PSC - 16

HOUSTON engineering, inc.

Technical Memorandum

To:	**Johnathan Emmer, Assistant Director**
	North Dakota Public Service Commission
From:	**Michael HI Gunsch, PE, CFM**
	Houston Engineering, Inc.
Subject:	**Coteau Mine Permit Evaluation - NACT-9501**
	(Case No. RC-22-339)
Date:	August 24, 2022
Project:	R011252-0001-001

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am duly Licensed Professional Engineer under the laws of the State of North Dakota.

MICHAEL H. GUNSCH REGISTERED PROFESSIONAL P.E. 8417 ENGINEER NORTH DAKOTA

8/24/22

Michael H. Gunsch, PE CFM — Date

The Public Service Commission requested an independent review of the pre and post mining hydrologic conditions for Watersheds 14-14 and 14-15 in Mine Permit NACT-9501. Data from the NACT-9501 Coteau Hydrological Consequences Report (HCR), along with HEC-HMS hydrologic models from PSC records were used to compare results to our computations. This followed a review of the original data entry, along with an evaluation of supporting documentation, the HCR Report, and modeled results. The hydrologic models from The Coteau Properties were not available.

Hydrological Model Findings

The following presents the findings identified during our review.

Pre and Post Hydrology Runs: HEC-HMS

The model data input and results were consistent with engineering standards and practices, at the time the permit was submitted, with no notable variations or deficiencies identified. The modeled results from The Coteau Properties and PSC were generally conservative and their results consistent. There was one deviation in the PSC's data entry for Watershed 14-14 related to the post mine drainage area. Our model results, as reported in the data table, mirrored the Coteau/PSC determinations with variations associated with watershed areas and engineering judgment on soils and times of concentration.

Soils Conditions = CN Values

The soils data entry was consistent for pre and post mine conditions, and the original permit values are reasonable within the engineering standards used at the time of the permit application. There are currently newer soils classifications (revisions/updates) that could be applied based under today's engineering practices; however, our review was limited to the standards that applied at the time of the application. Our revisions from the original evaluation reflected changes in Hydrologic Soils Group (HSG) for several soils. In addition, when utilizing a blended soils approach versus using a predominant soils approach this results in an increase in peak flows. These were consistent with the Coteau/PSC data, the exception being our flows from Watershed 14-15 were higher.

Time of Concentrations = Tc

The times of concentrations are consistent with standard practices. There are several methodologies that could be used, and we reasonably replicated the original results.

Basin Areas = BA

The results were consistent with the topography provided, with no significant deviations of concern. Watershed 14-15 was in fact increased by mining activity from 78 acres to 210 acres, with our results indicating this to be 228.7 acres. Impacts associated with increasing the basin area are typically increases in peak flows and total runoff. The peak flows from pre to post conditions appear to be consistent and mitigated with minor changes. The change in runoff, however, also appears to have been mitigated when combining Watershed 14-14 and Watershed 15-15. Our results indicate the runoff volumes, under the blended soils approach are slightly higher than the Coteau/PSC results.

Subsequently, the changes in peak flows and runoff have been reasonably mitigated under post-mine conditions. The impacts related to the downstream complaint and diversion channel are outside the scope of our evaluation. Issues associated with extended flows associated with pond releases or specifics related to pond operations or watershed conditions during the period when the noted erosion occurred downstream were outside the scope of our evaluation. We have provided our observations regarding the diversion channel conditions based on the ground and aerial photos provided.

On-Permit Channel Design

Only a very limited review was undertaken related to the on-permit channel designs. There were questions associated with the design parameters, however this was not the focus or our scope of services, therefore, no further review was completed.

Table of Results

The attached table provides the results determined under the Coteau Hydrological Consequences Report, PSC HMS Results, and Houston Engineering's evaluation. Individual comparatives between pre and post conditions were reviewed, though not specifically tabulated. A combination of the flows from these watersheds was also not completed; however, the combined runoff values were reviewed. While there is consistency between the model results, as it relates to peak flows and runoff, the events that created the erosion issues were not evaluated. The downstream impacts appear best evaluated based on the conditions of the conveyance system and its ability to accommodate the projected flows, which is outside our scope of services.

