2024 MONITORING WELL MAINTENANCE PERFORMANCE REEVALUATION

FOR

MONONA COUNTY SANITARY LANDFILL

67-SDP-1-75C

TURIN, IOWA

by:
HLW Engineering Group
204 West Broad Street
P.O. Box 314
Story City, Iowa 50248
(515) 733-4144

May, 2024

HLW Engineering Group

Engineering *Management*

6036-24A.200

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Prepared by: _____ 5/10/24
Todd Whipple, CPG

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Monitoring Well Maintenance Performance Reevaluation Plan

INTRODUCTION

The purpose of this study is to ensure that all monitoring wells included in the approved Hydrologic Monitoring System Plan (HMSP) remain reliable monitoring points. A Monitoring Well Maintenance Performance Reevaluation (MWMPRP) is required to be performed every five (5) years at closed landfill sites (114.21(2)"d"). A total of five (5) monitoring wells are included in the approved HMSP for the closed landfill site (Figure 1).

The five (5) monitoring wells are designated MW-1, MW-3R, MW-4, MW-5, and MW-7.

Assessment of the well function and/or well deterioration is made through direct observation and measurement and through indirect testing methods. Assessment of the site hydrologic conditions is also made to determine whether changes in the static water level and/or groundwater flow path has occurred.

ASSESSMENT OF MONITORING WELL CONDITION

Physical Condition - Observation of the physical condition of each well is made during each sampling episode. Observation indicates that all protective casings and locks are in place and operable. All well casings are capped. The PVC well casings appear to be in satisfactory conditions and allow adequate access to the groundwater for water depth measurements and water sampling activities.

Well Depth and Sedimentation - Annual well depth measurements are made. Table 1 summarizes the original well depth and the most recent (April 18, 2024) well depths. The difference in the original bottom elevation and the April 18, 2024 bottom elevation is estimated to represent sedimentation in the well. As summarized in Table 1, sedimentation is minimal in all wells. Sedimentation is recorded to be 1.0 ft or less in all wells, except MW-4. At MW-4 sedimentation is recorded at 3.3 ft. The sediment recorded in the monitoring wells is not considered problematic at this time. Sedimentation does not appear to impact well production and/or sampling at any of the HMSP wells.

In-situ Hydraulic Conductivity Testing - Monitoring wells MW-1, MW-3R, MW-4, MW-5, and MW-7 were installed at this site between 1992 and 2011. MW-3 (1992) was replaced with MW-3R on September 10, 2013. Boring Logs and well construction information is included in Appendix A.

The record was reviewed and results of historic in-situ hydraulic conductivity testing at each of the five (5) monitoring wells is summarized in Table 2. In-situ hydraulic conductivity testing was again performed for the five (5) wells on April 18, 2024. The reported hydraulic conductivities (Table 2) do not demonstrate considerable changes at

any monitoring point. The historic hydraulic conductivity values and the 2024 hydraulic conductivity values are highly similar and may indicate a slight increase over time. Variability in the calculated hydraulic conductivities is not attributed to well deterioration. It is our interpretation that the variability is not excessive and falls within the anticipated range of deviation. The hydraulic conductivity calculations are included in Appendix B for reference.

ASSESSMENT OF SITE HYDROLOGIC CONDITIONS

Flow Paths - Figure 1 is a recent Site Plan. Figure 2 is a recent Groundwater Contour Map and illustrates the water table surface in October, 2023. A 1993 Groundwater Contour Map, a 2011 Groundwater Contour Map, and a 2019 Groundwater Contour Map are included in Appendix C. Review of the 1993, 2011, 2019, and 2023 Groundwater Contour Maps indicate that the water table surface appears unchanged between 1993 and 2023.

Groundwater flow at the site is inward from the south, converging at the ravine centerline to the north. The wells are positioned such that the flow paths are adequately intersected, and any release will be detected by the monitoring system.

Water Level Condition and Well Location - A summary of historic water elevation data (2013-2023) is included in Appendix D. Water elevation data over the past five (5) years has remained static.

Table 3 is a summary of the recorded April 18, 2024 water level data, along with pertinent well construction information. Column 8 of Table 3 is a direct comparison of the static water elevation (April, 2024) to the top of screen elevation in each respective well. A positive value indicates that the static water level is above the top of the screen, while a negative value indicates a static water level that is below the top of the screen (within the screened interval).

