MEMO

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Date:

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Arcadis Project No.:

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Subject:

Hudson Water Street Sediment Restoration Approach

Introduction

On March 28, 2012, the New York Department of Environmental Conservation (NYSDEC) issued a Record of Decision (ROD) regarding Operable Unit Number 02 (OU-2) at the National Grid former manufactured gas plant (MGP) site in Hudson, New York (the site). The Description of Selected Remedy section of the ROD includes the following element pertaining to restoration of the site:

8) Restoration of the stream bed and banks to the original bathymetry. To the extent possible, restoration will be with material similar to the existing substrate. A restoration plan will be developed during design and will meet the requirements of Article 15 and 6 NYCRR Part 608.

This memorandum serves as that restoration plan and proposes a restoration strategy that meets the requirements of the ROD to gain concurrence with NYSDEC ahead of completing and submitting the full Remedial Design.

Previous Habitat-Related Studies

Previous habitat-related studies conducted at the site include the following:

- General characterization during sediment sampling (1995-2009)
- Diver investigation of specific species and extent (2013)

Observations during sediment sampling events conducted in 1995-2009 as documented in the Revised Comprehensive Sediment Investigation Report for Operable Unit 2 (CSIR; ARCADIS 2010) and diver observations conducted in 2013 as documented in the Remedial Design Work Plan (RDWP; ARCADIS 2014) indicate that SAV is not present at the site. These studies also indicate that, based on specific site conditions, including irregular (steep and rocky) bed surface and water depths 3 to 4 times deeper than the desired 4- to 5-foot range, SAV growth is not expected within the boundaries of the remedial area. The RDWP provides a comprehensive detailed review of observations regarding submerged aquatic vegetation (SAV) at the site. The relevant text of this report is provided as Attachment 1 for reference.

Benthic data collected and analyzed at the site are discussed in general in Section 3.5.3 of the CSIR (ARCADIS 2010), the text of which is included as Attachment 2. The results are discussed in more detail in Sections 5.2 and 5.3 of Appendix A to the CSIR, the text of which is included as Attachment 3. Table 4-5 of this appendix, included here as Attachment 4, presents the benthic survey indices. In general, the benthic indices did not show significant correlation to the sediment chemistry data. Additionally, all but two individual sample locations correlated well with the reference locations.

Existing sediment grain size analyses are discussed in Section 3.1.3.1 of the RDWP (ARCADIS 2014), included in Attachment 1, with the raw data presented in Table 3-6 to that report, included here as Attachment 5. Of the 36 samples collected, all but three were considered coarse-grained. As anticipated, the top 6 inches of each sample typically contained the coarsest material with finer material in deeper samples and the embayment areas. This upper layer of coarse material indicates a level of natural armoring at the site.

Proposed Restoration Approach

SAV

Based on the various observations documented in the RDWP indicating the lack of SAV at the site and lack of growth potential, no subaqueous planting will be performed as part of the site restoration.

Benthic Habitat Restoration

As the benthic studies did not reveal any significant findings, the restoration will consist of replacing the removed sediment with similar material to allow the benthic community to recolonize naturally.

Backfill materials

The goal of the backfill strategy is to restore to the original bathymetry and replace the surficial sediment with material of a similar type. Two backfill materials will be specified: a silty medium to fine sand fill (Type 1 Fill) will be placed to within 2 feet of the pre-construction grade; and coarse-grained sand with gravel (Type 2 Fill; similar in grain size to the existing sediment surface) will be placed in the top two feet to meet pre-construction grade. The fill material was selected both to match the existing sediment gradation as closely as possible and to be representative of locally-available materials. The fill will be clean material free of debris, lumps or rocks larger than 3 inches, and loam organic matter. It is anticipated that the fill materials will be similar to the gradation of material presented in Tables 1 and 2. A plan view and cross sections of the remediation area, including information on post-removal restoration, are included in Attachment 6.

Table 1: Type 1 Fill Material Gradation

Sieve Size	Percent Passing
3”	100
1”	80-100
#4	70-95
#40	55-80
#200	10-30

Table 2: Type 2 Fill Material Gradation

Sieve Size	Percent Passing
3”	100
1”	80-100
#4	65-90
#40	50-75
#200	0-20

References

ARCADIS (with Foth and GEI Consultants). 2010. Revised Comprehensive Sediment Investigation Report for Operable Unit 2, Hudson (Water Street) Site. Hudson, New York. May 20.

ARCADIS. 2014. Remedial Design Work Plan, Operable Unit 2, Hudson (Water Street) Site. Hudson, New York. April 14.

Attachments

Attachment 1: RDWP Text

Attachment 2: CSIR Text

Attachment 3: CSIR Appendix A Text

Attachment 4: CSIR Appendix A Table 4-5

Attachment 5: RDWP Table 3-6

Attachment 6: Draft Restoration Profiles

ATTACHMENT 1

RDWP TEXT

1.5.1 Submerged Aquatic Vegetation Survey

As part of the PDI, a SAV evaluation was conducted that consisted of a desktop review of existing SAV information, followed by a diver survey. The preliminary desktop review of existing information identified that the growing zone of SAV in the Hudson River is often constrained to narrow fringing beds along the sub-tidal slope, a sufficient distance from the shoreline to avoid ice scour (Nieder et al. 2004) yet shallow enough to maintain adequate light penetration (Koch 2001). Specifically, while various entities have verified SAV beds in other areas of the upper (tidal) Hudson River, SAV has not been observed in the ARC during previous sampling events (ARCADIS 2010).

A diver survey of the ARC was performed by ARCADIS on August 7, 2013. The results of the diver survey indicate that the substrate within and along the front of Embayments #1 and #2 is soft silt (a few feet to a few inches) over rock. With increasing distance from the shoreline, the substrate is entirely rock and gravel with most substrate covered in zebra mussels. In front of Embayments #1 and #2, a tongue of the soft silt extends out and covers the rock substrate. This is likely caused by the surge created by the wakes of large ships passing through the navigation channel adjacent to the Site causing finer grained sediments to move into/out of the embayments. During the diver survey, ARCADIS divers observed the surge into/out of the embayments, and could also feel the movement while underwater.

