MEMORANDUM

TO: Lisa Humphreys, USACE PBOW Coordinator, and

FROM: Julie Weatherington-Rice

RE: Technical Review for the RAB of the Shaw Environmental March 2007 Draft "Feasibility Study for Groundwater TNT and Red Water Pond Areas"

DATE: May 1, 2007

Per our current contractual arrangement with USACE which requires both a technical memorandum for each report and an educational explanation to the RAB, this memorandum constitutes the technical review of the Shaw Environmental March 2007 Draft "Feasibility Study for Groundwater TNT and Red Water Pond Areas". Please forward these comments to those who should receive them.

In preparation for this review, on Thursday, April 5, 2007, Eric Dodrill, Erie Soil & Water Conservation District and I met with Blake Silkwood, Operations Manager Northern Ohio, Hanson Aggregates Mideast, Inc. and Rolland Krueger, Plant Manager, Wagner Quarry, Hanson Aggregates Mideast. Our morning session consisted of a meeting to discuss the general operations of the quarry as it relates to dewatering the pit and a site visit where Eric Dodrill and I made geologic observations and photographed the quarry, especially the southern end closest to the Plum Brook site. Our reasons for this field investigation were twofold: 1) to better understand and calibrate the bedrock stratigraphy of the area around Plum Brook and 2) to better understand the relationship of the dewatering operation at the quarry as it relates to static ground water levels at Plum Brook and the potential for contaminant transport in ground water from the site towards the quarry sump. The quarry and its relationship to Plum Brook can be seen on Figures 1 through 4. Water withdrawal pumping information is contained on Table 1.

This (hydro)geologic review of the Shaw Environmental Draft document is completed through the screen of the following gathered information:

1. The Delaware Limestone in Erie County where it is measured and quarried in the two active Hanson quarries, the one west of Route 4, just south of I-80 in southwestern Erie County and here at the Wagner Quarry ranges in thickness from 40 feet at the southwestern quarry to as thin at 15 feet in the southern end of the Wagner Quarry. The Delaware Limestone is relegated to Bench 1 in the Wagner Quarry. There is no naturally occurring petroleum in the Delaware Limestone.
2. The underlying Columbus Limestone at the Wagner Quarry ranges in thickness from 59 feet to 83 feet in the southern portion of the quarry. It is

200-1e
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located on the bottom of Bench 1 through Bench 3. This is the formation with naturally occurring petroleum. The naturally occurring petroleum is sporadic in occurrence. It is extremely thick in nature, more on the order of tar or asphalt. It moves very slowly out of the Columbus Limestone, taking a year or more to stain the face of the quarry walls after a new face has been blasted.

3. The entire Bench 4 and 5 are the upper portions of the Detroit River Dolostone (dolomite) formation. This formation continues to well below the bottom of Bench 5. The sump in the southeastern corner of the quarry that provides the dewatering point for the whole quarry is fully contained in the Detroit River Formation. The top of the Detroit River Dolostone has a marked strong hydrogen sulfide order. There is some elemental sulfur present with depth on Bench 5.
4. The entire Wagner Quarry is passively dewatered by just one small sump area in the southeast corner of the quarry. The surface elevation of the sump is maintained at approximately 460 feet above mean sea level (amsl). There is a pumping system that raises water from the sump and discharges it into a tributary to Pipe Creek where it then flows into Sandusky Bay and Lake Erie. The quarry's current average pumping rate is more than one million gallons per day. Pumping rates and volumes are reported annually to the Ohio Department of Natural Resources (ODNR), Division of Water. The annual pumping rates for 1990 through 2004 are listed on Table 1.
5. The quarry walls are intersected with hundreds, if not thousands, of vertical joints aligning with the regional jointing patterns for this part of Ohio. We measured one joint on the top of Bench 3 (floor of the quarry at Bench 2) as having a direction of N 45^0 E. The perpendicular jointing set will be approximately N 45^0 W. While the quarrying operation tends to enlarge the joint widths, the joint faces, where viewed face on, are case-hardened on the joint surfaces, which indicates that they have been open and active for a very long period of time. The ease of the dewatering operation indicates an extremely high velocity for the ground-water flow rate along the secondary fracture joints and bedding planes in all three of the carbonate formations exposed at the quarry.
6. The quarry has been in operation since 1912. There is additional space on the current property and only the southeastern portion of the quarry has been quarried to the bottom of Bench 5. There is a significant amount of rock reserve at the quarry. It is anticipated that the quarry will be in operation for many more years to come. As the quarry deepens over the larger portion of its footprint, it may well be necessary to increase the dewatering pumping rate to maintain a dry hole for the rock excavation. The quarry is currently operating within all the requirements of the ODNR Division of Water in terms of water withdrawal reporting. Since it is a pre-existing water withdrawal user, the quarry operation has the right of first withdrawal.
7. Since the Wagner Quarry is down gradient from the Plum Brook site, it is anticipated that the longest 'tail" of the dewatering capture zone will be to the south-southwest, back into the Plum Brook site. The dewatering cone will follow the dominant jointing patterns and will probably not involve much

matrix flow. This dewatering cone probably explains most, if not all, of the ground water trench found at PBOW in the earlier Shaw ground water reports.