Review of Table 3 indicates that the static water elevation is above the top of screen in all wells except MW-3R and MW-7. Exposure of the well screen to the atmosphere does not appear to be detrimental to the integrity of the MW-3R or MW-7 well screens. Excessive encrustation is not anticipated on the PVC screen.

The static water levels in each of the remaining wells fall above the screened interval of the given well. It appears that all wells function adequately to monitor groundwater. Draw-down in the water table recorded at the site monitoring wells during purging and bail testing (Column 11, Table 3) indicates that the water table surface descends into the screened interval in all the monitoring wells during purging activities. The samples collected over time adequately reflect water quality in the unconsolidated soils.

Replacement of those wells where the water table is above the screened interval is not recommended.

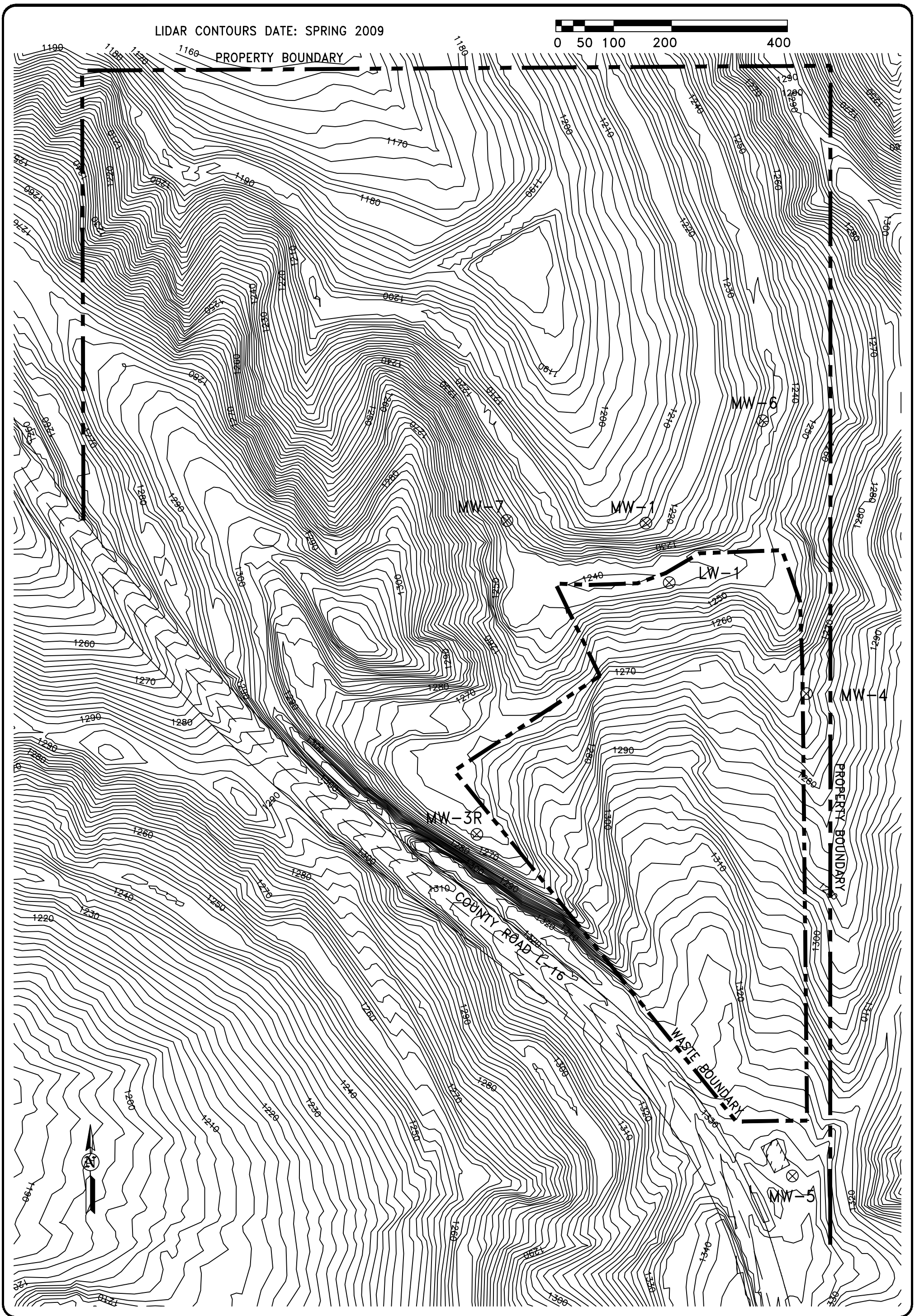
CONCLUSIONS & RECOMMENDATIONS

