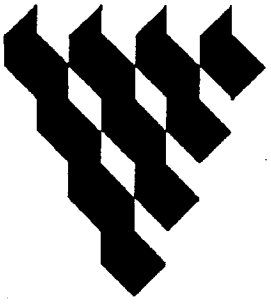

Quarterly Interim Progress Report
July - September 1998

Full-Scale Operations
Bioremediation Of Explosives-Contaminated Soil
NSWC Crane
Crane, Indiana

Unit Identification Code: N00164
Contract No. N62467-93-D-1106

December 1998

Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina
29419-9010

EXECUTIVE SUMMARY

This interim progress report has been prepared by Morrison Knudsen Corporation (MK) for Southern Division, Naval Facilities Engineering Command. This is the second quarterly report that has been prepared to document the progress of the full-scale bioremediation operation of explosives-contaminated soil at Naval Surface Warfare Center (NSWC) Crane, Crane, Indiana. It summarizes the work actions performed during July through September 1998 pursuant to the requirements of the approved *Full-Scale Operational Plan* and the *Quality Assurance Project Plan*. Full-scale bioremediation operations started in April 1998.

The scope of work includes initial site characterization by sampling and analysis; excavation and screening of explosives-contaminated soil; transportation of screened soil for treatment at the Biofacility; process monitoring and confirmatory sampling; and disposal of treated soil.

All initial characterization sampling at Mine Fill "A" (MFA) is now complete. Initial characterization sampling at Mine Fill "B" (MFB), in support of a construction project by others, indicated the presence of TNT. Results of initial characterization sampling at Ammunition Burning Ground (ABG), in support of another construction project by others, did not require any immediate excavation activity. In process and post excavation sampling for several grids in MFA has been completed, indicating that industrial clean-up goals have been achieved.

A total of 4,068 cubic yards of screened soil was transported to the Biofacility during this reporting period. This quantity represents a large increase in productivity compared to earlier periods. The increased quantity reflects improved weather conditions, much higher throughput with a new screener, and improved worker techniques and procedures. The project team is well on its way towards building a screened soil stockpile sufficient to continue uninterrupted compost operations through the winter months.

Amendment supplies have been secured to continue compost operations through next spring. Straw is on hand and available, while the chicken manure supplier is under contract and manure is trucked to the project on an as needed basis.

A total of sixteen windrows were constructed during this reporting period. Sixteen windrows reached Day Last during this period. Two other windrows are progressing towards their Day Last. One additional windrow is being constructed. A total of 3,097 cubic yards of contaminated soil was reduced to residential clean up levels for explosive compounds contamination during the reporting period. The project is now two and a half months ahead of schedule.

A total of 7,084 cubic yards (sixteen windrows) of completed compost was returned to MFA and staged for future use. There was no backfill or site restoration activity this period. Backfill activities are on hold pending Navy resolution of compost toxicity issues with U.S. Environmental Protection Agency, Region 5.

The following improvements to the operations were implemented during this quarter: purchased a new soil screening unit (Powerscreen) and started using a new dump truck at the excavation site. These improvements have contributed to increased soil screening production.

All interim measures work actions have been performed in accordance with the approved plans.

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ACRONYMS

ABG	Ammunition Burning Ground
CAAA	Crane Army Ammunition Activity
cfu/m^3	colony forming units per cubic meter
EPD	Environmental Protection Division
FCR	Field Change Request
HMX	cycloteremethylenetetranitramine
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quatitation
MFA	Mine Fill "A"
MFB	Mine Fill "B"
MK	Morrison Knudsen Corporation
MS	matrix spike
MSD	matrix spike duplicate
NSWC	Naval Surface Warfare Center
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
PID	photoionization detector
ppm	parts per million
QAPP	Quality Assurance Project Plan
QC	quality control
RDX	cyclotrimethylene trinitramine
SWMU	solid waste management unit
TLV	Threshold Limit Value
TNT	2,4,6-trinitrotoluene
U.S. EPA	United States Environmental Protection Agency

This interim progress report has been prepared by Morrison Knudsen Corporation (MK) for Southern Division, Naval Facilities Engineering Command. This is the second quarterly report that has been prepared to document the progress of the full-scale bioremediation operation of explosives-contaminated soil at Naval Surface Warfare Center (NSWC) Crane, Crane, Indiana. It summarizes the work actions performed during July through September 1998 pursuant to the requirements of the approved *Full-Scale Operational Plan* [MK, 1998a] and the *Quality Assurance Project Plan* [MK, 1998b]. Full-scale bioremediation operations started in April 1998.

NSWC Crane, located in southwestern Indiana, provides support for equipment shipboard weapons systems, and ordnance. This site also supports Crane Army Ammunition Activity (CAAA), which includes production and renovation, storage, shipment, and demilitarization and disposal of conventional ammunition. Explosive-compounds contaminated soils resulting from the above operations have been identified at four solid waste management units (SWMUs): Ammunition Burning Ground (ABG) (SWMU-03/10); Rockeye Munitions Facility (SWMU-10/15); Mine Fill "A" (MFA) – (SWMU-12/14); and Mine Fill "B" (MFB) – (SWMU-13/14).

On-site bioremediation of the explosive-compounds contaminated soil utilizing a windrow composting process has been selected as the preferred treatment alternative for the Interim Measures (IM) at these four SWMUs.

The scope of work includes initial site characterization by sampling and analysis; excavation and screening of explosives-contaminated soil; transportation of screened soil for treatment at the Biofacility; process monitoring and confirmatory sampling; and disposal of treated soil.

1.0 EXCAVATION

During this reporting period field work activities were conducted at MFA, MFB, and ABG. Work activities at the excavation sites include, sampling (i.e., pre-excavation, in-process, and post-excavation), and soil excavation and screening. Specifics for each SWMU site are discussed below.

All field work activities were performed in accordance with procedures included in the *Full-Scale Operational Plan* [MK, 1998a] and the *Quality Assurance Project Plan (QAPP)* [MK, 1998b].

Drawings showing the sampling and excavation grids of various locations are provided in Appendix A. Representative photographs of the excavation activities are provided in Appendix B.

1.1 Pre-Excavation Sampling

Pre-excavation sampling is performed to provide initial site characterization to delineate excavation efforts and to establish that clean-up goals have been achieved if no

excavation is required. Pre-excavation samples are analyzed for SWMU-specific compounds by an off-site analytical laboratory.

A minimum of three soil samples were obtained from each grid for characterization of the soil prior to excavation. Explosive compounds and metals analysis were completed on composite samples obtained from zero to 12-inches in depth and 24 to 36-inches in depth. Volatile analysis was completed on grab samples obtained at 12-inches. Additional samples were obtained for volatile analysis based on photoionization detector (PID) screening.

1.1.1 Mine Fill "A"

Pre-excavation sampling is complete at MFA. Additional sampling required at Building No.160 is complete with no explosive compounds detected.

The horizontal boundaries of explosive constituents have been delineated by buildings, roads, railroad tracks, and grids with either no detectable levels of the respective constituent or levels that are below the clean-up action. To date, no metals or volatile compounds have been detected above clean-up action levels in any sample.

1.1.2 Mine Fill "B"

Pre-excavation sampling continued at Building No.165 in anticipation of the CAAA's installation of a C-4 extruder. No explosive compounds were detected since the last reporting period in any grid except 2,4,6-trinitrotoluene (TNT) at 2.5 parts per million (ppm) in Grid No.94.

Pre-excavation sampling was completed in three grids at Building No.168. Explosive compounds cycloteremethylenetetranitramine (HMX), cyclotrimethylene trinitramine (RDX), and TNT were detected as follows: HMX ranged from non-detect to 12.7 ppm; RDX ranged from 44 ppm to 10,400 ppm; and TNT ranged from 14 ppm to 16,600 ppm.

Further pre-excavation sampling will be performed at MFB prior to excavation activities.

1.1.3 Ammunition Burning Ground

Pre-excavation sampling was completed in the area of the proposed storage building location at ABG. No explosive compounds were detected in any of the 14 grids sampled except HMX at 3.4 ppm in Grid No.12. Arsenic was detected in all grids as high as 8.6 ppm above the 2.4 ppm industrial clean-up goal. The NSWC Crane Environmental Protection Department (EPD) directed that MK take no immediate remedial action in this area.

1.2 In-Process Excavation Soil Sampling

In-process excavation soil sampling is performed to assist field crew in planning excavation activities. Field screening test kits are used for testing TNT and RDX levels in the in-process soil samples to provide quick results.

1.2.1 Mine Fill "A"

In-process excavation soil sampling and field screening for explosive compounds has been accomplished on Grid Nos. 5-8, 16-18, 20, 22, 137-140, 163-167, and 176 at Building Nos.153/154. Field screening indicated that TNT and RDX contamination were still present in the soil after the first layer of contaminated soil was excavated in Grid Nos. 5-8, 16-18, and 137-139. Subsequent excavation and screening indicate that contamination levels are below industrial clean-up goals.

