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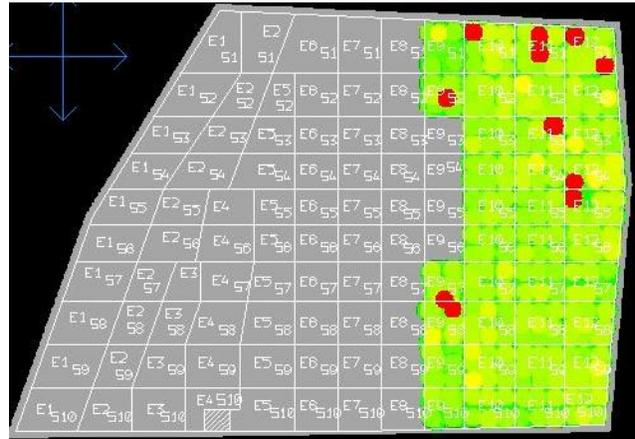
## LTC General Approach to ISS/ISCO Soil Mixing Projects

This document is not specific to any site. The approach to specific projects can vary significantly due to site specific conditions, specifications, and cleanup criteria.

ISS/ISCO soil mixing uses persulfate activated with an alkaline component and Portland cement. A persulfate solution is mixed in tanks on the ISCO Mixing Plant and pumped in controlled quantities to the ISS Mixing Plant where it is mixed with cement and pumped to the LTC Dual Axis Blender, which mixes the slurry into the contaminated soil. This process is extremely efficient as it accomplishes both ISS and ISCO in one pass. In order to insure complete contact between the ISCO reagent and the contaminants in the soil it is usually necessary to use a lot of water to break up clay lumps and obtain a homogenous mixture. With only an ISCO approach the site is very often too wet to do anything with for a long period of time. The ISS/ISCO approach makes it possible to use the site immediately after the ISS/ISCO procedure is completed. Most ISS/ISCO projects use a mix design that yields 20-50 psi unconfined compressive strength. ISS/ISCO has the added remedial advantage of reducing the hydraulic conductivity of the soil.

### Soil Mixing Equipment:

- LTC Dual Axis blender equipped with an onboard GPS. Information showing that the treatment area has been mixed to the specified horizontal and vertical limits can be downloaded from the onboard computer.



- LTC ISS Mixing Plant equipped with a scale system that records the quantities of reagent delivered to each mixing cell. This plant includes an LTC Slurry Mixing Truck, an 800 cubic foot silo and a piston grout pump.





LTC ISCO Mixing Plant equipped with a dual platform integrated scale system that records the quantities of reagent delivered to each mixing cell. The plant includes a dry bulk bin with computerized scale system and pumps and plumbing for handling liquid reagent batching. The system is capable of batching a combination of dry and liquid reagents.



Fully equipped service truck

Telehandler equipped with forks and sample taking tool.