Assessment of the monitoring well condition indicates that all wells are in satisfactory condition and have not experienced excessive sedimentation. Excessive well deterioration is not apparent based on the comparison of historic in-situ hydraulic conductivity testing and the hydraulic conductivity testing performed in April, 2024.

The water table surface is relatively unchanged between 1993 and 2023, and the well are interpreted to be located appropriately to detect water quality changes.

Water levels in several of the site monitoring wells are consistently above the screened interval. The water samples collected appear to adequately reflect water quality in the subsurface saturated soils.

No changes to the monitoring wells are recommended. Further assessment of the monitoring well conditions should be made in 2029.



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SITE PLAN

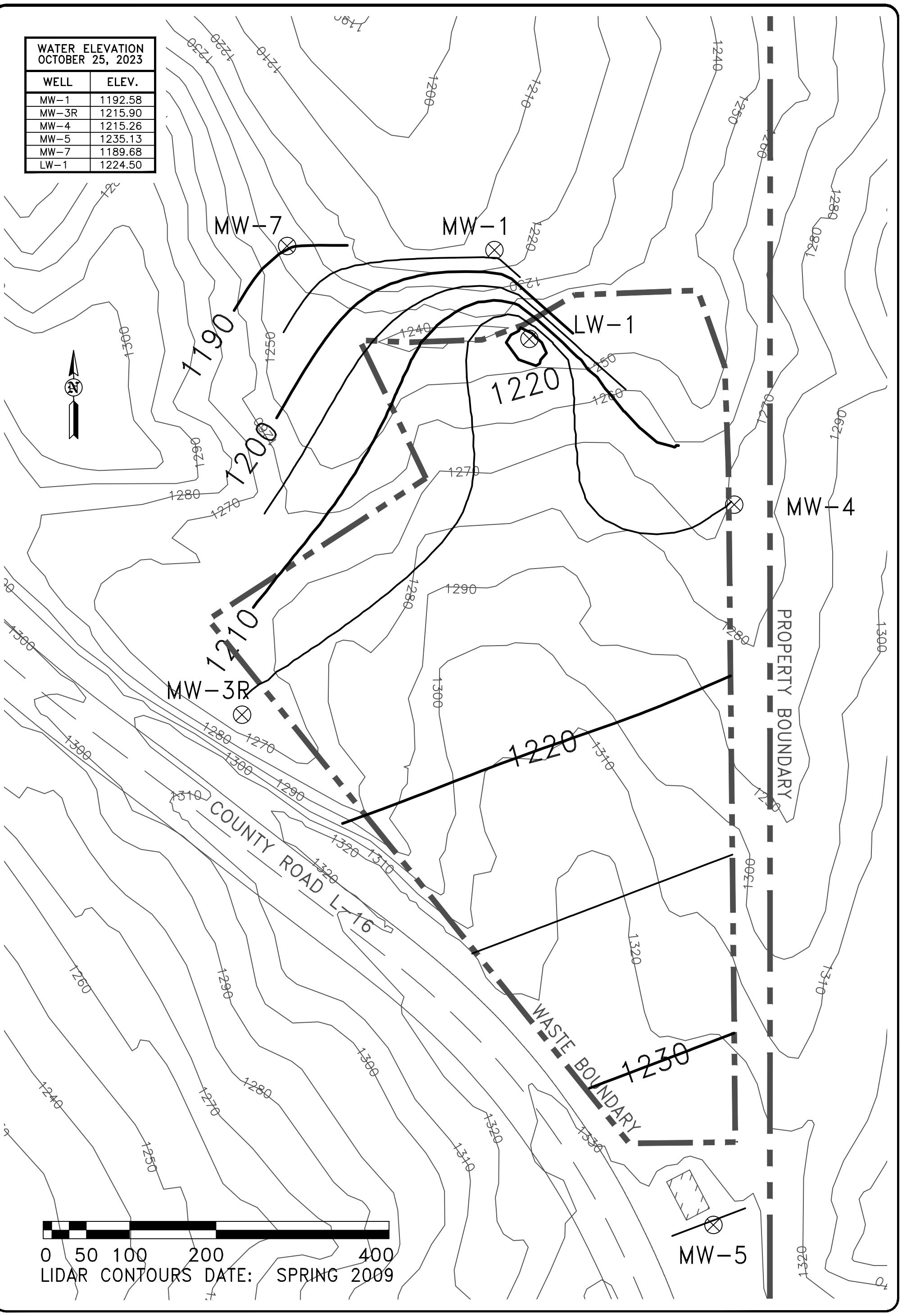
MONONA COUNTY SANITARY LANDFILL
TURIN, IOWA