1.3 Post-Excavation Soil Sampling

Post-excavation soil sampling (i.e., confirmation samples) is performed to provide confirmation that the excavation meets the established industrial clean-up goals. Confirmation samples are analyzed for SWMU-specific compounds by an off-site analytical laboratory.

1.3.1 Mine Fill "A"

Post-excavation soil characterization subsequent to contaminated soil removal has been accomplished on Grid Nos. 20, 22, 136, 140, 163-167, and 176 at Building Nos.153/154, and Grid Nos. 41, 42, and 144-148 at Building Nos.158/159. No explosive compound was detected above industrial clean-up goals in any grid (data has not yet been reported for Grid No.166 and No.167).

1.3.2 Mine Fill "B"

No post-excavation soil characterization has been initiated at MFB.

1.4 Soil Excavation and Screening

Soil excavation continued at MFA around buildings Nos.153/154 and Nos.158/159. Approximately 50 cubic yards of soil was excavated at MFB to remove soil in advance of construction activity by others. Total of 4,068 cubic yards of soil have been excavated and screened during this reporting period. To date, 6,571 cubic yards of soil have been excavated and screened versus 7,000 cubic yards planned. However, since the arrival of the new Powerscreen screener, production over the last two months has been 3,197 cubic yards versus 2,000 cubic yards planned. It now seems possible that, by the middle of December, a substantial stockpile of screened soil will be available to continue uninterrupted compost operations throughout the winter. Weather conditions have been favorable during this reporting period. The excavation crew has improved

productivity as their experience has increased. The new screener and the new excavation site dump truck have contributed to improvements in productivity.

The planned and actual screened soil quantities are shown in Figure 1. Table 1 entitled "Full-Scale Operations Soil Excavations and Screening at MFA" included in Appendix C provides the production data.

2.0 COMPOSTING OPERATIONS

Treatment of explosive-compounds contaminated soil by composting involves microbial degradation of explosive-compounds by optimizing the availability of organic material, temperature, moisture content, pH, and oxygen. Composting operation process description is provided in Section 5.0 of the approved *Full-Scale Operational Plan* [MK, 1998a].

This section provides details of procurement and delivery of amendments, quantity of amendments used in the treatment operations, construction and treatment of windrows, and analytical data interpretation. Representative photographs of the composting activities are provided in Appendix B.

2.1 Amendments

The compost mix used in the full-scale operations consists of 25% soil, 15% chicken manure, and 60% straw by volume.

Straw deliveries were made to the project satisfying all but 600 tons of the bulk straw orders. The remaining deliveries are scheduled to begin in December. A large stockpile of straw is available to satisfy composting needs into next spring.

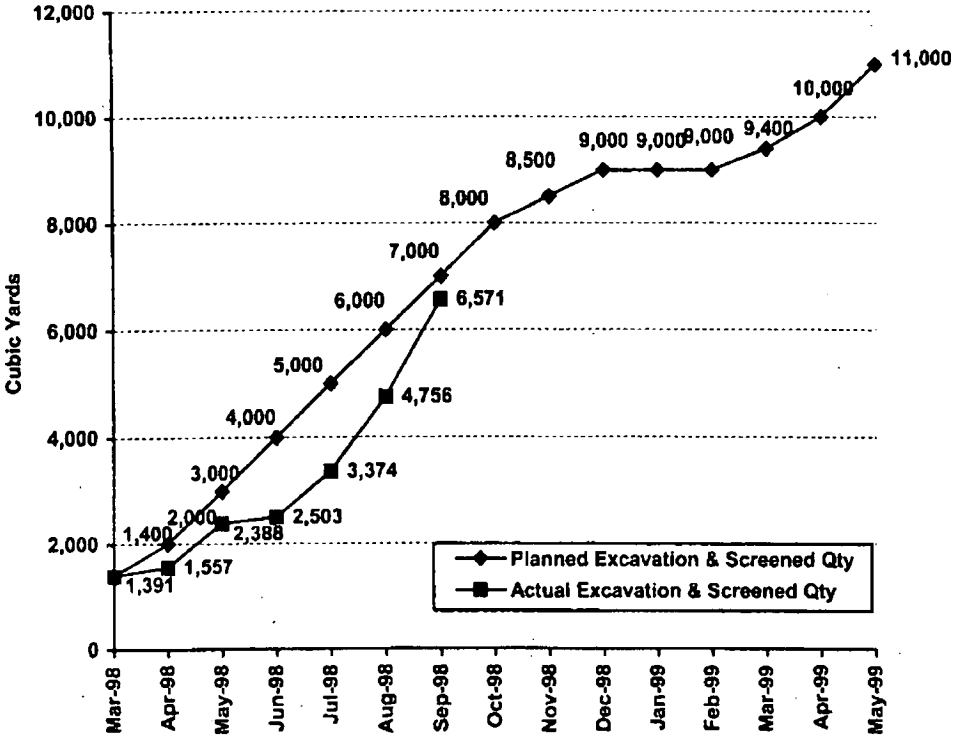
Chicken manure continues to be trucked to the Biofacility on an as needed basis. Contract quantities of chicken manure are sufficient to support operations through next spring.

2.2 Quantity of Amendments Used

The following table summarizes the amendments used during this reporting period.

Amendment Type		This Period (Tons)	Cumulative (Tons)
Chicken Manure	Received	1,602	2,636
	Used	1,598	2,579
Straw	Received	2,3400	1,976
	Used	890	1,374

FIGURE 1
NSWC CRANE MFA - SOIL EXCAVATION AND SCREENING VOLUMES
(cumulative values)



2.3 Windrow Construction and Treatment

Field screening has been performed at least weekly to monitor the RDX and TNT levels. Final compost samples have been collected once the field test kits indicated RDX and TNT readings are below detectable levels. The day that the final compost samples are collected for off-site laboratory confirmation analysis is referred to as Day Last.

Sixteen windrows have achieved Day Last status during the second quarter of full-scale operations. Twenty-one windrows have achieved Day Last status since the beginning of full-scale operations. Two additional windrows have been constructed and are processing toward their Day Last. One windrow is under construction, with amendment placement underway. Laboratory results have been received for windrows one through twenty. Day Last laboratory data is handled on a priority basis by MK and the off-site laboratory. The time between Day Last sample collection and receipt of the data varies from windrow to windrow. Lately, the time has ranged from seven to 14 days with an average time of 11 days. Residential clean-up levels for explosive compounds were achieved for these windrows. Analytical data regarding windrows that achieved Day Last during this period are discussed in Section 2.4.

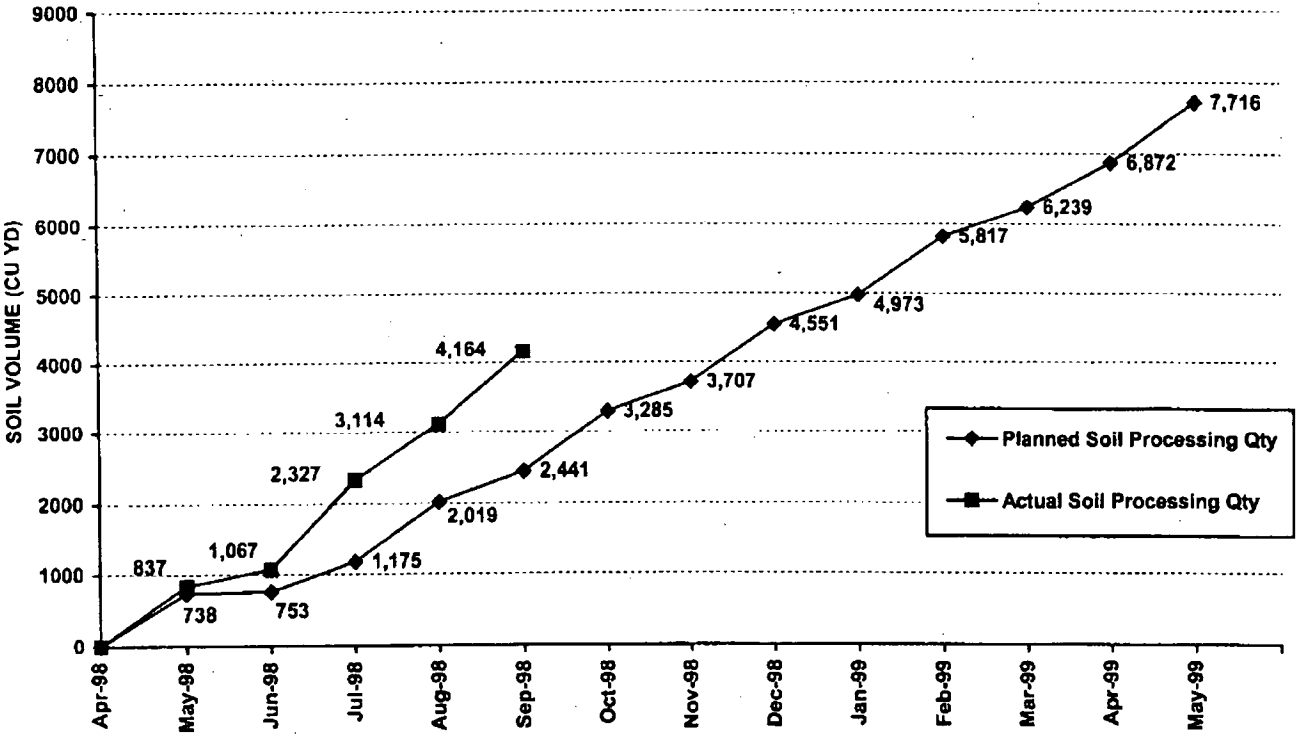
Actual schedule performance continues significantly ahead of the planned dates. This is primarily due to the relatively short bio-degradation period. The average number of days between Day Zero and Day Last for the first twenty-one windrows is ten days. The schedule planned this period to be thirty days. MK continues to closely monitor the bioremediation of the windrows with the use of available data including field test kits. Windrows reaching clean-up goals are sampled for Day Last laboratory analysis. The details of the progress of windrows are included as Table 2, Appendix C.