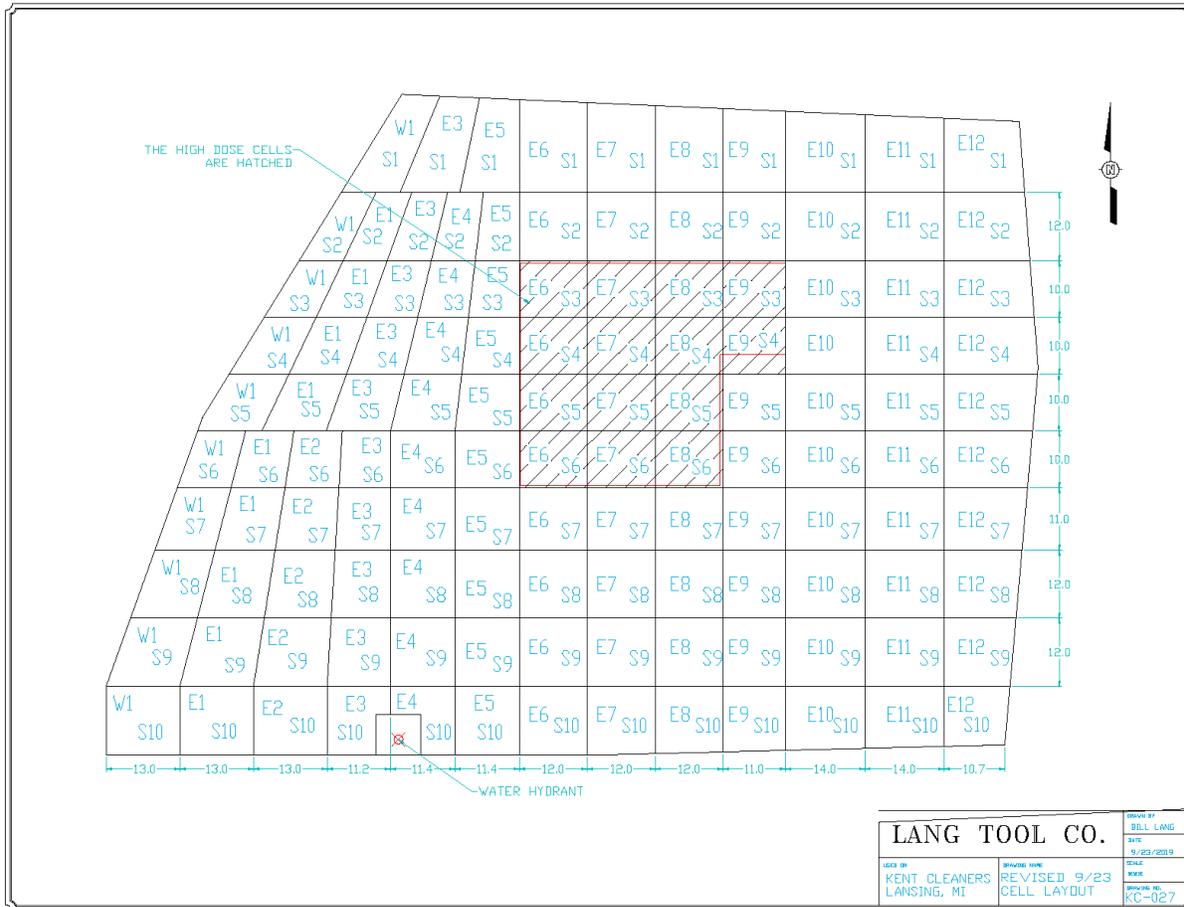
GPS equipment for layout, operation and QA/QC.

The ISS Plant and the ISCO Plant set up on the former Dana site in Columbia City Indiana



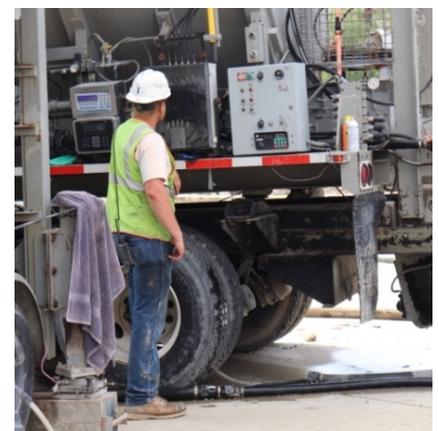
**Mixing cell layout and designation:**

Drawing KC-027 shows the mixing cell layout for the Kent Cleaners project in Lansing Michigan. The cell designation is based on east columns and south rows.



**Reagent Delivery:**

- LTC develops an Excel workbook that calculates the quantity of reagent required for each cell. The ISCO reagents required for each cell are shown on the ISCO Cell Qt'ys Sheet of the workbook. The ISS reagents required for each cell are shown on the ISS Cell Qt'ys sheet. These quantities are calculated from the soil volume of each cell on the Yd3 sheet and the formulas entered on the Mix Design sheet. Changes in the workbook can be made quickly if field conditions warrant it.
- On both plants the correct amount of reagent by weight for a cell is entered into the onboard computer along with the water volume. When the entered quantities are reached the system automatically shuts off the delivery preventing any inadvertent overdosing.



