ATTACHMENT 2

Doyle Drive Test Program
Contract No. 04A3362

Cutter Soil Mixing Technical Submittal

By:

Malcolm Drilling Company, Inc.

3524 Breakwater Ave., Suite 108
Hayward, CA 94545

1. General

The CSM system is a modified trench cutter “Hydro Mill” type machine. Unlike conventional soil mixing tools that utilize end mixing mechanical tools depending on mechanical mixing between shear blades in axial motion, the CSM system utilizes a set of milling wheels working in the vertical plane. This mechanical action shears the soil into small particles; this is particularly advantageous in cohesive soil where the competing technologies do not have the capacity for shearing soils into smaller than 6 in diameter lumps. The CSM machine has a very stiff non rotating Kelly attachment to a base machine. This stiff Kelly coupled with the CSM’s inclinometers allow the cutter head to be steered in the “X” axis by altering wheel speed and in the ‘Y” axis by the base machine’s parallelogram. This telemetry control allows panels to be cut with full confidence that the cut-off wall has the required integrity.

Other advantages of the CSM method are:

High productivity

Low waste.

The in-situ soil is used as a construction material

There is very little generation of spoil (important factor in contaminated areas)

No vibrations are induced during construction (very important when working in soft soils or in the vicinity of structures and services).

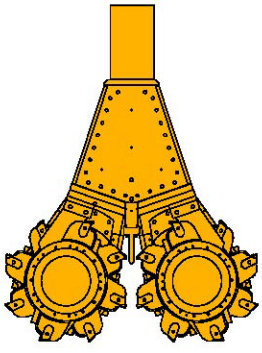
2. Construction Procedure

The construction process comprises the following sequence of steps:

2.1. Pre-excavation

A guide trench is first excavated to collect spoil; its dimensions depend on the nature of the soil and the amount of binder that is to be injected. A trench approximately 3 feet wide and 3 feet deep will be used.