Operations remediated 3,097 cubic yards of contaminated soil during the second quarter. Cumulative operations since the beginning of full-scale have remediated 4,164 cubic yards of contaminated soil versus 2,441 cubic yards planned. The 4,164 cubic yards represents progress not planned to be reached until the middle of December. Windrows No.12 and No.13 were smaller in size due to a temporary break down of the tub grinder during amendment operations. The equipment has been repaired and is now fully operational. Figure 2 charts the progress of composting operations.

2.4 Analytical Data Interpretation and Validation

Table 3 (see Appendix C) provides this quarter's laboratory analysis results for HMX, RDX, and TNT. All windrow results represent an average of 15 individual data points (five cross sections, three sample locations per cross section). Day Zero and Day Last results are given for each windrow, demonstrating the effectiveness of the bio-degradation.

FIGURE 2
NSWC CRANE BIOFACILITY SOIL PROCESSED VOLUMES
(cumulative values)



All data associated with windrow monitoring was verified, and at least 10% of the samples were validated, and compared with field and laboratory quality control (QC) sample data to assess the data's usability for supporting full-scale operations. Data were verified by reviewing chain-of-custody forms, sample preservation records, analytical holding times, requested turnaround times, sample data in comparison to QC data, and reporting requirements. In addition, more than 10% of the data were validated using the validation procedures specified in Section 9.2.2 of the *QAPP*.

Analytical results for the trip blanks, field blanks, equipment rinsates, and field duplicates were evaluated to identify potential sources of error introduced during sampling, transportation and storage. Field QC performed with the monitoring of Windrow No.6 through Windrow No.20 during this quarter have been performed according to the requirements defined in the *QAPP*.

Laboratory QC consists of method blank, sample matrix spike (MS), sample matrix spike duplicate (MSD), surrogate, laboratory control sample (LCS), and laboratory control sample duplicate (LCSD) analyses to evaluate laboratory accuracy and precision. Laboratory quality control was performed consistent with the requirements of the QAPP. Method blanks, LCS, LCSD, and surrogates were acceptable in almost every analytical batch. MS and MSD data was generally acceptable. In some of the Day 0 data, consistent elevated MS and MSD recoveries of RDX and HMX are often seen in the analytical data because of the high levels of these compounds initially present in the sample. The Day 0 samples often require dilutions to bring the concentration of RDX and HMX to a quantifiable level. This dilution which occurs after spiking of the sample, dilutes the concentration of the spiking solution to a low level which cannot often be distinguished from the variability of the sample itself. Day Last data did not show similar interferences because initial concentrations were low in comparison to the concentration of spiking solution added to the sample. Other MS and MSD recoveries, which did not meet the established criteria in the *QAPP* include recoveries for tetryl. This compound often suffers from degradation, which results in low recovery of the compound in the MS and MSD. However, based upon the undetectable levels of tetryl found in these samples and the relation of the analytical reporting limits to the industrial and residential clean-up levels, the data is determined to be acceptable to show that clean-up goals have been successfully met.
Based on technical review of the field and laboratory QC data, analyses were performed within acceptable accuracy and precision requirements specified in the *QAPP*. The confirmation data meets the project's data quality objectives and are therefore considered usable to support full-scale operations.

Table 4 (see Appendix C) provides the average explosive compound levels for day zero and Day Last for the laboratory results received this quarter. Table 5 (see Appendix C) lists the clean up goals for HMX, RDX and TNT. All windrows to-date meet residential clean-up goals for explosive compounds. The project objective is to meet industrial clean-up goals. However, the bio-degradation has been so efficient that residential goals are readily being achieved.

3.0 DISPOSAL OF TREATED SOIL

Treated soil from the first twenty windrows has been transported back to MFA. A temporary staging area has been established to receive and hold this material in accordance with an approved field change request (FCR). The disposal activity to date is shown in Table 6, Appendix C. Representative photographs of the staging area are provided in Appendix B.
The treated soil compost material will be used as backfill material during future site restoration activities. Excess compost, beyond that used for backfill, will be placed as directed by NSWC Crane EPD.

4.0 BACKFILLING AND SITE RESTORATION

There were no backfilling or site restoration activities during this period. Backfill activities are on hold pending Navy resolution of compost toxicity issues with United States Environmental Protection Agency (U.S. EPA), Region 5. The toxicity test procedures (Appendix G of the QAPP) have not been approved by U.S. EPA. It is expected to be approved by the next quarter.

5.0 STATUS OF VARIOUS REPORTS

Various MK generated reports have been drafted and are undergoing review and approval as discussed below.

A. Initial Batch Performance
The report confirms the performance of the full-scale compost operation, based on windrow S-001, as compared to pilot-scale testing and recommends continuance of full-scale operations. This report is being reviewed by the Navy.

B. 30% Soil Demonstration
This report summarizes the windrow composting operation using 30% soil loading. The results indicate that a 30% soil loading meet the performance and remedial goals established for this project. Navy comments are being incorporated.

C. Toxicity Report
The report concludes that treated compost is suitable for use as a top dressing for general land application and does not contain leachable contaminants. The Microtox® and earthworm toxicity results conclude that bioremediated explosive compounds-contaminated soil is no more toxic than non-contaminated soil, which has been subjected to similar windrow composting activities. This report is being reviewed by the Navy.

D. Audit Demonstration Report
The report recommends against the use of the Wiley Mill/Riffle splitter at the site prior to laboratory testing. The report also recommends that the current practice of using the

field test kits as an indicator prior to laboratory testing be continued. This report is being reviewed by the Navy.

E. MFB Excavation Plan
This plan provides methods and controls for excavation, screening, transportation, and storage of explosive compounds-contaminated soils from MFB. This document is under review by the Navy and the U.S. EPA.

F. Pilot-Scale Treatability Test Report
The results of the pilot-scale testing of bioremediation of explosive compounds-contaminated soils at NSWC Crane are documented in this report. This document is under review by the Navy and the U.S. EPA.

G. Full-Scale QAPP Revision No.3
This revision incorporates the standard operating procedures of our next off-site laboratory. MK is incorporating Navy comments.

6.0 QUALITY CONTROL

Quality control inspections included excavation site operations, composting operations, sampling activities, field test kit analyses, and facility maintenance. Quality control checks were performed at required intervals using the field inspection checklists provided in Appendix F of the approved *Full-Scale Operational Plan* [MK, 1998a]. Copies of all inspection records are maintained at the Biofacility office.

During this quarter 1,038 individual items were verified and 24 deficiencies were identified. Typical deficiency findings were minor in nature, such as: retention pond levels with less than two feet of freeboard remaining immediately after a major rain event. These deficiencies have been corrected satisfactorily. These deficiencies do not impact the quality of the composting operations.

7.0 SAFETY AND INDUSTRIAL HYGIENE

7.1 General Safety

During this period 11,718 man-hours were expended without an Occupational Safety and Health Administration (OSHA) recordable injury. This brings the project to a cumulative total of 133,144 man-hours without an OSHA recordable injury. One first aid case of a small laceration on the right forearm caused by a sharp edge of a haul trailer was observed on July 31, 1998.

Ten formal safety inspections were performed during this quarter. No significant findings of an imminent or serious nature were found. Immediate actions were taken to correct any minor findings observed. Daily informal walk around safety inspections reinforced and improved the worker safety performance.