8. There is no off-site Plum Brook Ordnance Works (PBOW) monitoring well on the Hanson Wagner Quarry property. Blake Silkwood reported that someone approached him some years ago about placing a monitoring well on the Wagner Quarry property. Mr. Silkwood indicated that company policy required a "hold harmless" clause for the well installation and future access. For some unknown reason, whoever discussed the issue with Mr. Silkwood was unable and/or unwilling to provide this standard Ohio agreement so no monitoring well was installed. In addition, the sump is not identified as a surface sampling location for Plum Brook. Therefore, the quality of the ground water moving from the PBOW into the Wagner Quarry sump is unknown and the quarry staff members that come into contact with the sump water have not been evaluated for possible risk factors. In addition, the NPDES permit for dewatering the quarry would not require monitoring for TNT breakdown products, as none were made on the quarry site, so no one is conducting a sampling program for the discharge water flowing into Pipe Creek. When Shaw and/or other contractors and/or Army Corps of Engineers are ready to discuss future monitoring efforts on the Wagner Quarry property, Mr. Silkwood can be reached at (419) 483-4390 of by e-mail at Blake.Silkwood@Hanson.biz.

- why not? changing from GW to surface water criteria!

Specific Comments on the Report

With this review, I have tried to anticipate the locations in this Feasibility Study where the dewatering efforts at the Wagner Quarry would come into play. Neither the dewatering efforts at the NASA Reactor or the Wagner Quarry are incorporated into this current version of the Feasibility Study. This review should provide a template for the revision of the feasibility study process and help develop an acceptable set of options for the ground water clean-up at Plum Brook.

Executive Summary

No specific comments and/or corrections were made to the Executive Summary as this is a shortened portion of the full text. Comments and/or corrections made in the full body of the text that affect the information in the Executive Summary should have those corrections brought forward.

Chapter 1

1.4.1 Nature and Extent of Soil Contamination

1. This is a good summary of conditions at the site. (page 1-11)

1.7 Groundwater Modeling and Fate-and-Transport Modeling (For additional comments see Appendix A discussions)

2. Measurable impacts on the underlying carbonates are also a function of how actively portions of Plum Brook are being dewatered. (1-33)

1.8 Groundwater Risks

3. Workers at the Wagner Quarry are also part of the "at risk" population of workers who could be impacted by ground water contamination at Plum Brook. This population needs to be added to the evaluated groups. (page 1-35)

4. The Wagner Quarry sump is discharged to a tributary of Pipe Creek. This discharge becomes a ground water to surface water transport path which allows contaminated ground water to move to environmental receptors. This transport path has not been previously identified or investigated and needs to be for completion of the Remedial investigation process for the site. (page 1-36)

Chapter 2

2.2.2 Local Geology

5. The designation of the thickness of the Delaware Limestone and it's characteristics in the Shaw report are at odds with the stratigraphic column and site visit information from the Wagner Quarry. The descriptions for the carbonate wells need to be corrected based on local, field-identified formational data. (See information presented on Figures 3 and 4.) Once natural petroleum products are intersected, the wells have penetrated the Columbus Limestone. The strong hydrogen sulfide gases and elemental sulfur are more typical of the Detroit River Dolostone. (page 2-2)

2.2.3 Local Soils

6. The soils section is badly out of date. It should be updated to incorporate soils changes in the February 2002 Interim Report and the Erie SSURGO DDS 2.1 Soil Survey available from the Erie Soil & Water Conservation District. (page 2-3)

2.2.4.2 General Site Hydrogeology

7. The direction of flow in the underlying carbonate bedrock to the north-northeast is the direction of flow that would be expected as a reflection of the dewatering sump at the Wagner Quarry. Flow is controlled by travel along the directions of regional jointing and the static water levels are controlled by how close or how far the measuring points are from the active dewatering cone of the quarry. There is an additional, smaller complication from the dewatering sump of the NASA Reactor that also needs to be considered but

the quarry dewatering effort is so large and the elevation of the sump so deep that this system may overwhelm any other system that has an impact on the site. (page 2-4)

2.4 Site Conceptual Model

8. While regional ground water recharge flow can be viewed in an "averaged" approach, contaminant transport is the "fastest route". The second paragraph describes a hydrogeologic setting that is poorly represented by the MODFLOW ground water flow model which assigns averaged input values for each grid cell. There are much better fractured rock models which allow for multiple vertical and horizontal hydraulic conductivities that should have been used to model the setting at Plum Brook. The modeling results could have been more believable. (page 2-5)

2.5.2 Groundwater Use

9. I cannot find the well referenced as "the nearest private well to PBOW is approximately 840 feet northeast" on Figure 1-2. Please add it to the figure. (page 2-6)

10. This section discusses six known private wells within a mile down gradient from PBOW, most, if not all, missing on Figure 1-2, but fails to mention the Wagner Quarry which is considerably less than one mile down gradient from Plum Brook and is actively dewatering at least portions of Plum Brook on a continuous basis. The Wagner Quarry needs to be added to the text and its dewatering cone needs to be factored into any ground water flow model created for the Plum Brook site. The top of water level in the sump is approximately 460 feet amsl which is as much as 200 feet lower in elevation than some of the static water levels recorded at the far edges of the site. (page 2-7)

2.6 Groundwater Quality

Overburden/Shale

11. The reported background chloride level of 34,600 mg/L in the shale is extremely high for these shale formations and should be investigated to determine if there is a possible man-made contamination reaching the well. These numbers at shallow depths are more typical of wells that have been contaminated by highway de-icing activities. In addition, the dissolved solids level of 43,800 mg/L is unusually high for these formations. (page 2-7)