The desktop review of existing SAV mapping information indicated that SAV was present in areas of the Hudson River near the Site. The regional SAV mapping was used to identify what species were growing in what water depths in areas surrounding the Site. Along the eastern shoreline of the Hudson, *Trapa natans* (water chestnut) and *Myriophyllum spicatum* (Eurasian water milfoil) were observed growing in a cove downstream of the Holcim property. Both of these species are considered to be invasive and undesirable. Upon visual observation, the SAV bed in this area was irregular at best, and growth occurred in depths of water between 4 to 5 feet (at high tide). The shoreline upstream of the Site was predominantly steep and rocky, and supported the boat docking and marina operations. No SAV was previously mapped or observed during the reconnaissance in this area upstream of the Site. The only place water depths of 4 to 5 feet exist onsite are along the inner ends of Embayments #1 and #2 – where *T. natans* and *M. spicatum* were observed during the diver survey. Water depths in the ARC exceed these growing zones of 4 to 5 foot water depths (at high tide) by at least 3 to 4 times. As such, SAV would not be expected to grow within the boundaries of the ARC. This assumption was confirmed during the diver survey, as no SAV was observed in the ARC.

What appears to be a remnant bulkhead feature runs the length of the waterfront – immediately offshore of the peninsula between Embayments # 1 and #2 and continues along the shore-side of the Hudson River Cruise boat docks. Due to poor underwater visibility, it was difficult to determine the configuration of the structure, but there appeared to be two parallel timber-pile walls with 3 to 4 feet of void space between them. Various pieces of timber-piles and driftwood/logs were caught in the void space. The lack of visibility and entrapment hazards associated with that void space precluded any further investigation of the timber-pile wall. The feature appeared to be consistent over the entire length of the Site waterfront except in front of Embayment #1, and appeared to be in various states of degradation.

1.5.2 Environmental Borings

Environmental drilling activities were conducted by Atlantic Testing Laboratories (ATL) under the direct supervision of ARCADIS between August 28, 2013 and September 17, 2013. Drilling was conducted with a CME-850X drill rig situated on the deck of a 70-foot CL-105 Lift Boat provided by Northstar Environmental & Marine Services (Northstar). Four-inch inside diameter steel casing was advanced into the sediment at each location for water quality considerations and drilling rod stability. Two-inch and 3-inch split spoon samplers were used to conduct continuous sampling at each boring location. Soil was visually characterized and screened with a photoionization detector (PID). The geologic composition, recovery, PID screening results, and the presence of visible NAPL, coating, staining, sheens, and odors were documented per the NYSDEC Field Descriptions of Samples for Former MGP Sites. Each boring was backfilled to grade with a bentonite/cement grout.

Five borings (EB-1, EB-6, EB-11, EB-13, and EB-18) were advanced within the ARC in an effort to refine the horizontal extent of the ARC boundary. A sample from each of these borings was collected and submitted for analysis of PAHs in porewater by solid phase microextraction (SPME). Twelve borings (EB-2 to EB-5, EB-7 to EB-10, EB-10A, EB-10B, EB-12, and EB-19) were advanced to refine the depths of the proposed dredge polygons. Four borings (EB-14 to EB-17) were advanced in an area to the south of the ARC to either confirm or refute the presence of sheen-producing sediments. Samples of the surface water sheen generated during advancement of borings EB-14 to EB-17 were collected and submitted for analysis of forensic PAHs and forensic total petroleum hydrocarbons (TPH).

The results of the borings designed to refine the horizontal extent of the ARC boundary are presented in Table 5 below. The environmental boring logs are presented in Appendix A.

ATTACHMENT 2

CSIR TEXT

The survival and growth of *H. azteca* exposed to the 32 Site sediment samples were compared to the survival and growth of the nine pooled reference location samples using the non-parametric Wilcoxon Rank Sum Test with Bonferroni's adjustment (USEPA 2000). All statistical analyses were performed using MINITAB® Release 14 (Minitab, Inc.).

- Amphipod Survival - Significant ($p < 0.05$) reduction in *H. azteca* survival compared to the field reference sample was observed for amphipods exposed to the Site sediment samples HD131, HD138, HD142, HD143, HD146, HD147, and HD148. The geographic distribution of samples determined to result in a significant reduction in survival was localized adjacent to Embayment #1 and two sample locations downriver (HD131 and HD138). Five of the seven samples which indicated a significant reduction in survival contained NAPL, including HD-131, HD-143, HD-146, HD-147, and HD-148.

- Amphipod Growth - Significantly reduced growth ($p < 0.05$) of *H. azteca* compared to the field reference sediments was observed in amphipods exposed to Site sediment samples HD118 and HD139.

3.5.3 Benthic Macroinvertebrate Data

The 41 sediment samples evaluated for toxicity testing were also evaluated for benthic macroinvertebrates. Macroinvertebrates recovered from each sample were sorted, counted, and identified down to the lowest feasible taxonomic level (Genus). The complete laboratory report from Aquatec is provided in Appendix A.

Up to 679 total organisms (N) and 25 individual taxons (S) were identified in the sediment samples (Appendix A). To simplify the data reporting and subsequent interpretation, several common indices were calculated from these raw count data. The four main indices were: diversity; richness; Hilsenhoff Biotic Index (HBI); and dominance. In order to more easily compare diversity, richness, HBI, and dominance, it was necessary to reverse the scaling for dominance and HBI by subtracting their values from 10. This allowed all four factors to be examined side-by-side, with high values representing good sediment conditions, and low values representing poor conditions. A detailed description of how each index was calculated, including method references, is provided in Appendix A.

- The ranges for N in the reference and Site sediment samples were from 10 to 414 and 4 to 679 organisms, respectively. The ranges for S were from 5 to 20 and 1 to 25, respectively.

- The ranges for each of the indices were similar between the reference and Site sediment samples. Diversity ranged from 0.9 to 3.1 in the reference sediments and 0.0 to 3.8 in the Site sediments. Richness ranged from 1.3 to 4.3 in the reference sediments and 0.0 to 4.2 in the Site sediments. The 10-HBI ranged from 0.1 to 2.8 in the reference sediments and 0.5 to 3.6 in the Site sediments. Finally, 10-dominance ranged from 1.7 to 7.6 in the reference sediments and 0.0 to 8.4 in the Site sediments.