Off Permit Diversion Channel

The diversion channel design information was provided for review, and while a detailed evaluation was outside our scope, we are providing a general overview without exhibits. Based on observations using the available ground photos and the diversion design (circa 2012) questions arose relative to the visual field and channel erosion that occurred, which are noted as follows:

1. The two on-permit channels drain into the diversion channel either at grade or one with a concrete articulating block chute. Each channel has a direction change relative to the diversion channel, with the greatest direction change occurring on the northern most channel, which includes the drop structure. Under high flow or velocities this could result in overtopping the diversion resulting in flows west into the field. This appears to have occurred based on the available site photos. It is unknown how this is occurring or the event or circumstances that created these flows as an on-site review or documentation of the diversion channel design was not completed. It is apparent under natural conditions flows through the cropland were part of the natural drainage pattern (off permit) that remains unchanged; however, the drainage pattern was altered by the diversion. The diversion channel's conveyance capacity governs the risk for overflows into the natural drainage pattern, as would the size of a given rainfall event. The events creating the erosion were not defined, in the data reviewed, though the damage documentation starts in 2011, which was a year of high precipitation and record stream flows throughout North Dakota, and likely affected the pond releases during this period. As a corollary once erosion occurs it has the propensity to grow and expand over time. The diversion reconstruction design was completed in 2012.

2. The diversion channel was intended to convey surface drainage from the east and north along and around the cropland, versus allowing them to continue flowing west through the cropland. The complaint includes photographs of the original diversion (swale) in 2008 (pg 12 of 45) and photos of erosion in the original diversion and road ditch dated August 31, 2011 (pg 13 of 45). The diversion and road ditch were re-constructed in 2012. Additional erosion photos were dated September 16, 2014.

3. Observations relative to the diversion channel design:
    a) The design appears intended to convey the more frequent event runoffs that naturally drained west through the cropland. Anticipate it may have been sized to accommodate upstream pond releases, though that is undetermined. Its capacity is based on establishing a 3-foot flow depth using 3:1 Side Slopes and either the natural or established gradient, which varies along its length.
    b) There are several locations, where the diversion channel depth is less than 3 feet (~2.5 feet) on the eastern boundary. These are located at the original natural drainage patterns through the field, which act as an overflow section (e.g., Station 9+00, 10+50 and 12+50).
    c) The capacity of the diversion varies by location associated with the gradient and containment elevation of 2.5 to 3 feet.
    d) The topography along the east side of the cropland north of the discharge point for Watershed 14-15 indicates a shallow swale that even prior to the diversion conveyed flows north along the field. Those waters that were not conveyed west into the natural field drainage, continued north and combined with flows from Watershed 14-14 at around Station 12+50. The combined waters then drained west into the field and then north to the township roadway through the field. This appears to have been documented in the 2011 erosion photos. With the diversion in place the drainage into the field has been reduced and conveyed directly to the township roadway ROW.
    e) The diversion channel design below the Watershed 14-15 outfall has the capacity to convey around a 10-year event. Where these combine with Watershed 14-14 flows, the design capacity is less than a 10-year event. The measure point for capacity is based on the overflow section into the field drainage.

4. Based on the more recent site photos provided the diversion channel shows heavy vegetative growth. This tends to increase flow depths and could force waters outside the diversion into the natural field drainage pattern, or as noted along the diversion channel which is the path of least resistance. This appears to have occurred where the channel changes direction from north to west near the township roadway. The erosion path being along the west side of the diversion. The status of sedimentation or associated channel capacity degradation was not determined.