7.2 Industrial Hygiene Sampling

During this period, airborne bacteria/fungi (molds and yeast), total dust, airborne explosive compounds, and ammonia monitoring were performed. Bioaerosol sampling for airborne bacteria was completed inside and outside the compost buildings. The average inside bacteria concentration was 142 cfu/m^3 (colony forming units per cubic meter). The average bacteria concentration outside the Biofacility buildings was 248 cfu/m^3. This correlates to 1.8 times more bacteria outside than inside. The species of bacteria identified are essentially non-pathogenic and are only linked to common infections. No *E-coli* or *total coliform bacteria* were detected.

Inside and outside fungi (molds and yeast) samples were also collected for comparison. Based on laboratory results the average inside fungi concentration was 575 cfu/m^3. The average concentration outside the compost buildings overloaded counting capabilities due to "shadow yeast". Shadow yeast (*sporobolomyces*) interference on outside fungi samples was probably due to the close proximity to trees (< 50 feet) during peak shadow yeast production period (June through August). In addition, the background fungi samples were taken in the early morning hours when spore counts are the highest. Fungi samples from the previous sampling period did not reflect significant shadow yeast interference due to the greater distance from the trees. Also, previous samples were taken in the afternoon when shadow yeast spore counts would be at its lowest. One species of *aspergillus* fungi was detected that has been linked to the chronic lung condition, *Aspergillosis*. Another species was detected which has been reported to cause skin and pulmonary infections and is a common cause of fungal related ear infection, *Otomycosis*. However, based on the occurrence, frequency, and concentrations neither of these species is of concern.

The average fungi/bacteria concentrations are low when compared to the occupational exposure limits. Average concentrations are less than the 10,000 cfu/m^3 recommended total and less than the pathogenic limit of 500 cfu/m^3. The average gram negative bacteria concentration was also less than the recommended threshold limit value (TLV) of 1,000 cfu/m^3.

Ammonia samples were taken at the Biofacility by colorimetric methods. Sampling indicates ammonia levels greater than the occupational exposure limits of 50 ppm permissible exposure limit (PEL) and 25 ppm (TLV). During windrow construction, and during the first five to seven days of the windrow life cycle, twenty-eight grab samples were taken. The chicken manure amendment is the primary contributor to the ammonia concentrations. Full-face air purifying respirators with ammonia cartridges were worn during windrow formation and during the first five to seven days of the windrow life cycle. Ammonia is localized near each pile and is significantly affected by natural ventilation of the building, moisture in windrow, and turning of windrow. The maximum ammonia level detected was 151 ppm. The average maximum for a new windrow is approximately 78 ppm.

Airborne explosive compounds dust sampling was also performed at the Biofacility. Three area samples and three personal samples were taken. Results of all samples were less than the lower limit of quatitation (LOQ) for applicable explosive compounds and far below any occupational exposure limits.

Nuisance dust measurements, using a laser dust monitor, were taken during activities that have the greatest potential to generate dust. During these activities water is used to prevent and suppress any dust that could be generated. The average dust level detected was 0.39 mg/m^3. The maximum dust level detected was 0.98 mg/m^3 during soil screening activities. All dust samples were well below the 10 mg/m^3 non-respirable limit and the 3 mg/m^3 respirable limit.

A total of ten wipe samples were taken to identify any spread of explosive compounds contamination out of work zones. Samples were taken in the clothing change, shower, laboratory, office, and lunch areas. No explosive compounds contamination was found outside the controlled areas. Some explosive compounds contamination was detected in clothing change and shower areas. No occupational exposure limit exists for explosive compounds contamination. However, an administration control level of 1 ppm has been established. All wipe samples were below the administration action level.

In summary, monitoring during this period indicates no airborne explosive compounds hazard; no significant airborne bacteria or fungi hazard; and adequate dust controls. Ammonia monitoring indicates respiratory protection is warranted during the first five to seven days of the windrow life cycle. Wipe sampling for explosive compounds, coupled with aggressive housekeeping activities, are required to prevent any detectable spread of explosive compounds outside work zones.

8.0 FACILITY MAINTENANCE AND REPAIRS

There were no significant repairs made to the facility during this period. Routine maintenance and housekeeping activities were performed.