FIGURE: 1

REVISION	NO.	DATE

DRAWN	PROJECT NO.	DATE
DRA	6036	10-27-23

WATER ELEVATION OCTOBER 25, 2023	
WELL	ELEV.
MW–1	1192.58
MW–3R	1215.90
MW–4	1215.26
MW–5	1235.13
MW–7	1189.68
LW–1	1224.50



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WATER TABLE MAP

MONONA COUNTY SANITARY LANDFILL
TURIN, IOWA

FIGURE: 1

REVISION	NO.	DATE
DRAWN DRA	PROJECT NO. 6036	DATE 10–27–23

TABLE 1
Assessment of Well Depth & Sedimentation

Well No.	Top of Casing Elevation	Original Bottom Depth	Original Bottom Elevation	April, 2024 Bottom Depth	April, 2024 Bottom Elevation	April, 2024 Sediment Thickness (ft)
MW-1	1219.49	42.19	1177.3	42.5	1176.99	-0.31
MW-3R	1266.20	66.7	1199.5	66.7	1199.5	0
MW-4	1275.60	82	1193.6	78.7	1196.9	3.3
MW-5	1335.64	121.64	1214	121.5	1214.14	0.14
MW-7	1236.98	54.78	1182.2	54.5	1182.48	0.28

TABLE 2

Hydraulic Conductivity Summary Data
Monona County Sanitary Landfill

Well No.	Installation Date	11/24/1992 K cm/sec	1/6/2012 K cm/sec	4/15/2019 K cm/sec	4/18/2024 K cm/sec
MW-1	3/24/1992	8.10E-05	8.10E-05	1.81E-04	2.68E-04
MW-3R	9/10/2013	4.20E-05	4.20E-05	3.71E-05	3.26E-05
MW-4	11/6/1992	3.00E-05	3.00E-05	4.16E-05	4.92E-05
MW-5	11/12/1992	1.60E-05	1.60E-05	4.43E-05	3.03E-05
MW-7	10/6/2011	DNE	2.40E-05	5.15E-05	6.70E-05

DNE = Does not exist

TABLE 3
Water Elevation Versus Top of Screen (April, 2024)

Well No.	Top of Casing Elevation	Top of Screen Elevation	Bottom of Screen Elevation	Screen Length	Static Water Depth	Static Water Elevation	Static Water Level Versus Top of Screen	Purged Water Depth	Purged Water Elevation	Purged Water Level Versus Top of Screen
MW-1	1219.49	1192.3	1177.3	15	27.16	1192.33	0.03	30.2	1189.29	-3.01
MW-3R	1266.20	1215.2	1200.2	15	51.21	1214.99	-0.21	58.8	1207.4	-7.8
MW-4	1275.60	1208.6	1193.6	15	56.92	1218.68	10.08	73.35	1202.25	-6.35
MW-5	1335.64	1229	1214	15	101.35	1234.29	5.29	115.9	1219.74	-9.26
MW-7	1236.98	1197.2	1182.2	15	47.35	1189.63	-7.57	51.4	1185.58	-11.62

"-" = feet below top of screen (within the screened interval). All positive values are feet above the screen.