3.5.4 Data Interpretation

The three measurement endpoints were evaluated in a weight-of-evidence (WOE) assessment to characterize surface sediments at the Site: sediment chemistry, toxicity testing, and benthic macroinvertebrate survey. This WOE assessment was organized into four main components:

1. Correlation between sediment total (PAH_{16}) and pore water (PAH_{34}) measurements and the survival and growth of *H. azteca*

2. Correlation between sediment total and pore water PAH measurements and the benthic macroinvertebrate survey indices

3. Comparison of benthic macroinvertebrate survey indices between reference and Site sediment samples

4. SQT assessment combining the three measurement endpoints into a matrix.

3.5.4.1 Sediment Chemistry and Toxicity Testing

NYSDEC technical guidance sediment screening values of 4.0 mg/kg Effects Range Low (ERL) and 44.8 mg/kg total PPPAHs Effects Range Median (ERM) (NYSDEC 1999) did not provide sufficient discrimination between “toxic” and “non-toxic” sediments at the Site. For example, 33 of the 41 (81 percent) sediment samples analyzed from the Site exceeded the ERL value, despite the fact that only seven of the 33 sediment samples (21percent) were toxic to *H. azteca*. Twenty-four samples exceeded the ERM value, but only seven of the 62samples (29 percent) were toxic to *H. azteca* (Table 3-22).

The Lowest Observed Effect Level (LOEL) total PAH_{16} concentration associated with a significant reduction in amphipod survival was 112 mg/kg (HD142 at 18 percent survival). However, sediment samples with total PAH_{16} concentrations as high as 566 mg/kg (HD151) showed no significant reductions in *H. azteca* survival (Table 3-21). Therefore, a LOEL

ATTACHMENT 3

CSIR APPENDIX A TEXT

Table of Contents

The survival and growth of *H. azteca* exposed to the 32 site sediment samples was compared to the survival and growth of the nine pooled reference sediment samples using the nonparametric Wilcoxon Rank Sum test with Bonferroni's adjustment (U.S. EPA, 2000).

Amphipod Survival

Survival of *H. azteca* in the laboratory controls and all nine field reference sediments was 100%. Significant ($p < 0.05$) reduction in *H. azteca* survival compared to the field reference sample was observed for amphipods exposed to the sediment samples HD131, HD138, HD142, HD143, HD146, HD147, HD148 (Table 4-4).

The geographic distribution of samples determined to result in a significant reduction in survival was concentrated adjacent to Embayment #1, with two sample locations extending down-river (HD131 and HD138) [Figure 4-3].

Amphipod Growth

Growth of *H. azteca* for the nine field reference samples ranged from 0.303 ± 0.096 to 0.442 ± 0.061 mg dry wt./organism. Significantly reduced growth ($p < 0.05$) of *H. azteca* compared to the field reference sediments was observed in amphipods exposed to samples HD118 and HD139 (Table 4-4).

4.5 Benthic Macroinvertebrate Data

The 41 sediment samples were evaluated in the laboratory to determine their effects on the benthic macroinvertebrate community structure. Macroinvertebrates recovered from each sample were sorted, counted, and identified down to the lowest feasible taxonomic level (Genus) by Aquatec. The complete digital reporting of the laboratory results from Aquatec is provided in Appendix E.

Up to 679 total organisms (N) and 25 individual taxons (S) were identified in the sediment samples (Table 4-5). To simplify the data reporting and subsequent interpretation, several common indices were calculated from these raw count data. The four main indices included:

1. Diversity,
2. Richness,
3. Hilsenhoff Biotic Index (HBI), and
4. Dominance.

Detailed descriptions of how each index was calculated, including method references, are provided below.

Calculation of Indices

Shannon's diversity index (diversity) was computed according to Shannon (1948):

$$Diversity = -\sum_{i=1}^{s} p_i \log_2 p_i$$

where s is the number of taxons per sample and p_i is the proportion of total individuals in the *i*th species.

Margalef's species richness index (richness) was computed according to Margalef (1958):

$$Richness = \frac{s-1}{\ln(N)}$$

where s is the number of taxons and N the total number of individuals in a sample.

The HBI was adapted from Hilsenhoff (1987) to include tolerance values listed by NYSDEC (NYSDEC, 2002):

$$HBI = \frac{\Sigma TV_i N_i}{\Sigma N_i}$$

where TV_i is the pollution tolerance value of the *i*th species (1 = very intolerant and 10 = highly tolerant) and N_i is the abundance of the *i*th taxa. HBI was expressed as (10-HBI) for order of scales (i.e., a low 10-HBI correlates with degraded conditions).

Lastly, dominance was the percent contribution of the most numerous species (NYSDEC, 2002). Dominance was also expressed as (10-dominance) for order of scales (i.e., a low 10-dominance correlates with degraded conditions, which represent conditions that are dominated by only a limited number of species).

Benthic Index Summary

Table 4-5 lists the results of the benthic macroinvertebrate survey. The ranges for N in the reference and site sediment samples were from 10 to 414 and 4 to 679 organisms, respectively. The ranges for S were from 5 to 20 and 1 to 25, respectively.

The ranges for each of the indices were similar between the reference and site sediment samples as shown below:

- Diversity ranged from 0.9 to 3.1 in the reference sediments and 0.0 to 3.8 in the site sediments;
- Richness ranged from 1.3 to 4.3 in the reference sediments and 0.0 to 4.2 in the site sediments;
- The 10-HBI ranged from 0.1 to 2.8 in the reference sediments and 0.5 to 3.6 in the site sediments; and
- 10-dominance ranged from 1.7 to 7.6 in the reference sediments and 0.0 to 8.4 in the site sediments.

The benthic macroinvertebrate indices were variable across the site. For example, diversity varied by a factor of two within an individual reference area and, unlike the PAH chemistry and toxicity testing, showed no relationship with Embayment #1 (Figure 4-4). These indices are discussed along with all of the other measurement endpoints in Section 5 (Interpretation).

The growth of *H. azteca* showed no significant correlation with respect to the concentration of total PAH_{16}, total PAH_{34}, or SPME pore water PAH_{34} (Figure 5-2). The p-values for the Spearman's rho for total PAH_{16}, total PAH_{34}, and SPME pore water TU_{34} concentrations versus *H. azteca* growth were 0.437, 0.405, and 0.139, respectively. Therefore, none of the measurements of PAH concentration could explain a significant ($p < 0.05$) fraction of the variability in the growth of *H. azteca*.

Due to the lack of correlation between sediment PAH chemistry and the growth endpoint, this measurement endpoint was not considered further in the WOE assessment of sediments at the Site.

5.2 Sediment Chemistry and Benthic Indices

Comparisons of sediment total and pore water PAH measurements to benthic macroinvertebrate indices were also made using Spearman's rho. The benthic macroinvertebrate indices showed no significant correlation ($p > 0.322$ for all comparisons) with respect to the concentration of total PAH_{16}, total PAH_{34}, or SPME pore water TU_{34} (Figure 5-3).