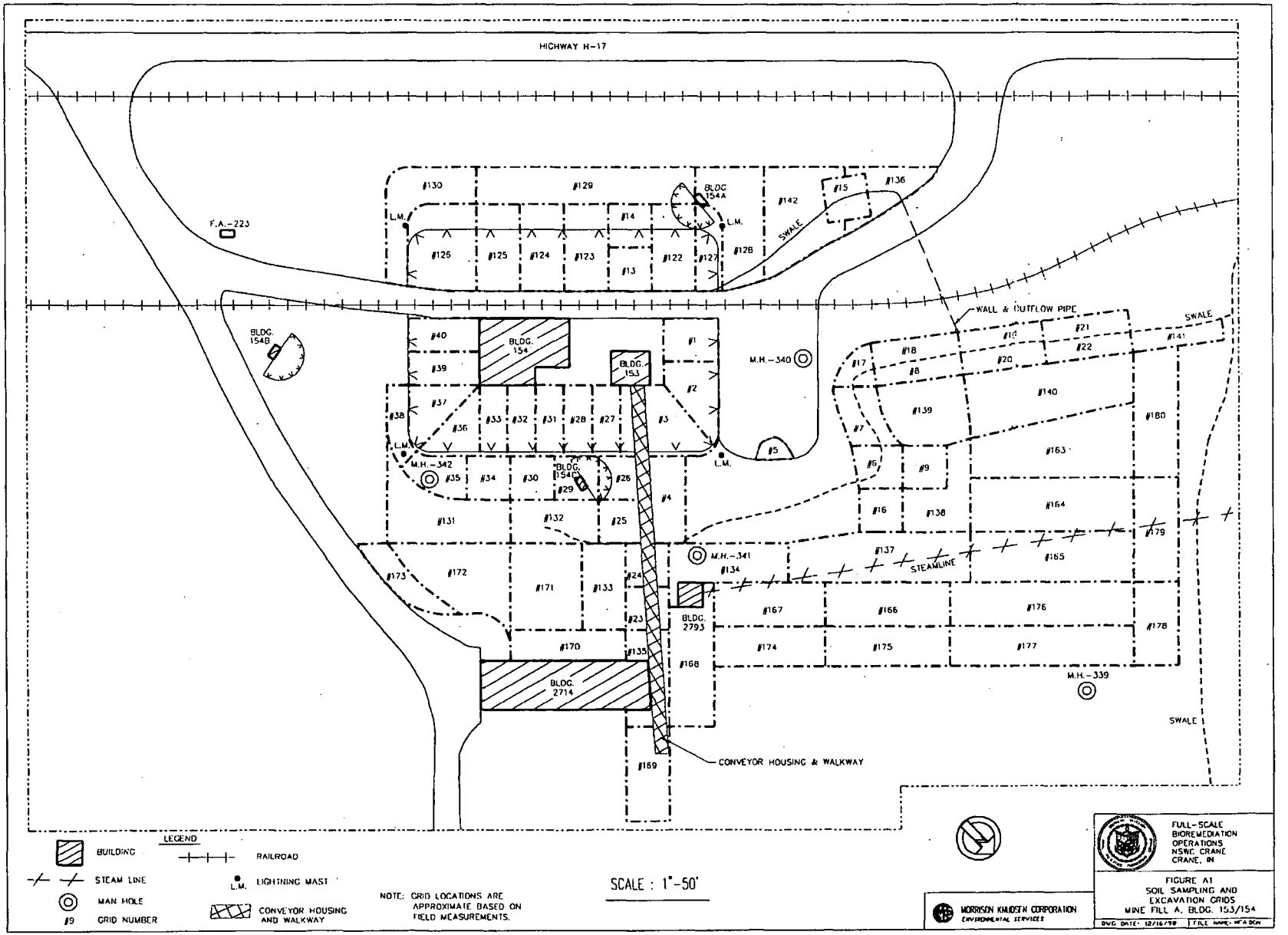
9.0 REFERENCES

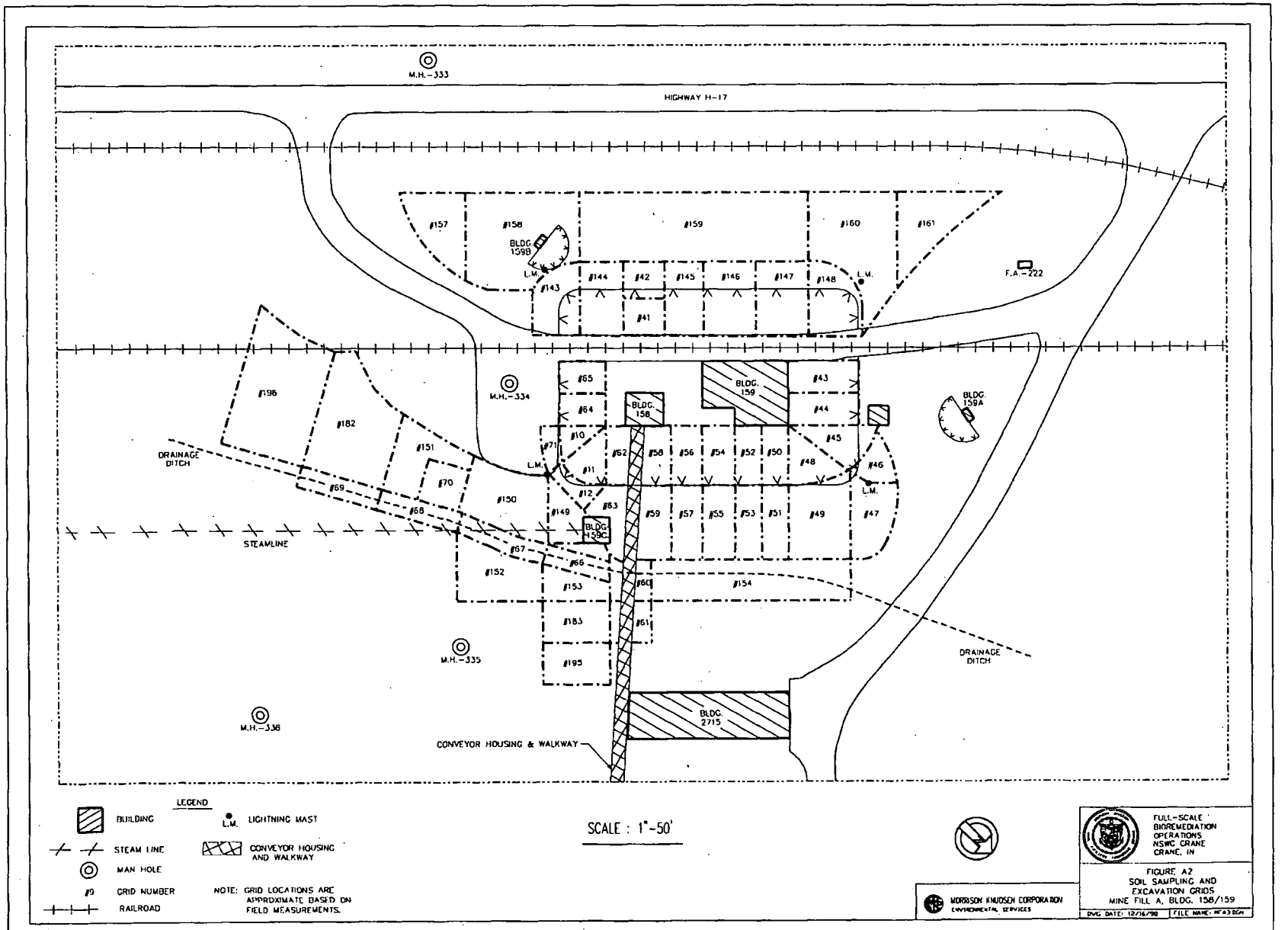
MK, 1998a. *Full-Scale Operational Plan for Soils Bioremediation Facility, NSWC Crane, Crane, Indiana.* Delivery Order Number 0009, Contract Number N62467-93-D-1106. Prepared by Morrison Knudsen Corporation, Environmental Services Group. Revision 2, March 12, 1998.

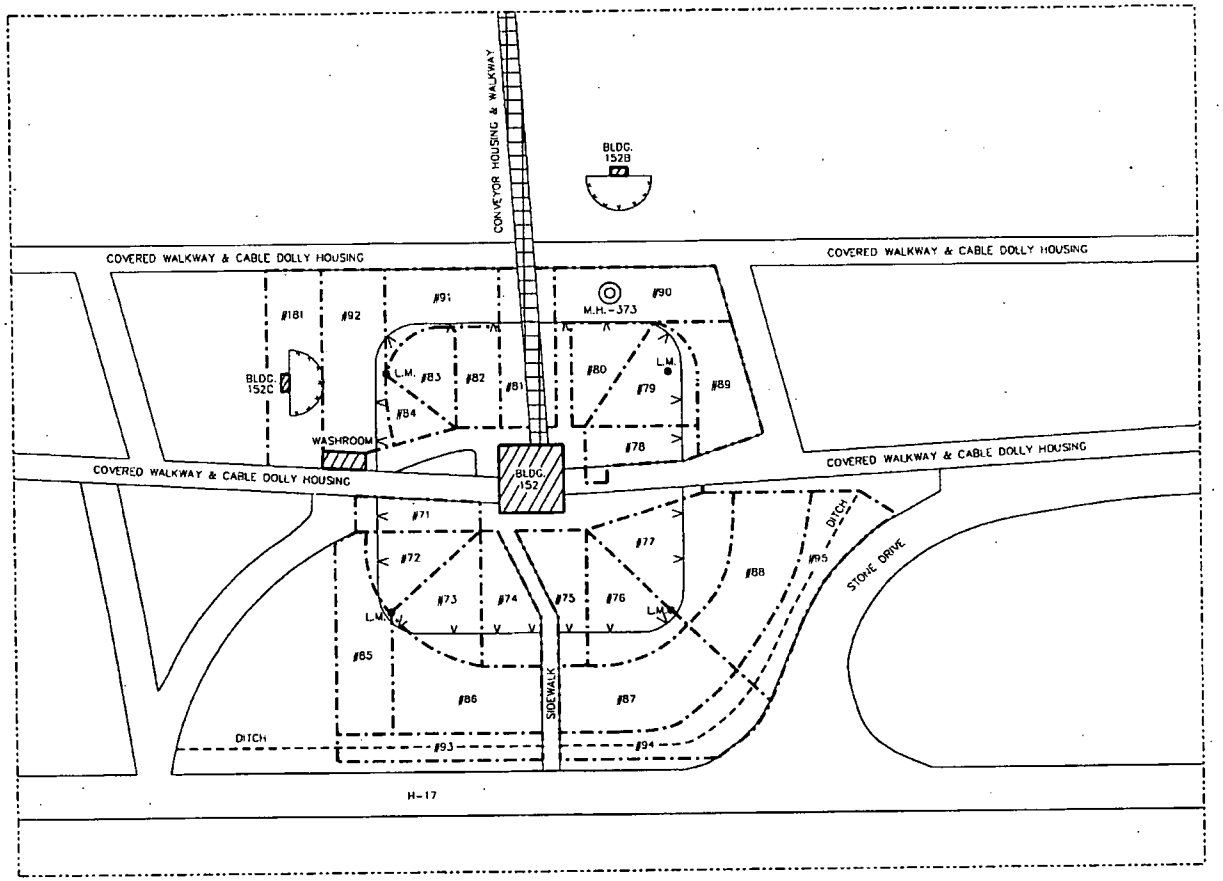
MK, 1998b. *Quality Assurance Project Plan for Full-Scale Operations, Soils Bioremediation Facility, NSWC Crane, Crane, Indiana.* Delivery Order Number 0009, Contract Number N62467-93-D-1106. Prepared by Morrison Knudsen Corporation, Environmental Services Group. Revision 2, March 12, 1998.

Appendix A
Soil sampling and Excavation Grids

Drawing A1: Mine Fill A, Bldg. 153/154
Drawing A2: Mine Fill A, Bldg. 158/159
Drawing A3: Mine Fill A, Bldg. 152
Drawing A4: Mine Fill A, Bldg. 157


HIGHWAY H-17
F.A.-223
BLDG. 154A
BLDG. 154B
BLDG. 154
BLDG. 153
BLDG. 154C
BLDG. 2793
BLDG. 2714
M.H.-340
M.H.-341
M.H.-342
M.H.-339
L.M.
SWALE
WALL & OUTFLOW PIPE
STEAMLINE
CONVEYOR HOUSING & WALKWAY
LEGEND
BUILDING
RAILROAD
STEAM LINE
LIGHTNING MAST
MAN HOLE
#9 GRID NUMBER
CONVEYOR HOUSING AND WALKWAY
NOTE: GRID LOCATIONS ARE APPROXIMATE BASED ON FIELD MEASUREMENTS.
SCALE : 1"-50'
MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES
FULL-SCALE BIOREMEDIATION OPERATIONS NSWC CRANE CRANE, IN
FIGURE A1
SOIL SAMPLING AND EXCAVATION GRIDS
MINE FILL A, BLDG. 153/154
DWG DATE: 12/16/98
FILE NAME: MFA.DGN


M.H.-333
HIGHWAY H-17
#157
#158
BLDG. 159B
#159
#160
#161
L.M.
#143
#144
#42
#145
#146
#147
#148
#41
F.A.-222
#196
#182
#151
#70
#150
#65
#64
#10
#71
#62
#58
#56
#54
#52
#50
#48
#11
#12
#63
#59
#57
#55
#53
#51
#49
#47
#46
#45
#44
#43
BLDG. 158
BLDG. 159
BLDG. 159A
M.H.-334
DRAINAGE DITCH
#69
#68
#67
#66
#60
#61
#152
#153
#154
#183
#195
BLDG. 159C
STEAMLINE
M.H.-335
M.H.-336
BLDG. 2715
CONVEYOR HOUSING & WALKWAY
LEGEND
BUILDING
L.M. LIGHTNING MAST
STEAM LINE
CONVEYOR HOUSING AND WALKWAY
MAN HOLE
#9 GRID NUMBER
RAILROAD
NOTE: GRID LOCATIONS ARE APPROXIMATE BASED ON FIELD MEASUREMENTS.
SCALE : 1"-50'
MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES
FULL-SCALE BIOREMEDIATION OPERATIONS NSWC CRANE CRANE, IN
FIGURE A2
SOIL SAMPLING AND EXCAVATION GRIDS
MINE FILL A, BLDG. 158/159
DWG DATE: 12/16/98
FILE NAME: AF A3 BGH



LEGEND

- BUILDING
- STEAM LINE
- MAN HOLE
- #9 GRID NUMBER
- RAILROAD
- L.M. LIGHTNING MAST
- CONVEYOR HOUSING AND WALKWAY

NOTE: GRID LOCATIONS ARE APPROXIMATE BASED ON FIELD MEASUREMENTS.