APPENDIX A

Boring Logs and Well Construction Information

LOG OF WELL NO. MW-1

CLIENT
Monona County Solid Waste Agency

SITE
24997 County Road L16
Turin, Iowa

PROJECT
Monona County Landfill Lateral Expansion

DESCRIPTION	
BOREHOLE DIA.:	8.25 in
WELL DIA.:	2 in
CASING AND SCREEN:	PVC (sch. 40); 0.01 slotted screen
TOP OF CASING:	1219.49 ft
GROUND SURFACE ELEV.:	1216.3 ft

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB
	LEAN CLAY (LOESS) Brown		5 10 15 20 25			HS					

Continued Next Page

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 30	WD	▽
WL	▽		▽
WL			

Terracon

BORING STARTED	3-24-92		
BORING COMPLETED	3-24-92		
RIG	CME 850	DRILLER	JB
LOGGED	R. Bauman	JOB #	05117092

WELL 05107026 LOGS.GPJ TERRACON.GDT 1/6/12

LOG OF WELL NO. MW-1

CLIENT: Monona County Solid Waste Agency

SITE: 24997 County Road L16, Turin, Iowa

PROJECT: Monona County Landfill Lateral Expansion

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB
	▽		30								
			35								
	40 1176.5		40								
	BOTTOM OF BORING										
	NOTE: Soil classifications were based on visual observations made by the field crew at nearby boring PZ-1A.										

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 30	WD	▼
WL	▽		▽
WL			

Terracon

BORING STARTED	3-24-92		
BORING COMPLETED	3-24-92		
RIG	CME 850	DRILLER	JB
LOGGED	R. Bauman	JOB #	05117092

WELL 05107026 LOGS.GPJ TERRACON.GDT 1/6/12

LOG OF WELL NO. MW-3R

CLIENT
Monona County Solid Waste Agency

SITE **24997 County Road L16**
Turin, Iowa

PROJECT
Monona County Landfill

DESCRIPTION	
BOREHOLE DIA.:	8.25 in
WELL DIA.:	2 in
CASING AND SCREEN:	PVC (sch. 40)
TOP OF CASING:	1270.56 ft
GROUND SURFACE ELEV.:	1268.6 ft

LEAN CLAY (LOESS)
Light brown

HS

Continued Next Page

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft		
WL	▽	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	9-10-13		
BORING COMPLETED	9-10-13		
RIG	CME 850	DRILLER	
LOGGED		JOB #	05137078

WELL 05137078 LOGS.GPJ TERRACON.GDT 2/17/16

LOG OF WELL NO. MW-3R

CLIENT
Monona County Solid Waste Agency

SITE
24997 County Road L16
Turin, Iowa

PROJECT
Monona County Landfill

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB
	43 1225.5 **LEAN CLAY (LOESS)** Brown		45								
			50								
			55								
			60								
	65 1203.5 **BOTTOM OF BORING**		65								

NOTE: Soil classifications were based on visual observations made by the field crew at nearby well PZ-3.
Log for monitoring well MW-3R not prepared. Monitoring well MW-3R adapted from nearby PZ-3 and MW-3 boring and monitoring well logs.

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft		
WL	▽	▼
WL	▽	▼
WL		

Terracon

BORING STARTED			9-10-13
BORING COMPLETED			9-10-13
RIG	CME 850	DRILLER	
LOGGED		JOB #	05137078

WELL 05137078 LOGS.GPJ TERRACON.GDT 2/17/16

LOG OF WELL NO. MW-4

CLIENT
Monona County Solid Waste Agency

SITE
24997 County Road L16
Turin, Iowa

PROJECT
Monona County Landfill Lateral Expansion

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB
	BOREHOLE DIA.: 8.25 in WELL DIA.: 2 in CASING AND SCREEN: PVC (sch. 40); 0.01 slotted screen TOP OF CASING: 1275.60 ft GROUND SURFACE ELEV.: 1258.6 ft										
	LEAN CLAY (LOESS) Brown		5 10 15 20 25			HS					

Continued Next Page

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 65.0	WD	▼ 55.0 24 HRS. AB
WL	▽		▼
WL			

Terracon

BORING STARTED	11-5-92		
BORING COMPLETED	11-6-92		
RIG	CME 75	DRILLER	JB
LOGGED R. Bauman		JOB.#	05117092

WELL 05107026 LOGS.GPJ TERRACON.GDT 12/12/11

LOG OF WELL NO. MW-4

CLIENT: Monona County Solid Waste Agency

SITE: 24997 County Road L16, Turin, Iowa

PROJECT: Monona County Landfill Lateral Expansion

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB
			30								
			35								
			40								
			45								
			50								