The benthic macroinvertebrate survey data are potentially the most ecologically relevant of the three measurement endpoints, as these data represent a snapshot of the in-situ benthic community. Therefore, rather than exclude this measurement from further evaluation, the benthic macroinvertebrate indices for site sediment samples were compared against the nine reference sediment samples (Section 5.3).

5.3 Site and Reference Benthic Indices

Four benthic macroinvertebrate indices (diversity, richness, 10-HBI, and 10-dominance) were compared simultaneously between site and reference sediment samples. Prior to this comparison, the metrics were scaled on a 0 to 99-scale for inter-metric scale consistency per NOAA (2004):

$$\text{Scaled Value} = \frac{(\text{Initial Value} - \text{Minimum Value})}{(\text{Maximum Value} - \text{Minimum Value})} \times 99$$

This methodology for scaling introduces no mathematical aberrations (i.e., noise) into the data, and was therefore chosen for the multi-metric comparison as opposed to the NYSDEC Appendix V formulas for calculating biological assessment profile values for ponar samples (NYSDEC, 2002).

The range in the four benthic macroinvertebrate indices for the reference sediment samples, normalized on a 99-scale for comparison, was similar to the range observed in the site sediment samples. Two site sediment samples were consistently lower than the reference range for diversity, richness and 10-dominance, and were in the bottom 25^{th} percentile (i.e., less than 25) for these indices (HD143 and HD148). One reference sediment sample was consistently lower than the others (HD157). The 10-HBI metric did not provide discrimination between reference and site sediment samples, as the reference range was lower than the range for site sediment samples (Figure 5-4).

Based on this multi-metric comparison, the in-situ benthic macroinvertabrate community in the site sediment samples, with the exclusion of HD143 and HD148, is commensurate with (i.e., within the expected range) the three reference locations. Therefore, in the WOE assessment, only samples HD143 and HD148 are classified as "significant".

5.4 Sediment Quality Triad Assessment

The three measurements endpoints were combined into a matrix (table) for a WOE evaluation of impacts (Table 5-2). Sediment samples were denoted with an asterisk for the following metrics:

- If they exceeded 44.8 mg/kg total PAH_{16} PEC value (Section 4.1, MacDonald et al., 2000);
- If they exceeded 5.4 SPME pore water TU_{34}, the lower 95% confidence level (LCL_{95}) for the LD_{20} (Section 5.1);
- If they had significantly reduced *H. azteca* survival as compared to the field reference sediment samples (Section 4.4); and
- If they were consistently lower than the reference range for the benthic macroinvertabrate multi-metric comparison between site and reference sediment samples (Section 5.3).

Only two of the site sediment samples failed all four criteria, HD143 and HD148. Of the 12 site sediment samples exceeding 5.4 SPME pore water TU_{34}, seven of these samples had significantly reduced *H. azteca* survival as compared to the field reference sediment samples.

The relatively high fraction of SOC/TOC in the sediment samples (up to 90% in some site sediment samples, Table 4-1) provides an explanation for why the ER-L/ER-M screening values for total PAH_{16} concentrations do not predict biological effects. The PAHs are much more strongly bound to sediment organic carbon than is assumed by the standard equilibrium partitioning assumptions. PAHs sorb to anthropogenic sources of "hard" organic carbon (e.g. charcoal, soot, coal or coke fines, or coal tar pitch) more strongly than to natural sources of "soft" organic carbon (e.g., natural organic matter). As a consequence, the total PAH_{16} concentration is not bioavailable. By contrast, the direct measurement of sediment pore water (SPME pore water TU_{34}) only measures the concentration of PAHs that partition from the solid phase (i.e., sediment) to the dissolved phase (i.e., pore water). It is this bioavailable fraction which drives exposure, and is therefore a better predictor of biological effects (e.g., *H. azteca* survival).

The reduction in *H. azteca* survival in the seven site sediments can positively be attributed to PAHs in sediment. Logistic regression shows a high degree of certainty between these two measurement

6. Conclusions

This characterization of toxicity and bioavailability of PAHs in aquatic sediments from Hudson indicates that the PAHs present in sediment samples are not as toxic to benthic aquatic organisms as is currently assumed by the NYSDEC regulatory guidance for screening contaminated sediments. Sediment samples with total PAH_{16} concentrations as high as 566 mg/kg showed no significant reductions in *H. azteca* survival.

The concentrations of pore water PAHs measured using SPME were a better predictor of *H. azteca* survival than total PAH_{16} concentrations. The site-specific threshold value for Hudson appears to be closer to 5 SPME pore water TU_{34} instead of the 20 SPME pore water TU_{34} value determined from the previous work conducted in 2003, 2005, and 2006.

The locations where toxicity to *H. azteca* is due to bioavailable PAHs are primarily adjacent to Embayment #1.

Evaluation of the benthic macroinvertebrate data showed that there were no significant correlations between higher concentrations of PAHs measured by total PAH_{16} or SPME pore water TU_{34} and lower diversity, richness, dominance, or HBI of the sediments analyzed.

The WOE assessment of sediment chemistry, toxicity testing, and benthic macroinvertebrate survey shows that only the seven site sediments with both SPME pore water TU_{34} concentrations greater than 5.4 TU and significant reduction in *H. azteca* survival pose a potential risk to benthic invertebrates at the Site. The locations of these seven sediment samples are primarily adjacent to Embayment #1.