2.2. Cutting and Mixing cycles

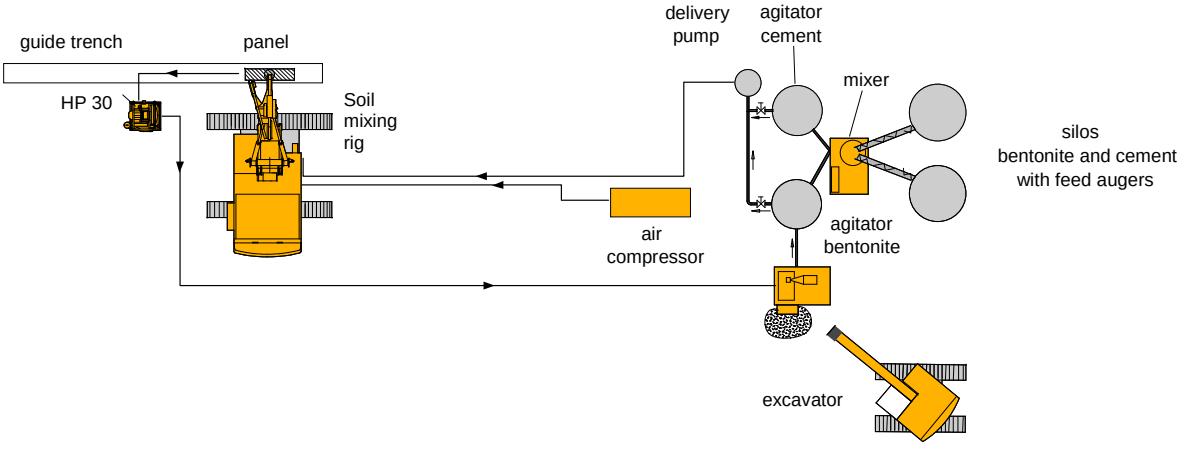


The mixing tool (CSM) is driven into the ground at a continuous rate. The soil matrix is broken up by the cutting wheels and at the same time a fluid is pumped through a set of nozzles, located between the cutting wheels, where it is mixed thoroughly with the loosened soil. The direction of rotation of the wheels can be changed at any time. The direction of rotation used on this project will be from the outside inwards. The rotating wheels and cutting teeth push the soil particles through vertically mounted shear plates that have the effect of a compulsory mixer. Penetration speed of the cutter and the volume of fluid pumped into the soil are adjusted by the operator to optimize the absorption of power and to create a homogeneous, fluid, mass that permits easy penetration. Spoils will be placed into designated spoils area and off hauled to an approved disposal location. Excess water will be pumped into baker tanks and off hauled to an approved location.

The cutting and mixing cycles will be carried out using the **Single Phase**

2.2.1. The single phase system

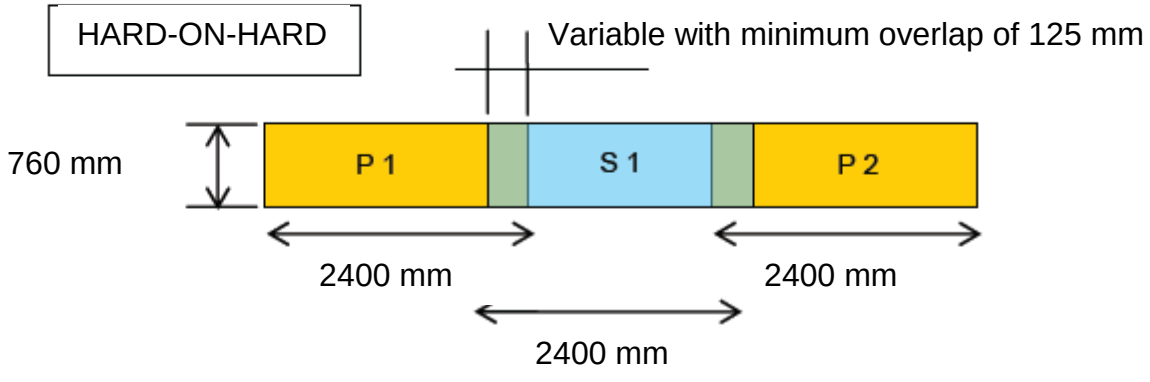
During the penetration phase, cutting, mixing, fluidifying and homogenising is performed while pumping cement grout into the soil.



After reaching the design depth, the flow of grout is reduced and the extraction of the machine begins and the binder is mixed thoroughly with the fluidified soil. The speed of extraction and flow of binder are adjusted to ensure that the total calculated quantity of binder is blended with the soil.

2.3. Forming a continuous wall

A continuous wall is formed by a series of overlapping primary and secondary panels. Overcutting into fresh adjacent panels is called the “fresh-on-fresh method“. The CSM technique also performs the “hard-on-hard method“, where secondary panels cut into hardened primaries - a typical sequence after work interruptions (weekends or holiday breaks). For this project, “hard-on-hard” method is the preferred method.



3. Quality Control

3.1. Before construction

Good knowledge of the type of soil and its conditions is fundamental; factors that affect the results of treatment of soils by Deep Mixing methods are:

- soil type
- soil consistency (CPT and/or SPT)
- bulk density
- grain size distribution
- water content
- Atterberg limits
- Soil Chemistry

Before commencing work in new ground, it is essential to review the soil investigation followed by tests and trials in order to determine the appropriate soil/binder mix,

Laboratory Testing

A single test column will be mixed at the beginning of the project. Grab samples will be taken from this column to confirm strength and permeability requirements will be met during production.

3.2. During construction

During the CSM process the following tests will be carried out to monitor quality of the work: Geometric checks of individual column positions. Real time monitoring of the inclination and deviation of the “X” and “Y” axes will allow for corrections to ensure that total deviation is less

than 0.5%.
Real time monitoring of the grout quantity pumped over depth and other computer monitored parameters.
A minimum of one test of the grout at the grout plant for specific gravity per day.