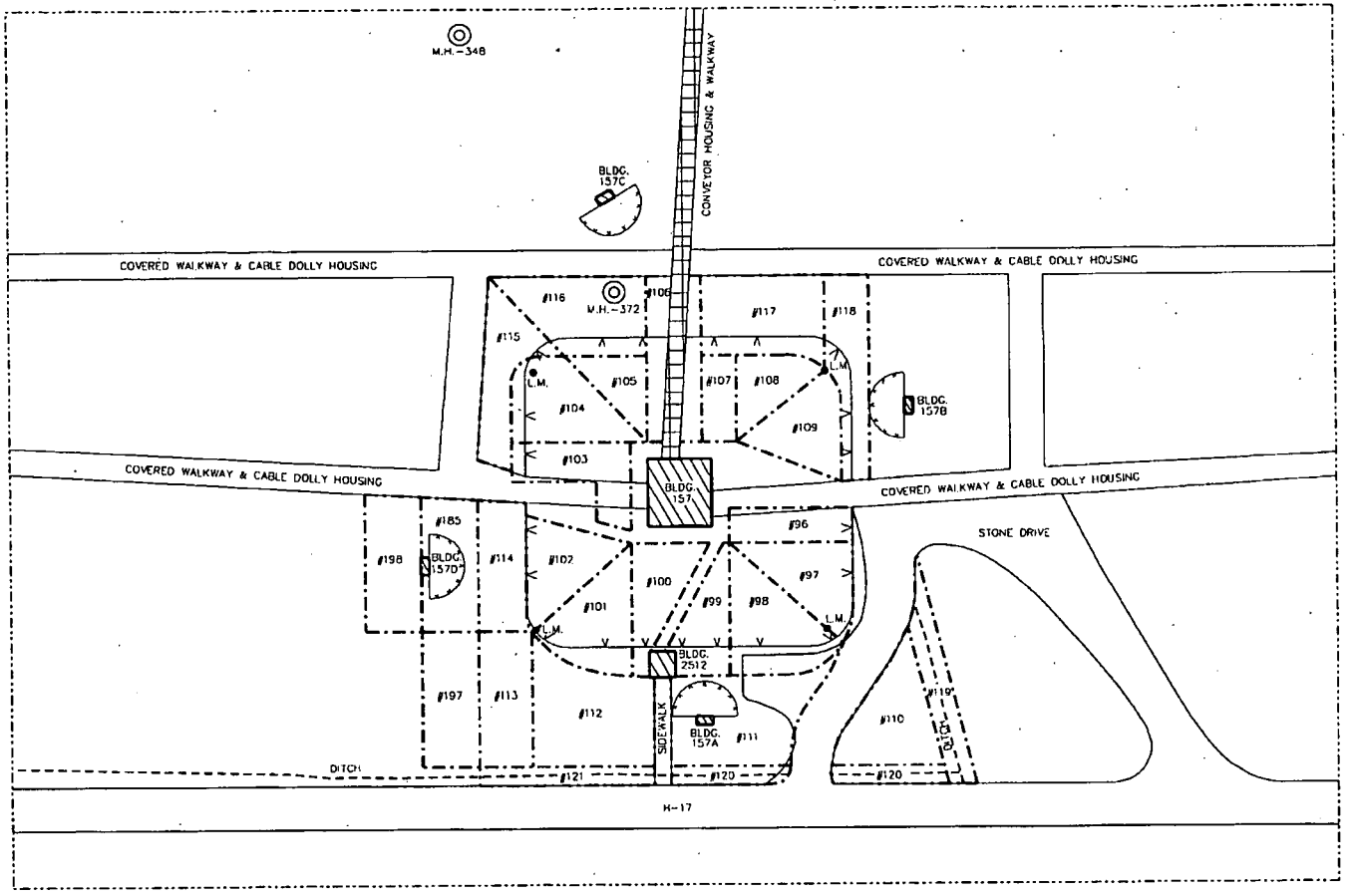
SCALE : 1"-50'

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES

FULL-SCALE BIOREMEDIATION OPERATIONS NSWC CRANE CRANE, IN

FIGURE A3
SOIL SAMPLING AND EXCAVATION GRIDS
MINE FILL A, BLDG. 152

DWG DATE: 12/16/98 | FILE NAME: MFA2.DGN



LEGEND

- BUILDING
- L.M. LIGHTNING MAST
- STEAM LINE
- CONVEYOR HOUSING AND WALKWAY
- MAN HOLE
- #9 GRID NUMBER
- RAILROAD

NOTE: GRID LOCATIONS ARE APPROXIMATE BASED ON FIELD MEASUREMENTS.

SCALE : 1"=50'

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES

FULL-SCALE BIOREMEDIATION OPERATIONS NSWC CRANE CRANE, IN

FIGURE A4
SOIL SAMPLING AND EXCAVATION GRIDS
MINE FILL A, BLDG. 157

DWG DATE: 12/04/98 | FILE NAME: MFA4.DGN

12-14-98/JH

Appendix B
Representative Project Photographs

Roll FS-8, Log#13: Excavator Loading Soil Into PowerScreen At Bldg. 153/154, Mine Fill "A"

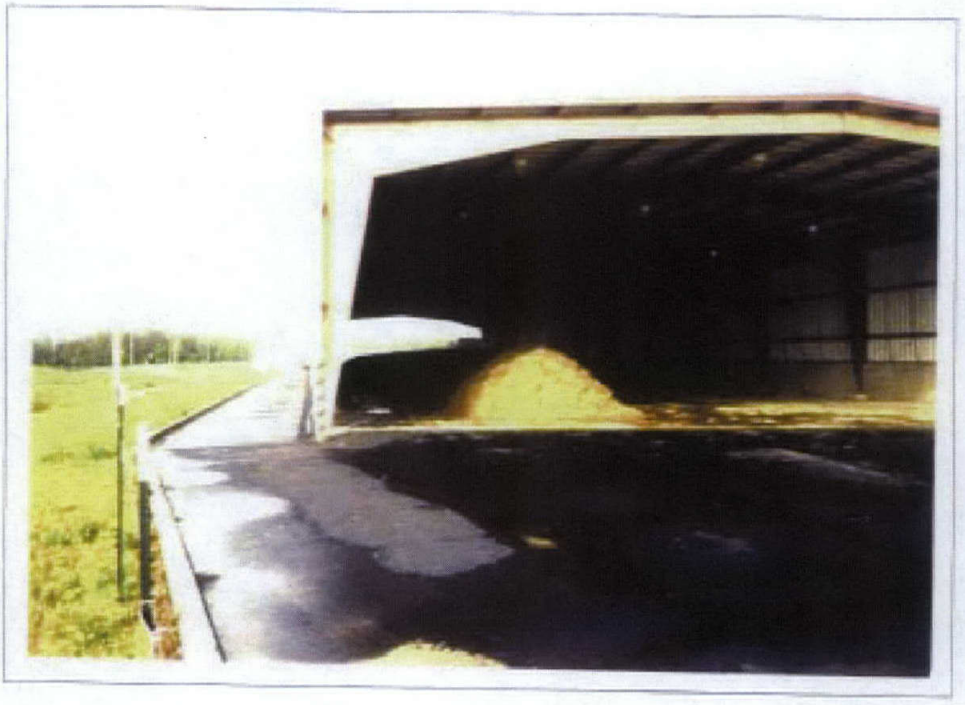
Roll FS-6, Log#18: West Berm of Bldg. 158/159, Mine Fill "A" After Excavation