ATTACHMENT 4

CSIR APPENDIX A TABLE 4-5

Table 4-5
Benthic Macroinvertebrate Survey Indices

SID	Type	Total N[1]	Total S[2]	Shannon Diversity[3]	Margalef Richness[4]	Dominance[5]	10-Dominance	Hilsenhoff Biotic Index[6]	10-HBI
HD113	TEST	37	11	3.0	2.8	2.7	7.3	7.1	2.9
HD118	TEST	97	19	3.8	3.9	1.6	8.4	7.5	2.5
HD119	TEST	45	13	2.9	3.2	4.4	5.6	6.4	3.6
HD120	TEST	124	18	3.2	3.5	3.2	6.8	7.0	3.0
HD122	TEST	182	22	3.4	4.0	2.3	7.7	7.2	2.8
HD123	TEST	54	13	3.0	3.0	3.3	6.7	7.4	2.6
HD124	TEST	171	13	2.7	2.3	3.1	6.9	7.6	2.4
HD127	TEST	39	9	2.0	2.2	6.2	3.8	9.5	0.5
HD128	TEST	47	8	2.4	1.8	3.2	6.8	8.2	1.8
HD129	TEST	186	16	3.3	2.9	2.3	7.7	8.2	1.8
HD130	TEST	109	16	3.1	3.2	3.2	6.8	7.4	2.6
HD131	TEST	40	12	2.9	3.0	4.0	6.0	7.3	2.7
HD132	TEST	157	16	3.1	3.0	3.3	6.7	7.4	2.6
HD133	TEST	192	12	2.9	2.1	2.7	7.3	8.4	1.6
HD134	TEST	128	12	2.5	2.3	4.1	5.9	7.2	2.8
HD137	TEST	18	8	2.8	2.4	2.8	7.2	7.4	2.6
HD138	TEST	32	8	2.0	2.0	5.9	4.1	9.2	0.8
HD139	TEST	130	13	3.1	2.5	2.4	7.6	8.0	2.0
HD140	TEST	222	16	3.1	2.8	3.4	6.6	8.5	1.5
HD141	TEST	137	20	3.1	3.9	2.7	7.3	8.1	1.9
HD142	TEST	161	22	3.1	4.1	3.2	6.8	7.7	2.3
HD143	TEST	10	2	0.5	0.4	9.0	1.0	8.0	2.0
HD144	TEST	679	25	2.0	3.7	6.4	3.6	6.7	3.3
HD145	TEST	85	13	3.1	2.7	2.2	7.8	7.5	2.5
HD146	TEST	8	5	2.2	1.9	3.8	6.3	7.2	2.8
HD147	TEST	200	23	2.8	4.2	4.2	5.8	7.5	2.5
HD148	TEST	4	1	0.0	0.0	10.0	0.0	8.0	2.0
HD149	TEST	105	15	3.2	3.0	2.8	7.2	8.4	1.6
HD150	TEST	27	11	3.0	3.0	3.0	7.0	8.4	1.6
HD151	TEST	239	16	2.2	2.7	5.7	4.3	6.9	3.1
HD152	TEST	325	14	1.9	2.2	6.7	3.3	6.7	3.3
HD153	TEST	169	18	3.1	3.3	3.4	6.6	7.3	2.7
HD154	REFERENCE	206	18	3.1	3.2	2.4	7.6	7.9	2.1
HD155	REFERENCE	339	20	2.7	3.3	3.7	6.3	7.6	2.4
HD156	REFERENCE	40	7	2.0	1.6	5.5	4.5	7.4	2.6
HD157	REFERENCE	18	5	0.9	1.4	8.3	1.7	9.9	0.1
HD158	REFERENCE	11	5	2.1	1.7	3.6	6.4	8.2	1.8
HD159	REFERENCE	10	8	2.8	3.0	3.0	7.0	8.7	1.3
HD160	REFERENCE	192	8	2.1	1.3	4.6	5.4	7.4	2.6
HD161	REFERENCE	90	9	2.5	1.8	4.3	5.7	8.0	2.0
HD162	REFERENCE	414	16	2.1	2.5	4.6	5.4	7.2	2.8

[1]Total N is the total number of organisms identified in a sample.

[2]Total S is the total number of taxons identified in a sample.

[3]Shannon's diversity index (Diversity) was computed according to Shannon (1948).

[4]Margalef's species richness index (Richness) was computed according to Margalef (1958).

[5]Dominance was the percent contribution of the most numerous taxon (NYSDEC, 2002).

[6]Hilsenhoff Biotic Index (HBI) was computed according to Hilsenhoff (1987) with species tolerance values take from NYSDEC (2002).

ATTACHMENT 5

RDWP TABLE 3-6

Table 3-6. Summary of Sediment Grain-Size Data
Revised Comprehensive Sediment Investigation Report for OU2
Hudson (Water Street) Site - Hudson, New York - National Grid