Delaware Limestone Bedrock

12. Once natural occurring petroleum is reached, the well has entered the Columbus Limestone. By observations at the Wagner Quarry, there is no naturally occurring petroleum in the Delaware Limestone. Any natural petroleum encountered in drilling should be very thick and viscous. Typically it's seen as asphalt staining on the rock cores. Other types and consistencies of petroleum products encountered in drilling are probably NOT from natural sources and should be collected and fingerprinted for source of origin. Any escaped man-made hydrocarbons should be remediated as part of the Plum Brook clean-up activity. (page 2-8)

13. This is the first reference to "sellite (sodium sulfate) and its disposal that I remember seeing. What was it used for? (page 2-8)

2.7 Potential for Natural Attenuation of Nitroaromatics

14. This section fails to list "dewatering and dilution" as another, and very likely major cause of the removal of nitroaromatics in the Delaware Limestone and underlying formations. (page 2-8, 2-9)

Chapter 3

3.2 Site-Specific Considerations

15. This section states that "neither the overburden/shale nor the Delaware limestone bedrock is a desirable source of groundwater for human consumption." This statement significantly misrepresents the critical importance of the Delaware and underlying Columbus limestones as major private water well resources and/or public ground water supplies from Lake Erie to the Ohio River. In addition, the shales are also used heavily as private water well resources in rural areas from Lake Erie to the Ohio River; although their yields are greatly reduced when viewed against the yields found in the Columbus and Delaware limestones and their water quality is diminished. If water quality is significantly impacted at Plum Brook, man-made sources are probable contributors. Please rewrite this section to remove the unsupported bias against the water quality of the Columbus and Delaware limestones. (page 3-1)

16. The report in this section mixes the properties of the Delaware Limestone, the Columbus Limestone, and the Detroit River Dolostone. It is important to know which formation has been reached when assigning properties. This needs to be rewritten correctly. (page 3-2)

3.4 Remedial Goal Options

Delaware Limestone

17. The table referenced at the end of the 2nd paragraph should be Table 3-2. (page 3-3)

3.6 Areal Extent of Contaminated Groundwater

18. Bottom of page. Are the remediation areas of TNT-A subject to change as removals begin like TNT-B and TNT-C? If so, what does that do to the ground water remediation areas? (page 3-7)

3.7 Volumes of Contaminated Groundwater – assumptions page 3-10

19. Migration into the competent shale will depend on fracture flow. Identification of the migration will depend on where the sampling points are located and how wide the diameter of the sampling points. If the points are small, they can miss the migration routes. Therefore, what were these assumptions based on? (page 3-10)

20. We have contaminated carbonates below the shale so why is the shale assumed to be capable of preventing contamination from reaching the carbonates? (page 3-10)

21. How does the dewatering at the site by the NASA Reactor and the Wagner Quarry come into play in these assumptions? (page 3-10)

22. The "very low concentrations of nitroaromatics" in the "Delaware Limestone" also suggests that they have been pumped away. Was this remediation by off-site pumping route taken into consideration here? (page 3-10, 3-11)

3.7.1 Volumes in Overburden/Shale for Protection of the Delaware Limestone Bedrock Groundwater

23. I do not feel confident with this methodology and approach. I don't see the Wagner Quarry pumping volumes and rates being part of this set of calculations. (page 3-11)

3.8.1 Location-Specific Applicable or Relevant or Appropriate Requirements

Special Areas

24. The report states that the "National Wetlands inventory maps of PBOW do not show wetlands areas on the installation". Has the Erie Soil & Water Conservation District been asked to assist with the wetlands survey review

for the sites? Some of the settings, especially the Red Water ponds lend themselves to wetlands development and delineations. (page 3-13)

Chapter 4

4.3.1 Long-Term Monitoring

25. "Groundwater modeling indicates that COCs in Delaware Limestone bedrock groundwater in the PRRWP Area plume may migrate off site within 150 years." Reviewing the elevation of the top of the sump in the Wagner Quarry and the rate of ground water withdrawal there to keep the quarry dry, a more conservative view would be that the ground water contamination in the carbonates has been moving off site for years. The quarry was already in operation and pumping when the PBOW was built. (page 4-1)

26. "The monitoring well closest to the property boundary within the PRRWP Area plume is contaminated, although the nearest off-site well is not". Which well is that? Is that nearest off-site well in the correct location to intercept ground water moving off of the PBOW site towards the dewatering sump at the Wagner Quarry? (page 4-1)

27. If PBOW is going to include long term monitoring in the remediation mix, there must be properly placed monitoring wells drilled deep enough to monitor ground water flow towards the Wagner Quarry. This monitoring route appears to be missing on Figure 1-2. (page 4-2)

4.3.2 Monitored Natural Attenuation

Effectiveness

28. Plum Brook cannot use monitored natural attenuation for a remediation alternative because at least portions of the site are undergoing active dewatering by the Wagner Quarry. Plum Brook would have to be able to control and/or at least predict ground water flow off site. They can't because the quarry has control of at least the northern portion of the site with its dewatering activities. (page 4-2)

Implementability

29. Before natural attenuation could even be considered at any point on the Plum Brook site, the full area impacted by dewatering at the NASA Reactor and at the Wagner Quarry will have to be determined. Only areas outside the area of influence of the dewatering operations could be considered for this application. (page 4-4)

4.3.3 Groundwater Extraction

Effectiveness

30. At least portions of the Plum Brook facility are already undergoing a ground water extraction process and have been since the facility was in operation. Furthermore, it is not a static volume that can be calculated and be expected to remain the same over time. With the ongoing increase in depth and size of the Wagner Quarry over time as the quarried reserves are removed, that level of unplanned "ground water extraction" will continue to grow. (page 4-4)

