Installation and Efficacy Testing

A stepwise approach to the installation of the underdrain system can be implemented to generally confirm the feasibility and efficacy of a passive underdrain system. By installing portions of the system, the ability for the individual aspects of the system (and potential feasibility of a complete system) can be tested.

We recommend starting a trench on the east side of the pit near the middle of the "Zone B" perimeter reach (the "pilot hole" location just north of MW-2). Initial trenching should start with a shallow, open, investigative trench constructed to approximately 3 feet in depth with the intention of observing shallow ground water conditions at the edge of the pit. If the initial trenching is dry to 3 feet, the trenching should be extended upgradient (to the south) until ground water inflow is encountered and continued to the south to induce ground water inflow to be captured by the trench. A minimum 300 feet of additional trenching upgradient should be planned for and additional trenching may be necessary based on ground water conditions. If the initial trenching is saturated at 3 feet, the trenching should be extended down gradient (to the north) to provide for conveyance and discharge of captured inflow. The trenching would then be expanded based on field observations. Initial trenching of up to 500 to 1000 feet may be required. The recommended location of the initial trenching (both the pilot hole and the general trench area) has been presented in Figure 2.

Feasibility of a perimeter trench design will be based on:

- The ability of the trench to encounter and capture ground water inflow. In areas, the trenching should be able to encounter and collect ground water and saturated conditions should be observed in the shallow subsurface around the southern portions of the proposed initial trenching.

- The ability of the trench to convey captured inflow. Flow should be observed in the trenching from the south to the north.

- The capacity of the trench to discharge captured inflow. If saturated conditions are encountered and flow to the north can be induced in the trench, as expected, then the captured inflow will either collect in the northern portions of the trench or infiltrate into the subsurface evidenced by reduced trench flow to the north and even a dry northern terminus of the trench. If water accumulates in the northern end of the trench, the trench should be extended to the north or it is simply an indication that a sump structure may be a more integral part of the outlet works of the underdrain system.

Ongoing Water Level Monitoring

Water level measurements should continue to be collected in the existing monitoring wells before, during and after the installation of any drainage system to investigate the impact of the system on the ground water elevations around the pit. The full drainage system should effectively lower ground water elevations to the south and east of the pit and increase ground water elevations to the north and west of the pit as it essentially redirects water around the pit fill.

If the proposed initial trenching is successful, we would expect to see slightly higher elevations in the MW-2, MW-1 and NW-2 wells.

Recommendations

- E-470 should further investigate the feasibility and efficacy of a passive drainage system by excavating an initial length of trench where indicated to confirm that:
    - An excavated trench will communicate with ground water,
    - The trench will effectively convey water to the north,

  - The captured ground water can be discharged into unsaturated material.

- It is recommended that BBA be onsite for portions of the initial excavation to observe ground water inflow, conveyance and discharge and to provide guidance for the expansion of the trenching for the initial investigation.

- If ground water is captured and conveyed in the initial trenching, the trench flow should be gaged to confirm inflow expectations.

- Continue the collection and review of water level measurements in the existing monitoring wells.

- Review operation of initial trenching and consider potential additional trenching expansion and sump testing.

Figure 1
E-470
Sandy Acres Pit
Monitoring Well Locations

Date: 6/29/2021 | Job No. 9607.00

Legend

- Monitoring Holes (Name, Permit No.)
- Sandy Acres Pit Former High Water Line

Aerial Photo Date: 8/3/2019 NAIP-USDA
Data Source: CDSS, CDOT, USGS, BLM

Overview Map

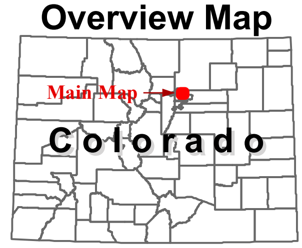


Figure 2
E-470
Sandy Acres Pit
Ground Water Inflow

Date: 9/27/2021 | Job No. 9607.00
Aerial Photo Date: 8/3/2019 NAIP-USDA
Data Source: CDSS, CDOT, USGS, BLM

Legend

- Pilot Hole
- Monitoring Holes (Name, Permit No.)
- Proposed Initial Trenching

Pond Zone Reach

- Zone C
- Zone B
- Zone A
- Former Pond High Water Line

Overview Map

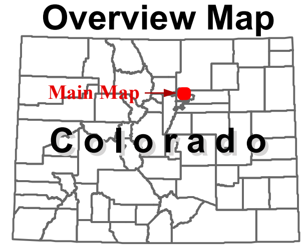


Figure 3
E-470
Sandy Acres Pit
Cross Section of Proposed Trench Construction