Roll FS-6, Log#3: Amendment Off-loading Over Wall

Roll FS-8, Log#23: Straw Storage Area – South of Biofacility

Roll FS-5, Log#1: Amendment Mixing for Windrow #03

Roll FS-4, Log#10: Positioning Conveyor for Soil Loading on Windrow #01



Roll FS-4, Log#22: Windrow #01 on Day 0

Roll FS-6, Log#12: Completed Compost Staging Area At Mine Fill "A"

Roll FS-8, Log#8: Loader At Mine Fill "A" Staging Area for Completed Compost

Appendix C
List of Tables

TABLE 1
FULL-SCALE OPERATIONS SOIL EXCAVATION AND SCREENING AT MFA

	PLANNED QUANTITY (cu. yds.)		ACTUAL QUANTITY (cu. yds.)		VARIANCE QUANTITY (cu. yds.)	
Period	Period	Cum	Period	Cum	Period	Cum
Nov 97-Mar 98	1,400	1,400	1,391	1,391	-9	-9
Apr-98	600	2,000	166	1,557	-434	-443
May-98	1,000	3,000	831	2,388	-169	-612
Jun-98	1,000	4,000	115	2,503	-885	-1,497
Jul-98	1,000	5,000	871	3,374	-129	-1,626
Aug-98	1,000	6,000	1,382	4,756	382	-1,244
Sep-98	1,000	7,000	1,815	6,571	815	-429
Oct-98	1,000	8,000				
Nov-98	500	8,500				
Dec-98	500	9,000				
Jan 99-Mar 99	400	9,400				
Apr-99	600	10,000				

TABLE 2
OPERATIONS SCHEDULE

Windrow #	Schedule Actual	Start Date	Complete Load	Day Zero	Day Last	Lab Results	Complete Unload	Qty Soil Processed	Cumulative Soil Qty
1	Schedule	4/13/98	4/15/98	4/15/98	5/15/98	5/30/98	6/11/98	211	211
1	**Actual**	**4/13/98**	**4/15/98**	**4/15/98**	**5/11/98**	**5/29/98**	**6/24/98**	**211**	**211**
2	Schedule	4/15/98	4/17/98	4/17/98	5/17/98	6/1/98	6/11/98	211	422
2	**Actual**	**4/15/98**	**4/17/98**	**4/17/98**	**5/8/98**	**5/29/98**	**6/25/98**	**211**	**422**
3	Schedule	4/20/98	4/22/98	4/22/98	5/22/98	6/6/98	6/30/98	211	633
3	**Actual**	**4/20/98**	**4/22/98**	**4/22/98**	**5/7/98**	**5/29/98**	**6/26/98**	**215**	**637**
4	Schedule	4/22/98	4/24/98	4/24/98	5/24/98	6/8/98	6/30/98	105	738
4	**Actual**	**4/22/98**	**4/24/98**	**4/24/98**	**5/8/98**	**5/29/98**	**6/30/98**	**200**	**837**
30%	Schedule	4/27/98	4/27/98	4/27/98	6/26/98	7/11/98	7/13/98	15	753
30%	**Actual**	**4/27/98**	**4/27/98**	**4/27/98**	**6/26/98**	**7/13/98**	**9/1/98**	**20**	**857**
Control	Schedule	4/27/98	4/27/98	4/27/98	5/27/98	6/17/98	6/28/98		Clean soil used
Control	**Actual**	**4/24/98**	**4/24/98**	**4/24/98**	**5/20/98**	**6/21/98**	**9/1/98**		
5	Schedule	6/15/98	6/17/98	6/17/98	7/17/98	8/1/98	8/3/98	211	964
5	**Actual**	**6/1/98**	**6/3/98**	**6/3/98**	**6/18/98**	**7/2/98**	**7/2/98**	**210**	**1067**
6	Schedule	6/17/98	6/19/98	6/19/98	7/19/98	8/3/98	8/5/98	211	1175
6	**Actual**	**6/15/98**	**6/17/98**	**6/17/98**	**7/1/98**	**7/13/98**	**7/14/98**	**210**	**1277**
7	Schedule	7/1/98	7/3/98	7/3/98	8/2/98	8/17/98	8/19/98	211	1386
7	**Actual**	**6/22/98**	**6/24/98**	**6/24/98**	**7/7/98**	**7/15/98**	**7/16/98**	**210**	**1487**
8	Schedule	7/3/98	7/5/98	7/5/98	8/4/98	8/19/98	8/21/98	211	1597
8	**Actual**	**6/29/98**	**7/1/98**	**7/1/98**	**7/9/98**	**7/23/98**	**7/24/98**	**210**	**1697**
9	Schedule	8/4/98	8/6/98	8/6/98	8/27/98	9/11/98	9/13/98	211	1808
9	**Actual**	**7/6/98**	**7/8/98**	**7/8/98**	**7/16/98**	**7/27/98**	**7/28/98**	**210**	**1907**
10	Schedule	8/6/98	8/8/98	8/8/98	8/29/98	9/13/98	9/15/98	211	2019
10	**Actual**	**7/15/98**	**7/17/98**	**7/17/98**	**7/27/98**	**8/6/98**	**8/7/98**	**210**	**2117**
11	Schedule	8/20/98	8/22/98	8/22/98	9/12/98	9/27/98	9/29/98	211	2230
11	**Actual**	**7/20/98**	**7/22/98**	**7/22/98**	**7/31/98**	**8/12/98**	**8/14/98**	**210**	**2327**
12	Schedule	8/22/98	8/24/98	8/24/98	9/14/98	9/29/98	10/1/98	211	2441
12	**Actual**	**7/27/98**	**7/28/98**	**7/28/98**	**8/4/98**	**8/13/98**	**8/17/98**	**52**	**2379**

TABLE 2 (continued)

Windrow #	Schedule Actual	Start Date	Complete Load	Day Zero	Day Last	Lab Results	Complete Unload	Qty Soil Processed	Cumulative Soil Qty
13	Schedule	9/14/98	9/16/98	9/16/98	10/7/98	10/22/98	10/24/98	211	2652
13	**Actual**	**8/3/98**	**8/4/98**	**8/4/98**	**8/11/98**	**8/21/98**	**8/24/98**	**120**	**2499**
14	Schedule	9/16/98	9/18/98	9/18/98	10/9/98	10/24/98	10/26/98	211	2863
14	**Actual**	**8/4/98**	**8/6/98**	**8/6/98**	**8/14/98**	**8/24/98**	**8/26/98**	**210**	**2709**
15	Schedule	9/30/98	10/2/98	10/2/98	10/23/98	11/7/98	11/9/98	211	3074
15	**Actual**	**8/10/98**	**8/12/98**	**8/12/98**	**8/19/98**	**8/31/98**	**9/4/98**	**200**	**2909**
16	Schedule	10/2/98	10/4/98	10/4/98	10/25/98	11/9/98	11/11/98	211	3285
16	**Actual**	**8/13/98**	**8/15/98**	**8/15/98**	**8/21/98**	**9/4/98**	**9/8/98**	**205**	**3114**
17	Schedule	10/25/98	10/27/98	10/27/98	11/17/98	12/2/98	12/4/98	211	3496
17	**Actual**	**8/24/98**	**8/26/98**	**8/26/98**	**9/2/98**	**9/16/98**	**9/17/98**	**205**	**3319**
18	Schedule	10/27/98	10/29/98	10/29/98	11/19/98	12/4/98	12/6/98	211	3707
18	**Actual**	**8/26/98**	**8/28/98**	**8/28/98**	**9/3/98**	**9/16/98**	**9/18/98**	**210**	**3529**
19	Schedule	11/10/98	11/12/98	11/12/98	12/3/98	12/18/98	12/20/98	211	3918
19	**Actual**	**9/8/98**	**9/9/98**	**9/9/98**	**9/16/98**	**9/23/98**	**9/25/98**	**215**	**3744**
20	Schedule	11/12/98	11/14/98	11/14/98	12/5/98	12/20/98	12/22/98	211	4129
20	**Actual**	**9/10/98**	**9/11/98**	**9/11/98**	**9/18/98**	**9/25/98**	**9/28/98**	**210**	**3954**
21	Schedule	12/5/98	12/7/98	12/7/98	12/28/98	1/12/99	1/14/99	211	4340
21	**Actual**	**9/16/98**	**9/18/98**	**9/18/98**	**9/25/98**			**210**	**4164**
22	Schedule	12/7/98	12/9/98	12/9/98	12/30/98	1/14/99	1/16/99	211	4551
22	**Actual**	**9/21/98**	**9/23/98**	**9/23/98**				**210**	
23	Schedule	12/21/98	12/23/98	12/23/98	1/13/99	1/28/99	1/30/99	211	4762
23	**Actual**	**9/28/98**	**9/30/98**	**9/30/98**				**210**	
24	Schedule	12/23/98	12/25/98	12/25/98	1/15/99	1/30/99	2/1/99	211	4973
25	**Actual**	**9/30/98**							
25	Schedule	1/15/99	1/17/99	1/17/99	2/7/99	2/22/99	2/24/99	211	5184
25	**Actual**								
26	Schedule	1/17/99	1/19/99	1/19/99	2/9/99	2/24/99	2/26/99	211	5395
26	**Actual**								