Implementability

31. This scenario does not include the current impact of the Wagner Quarry or the NASA Reactor on the site either currently or over time. It also does not include the long-term plan of operations for either of these facilities and how those plans will impact this option over time. Without including those aspects, this option is not acceptable for the WARWP and especially not for the PRRWP which is considerably closer to the two identified dewatering sites in the region. (page 4-5)

4.3.6 In Situ Enhanced Bioremediation

32. This alternative has to be reviewed against the active dewatering cones from the NASA Reactor and the Wagner Quarry. Active ground water movement may alter the amount of enhanced carbon substrate that needs to be added to the contamination plumes. (page 4-14)

4.3.7 In Situ Chemical Oxidation

33. The impact of the reactor and the Wagner Quarry dewatering cones on the carbonate bedrock is not factored into this process. (page 4-17)

4.3.10 Groundwater Use Restrictions

Implementability

34. "Groundwater use restrictions are implementable at PBOW". No, they are not. Plum Brook is currently being actively dewatered by the NASA Reactor and, dominantly, by the Wagner Quarry. Therefore, regardless of what Plum Brook claims to have as a policy, they don't have control over the ground water flow and off-site migration of contaminants. (page 4-20)

4.3.11 Apatite II

35. Given the current "soluble phosphorus" crisis in western Lake Erie and the bays, any solution based on a phosphate process applied to water could have a significant negative public acceptance. (page 4-20)

Chapter 5

5.1.5 Reduction of Toxicity, Mobility, or Volume (No Action)

36. This alternative will potentially impact the environment and the community because of the carbonate bedrock flow to the Wagner Quarry sump. (page 5-3)

5.2.1 Description (Groundwater Monitoring and Institutional Controls)

37. Regarding the remedial components. There already is off-site migration of contamination in the direction of the Wagner Quarry. The level of that contamination is unknown, however, because there are no monitoring wells installed, located and designed to intercept that ground water flow before it reaches the Wagner Quarry sump, and monitored on an on-going basis to determine the levels of contaminant transport off site. (page 5-4)

38. Plum Brook already has impacted off-site receptors, the quarry workers at the Wagner Quarry and the environmental receptors in the tributary of Pipe Creek which receives the dewatering flow from the sump pit. The contamination completion pathway is already in place. It is only the level of contamination, both historically and currently being received, that is unknown because the completion pathway is not being monitored. (page 5-4)

39. Plum Brook cannot restrict what it cannot control. For at least the northern portions of the site, Plum Brook does not control the ground water flow off site, the Wagner Quarry does. (page 5-4)

40. Where would the new wells be located and how deep would they be drilled? (page 5-4)

41. Once a year monitoring is probably not sufficient for these monitoring wells, given the actual rate of ground water flow in the carbonates. (page 5-4)

5.2.2 Overall Protection of Human Health and the Environment

42. No, it is not. Please see earlier comments. (page 5-5)

5.2.6 Short-Term Effectiveness

43. There already are impacts to the environment and workers off site. The completion pathway exists. Only the amount of the impacts is yet to be defined. (page 5-7)

5.2.6 Implementability

44. The components of Alternative GW-2 are not administratively implimentable because the PBOW does NOT control ground water flow on at least the northern portions of the site, the Wagner Quarry does. Plum Brook cannot implement what it cannot physically control. (page 5-7)

5.3 Alternative GW-3 – In Situ Enhanced Bioremediation/Pump and Treat for Mitigation/Protection of the Delaware Limestone Bedrock Aquifer

45. This is an acceptable physical hydrogeological alternative as long as the Quarry's roll in off-site ground water flow is factored into the plan. (page 5-8)

46. A similar treatment is currently being implemented at the YSI clean-up site in Yellow Springs, OH. The bedrock formations are also carbonates and the glacial materials are similar but coarser-grained. This project is being reviewed by Ohio EPA Southwest District Office in Dayton. (page 5-9)

5.3.1.2 P&T with Reinjection in Delaware Limestone Bedrock Aquifer – BED-MW27 monitoring well discussion, bottom of page 5-12

47. The discussion of "a naturally occurring light nonaqueous-phase liquid (LNAPL) petroleum hydrocarbon" that ranges in thickness "from a sheen to as much as 0.5 feet on the surface of the groundwater" is completely at odds with the descriptions of the natural petroleum products intersected at the Wagner Quarry. The only petroleum products encountered there are thick and dense. The possibility exists that the LNAPL in BED-MW27 is from a man-made source. It needs to be fingerprinted as soon as possible to identify the source. There may be an on-site release of LNAPL materials that also needs to be remediated. (page 5-12)

5.3.1.3 Groundwater Monitoring

48. Where will the new wells be installed and which wells would be monitored? (page 5-13)

5.3.1.4 Institutional Controls

49. Plum Brook cannot apply institutional controls to ground water use because at least part of the site is being actively dewatered by the Wagner Quarry and Plum Brook does not have flow control. (page 5-14)

5.3.2 Overall Protection of Human Heath and the Environment

50. "Contaminated groundwater does not present a threat to ecological receptors or other environmental media, as impacted ground water does not discharge to surface water". This statement is not true. The pathway from Plum Brook to the Wagner Quarry sump to the tributary of Pipe Creek has been completed. The levels of contamination being transported have not yet been tested. Monitoring periods need to be significantly shorter than yearly because the time-of-travel in the carbonates is rapid. (page 5-14)

5.4.1.3 Groundwater Monitoring

51. Where will the wells discussed in this section be located? Monitoring the wells once a year is probably not often enough based on the active dewatering operations at the NASA Reactor and at the Wagner Quarry. (page 5-22)