Soil/binder slurry testing. Wet grab samples will be taken during the production process from all panels. The samples will be taken approximately fifteen feet from column tip. Each sample will produce seven 3" x 6" cylinders. The slurry samples will be screened through a #4 sieve before being placed in the cylinders. During the project a total of six cylinders will be tested for hydraulic conductivity in accordance with ASTM D5084 (Falling Head Method). The maximum hydraulic conductivity of the soil-cement mix shall be 5×10^{-6} cm/sec. Each panels' cylinders will be tested for unconfined compressive strength in accordance with ASTM D 4832-02 (Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders) and ASTM D 1633-00 (Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders) according to the following schedule by an outside testing agency approved by the owner:

- 3 day strength – 2 cylinders
- 14 day strength –1 cylinder
- 28 day strength – 3 cylinders

The remaining cylinder will be a "hold" cylinder. The "hold" cylinder can be tested as required. Test results will be forwarded to the Engineer to ensure that the soil/binder mix meets the criteria established during the design and pre-job trial panel process. The soil-cement mixture shall have a 28-day average UCS 145 psi. Ninety (90) percent of UCS values shall be above 67 percent of the required average UCS value.

MDCI proposes Smith Emery Company as the independent testing laboratory; Smith Emery Company is certified by the City and County of San Francisco as an independent testing laboratory.

Smith Emery Company
1940 Oakdale Ave.
San Francisco, CA 94124
415 642 7326
Point of contact: Patrick Morrison

Also, during the DSM process, the following control of production parameters will be displayed on the rig's monitor:

- Depth
- Flow and total volume of slurry
- Slurry pressure
- Pumped slurry volume vs. depth
- Inclination "X" + "Y" axes
- Torque output of the drill rig as measured by hydraulic pressure
- Rotation speed of the mixing tool
- General equipment data

The ability to monitor and control production parameters allows for real time quality control.

3.3. Grab Sampling

Grab samples are taken with a sampler that attaches to the end of an I beam. After a panel is mixed the sampler is lowered into the mix. The sampler then closes at a specified depth and is brought to the surface and dumped into a 5 gallon bucket. The mix is run through a #4 sieve before being placed into cylinders.

3.4. Post Construction

An independent third party shall drill one boring 11 calendar days and four at 25 calendar days following the construction of the soil mix to obtain samples for UCS tests. The borings shall be drilled to a depth of about 5 ft below the tip of the CDSM test panel. Cored Holes shall be made with a double tube split tube sampler (75 mm I.D.) (PQ3 System). Coring methods and equipment must have capacity to provide intact cores for the entire length of the pile concrete. Coring logs shall include complete descriptions of inclusions and voids encountered during coring, and shall be delivered to the engineer upon completion. Cores shall be preserved, identified as to location and made available for inspection by the engineer. Advanced notice of drilling schedule shall be provided by the engineer. Coring locations can be found in Attachment 2.

The required compressive strength of the test panel shall be established based on the UCS tests performed on 8 samples obtained at 5 ft depth intervals to the full depth in each of the small diameter borings drilled in the test panel.

3.5. Soil Mixing Records

Quality control procedures shall be maintained throughout the work so that the completed project complies with all requirements indicated herein and elsewhere in the contract documents.

Attachment (1) is a sample of the report that will be furnished for each CSM column. It will provide grout feed down and up over depth, drill-down and pull-up rates at half minute intervals, revolutions over depth, and withdrawal and penetration rates over depth. In addition the report will include documentation of daily construction progress and materials testing and construction monitoring results.

3.6. Documentation

Quality control procedures shall be maintained throughout the work so that the completed project complies with all requirements indicated herein and elsewhere in the contract documents. This documentation shall include CSM and DSM test details and results as well as coring strength and hydraulic results.