5. There were also photos of erosion occurring within the diversion channel. Given its steeper gradient and the associated fill section for conveyance near the township roadway, the risks of erosion are not totally unexpected during high runoff events under either pre-mine or post-mine conditions. The diversion channel's long-term stability can only be determined with additional evaluation, which is outside our current scope of services.

6. A conclusion that can be drawn from these observations is that the diversion reduces the risk for and amount of drainage across the cropland. This comes at the expense of a portion of cropland being converted to use for the diversion channel. The specific conditions that resulted in the erosion and overflows into the cropland were not determined.

Coteau Mine Permit Hydrological Evaluation - NACT-9501 (Case No. RC-22-339)

	Coteau Hydrologic Consequences Report				As-Received PSC HMS Model Inputs and Results				Hydrologic Data Analysis consistent with the standards and practices at the time of permit submittal					
Subbasin ID	**14-14**		**14-15**		**14-14**		**14-15**		**14-14**			**14-15**		
Basin Characteristic	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre[1]**	**Post[2]**	**Post (Blend)[3]**	**Pre[1]**	**Post[2]**	**Post (Blend)[3]**
Drainage Area (ac)	340.0	335.0	78.0	210.0	345.6	281.6	70.4	211.2	339.6	321.6	321.6	79.8	228.7	228.7
Curve Numbers	77	70	69	70	77	71	77	71	79	63	72	81	63	72
Watershed Slope (%)	12.2	7.9	13.7	7.0	-				13.0	5.3	5.3	13.1	6.9	6.9
Lag Time (min)[4]	29	35	14	41	62	36	25	77	27	62	49	13	60	48
Time of Concentration (min)[4]	48	58	23	68	103	60	42	128	45	103	82	22	100	80
2-yr Discharge (cfs)[5]	92.9	21.5	6.1	11.9	39.7	19.8	13.5	8.4	79.0	3.5	22.4	28.7	2.5	16.3
10-yr Discharge (cfs)[5]	292.0	125.1	40.1	63.2	134.0	101.6	47.7	44.8	243.8	38.7	102.9	82.1	28.3	75.4
PSC HMS 10-yr (cfs)	-				147.3	103.8	50.9	45.7	-					
25-yr Discharge (cfs)[5]	388.5	187.0	59.6	93.5	181.5	148.5	64.8	66.5	325.4	63.6	147.9	107.5	47.1	108.2
2-yr Volume (ac-ft)[5]	12.4	5.8	1.2	3.8	11.4	5.4	2.4	3.3	13.4	2.1	6.8	3.6	1.5	4.9
10-yr Volume (ac-ft)[5]	33.9	21.4	4.7	13.8	32.5	19.2	6.7	12.4	35.8	12.5	23.6	9.0	9.0	16.6
PSC HMS 10-yr (ac-ft)	-				32.0	17.1	6.6	10.9	-					
25-yr Volume (ac-ft)[5]	44.4	30.0	6.6	19.2	43.0	26.6	8.9	17.8	46.8	18.7	31.6	11.6	13.5	22.7