Chapter 6 – no comments

Chapter 7

7.2 Development and Evaluation of Remedial Alternatives

52. Plum Brook cannot apply intuitional controls to ground water because at least on the northern portion of the site, they do not control the ground water flow, the Wagner Quarry does. (page 7-1)

7.3 Recommendations for Additional Work

53. I agree with all the work items listed. I recommend the expansion of the second item discussing "Groundwater flow within the Delaware Limestone" to include the following additional work efforts:

    a. Conduct a dye test of the carbonate wells on site to determine the time-of-travel to the Wagner Quarry sump. Assistance can be requested from ODNR's Division of Water. They have experience with dye-testing these formations.

    b. Create a new ground water model that more accurately represents the fractured bedrock setting. When running the new model, add the Wagner Quarry sump elevation and pumping rate and the measured time-of-travel from the dye test to help in the model calibration. (page 7-4)

54. I concur with the importance on the last item on page 7-5. There has to be a carefully designed and installed off-site monitoring system to determine the levels of contamination migrating off site. There is no question that the contaminants are leaving the facility, the question is how completely they are diluted as they leave and do they still pose a threat at their diluted levels. (page 7-5)

Tables

Table 6-1

55. This table has to be redeveloped after the off-site impact of the Wagner Quarry has been factored in to the evaluations.

Figures

Figure 1-1 PBOW Vicinity Map

56. The Wagner Quarry has to be added to the large plain yellow area between US 205 and Columbus Ave., just north of Bogart Rd. The Quarry footprint will encompass most of the blanked out area.

Figure 2-2 Generalized PBOW Block Diagram

57. This is a good visualization tool to understand the complexities of the site. As a first step to begin determining where the dewatering impacts of the Wagner Quarry are active, it would be useful to create a plan view map of bedrock monitoring wells where the water levels in the wells are below the bottom of the glacial overburden and/or shale units.

Appendix A Groundwater Fate and Transport Modeling

2.0 Previous Modeling

58. VLEACHSM allows for several different horizontal layers with different properties, but the input for the vertical hydraulic gradient requires the same matrix permeability in put parameter as the original VLEACH model did. This model assumes leaching flow from the matrix material only. This is not a good model to use in this setting where while there may be reservoirs of contaminants in the matrix, most all of the transport will be through the secondary fracture network. A better model for this site would be the USDA Root Zone Water Quality Model which allows modeling through the vadose zone and which also has a vertical fracture module which has been calibrated

by USDA Agricultural Research Service soil scientists and agricultural engineers for Ohio soils. Leaching will probably occur more quickly than the VLEACHSM model predicts. Total leaching will depend on how much of the contaminants are stored in the matrix materials. (pages 1 & 2)

59. Both MODFLOW and MT3D are block-centered ground water flow models. They function on the assumption that the whole cell or block has the same properties. These kinds of models are very useful in sand and gravel settings or when calculating regional ground water recharge. The further away from that kind of setting the user gets the less useful and appropriate these models are. Modeling fastest time contaminant transport in fractured carbonate bedrock with well developed regionally controlled jointing structures and bedding plans is about as opposite an application as can be derived. The answers developed from these models will not represent closely the actual conditions at the site. There are far better fractured rock models available that would create more meaningful results. One of them should have been used here if meaningful results were anticipated. (page 2)

Appendix B Evaluation for Monitored Natural Attenuation of Nitroaromatics in Bedrock

2.0 Geologic Controls on Contaminant Transport – Pages B-2 & B-3

60. A third scenario is that the dewatering at the Wagner Quarry results in rapid transport of the contaminants in the carbonates away from the discharge points and dilutes the contaminants as they travel towards the dewatering sump at the Wagner Quarry. (page B-3)

61. A fourth scenario is that contaminants that may reside in the matrix of the overburden glacial materials and/or shales are only slowly released to the underlying carbonates by fracture flow during seasonal/annual recharge events. (page B-3)

4.0 Geochemical Parameters – Page B-6

62. Areas of the PBOW site where shale covers the carbonates will have naturally occurring hydrogen sulfide leached down from the overlying shale. The Plum Brook and Ohio shales were deposited in anaerobic conditions and are naturally higher in hydrogen sulfide. The Detroit River Dolostone has also been identified as having hydrogen sulfide in the formation. The lower levels have deposits of elemental sulfur. See Figure 3. In addition, both the Plum Brook and the Ohio shales are carbonaceous "oil shales" and so have their own natural "TOC" content. (page B-6)

63. "At TNTA-BEDGW-002, a 3.5-foot layer of free-phase hydrocarbon was encountered prior to sampling." This observation is so at odds with the observation of naturally occurring petroleum products at the Wagner Quarry that

this material should be collected and fingerprinted to determine if it is from an alternative, man-made source. (page B-6)

64. There is no TNTA-BEDGW-002 on Figure 1-2. Is the well point missing from the map or is this label misidentified, typed in error, and the well is actually some other location? Please correct whichever way the correction needs to be made. (page B-6)

65. There is no PB-BED-MW23 on Figure 1-2. There is a BED-MW23 northwest of PRRWP. Given the location of TNT-A and PRRWP on the site, is this well possibly mislabeled either on the map or in the text? Please correct. (page B-6)

66. There is not PB-BED-MW24 on Figure 1-2. There is a BED-MW24. Is this well mislabeled either on Figure 1-2 or in the text? If so, please correct. (page B-6)

This ends the specific list of comments and corrections to this report. Please distribute these technical comments to those who need them. If you have any questions and/or need further clarification on any portion of this review, please feel free to contact me.