4. Mix Design

4.1. Components of the binder

The components of binders normally used in CSM walls are: cement, bentonite, and water. It is possible also to use additives if required or admixtures such as fly-ash, retarders, fillers, etc. Proposed binder components for this project are:

Cement: Portland Cement Type II

Bentonite: Sodium bentonite (API 13A) without additives

Additives: Delvo, or equivalent.

4.2. Mix design and rate of consumption

The mix proportions will be determined by suitability tests prior to the start of construction.

The following tables give values for a first design of the mix proportions. They should be used for reference only and must be confirmed by appropriate suitability tests.

Cement	550 kg (1210 pounds)
Water	800 liters (211 gallons)
Bentonite	55 kg (121 pounds)
W/C ratio	1.45
Injection rate	(50% Vol. Column)
Specific gravity of grout	1.405 +/- 0.2

4.2.1. Required wall characteristics

Compressive strength	1mPa	145 psi

5. Equipment

The CSM rig is made up of three main components: The base carrier, a BCM cutting/mixing head with four mixing wheel drums, a suspension and guide system that connects the head to the base carrier.

The rig is made up of a series of modules that can be interchanged to suit varying conditions (different soils, depths, panel dimensions)

5.1. BCM Cutting and mixing head

The mixing head is based on the Bauer trench cutter technology. The wheels are driven by two standard BC cutter gear boxes. The drive motors are located inside a watertight box that also incorporates the instrumentation. The volume and shape of the box is designed to enable the unhindered passage of fluidified soil around it.

The BCM 5 unit will be used on this project. The properties of the BCM 5 are listed in the following table.

5.2. Mixing wheels

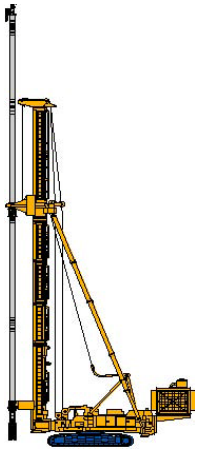
The wheels are designed to cut and loosen the soil matrix and then to mix it with the slurry. The soil type dictates whether more emphasis needs to be put on the wheel's cutting or mixing capability. In order to cover varying ground conditions, different types and configurations of cutting teeth are available for the cutting wheels.

		BCM 5
Torque	kNm	**0 - 57**
Rotation speed	rpm	**0 - 40**
Height H	m	**3,35**
Panel length L	m	**2,4**
Panel width W	mm	**760**
Weight	kg	**5100**

Cutting wheel

Rig configurations

A variety of base carriers and mounting system configurations are available. The most appropriate system is selected on the basis of depth, the soil conditions and the type of base carrier that is available. For this project, MDCI plans on using a RG23S base carrier with a BCM 5 cutting and mixing head (shown below). Based on equipment availability, another base carrier could be substituted for the RG23S.



RG23S
BCM 5

Non rotating
Rectangular Kelly
Without or with extension

5.2.1. Kelly guided system

The BCM unit is supported by a Monokelly system. For this project, with extended depths up to 36 m, a Kelly bar with a rectangular cross-section (600 mm x 340 mm) is used. With this cross-section the Kelly bar can, if necessary, be extend beyond the height of the drill rig mast.

Two guide sledges connect the Kelly bar to the drill rig's mast, they provide alignment, crowd and extraction forces and rotational movement. A hydraulically operated locking mechanism transfers crowd and extraction forces to the Kelly bar and a rotating arrangement incorporated in the guides enables the CSM unit to be rotated +45° to -90°.