TABLE 2 (continued)

Windrow #	Schedule Actual	Start Date	Complete Load	Day Zero	Day Last	Lab Results	Complete Unload	Qty Soil Processed	Cumulative Soil Qty
27	Schedule	1/31/99	2/2/99	2/2/99	2/23/99	3/10/99	3/12/99	211	5606
27	**Actual**								
28	Schedule	2/2/99	2/4/99	2/4/99	2/25/99	3/12/99	3/14/99	211	5817
28	**Actual**								
29	Schedule	2/25/99	2/27/99	2/27/99	3/20/99	4/4/99	4/6/99	211	6028
29	**Actual**								
30	Schedule	2/27/99	3/1/99	3/1/99	3/22/99	4/6/99	4/8/99	211	6239
30	**Actual**								
31	Schedule	3/13/99	3/15/99	3/15/99	4/5/99	4/20/99	4/22/99	211	6450
31	**Actual**								
32	Schedule	3/15/99	3/17/99	3/17/99	4/7/99	4/22/99	4/24/99	211	6661
32	**Actual**								
33	Schedule	4/7/99	4/9/99	4/9/99	4/30/99	5/15/99	5/17/99	211	6872
33	**Actual**								
34	Schedule	4/9/99	4/11/99	4/11/99	5/2/99	5/17/99	5/19/99	211	7083
34	**Actual**								
35	Schedule	4/23/99	4/25/99	4/25/99	5/16/99	5/31/99	6/2/99	211	7294
35	**Actual**								
36	Schedule	4/25/99	4/27/99	4/27/99	5/18/99	6/2/99	6/4/99	211	7505
36	**Actual**								

TABLE 2 (continued)

Windrow #	Schedule Actual	Start Date	Complete Load	Day Zero	Day Last	Lab Results	Complete Unload	Qty Soil Processed	Cumulative Soil Qty
37	Schedule	5/18/99	5/20/99	5/20/99	5/30/99	6/14/99	6/16/99	211	7716
37	**Actual**								
38	Schedule	5/20/99	5/22/99	5/22/99	6/1/99	6/16/99	6/18/99	211	7927
38	**Actual**								
39	Schedule	6/3/99	6/5/99	6/5/99	6/15/99	6/30/99	7/2/99	211	8138
39	**Actual**								
40	Schedule	6/5/99	6/7/99	6/7/99	6/17/99	7/2/99	7/4/99	211	8349
40	**Actual**								
41	Schedule	6/17/99	6/19/99	6/19/99	6/29/99	7/14/99	7/16/99	211	8560
41	**Actual**								
42	Schedule	6/19/99	6/21/99	6/21/99	7/1/99	7/16/99	7/18/99	211	8771
42	**Actual**								
43	Schedule	7/3/99	7/5/99	7/5/99	7/15/99	7/30/99	8/1/99	211	8982
43	**Actual**								
44	Schedule	7/5/99	7/7/99	7/7/99	7/17/99	8/1/99	8/3/99	211	9193
44	**Actual**								
45	Schedule	7/17/99	7/19/99	7/19/99	7/29/99	8/13/99	8/15/99	211	9404
45	**Actual**								
46	Schedule	7/19/99	7/21/99	7/21/99	7/31/99	8/15/99	8/17/99	211	9615
46	**Actual**								
47	Schedule	8/2/99	8/4/99	8/4/99	8/14/99	8/29/99	8/31/99	211	9826
47	**Actual**								
48	Schedule	8/4/99	8/6/99	8/6/99	8/16/99	8/31/99	9/2/99	211	10037
48	**Actual**								

All soil quantities are in cubic yards.

TABLE 3
EXPLOSIVE COMPOUNDS ANALYTICAL DATA

	Windrow #6		Windrow #7		Windrow #8		Windrow #9	
	Day 0	Day 14	Day 0	Day 13	Day 0	Day 8	Day 0	Day 8
HMX	14.0	2.2	19.0	2.2	24.8	2.2	4.4	2.2
RDX	85.3	1.0	136	1.0	160	1.1	23.6	1.8
TNT	7.4	0.25	2.5	0.25	16.8	0.29	0.68	0.45

	Windrow #10		Windrow #11		Windrow #12		Windrow #13	
	Day 0	Day 10	Day 0	Day 9	Day 0	Day 7	Day 0	Day 7
HMX	14.1	2.2	14.7	2.1	30.5	5.4	33.1	3.8
RDX	82.4	1.0	87.1	1.0	83.7	1.6	116	2.5
TNT	0.72	0.25	12.1	0.25	0.39	0.38	0.39	1.2

	Windrow #14		Windrow #15		Windrow #16		Windrow #17	
	Day 0	Day 8	Day 0	Day 7	Day 0	Day 6	Day 0	Day 7
HMX	21.0	2.2	28.9	1.9	23.0	2.0	7.9	1.9
RDX	82.8	1.0	103	1.1	127	1.1	19.7	1.1
TNT	0.31	0.25	0.32	0.25	5.6	0.26	0.25	0.25

	Windrow #18		Windrow #19		Windrow #20		Windrow #21	
	Day 0	Day 6	Day 0	Day 7	Day 0	Day 7	Day 0*	Day 7*
HMX	9.8	2.3	19.5	2.2	18.0	3.2	-	-
RDX	30.8	1.1	115	1.7	79.0	1.6	-	-
TNT	0.28	0.25	0.38	0.24	0.25	0.25	-	-

NOTES: All results in ppm
* -- Results not yet received from the laboratory.

TABLE 4
AVERAGE EXPLOSIVE COMPOUNDS LEVELS

	Day 0	Day Last
HMX	18.8	2.1
RDX	61.7	1.3
TNT	3.2	0.34

(All results in ppm)

TABLE 5
EXPLOISVE COMPOUNDS CLEAN-UP LEVELS

	Clean-Up Goals (ppm)	
	Residential	Industrial
HMX	3,300	34,000
RDX	4	17
TNT	15	64

TABLE 6
COMPLETED COMPOST DISPOSAL

Windrow	Soil Source	Soil Quantity	Day Zero	Day Last	Process Duration	Level Attained	Compost Quantity	Date Disposed	Compost Disposal Location
1	MFA	211	4/15/98	5/11/98	26	Residential	475	6/24/98	MFA staging area
2	MFA	211	4/17/98	5/8/98	21	Residential	475	6/25/98	MFA staging area
3	MFA	215	4/22/98	5/7/98	15	Residential	475	6/26/98	MFA staging area
4	MFA	200	4/24/98	5/8/98	14	Residential	475	6/30/98	MFA staging area
30%	MFA	20	4/27/98	6/26/98	60	Residential	45	9/1/98	MFA staging area
5	MFA	210	6/3/98	6/18/98	15	Residential	475	7/2/98	MFA staging area
6	MFA	210	6/17/98	7/1/98	14	Residential	475	7/14/98	MFA staging area
7	MFA	210	6/24/98	7/7/98	13	Residential	475	7/16/98	MFA staging area
8	MFA	210	7/1/98	7/9/98	8	Residential	475	7/24/98	MFA staging area
9	MFA	210	7/8/98	7/16/98	8	Residential	475	7/28/98	MFA staging area
10	MFA	210	7/17/98	7/27/98	10	Residential	475	8/7/98	MFA staging area
11	MFA	210	7/22/98	7/31/98	9	Residential	475	8/14/98	MFA staging area
12	MFA	52	7/28/98	8/4/98	7	Residential	118	8/17/98	MFA staging area
13	MFA	120	8/4/98	8/11/98	7	Residential	271	8/24/98	MFA staging area
14	MFA	210	8/6/98	8/14/98	8	Residential	475	8/26/98	MFA staging area
15	MFA	200	8/12/98	8/19/98	7	Residential	475	9/4/98	MFA staging area
16	MFA	205	8/15/98	8/21/98	6	Residential	475	9/8/98	MFA staging area
17	MFA	205	8/26/98	9/2/98	7	Residential	475	9/17/98	MFA staging area
18	MFA	210	8/28/98	9/3/98	6	Residential	475	9/18/98	MFA staging area
19	MFA	215	9/9/98	9/16/98	7	Residential	475	9/15/98	MFA staging area
20	MFA	210	9/11/98	9/18/98	7	Residential	475	9/28/98	MFA staging area
21	MFA	210	9/18/98	9/25/98	7		475		
22	MFA	210	9/23/98				475		
23	MFA	210	9/30/98						

NOTE: Process duration is in days.
All quantities are in cubic yards.
Level attained is for explosive compounds.