**ISCO Cell Quantities Sheet for the Kent Cleaners Project**

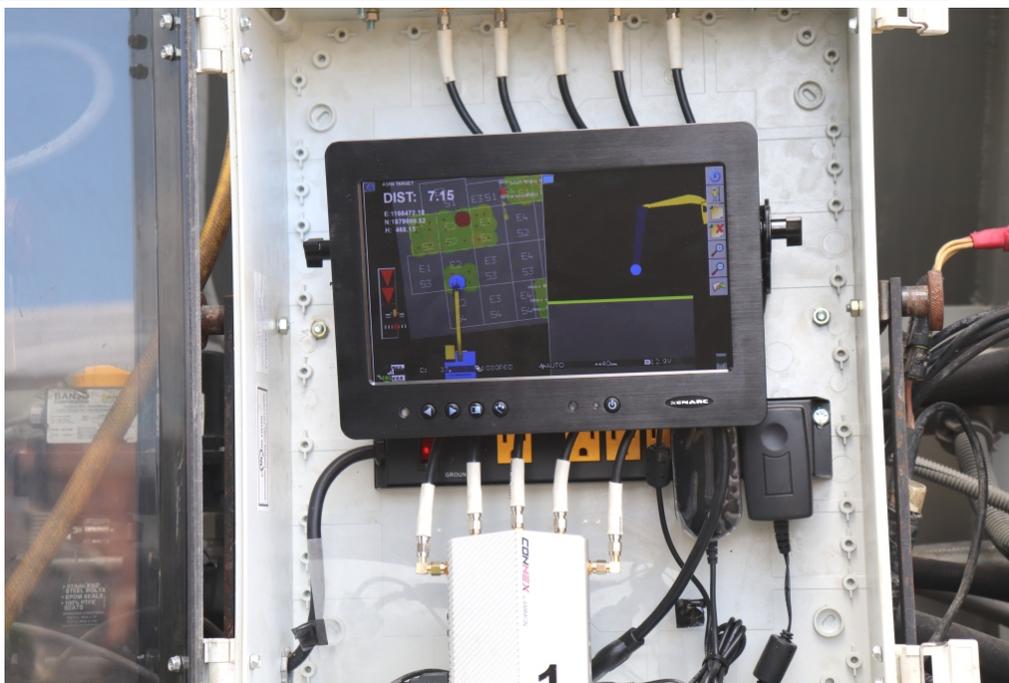
	W1	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
H2O S1	1,105	0	0	1,025	0	1,000	1,336	1,292	1,249	1,199	1,469	1,405	1,318
Klozur# S1	2,304	0	0	2,138	0	2,085	2,785	2,694	2,604	2,500	3,063	2,930	2,748
NaOH# S1	77	0	0	72	0	70	93	90	87	84	103	98	92
Solution	1,218	0	0	1,130	0	1,102	1,472	1,424	1,376	1,321	1,619	1,548	1,453
H2O S2	673	583	0	583	583	583	995	995	995	988	1,257	1,257	1,319
Klozur# S2	1,402	1,217	0	1,217	1,217	1,217	2,074	2,074	2,074	2,059	2,621	2,621	2,750
NaOH# S2	47	41	0	41	41	41	69	69	69	69	88	88	92
Solution	741	643	0	643	643	643	1,096	1,096	1,096	1,088	1,385	1,385	1,454
H2O S3	683	577	0	577	577	577	1,243	1,243	1,243	1,235	1,047	1,047	1,162
Klozur# S3	1,425	1,204	0	1,204	1,204	1,204	3,456	3,456	3,456	3,432	2,184	2,184	2,423
NaOH# S3	48	40	0	40	40	40	116	116	116	115	73	73	81
Solution	753	636	0	636	636	636	1,403	1,403	1,403	1,394	1,154	1,154	1,281
H2O S4	795	660	0	660	660	660	1,243	1,243	1,243	1,235	1,047	1,047	1,219
Klozur# S4	1,658	1,377	0	1,377	1,377	1,377	3,456	3,456	3,456	3,432	2,184	2,184	2,541
NaOH# S4	56	46	0	46	46	46	116	116	116	115	73	73	85
Solution	876	728	0	728	728	728	1,403	1,403	1,403	1,394	1,154	1,154	1,343
H2O S5	901	743	0	743	743	743	1,243	1,243	1,243	823	1,047	1,047	1,201
Klozur# S5	1,878	1,549	0	1,549	1,549	1,549	3,456	3,456	3,456	1,716	2,184	2,184	2,504
NaOH# S5	63	52	0	52	52	52	116	116	116	57	73	73	84