Attachment 1:

635 Elliott   MALCOLM DRILLING CO., INC.   04.07.443

Malcolm Drilling

Report	MX1-1.1 Cement mix data report			
Site	635 Elliott		**Mixture**	1299A
Foremen	Wayne Broughton		**Components**	4
Shift			**W/C - factor**	1.38

	Title	Req. quantity	Unit	Density factor
K1	water	830.00	Liter	1.000
K2	cement	600.00	Kg	3.150
K3	bent	45.00	Kg	2.150
K4	mixing-time	15.00	Second	

	Title	Req. quantity	Unit	Density factor
K5				
K6				
K7				

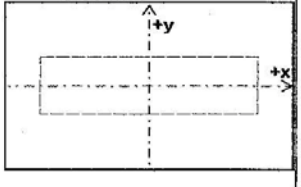
Notice: all required quantities are based on a size of 1 m³

Date	Start	End	Duration	Size[l]	K1/quantity	K2/quantity	K3/quantity	K4/quantity	K5/quantity	K6/quantity	Density [kg/l]
04/18/08	6:50:12	6:53:08	0:02:56	1000.00	831.43	590.97	47.86				1.412
04/18/08	6:53:09	6:56:12	0:03:03	1000.00	819.60	606.59	36.63				1.421
04/18/08	6:56:13	7:04:34	0:08:21	1000.00	837.15	583.64	46.89				1.405
04/18/08	7:04:35	7:07:55	0:03:20	1000.00	825.32	600.73	55.19				1.422
04/18/08	7:07:55	7:11:24	0:03:29	1000.00	837.15	617.83	41.51				1.422
04/18/08	7:11:24	7:14:43	0:03:19	1000.00	816.55	592.92	41.51				1.417
04/18/08	7:14:44	7:18:52	0:04:08	1000.00	840.58	596.34	51.77				1.412
04/18/08	7:18:53	7:23:13	0:04:20	1000.00	824.18	607.08	39.56				1.421
04/18/08	7:23:13	7:35:57	0:12:44	1000.00	834.10	596.34	45.91				1.413
04/18/08	7:35:57	7:40:46	0:04:49	1000.00	827.61	607.08	47.86				1.422
04/18/08	7:40:47	7:46:35	0:05:48	1000.00	835.24	589.99	42.00				1.408
04/18/08	7:46:35	7:52:14	0:05:39	1000.00	823.41	615.39	45.91				1.427
04/18/08	7:52:14	7:57:52	0:05:38	1000.00	833.33	596.34	42.00				1.412
04/18/08	7:57:52	8:03:16	0:05:24	1000.00	834.10	595.85	51.77				1.415
04/18/08	8:03:17	8:08:11	0:04:54	1000.00	824.56	601.22	34.68				1.416
04/18/08	8:08:11	8:14:09	0:05:58	1000.00	829.14	600.24	49.82				1.418
04/18/08	8:14:10	8:19:30	0:05:20	1000.00	832.95	604.64	40.05				1.416
04/18/08	8:19:30	8:24:40	0:05:10	1000.00	829.90	589.50	45.91				1.411
04/18/08	8:24:40	8:29:56	0:05:16	1000.00	827.23	600.24	45.42				1.418
04/18/08	8:29:56	8:35:34	0:05:38	1000.00	829.90	604.64	53.72				1.422
04/18/08	8:35:34	8:43:16	0:07:42	1000.00	829.14	609.04	40.54				1.420
04/18/08	8:43:16	8:46:40	0:03:24	1000.00	836.39	601.22	41.03				1.413
04/18/08	8:46:40	8:49:50	0:03:10	1000.00	824.18	591.94	49.33				1.416
04/18/08	8:49:50	8:52:55	0:03:05	1000.00	837.53	598.29	38.58				1.410
04/18/08	8:52:56	8:56:33	0:03:37	1000.00	820.74	600.73	50.79				1.422
04/18/08	8:56:33	9:00:50	0:04:17	1000.00	836.39	613.43	41.51				1.420
04/18/08	9:00:50	9:05:54	0:05:04	1000.00	824.56	588.03	42.00				1.411
04/18/08	9:05:54	9:11:10	0:05:16	1000.00	836.00	606.59	50.79				1.419