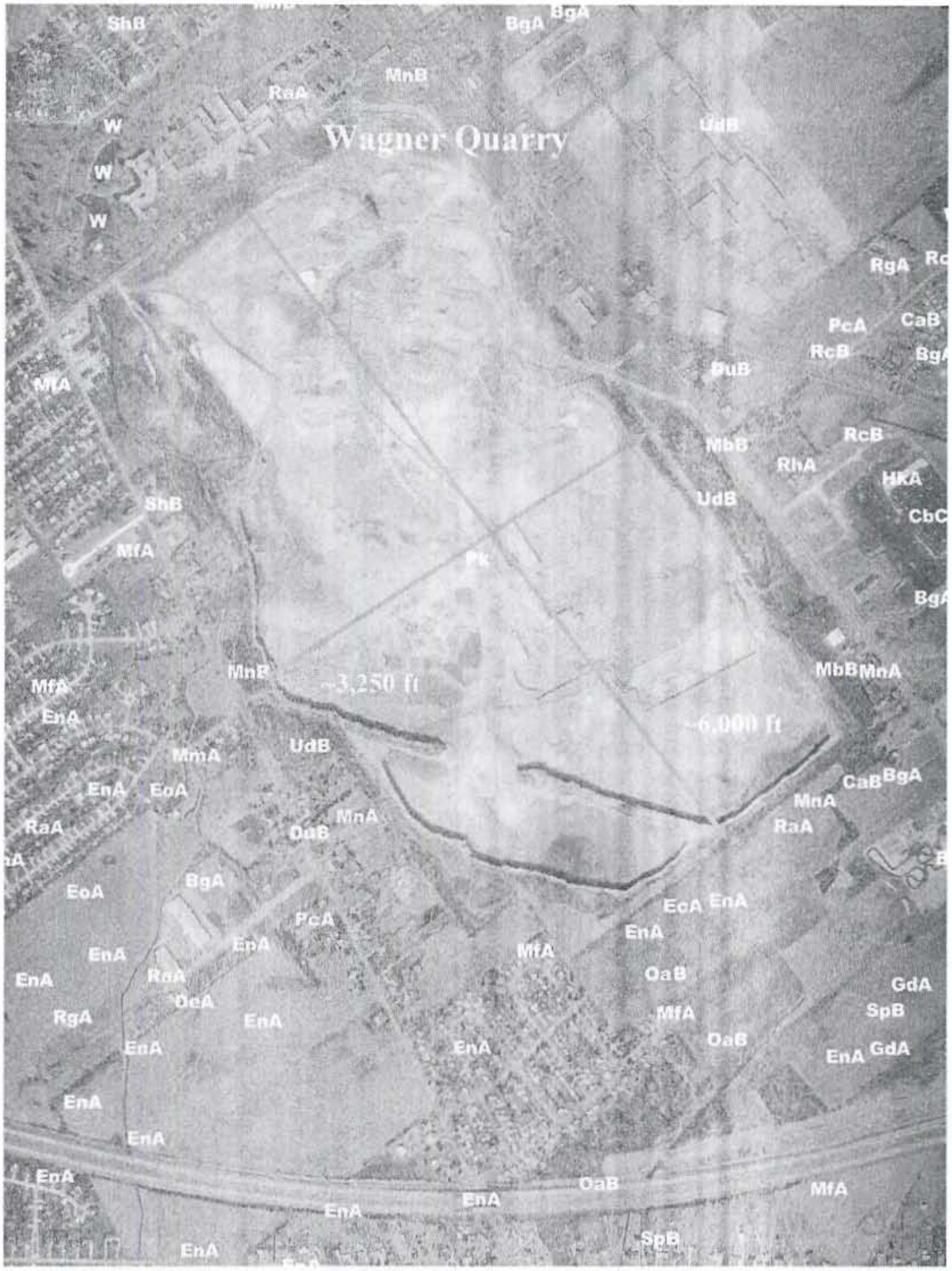

Figure 1: Close-up of the Hanson (Wagner) Quarry west of US Route 250 in Perkins Township, northeast of the PBOW site. The quarry mines the Delaware and Columbus Limestones and the Detroit River Dolostone formations. It is a dry excavation and is dewatered by a sump at 460' above mean sea level which is pumped to a tributary of Pipe Creek. Source, Erie County SSURGO Digital Soil Survey.