Solution	993	819	0	819	819	819	1,403	1,403	1,403	907	1,154	1,154	1,323
H2O S6	724	623	623	609	785	785	1,243	1,243	1,243	823	1,047	1,047	1,135
Klozur# S6	1,509	1,299	1,299	1,270	1,636	1,636	3,456	3,456	3,456	1,716	2,184	2,184	2,366
NaOH# S6	51	44	44	43	55	55	116	116	116	57	73	73	79
Solution	797	687	687	671	865	865	1,403	1,403	1,403	907	1,154	1,154	1,250
H2O S7	1,239	765	765	718	863	863	912	912	912	905	1,152	1,152	1,172
Klozur# S7	2,583	1,595	1,595	1,496	1,799	1,799	1,901	1,901	1,901	1,888	2,402	2,402	2,443
NaOH# S7	87	53	53	50	60	60	64	64	64	63	80	80	82
Solution	1,365	843	843	791	951	951	1,005	1,005	1,005	998	1,270	1,270	1,291
H2O S8	1,507	929	929	839	941	941	995	995	995	988	1,257	1,257	1,187
Klozur# S8	3,142	1,937	1,937	1,750	1,963	1,963	2,074	2,074	2,074	2,059	2,621	2,621	2,475
NaOH# S8	105	65	65	59	66	66	69	69	69	69	88	88	83
Solution	1,661	1,024	1,024	925	1,038	1,038	1,096	1,096	1,096	1,088	1,385	1,385	1,308
H2O S9	1,670	1,028	1,028	899	941	941	995	995	995	988	1,257	1,257	1,091
Klozur# S9	3,481	2,143	2,143	1,873	1,963	1,963	2,074	2,074	2,074	2,059	2,621	2,621	2,276
NaOH# S9	117	72	72	63	66	66	69	69	69	69	88	88	76
Solution	1,840	1,133	1,133	990	1,038	1,038	1,096	1,096	1,096	1,088	1,385	1,385	1,203
H2O S10	1,751	1,347	1,077	800	800	682	995	991	968	938	1,161	1,124	871
Klozur# S10	3,650	2,808	2,246	1,669	1,669	1,423	2,074	2,066	2,019	1,956	2,421	2,344	1,816
NaOH# S10	122	94	75	56	56	48	69	69	68	66	81	79	61
Solution	1,929	1,484	1,187	882	882	752	1,096	1,092	1,067	1,034	1,279	1,239	960