4/21/2008 7:32 AM   1 / 4   v 2.01 Obermann KG

PRODUCTION LOG, MIP

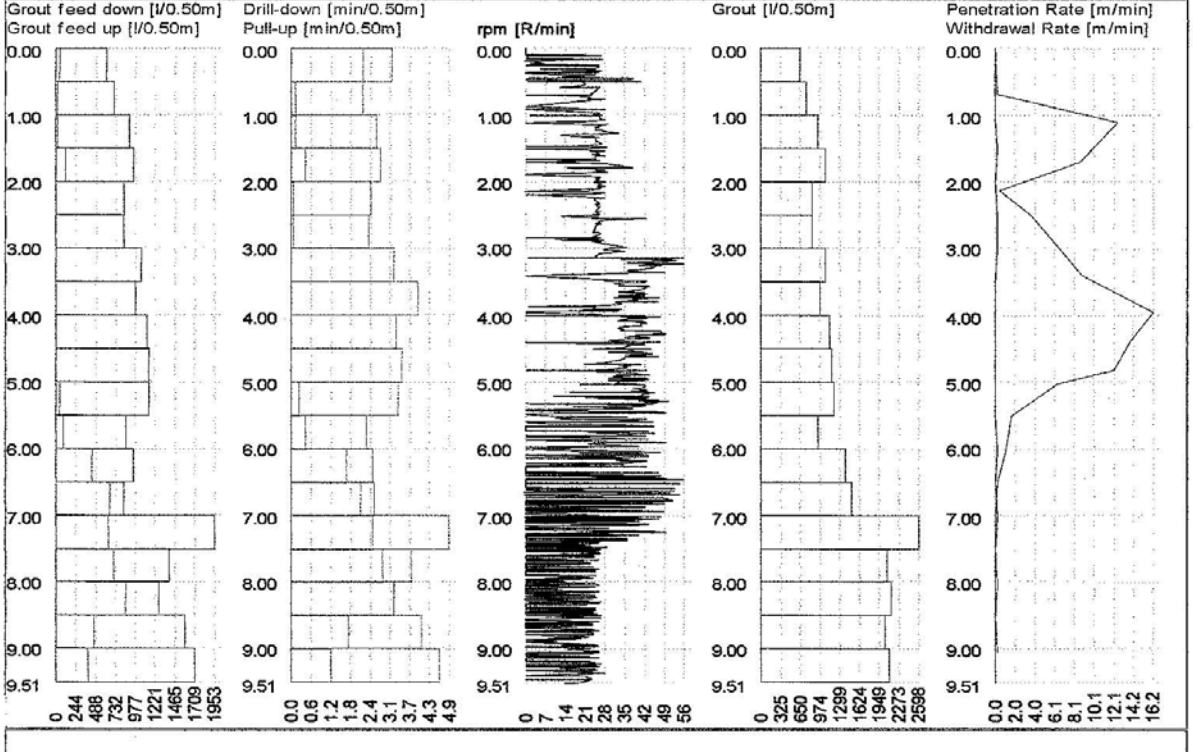
Jobsite:	Oakland Airport		
Client:	OFFC	Project No.:	07 08 001
Operator:	BILL	Cut:	ob1
Drilling Rig:	RG-23	Date:	Jul 14, 2009
I-No.:		Wall thickness/Dia.:	m
		Width of cut:	m
		Drilled depth:	9.51 m
		Column length:	9.51 m
		Ø deviation X:	0.00 mm
		Ø deviation Y:	0.00 mm