Continued Next Page

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 65.0	WD	▼ 55.0 24 HRS. AB
WL	▽		▼
WL			

Terracon

BORING STARTED	11-5-92		
BORING COMPLETED	11-6-92		
RIG	CME 75	DRILLER	JB
LOGGED	R. Bauman	JOB #	05117092

LOG OF WELL NO. MW-4

CLIENT: Monona County Solid Waste Agency

SITE: 24997 County Road L16, Turin, Iowa

PROJECT: Monona County Landfill Lateral Expansion

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB
	▼		55								
	59 1199.5										
	LEAN CLAY (LOESS) Gray		60								
	▽										
	66 1192.5		65								
	BOTTOM OF BORING										
	NOTE: Soil classifications were based on visual observations made by the field crew at nearby well PZ-4.										

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 65.0	WD	▼ 55.0 24 HRS. AB
WL	▼		▼
WL			

Terracon

BORING STARTED	11-5-92		
BORING COMPLETED	11-6-92		
RIG	CME 75	DRILLER	JB
LOGGED	R. Bauman	JOB #	05117092

WELL 05107026 LOGS.GPJ TERRACON.GDT 12/12/11

LOG OF WELL NO. MW-5

CLIENT: Monona County Solid Waste Agency

SITE: 24997 County Road L16, Turin, Iowa

PROJECT: Monona County Landfill Lateral Expansion

DESCRIPTION	
BOREHOLE DIA.:	8.25 in
WELL DIA.:	2 in
CASING AND SCREEN:	PVC (sch. 40); 0.01 slotted screen
TOP OF CASING:	1335.64 ft
GROUND SURFACE ELEV.:	1333.0 ft

GRAPHIC LOG	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB
LEAN CLAY (LOESS) Light brown		5 10 15 20 25			HS					

Continued Next Page

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft		
WL	▽	▼ 111.0 24 HRS. AB
WL	▽	▽
WL		

Terracon

BORING STARTED	11-10-92		
BORING COMPLETED	11-12-92		
RIG	CME 75	DRILLER	JB
LOGGED R. Bauman		JOB #	05117092

LOG OF WELL NO. MW-5

CLIENT: Monona County Solid Waste Agency

SITE: 24997 County Road L16, Turin, Iowa

PROJECT: Monona County Landfill Lateral Expansion

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB
			30								
			35								
			40								
			45								
			50								

Continued Next Page

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft		
WL	▽	▼ 111.0 24 HRS. AB
WL	▽	▼
WL		

Terracon

BORING STARTED	11-10-92		
BORING COMPLETED	11-12-92		
RIG	CME 75	DRILLER	JB
LOGGED	R. Bauman	JOB #	05117092

LOG OF WELL NO. MW-5

CLIENT: Monona County Solid Waste Agency

SITE: 24997 County Road L16, Turin, Iowa

PROJECT: Monona County Landfill Lateral Expansion

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB
	53 1280		55								
	LEAN CLAY (LOESS) Dark brown										
	58 1275		60								
	LEAN CLAY (LOESS), with oxidized iron Brown		65								
			70								
			75								

Continued Next Page

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft		
WL	▽	▼ 111.0 24 HRS. AB
WL	▽	▽
WL		

Terracon

BORING STARTED	11-10-92		
BORING COMPLETED	11-12-92		
RIG	CME 75	DRILLER	JB
LOGGED	R. Bauman	JOB #	05117092

LOG OF WELL NO. MW-5

CLIENT: Monona County Solid Waste Agency

SITE: 24997 County Road L16, Turin, Iowa

PROJECT: Monona County Landfill Lateral Expansion

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB
	88 1245 **LEAN CLAY (LOESS)**, with oxidized iron Brown and gray (mottled)		80								
	93 1240 **LEAN CLAY (LOESS)** Brown		85								
			90								
			95								
			100								

Continued Next Page

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft		
WL	▽	▼ 111.0 24 HRS. AB
WL	▽	▼
WL		

Terracon

BORING STARTED	11-10-92		
BORING COMPLETED	11-12-92		
RIG	CME 75	DRILLER	JB
LOGGED	R. Bauman	JOB #	05117092

LOG OF WELL NO. MW-5

CLIENT: Monona County Solid Waste Agency

SITE: 24997 County Road L16, Turin, Iowa

PROJECT: Monona County Landfill Lateral Expansion

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB
			105								
			110								
			115								
			120								

▼

118 1215

LEAN CLAY (LOESS)
Gray

120 1213

BOTTOM OF BORING

NOTE: Soil classifications were based on visual observations made by the field crew at nearby well PZ-5.