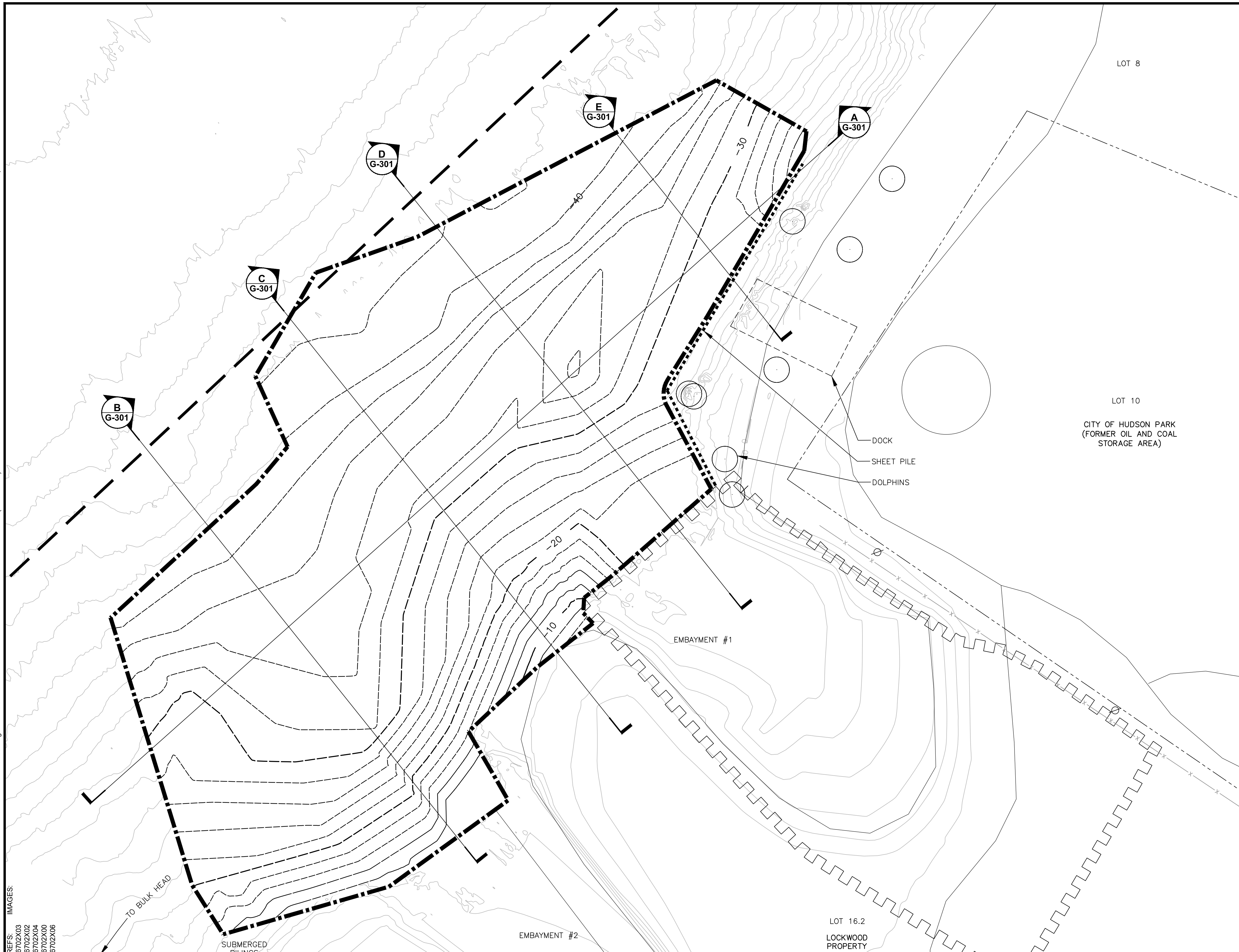
Sample Location	Depth	Sieve Size (Percent Passing)														
	(ft)	3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	#4	#10	#30	#40	#60	#100	#200
Phase I																
SD-10A and SD-04D	CS	100	100	100	100	100	100	100	99.1	99.0	98.2	92.4	85.8	66.4	21.8	10.2
SD-19B and SD-09B	2-4	100	100	100	100	100	100	100	98.2	96.2	91.9	83.1	80.4	59.6	46.5	21.3
SD-02B and SD-09A	CS	100	100	100	100	100	98.8	97.5	93.6	90.1	78.9	63.8	60.1	51.5	38.0	26.4
SD-17A, SD-03A, SD-01A, SD-13A, and SD-15A	0-2	100	100	100	100	100	92.0	78.9	63.3	55.8	42.8	32.8	29.9	19.4	7.8	3.5
Phase II																
SD-04	0-0.5	100	100	100	100	95.4	85.5	77.9	67.3	63.5	56.6	49.2	46.6	33.4	12.3	4.5
SD-05	0.5-2	100	100	100	95.9	85.9	66.0	50.4	30.7	23.1	14.5	9.9	9.0	7.5	5.8	4.0
SD-11	0-0.5	100	100	100	97.3	96.8	93.0	89.4	85.1	82.8	79.0	74.9	73.7	67.3	14.2	4.7
SD-15	0-0.5	100	100	100	95.6	92.2	85.5	81.1	72.6	69.3	61.9	49.1	43.0	25.7	8.7	2.6
SD-16	0-0.5	100	100	100	96.1	91.8	84.2	80.3	74.7	70.8	61.4	48.3	44.7	36.9	28.4	19.9
SD-22	4-6	100	100	100	97.8	97.7	97.6	97.1	96.1	95.7	94.7	91.9	90.2	85.9	58.6	38.1
SD-25	4-6	100	100	100	100	92.0	90.5	90.0	89.1	88.9	87.7	84.8	83.6	80.2	61.3	44.4
SD-29	0.5-2	100	100	100	97.7	97.7	96.9	95.8	95.1	94.4	93.1	90.2	88.1	79.2	26.7	9.6
SD-30	0-0.5	100	100	100	100	100	98.8	98.5	97.1	96.0	94.3	93.0	92.7	92.1	91.1	88.0
SD-30	6-8	100	100	100	100	100	98.4	98.3	97.5	97.2	96.7	95.6	95.2	94.4	93.4	89.2
2002 Site Investigation																
SD-05	0.5-2	100	100	100	100	97.6	94.8	93.7	91.8	90.7	86.8	81.0	79.1	75.1	62.5	37.7
SD-09	0-0.5	100	100	100	98.2	96.3	90.4	84.3	73.4	67.4	55.9	41.6	37.1	26.0	12.4	6.3
SD-12	0-0.5	100	100	100	100	98.6	96	92.8	90.6	89.6	86.3	80.6	77.9	68.2	30.8	13.5
SD-12	0.5-2	100	100	100	100	100	99.9	99.6	99.5	99.5	98.9	97.3	96.5	91.8	55.3	32.5
SD-13	0-0.5	100	83.5	77.1	70.9	69.1	67.8	67.5	66.0	64.2	59.6	49.5	45.9	36.9	13.5	5.3
SD-13	0.5-2	100	100	86.8	81.2	65.8	56.5	49.2	43.7	39.7	32.1	21.9	19.3	14.2	9.2	4.4
SD-13	2-4	100	70.3	70.3	70.3	70.3	70.3	70.0	69.1	68.6	67.0	63.8	61.7	55.3	20.0	8.8
SD-16	0-0.5	100	100	100	89.9	88.9	86.2	83.5	78.6	75.3	67.4	56.4	52.0	26.7	7.3	3.0
SD-22	0-0.5	100	100	91.6	91.6	90.7	89.1	86.5	83.9	82.6	79.3	75.1	73.6	70.0	47.4	20.1
SD-22	0.5-2	100	77.9	77.9	77.9	77.1	75.4	74.2	72.5	71.4	69.5	66.2	64.7	61.0	43.9	30.3
SD-22	2-4	100	100	100	100	100	100	99.6	97.2	95.7	92.5	88.7	87.3	84.0	69.7	47.6
SD-23	0-0.5	100	100	95.7	92.0	88.2	81.0	76.4	71.5	69.8	65.2	58.8	55.9	43.1	17.0	7.2
SD-34	0-0.5	100	100	100	97.9	97.9	96.7	95.0	92.6	91.4	90.0	87.9	86.8	76.3	18.7	3.0
SD-36	0-0.5	100	81.6	81.6	78.7	75.1	68.7	65.4	60.5	58.0	51.5	44.5	42.3	34.1	15.0	7.2
SD-45	0-0.5	100	100	100	100	99.5	99.3	98.4	96.7	95.7	93.2	88.4	84.9	71.8	33.7	17.5
SD-66	0-0.5	100	100	100	100	98.7	94.1	88.0	78.6	73.4	65.0	59.5	58.3	51.8	23.9	8.9
SD-69	0-0.5	100	100	100	100	99.3	97.3	95.0	91.8	89.8	85.0	78.9	75.9	66.9	22.4	8.6
SD-73	0-0.5	100	100	100	100	97.2	96.9	95.7	94.1	93.1	88.8	80.4	75.8	62.4	17.0	6.2
SD-73	2-4	100	100	100	100	100	100	99.2	99.1	98.8	91.8	38.7	35.5	31.9	19.4	10.6
SD-73	4-6	100	100	100	100	100	100	100	100	100	100	99.8	99.8	99.8	99.8	99.7
SD-79	0-0.5	100	100	100	100	100	98.6	98.6	97.9	97.6	96.2	94.0	92.9	86.0	34.4	19.2
SD-80	0-0.5	100	100	100	100	97.5	90.2	85.4	80.3	77.9	73.0	68.3	66.9	64.4	60.3	47.4

Notes:

1. CS = Indicates a composite sample:
   - A = Samples labeled with an "A" are from the 0- to 2-foot depth interval.
   - B = Samples labeled with a "B" are from the 2- to 4-foot depth interval.
   - D = Samples labeled with a "D" are from the 6- to 8-foot depth interval.