Additives

Quantity:
Grout density:-

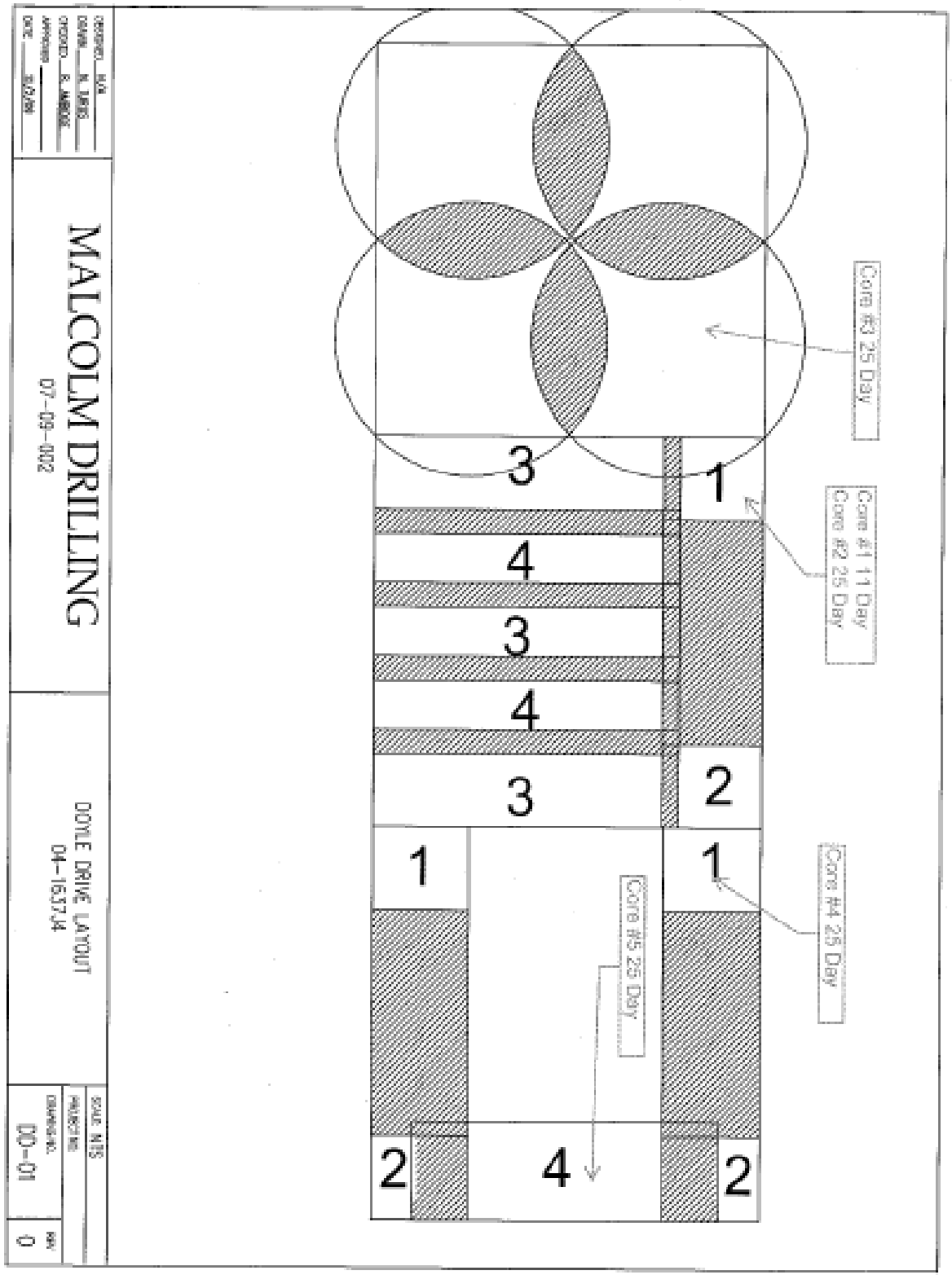
Start:	9:30:57 AM	Nom. grout consu...	0.00 m³
End:	10:51:53 AM	Actual. grout con...	25.833 m³
Total time:	01:20:55		



supervisor: Client:

BAUER Maschinen / Spezialtiefbau GmbH - D-86522 Schrobenhausen - Telefon +49 8252/97-0

Attachment 2


MALCOLM DRILLING
07-09-002
DOYLE DRIVE LAYOUT
04-163714
00-01
0
Core #3 25 Day
Core #1 11 Day
Core #2 25 Day
Core #4 25 Day
Core #5 25 Day
1
2
3
4