Notes

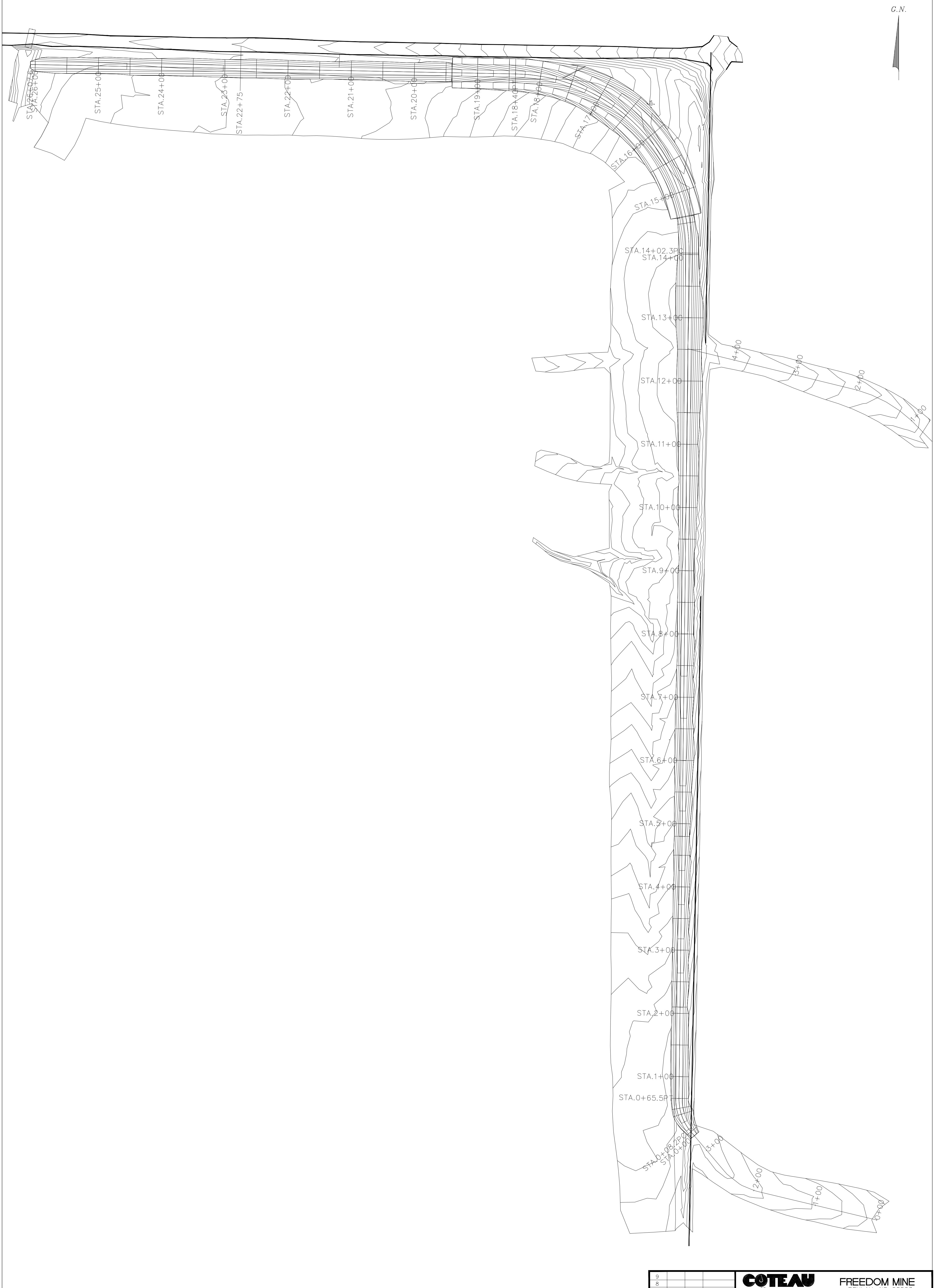
[1] Pre mine curve number values based on historic land use, soil classifications, and CN values listed in the original report

[2] Post mine curve number values based on current day land use, predominant hydrologic soil group (B), and CN values listed in the original report

[3] Post mine curve number values based on current day land use, blend of hydrologic soil groups (B&D), and CN values listed in the original report

[4] Watershed lag method. Relationship between lag time (L) and time of concentration (Tc), L=0.6Tc

[5] Determined from HMS based on SCS Type II storm consistent with ND hydrology manual at time of permit submittal



SCALE: 3/32" = 1'

NO.	BY	APP'D	DATE
9			
8			
7			
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4			
3			
2			
1			
0	WRK		10/22/12

DRAWING UPDATES

COTEAU
THE COTEAU PROPERTIES COMPANY

FREEDOM MINE
BEULAH, ND 58523

EISENBEIS DIVERSION

E1/2 NW1/4 SECTION 34, T146N, R88W

SCALE: AS SHOWN
PROJECT: ______ REVISION: ______