ATTACHMENT 6

DRAFT RESTORATION PROFILES



LEGEND:

- APPROXIMATE PROPERTY LINE
- CHAIN–LINK FENCE
- EXISTING BATHYMETRIC CONTOUR (2–FOOT INTERVAL)
- AS–BUILT SHEETPILE
- DREDGE AREA LIMIT
- APPROXIMATE BOUNDARY OF THE SHIPPING CHANNEL
- PROPOSED REMOVAL CONTOUR (MAJOR)
- PROPOSED REMOVAL CONTOUR (MINOR)
- EXISTING PERMANENT DOCK
- EXISTING DOLPHIN
- APPROXIMATE TEMPORARY SHEET PILE WALL

NOTES:

1. BASE MAP INFORMATION FROM C.T. MALE ASSOCIATES, P.C. WASBUILT.DWG DATED NOVEMBER 15, 2005, AT A SCALE OF 1 INCH = 20 FEET
2. BASE MAPS ARE IN COORDINATE SYSTEM NEW YORK, EAST ZONE, NAD 1983, FEET

CITY: SYRACUSE, NY DIV/GROUP: IMDV/CAD DB/LD: L.POSENAUER, K.SARTORI PM/TM: C.GUEST LYR:ON=*;OFF=*REF*
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XREFS: 36702X03 36702X02 36702X04 36702X00 36702X06 IMAGES:

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1"=20'

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Professional Engineer's No.: (PE NUM)		
State: NY	Date Signed	Project Mgr.: (MGR)
Designed by: (DSN)	Drawn by: KLS	Checked by: (CHK)

DRAFT

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DRAFT REMEDIAL DESIGN REPORT FOR OPERABLE UNIT 2

SEDIMENT REMOVAL PLAN

ARCADIS Project No.
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Date
JUNE 2016

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P.O. BOX 66
SYRACUSE, NY 13214
TEL: 315.466.9120

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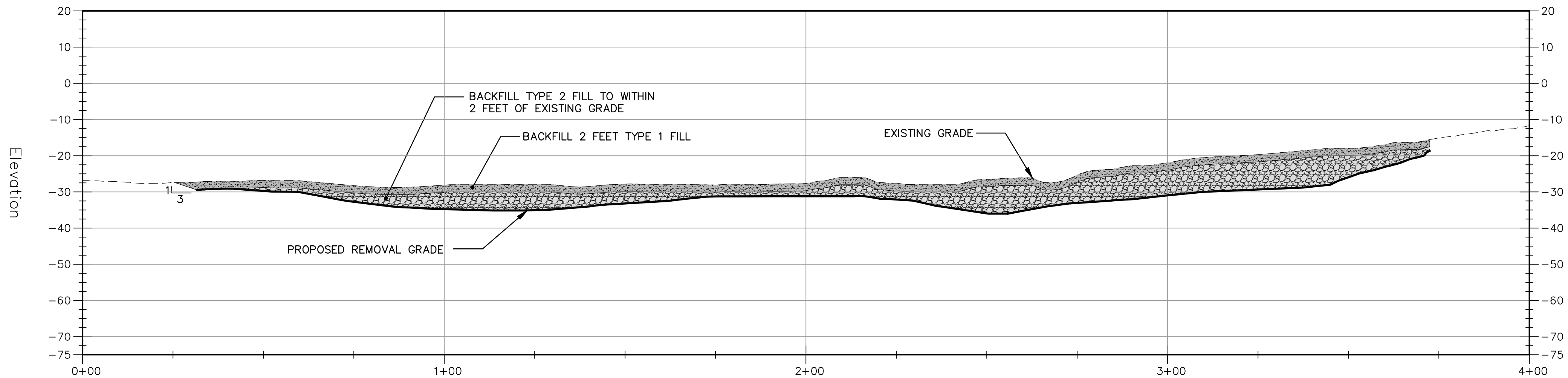

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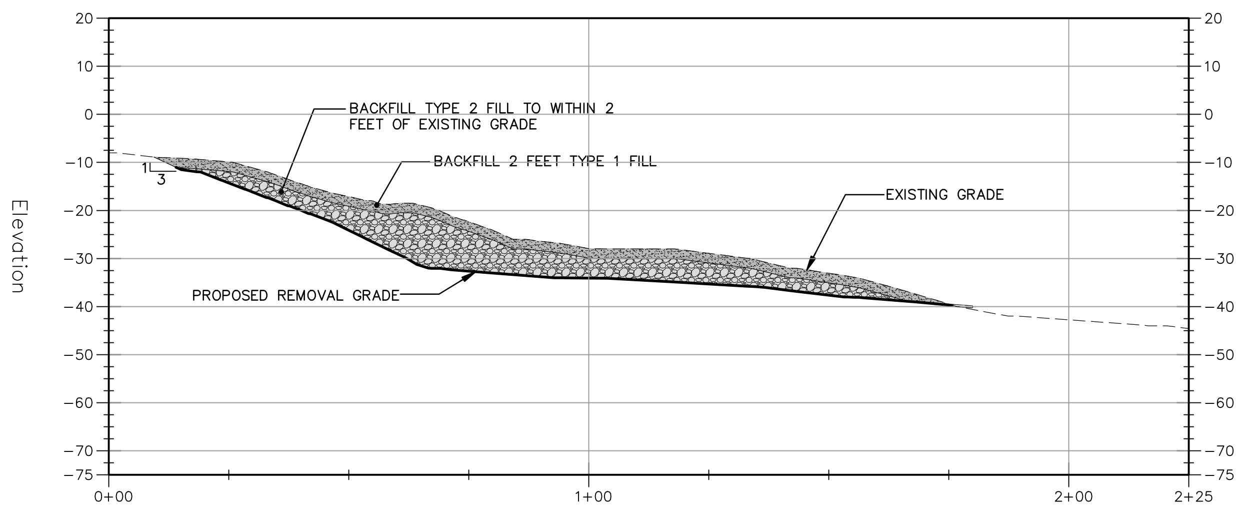