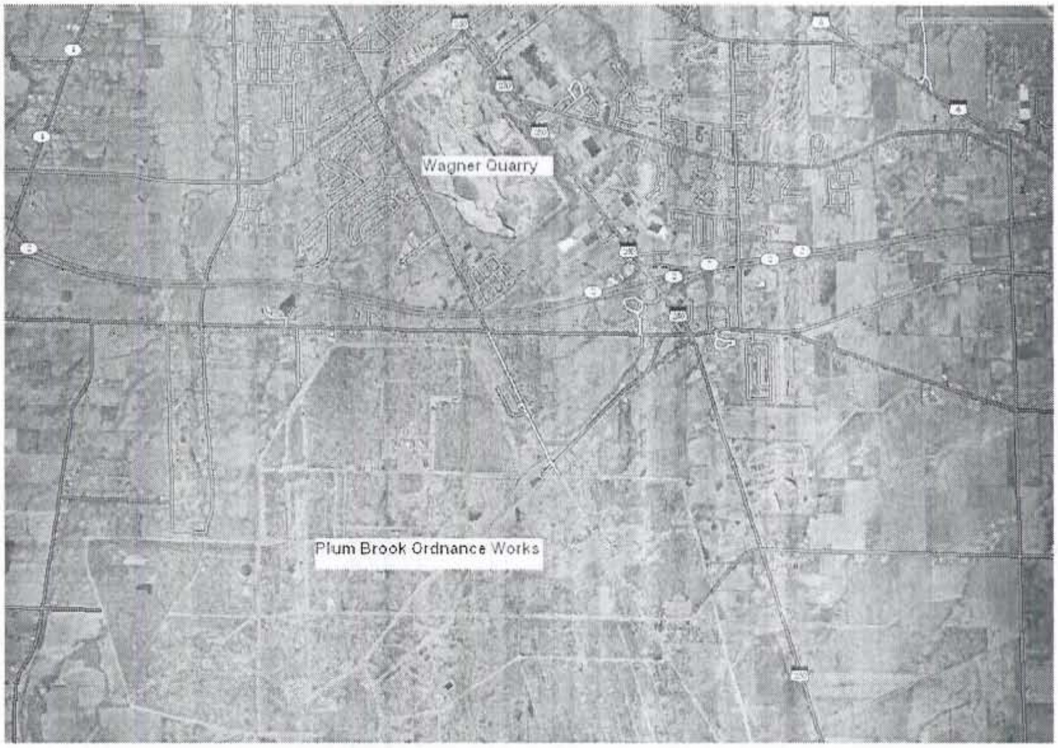

Figure 2: Location of the Wagner Quarry in relationship to the Plum Brook Ordnance Works. Distance between the two closest points of the PBOW and the quarry is ~ 3,300 feet. The dewatering of the quarry controls ground water flow at Plum Brook. Source of graphic, 2005 Aerial photographs of Erie County, graphic prepared and contributed by Eric Dodrill, Erie SWCD.

Generalized Stratigraphic Column

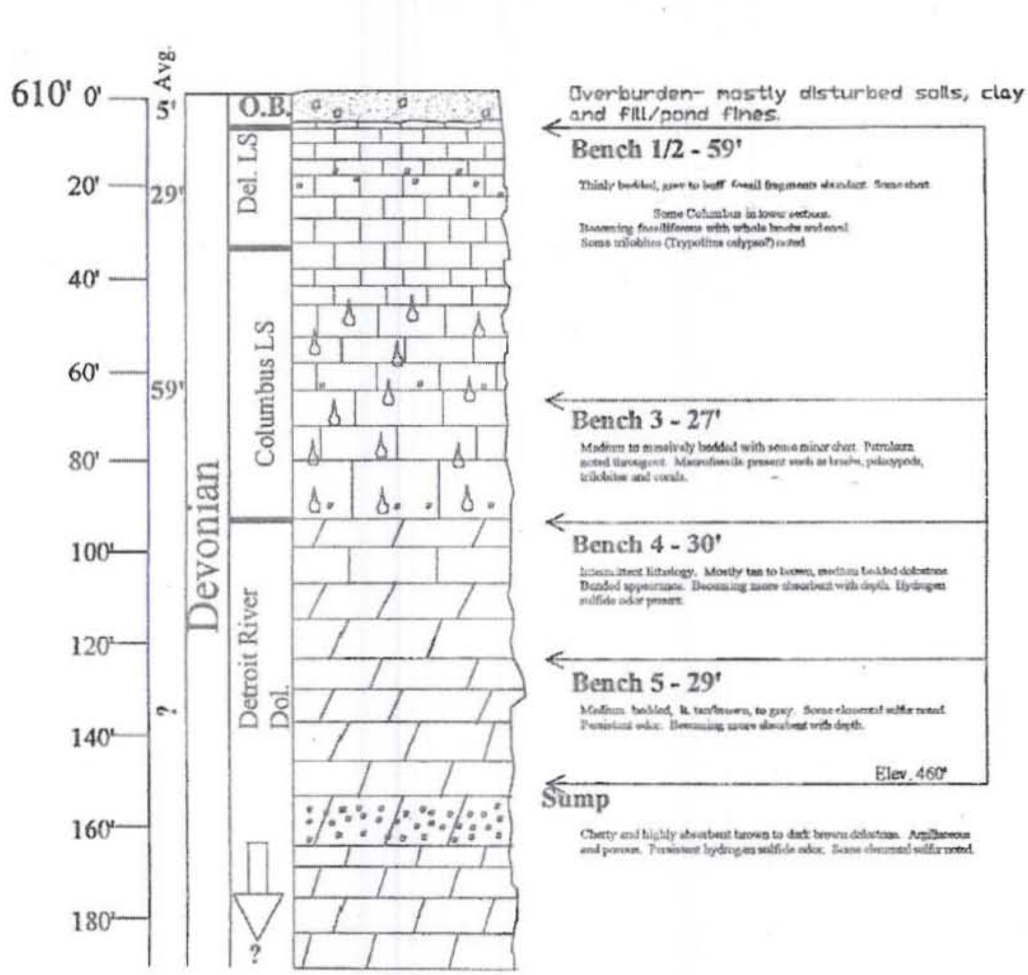

Figure 3: Generalized Stratigraphic Column for the Hanson Wagner Quarry showing the five benches at the quarry and the elevation of the top of water in the sump. Source of the graphic, Blake Silkwood, Operations Manager Northern Ohio, Hanson Aggregates Mideast, April, 2007.