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft		
WL	▽	▼ 111.0 24 HRS. AB
WL	▽	▽
WL		

Terracon

BORING STARTED	11-10-92		
BORING COMPLETED	11-12-92		
RIG	CME 75	DRILLER	JB
LOGGED	R. Bauman	JOB #	05117092

WELL 05107026 LOGS.GPJ TERRACON.GDT 12/12/11

LOG OF WELL NO. MW-7

CLIENT: Monona County Solid Waste Agency

SITE: 24997 County Road L16, Turin, Iowa

PROJECT: Monona County Landfill Lateral Expansion

DESCRIPTION	
BOREHOLE DIA.:	8.25 in
WELL DIA.:	2 in
CASING AND SCREEN:	PVC (sch. 40); 0.01 slotted screen
TOP OF CASING:	1236.98 ft
GROUND SURFACE ELEV.:	1234.2 ft

GRAPHIC LOG	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB	TESTS: PNT. TEST (TSF)
		0			HS						

LEAN CLAY (LOESS), trace oxidized iron and calcium carbonate bearing sediments
Brown and gray (mottled)
Dry

5
10
15
20
25
30

Continued Next Page

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft		
WL	▽	▼
WL	▽ 47.94 10/18/11	▼
WL		

Terracon

BORING STARTED	10-5-11		
BORING COMPLETED	10-6-11		
RIG Diedrich D-120		DRILLER	S. Pfouts
LOGGED S. Wozab		JOB #	05117092

LOG OF WELL NO. MW-7

CLIENT: Monona County Solid Waste Agency

SITE: 24997 County Road L16, Turin, Iowa

PROJECT: Monona County Landfill Lateral Expansion

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: FIELD VAPOR TEST (PPM)*	TESTS: SAMPLE SENT TO LAB	TESTS: PNT. TEST (TSF)
	The soils were moist at 38 feet below grade during drilling.		35									
				-37								
			40									
			45									
			50									
				-52								
	43 1191											
	LEAN CLAY (LOESS), trace oxidized iron Gray Moist The soils were wet at 48 feet below grade during drilling. ▼											
	53 1181											
	BOTTOM OF BORING NOTE: Soil classifications were based on visual observations made by the field crew at nearby boring PZ-7.											

The stratification lines represent the approximate boundaries between soil and rock types: in-situ, the transition may be gradual.

* ND indicates a reading of less than the field detection limit of one (1) part per million (ppm) isobutylene equivalents.

WATER LEVEL OBSERVATIONS, ft			
WL	▽		▼
WL	▽ 47.94	10/18/11	▼
WL			

Terracon

BORING STARTED	10-5-11		
BORING COMPLETED	10-6-11		
RIG Diedrich D-120	DRILLER	S. Pfouts	
LOGGED S. Wozab	JOB #	05117092	