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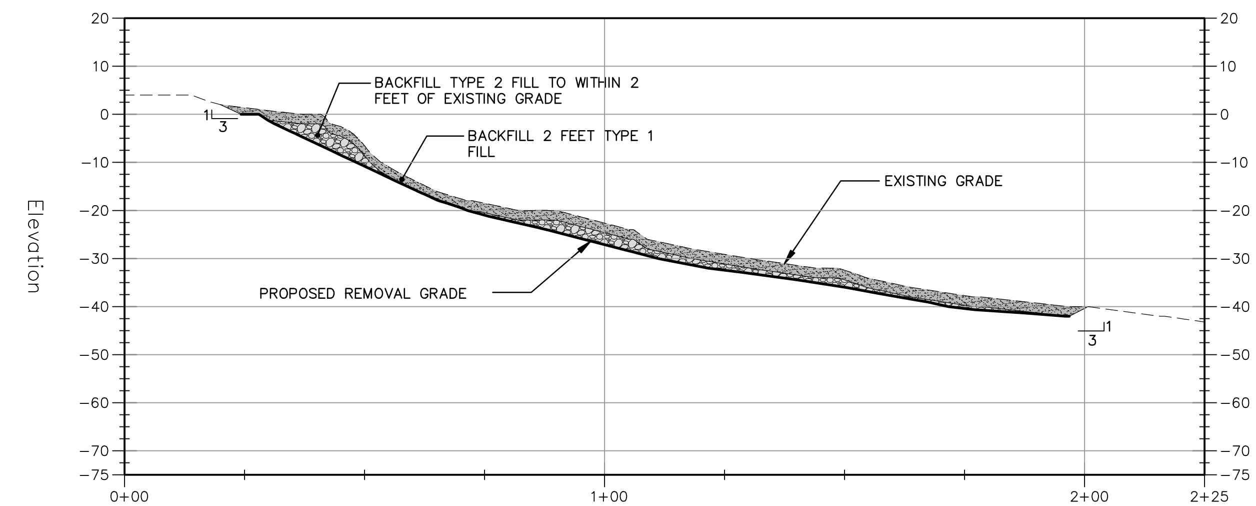

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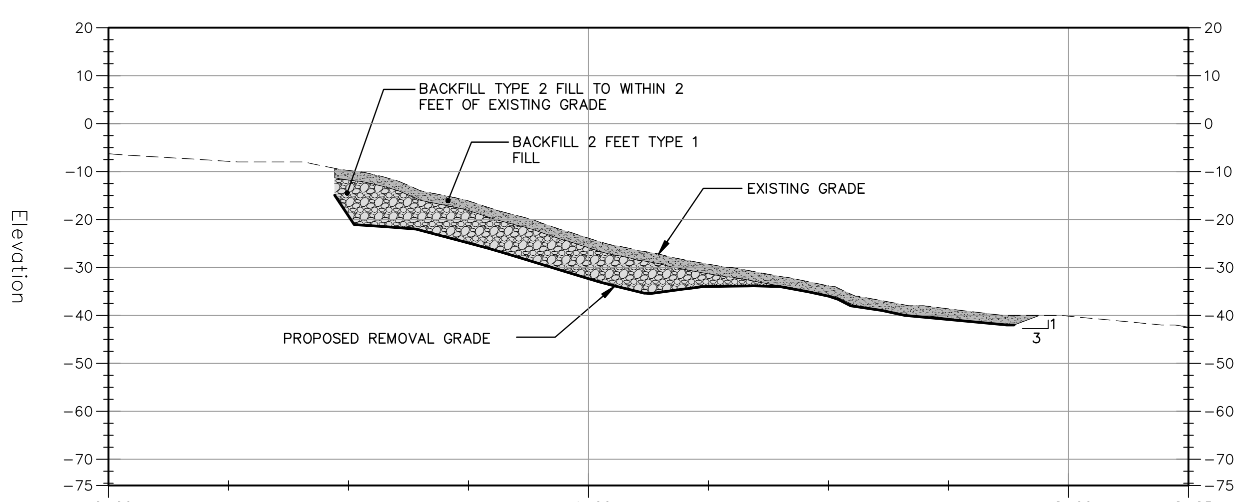

PROFILE D

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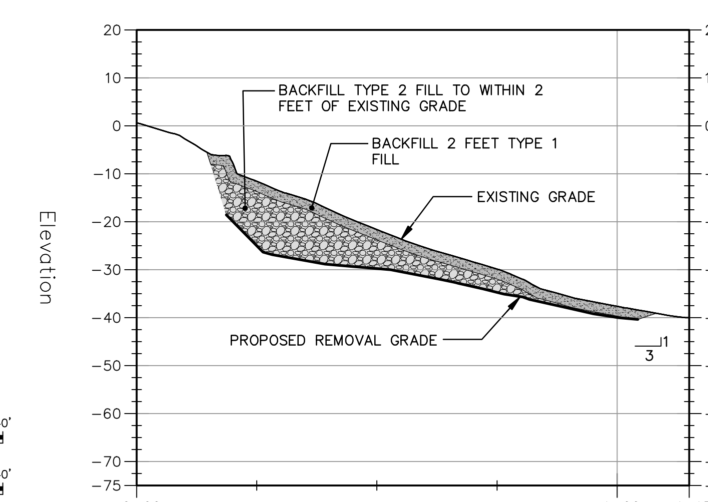
HORIZONTAL SCALE: 1"=20'
0 20' 40'
VERTICAL SCALE: 1"=20'



PROFILE E

CITY: SYRACUSE, NY DIV/GROUP: IMDV/CAD DB/LD: L.POSENAUER, K.SARTORI PM/TM: C.GUEST LYR:ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\ACT\B0036702\0002\00005\DWG\CONTRACT\OU-2\36702G301.dwg LAYOUT: G-301 SAVED: 6/9/2016 11:40 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 6/9/2016 11:46 AM BY: SARTORI, KATHERINE
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MARK GRAVELING		
Professional Engineer's No. (PE NUM)		
State: NY	Date Signed	Project Mgr. (MGR)
Designed by (DSN)	Drawn by KLS	Checked by (CHK)

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