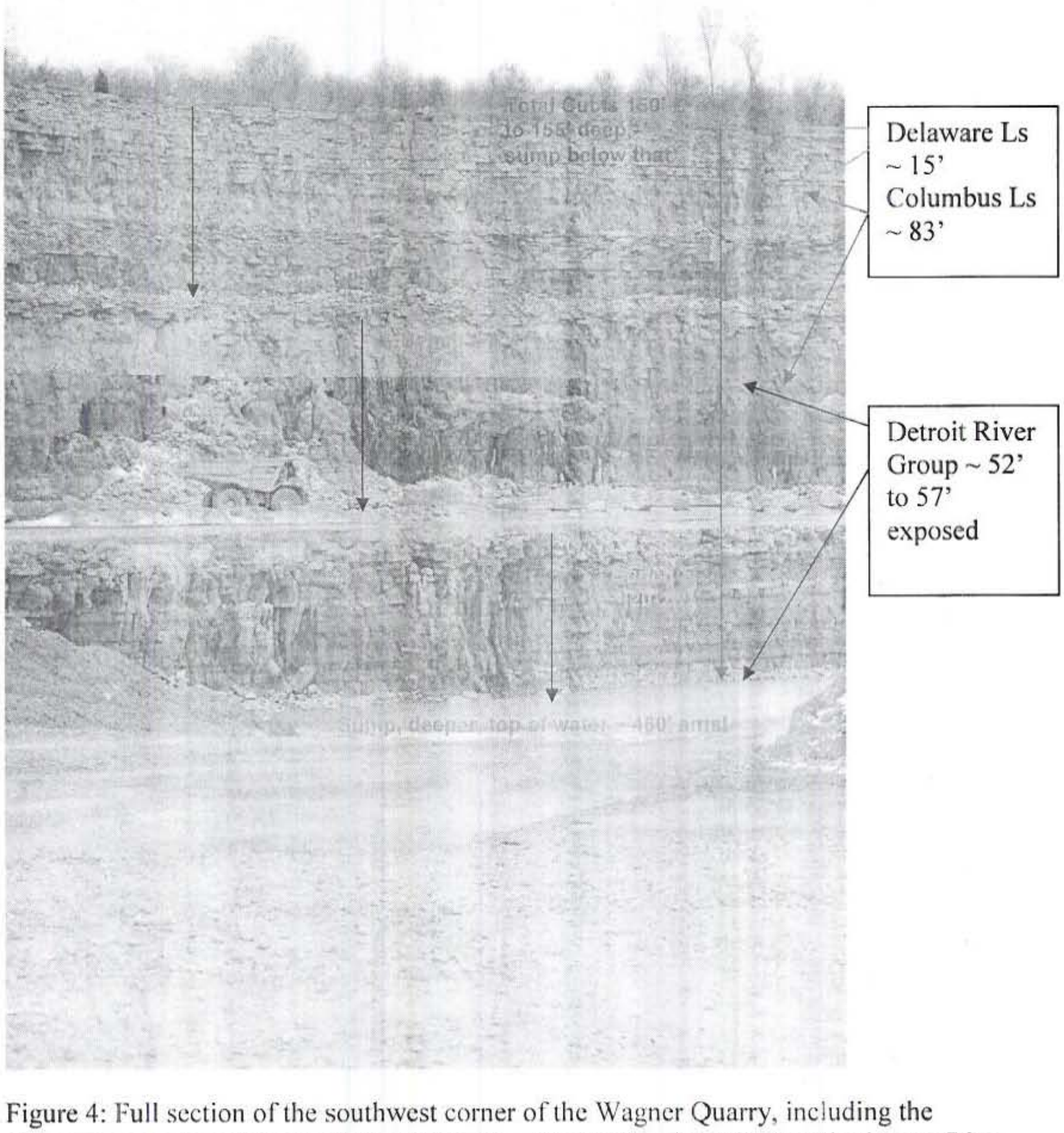

Figure 4: Full section of the southwest corner of the Wagner Quarry, including the dewatering sump with Earth Mover for Scale. Photo taken by Julie Weatherington-Rice on April 5, 2007.

Table 1

Water withdrawal Records for the Wagner Quarry, Erie County, Ohio
Years covered: 1990 through 2004

RegNo	FacilityID	Year	Surface Water Total*
00483	HANSON AGGREGATES-WAGNER QUARRIES	1990	250.694
00483	HANSON AGGREGATES-WAGNER QUARRIES	1991	209.6
00483	HANSON AGGREGATES-WAGNER QUARRIES	1992	14.05
00483	HANSON AGGREGATES-WAGNER QUARRIES	1994	247.78
00483	HANSON AGGREGATES-WAGNER QUARRIES	1995	255.97
00483	HANSON AGGREGATES-WAGNER QUARRIES	1996	337.26
00483	HANSON AGGREGATES-WAGNER QUARRIES	1997	296.4
00483	HANSON AGGREGATES-WAGNER QUARRIES	1998	332.28
00483	HANSON AGGREGATES-WAGNER QUARRIES	1999	242.1
00483	HANSON AGGREGATES-WAGNER QUARRIES	2000	275.31
00483	HANSON AGGREGATES-WAGNER QUARRIES	2001	308.69
00483	HANSON AGGREGATES-WAGNER QUARRIES	2002	328.81

RegNo	FacilityID	Year	Ground Water Total*
00483	HANSON AGGREGATES-WAGNER QUARRIES	1993	326.6
00483	HANSON AGGREGATES-WAGNER QUARRIES	2003	400.86
00483	HANSON AGGREGATES-WAGNER QUARRIES	2004	376.11

Note: Total gallons of water withdrawan are reported in millions of gallons