**ISS Cell Quantities Sheet**

	S	W1	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
PC 1	1	9,216	0	0	8,552	0	8,341	11,139	10,778	10,416	10,000	12,251	11,718	10,993
Solution		1,218	0	0	1,130	0	1,102	1,472	1,424	1,376	1,321	1,619	1,548	1,453
PC 2	2	5,610	4,866	0	4,866	4,866	4,866	8,294	8,294	8,294	8,237	10,483	10,483	11,002
Solution		741	643	0	643	643	643	1,096	1,096	1,096	1,088	1,385	1,385	1,454
PC 3	3	5,699	4,815	0	4,815	4,815	4,815	6,912	6,912	6,912	6,864	8,736	8,736	9,693
Solution		753	636	0	636	636	636	1,403	1,403	1,403	1,394	1,154	1,154	1,281
PC 4	4	6,631	5,507	0	5,507	5,507	5,507	6,912	6,912	6,912	6,864	8,736	8,736	10,164
Solution		876	728	0	728	728	728	1,403	1,403	1,403	1,394	1,154	1,154	1,343
PC 5	5	7,513	6,198	0	6,198	6,198	6,198	6,912	6,912	6,912	6,864	8,736	8,736	10,015
Solution		993	819	0	819	819	819	1,403	1,403	1,403	907	1,154	1,154	1,323
PC 6	6	6,035	5,197	5,197	5,081	6,543	6,543	6,912	6,912	6,912	6,864	8,736	8,736	9,463
Solution		797	687	687	671	865	865	1,403	1,403	1,403	907	1,154	1,154	1,250
PC 7	7	10,332	6,378	6,378	5,985	7,198	7,198	7,603	7,603	7,603	7,550	9,610	9,610	9,772
Solution		1,365	843	843	791	951	951	1,005	1,005	1,005	998	1,270	1,270	1,291
PC 8	8	12,570	7,748	7,748	7,001	7,852	7,852	8,294	8,294	8,294	8,237	10,483	10,483	9,898
Solution		1,661	1,024	1,024	925	1,038	1,038	1,096	1,096	1,096	1,088	1,385	1,385	1,308
PC 9	9	13,924	8,573	8,573	7,494	7,852	7,852	8,294	8,294	8,294	8,237	10,483	10,483	9,103
Solution		1,840	1,133	1,133	990	1,038	1,038	1,096	1,096	1,096	1,088	1,385	1,385	1,203
PC 10	10	14,602	11,232	8,986	6,676	6,676	5,691	8,294	8,263	8,076	7,822	9,682	9,376	7,262
Solution		1,929	1,484	1,187	882	882	752	1,096	1,092	1,067	1,034	1,279	1,239	960



The plant operators can control the rate of reagent delivery and have a constant readout of the rate, the remaining reagent required for the cell and the total amount of reagent on hand. The rate of delivery can be adjusted to match the mixing progress of the blender.



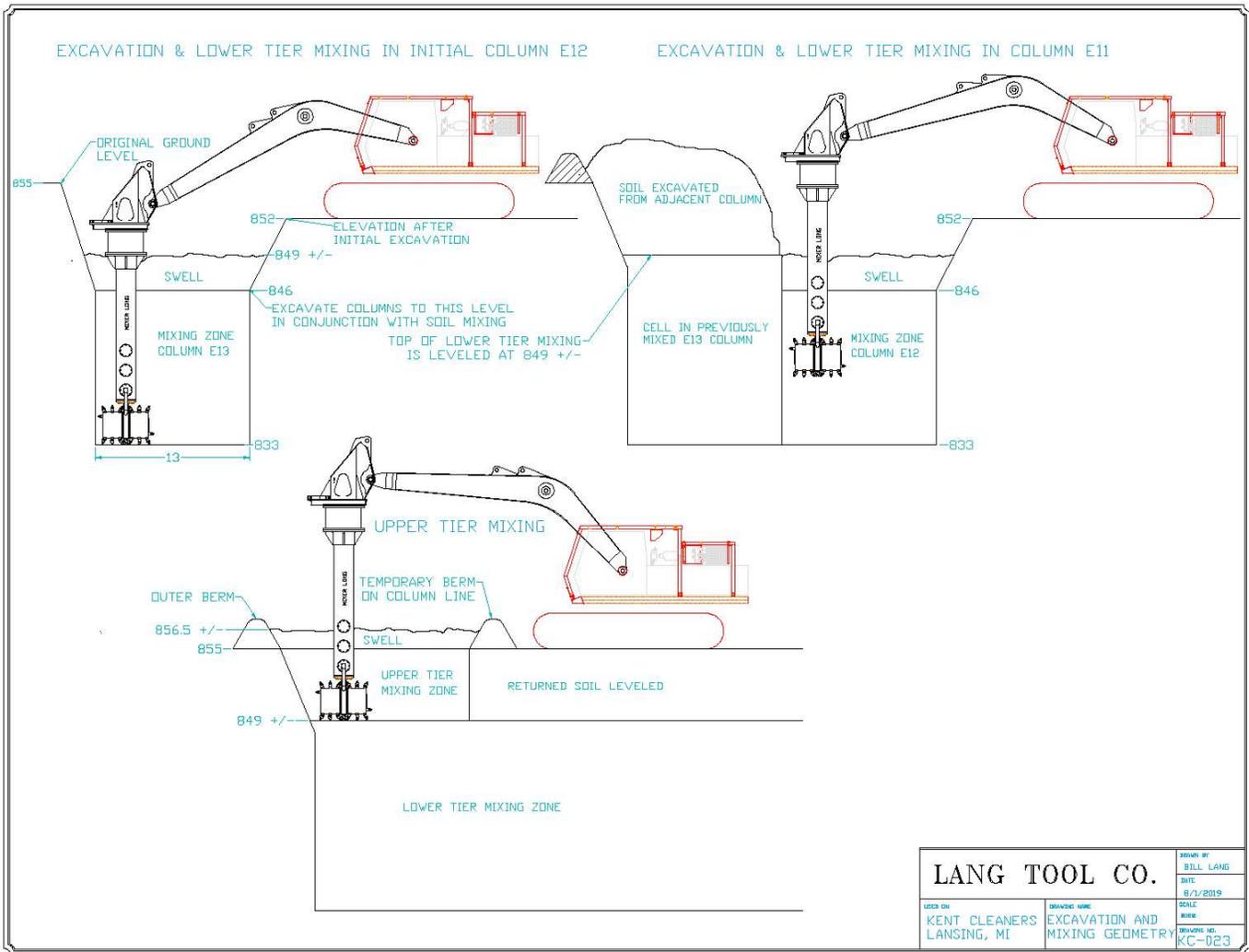
#### GPS Utilization:

The blender operator sees the cell layout and designation, the blender and the blender head on his screen. He also sees the downward progress of the blender head. This screen is broadcast to a screen on the ISS mixing plant so that the plant operator has real time information on which cell is being mixed and the rate of mixing production. This enables the plant operator to adjust the rate of reagent delivery to match the downward progress of the blender.

#### Excavation and Soil Mixing Procedure:

When chlorinated solvents are the contaminate, there often is a layer of clean overburden above the contaminated zone. Using ISS/ISCO allows the excavation and soil mixing to be conducted in conjunction eliminating the need to stockpile the clean soil and then return it at a later date. This increases efficiency, reduces cost and allows the Dual Axis Blender, the hoses and the crew to remain on the clean soil.

ISS/ISCO allows projects that involve deeper treatment depths to be done in lifts by employing the same procedure that is used when there is overlying clean soil. The drawing on the next page illustrates soil mixing and excavation done in conjunction. The drawing shows treating the soil in the upper tier. If there was clean overburden the procedure for mixing the bottom tier and excavating would be the same.



The pictures above were taken on the Kent Cleaners project in Lansing. At left the excavator is digging out the north end of the E10 column and placing the soil on top of the E11 column that had been treated the day before. The blender is completing mixing in the E11 column. Note that the stabilized soil in E11 is visible on the edge of the excavation above the excavation level indicating the swell from treatment. At right is the blender mixing in the E10 column. The soil placed on the E12 & E11 columns has been leveled. That soil was treated as shown on the drawing above the pictures. If there was clean overburden the procedure for mixing the bottom tier and excavating would be the same.

## QA/QC:

Information for daily and final reports can be downloaded from the onboard computers on LTC equipment. As described earlier, the GPS screen in the blender shows the cell layout and designation, the machine and the mixing tool. This screen is broadcast to a screen on the ISCO mixing plant so that the plant operator has real time information as to which cell the blender is working in and the mixing progress. This allows the plant operator to match the rate of reagent delivery to the mixing progress and insures that there is no confusion as to which cell the blender is working in.

- A color coded map showing the cells can be downloaded that verifies the cells have been mixed to the horizontal and vertical limits specified. An example is shown on page 5 of the ISCO SOQ,
- The plant computer records the cell designation, the quantity of reagent delivered to each cell and the time that the cell was completed. This information can be downloaded after every shift.



Dual Axis Blender mixing the last cell on the Kent Cleaners Project.

The attachments listed are part of this project approach.

- LTC ISS Statement of Qualifications, LTC ISCO Statement of Qualifications
- Kent Lower Level Qt'ys 09\_09
- LTC Project List 11\_2019



Kent Cleaners Site 4 hours after the ISS/ISCO equipment was demobilized from the site.