APPENDIX B

Hydraulic Conductivity Calculations

BOUWER-RICE SLUG TEST ANALYSIS

SITE
Monona County Sanitary Landfill

CLIENT
Monona County Sanitary Landfill
Job/Account: 6036 2024

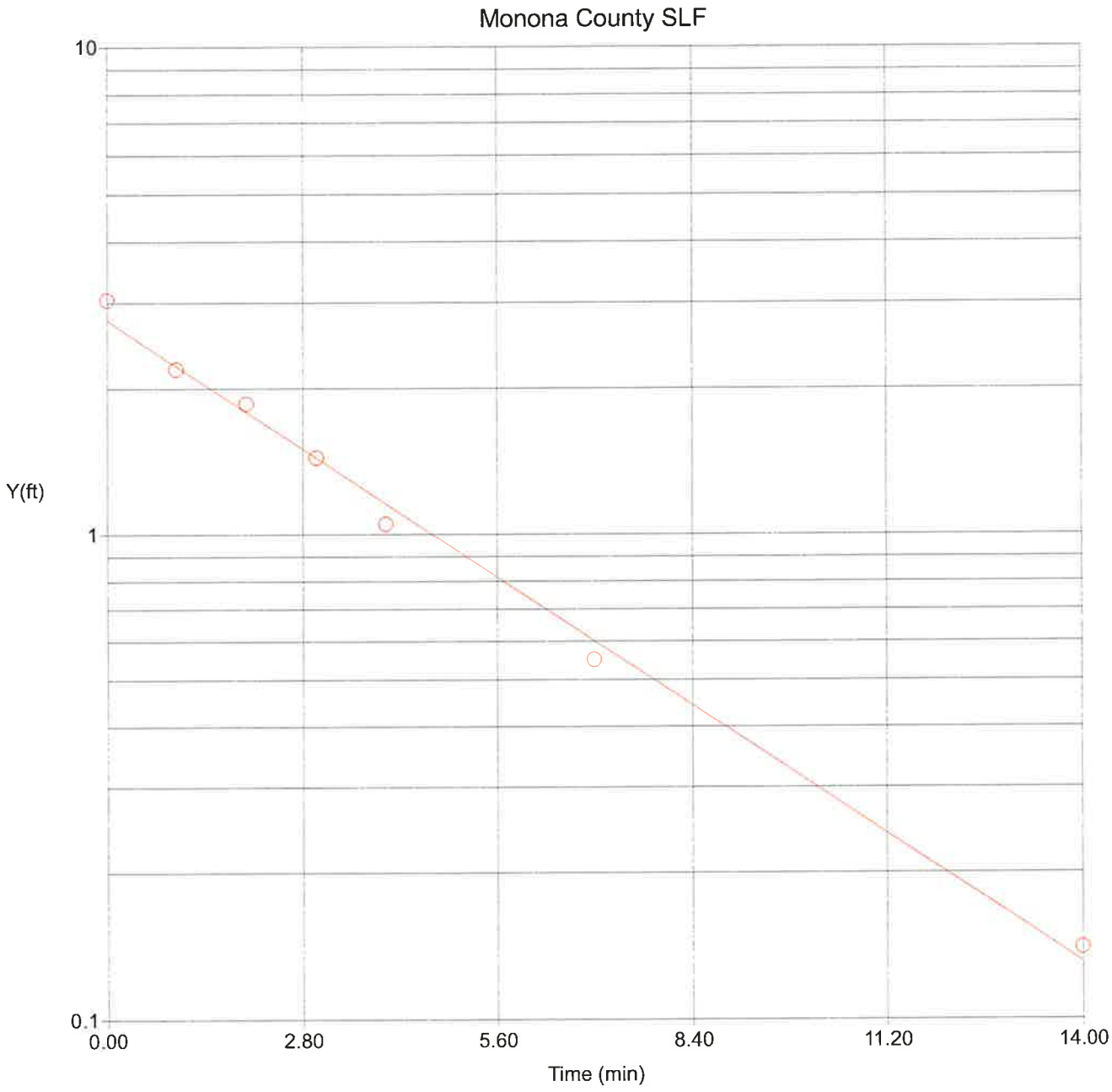
CONSULTANT
HLW Engineering Group

SLUG TEST
Hydraulic Conductivity: 2.68e-04 cm/sec
Monitoring Well: MW-1
Test Date: 04/18/2024
Field Testing by: TDW
Test Analysis by: TDW

WELL GEOMETRY
H: 25.34 ft
Lw: 15.34 ft
Le: 15.0 ft
dw: 0.66667 ft, rw: 0.333 ft
dc: 0.16667 ft, rc: 0.0833 ft
Drained Filter Pack Porosity (%): 20
Effective Radius (re): 0.167 ft
Slug Volume(L):

BOUWER-RICE COEFFICIENTS
Le/rw: 45.0
A: 2.82
B: 0.425
C: 2.47
Ln(Re/rw): 2.62

LEAST SQUARES BEST FIT
Ln(Y)-cm versus Time-sec
Slope: -3.63e-03
Intercept: 4.43



LUST No.:	Site Name: Monona County Sanitary Landfill	
Hydraulic Conductivity: 2.68e-04 cm/sec	Well: MW-1	Slug Test Date: 04/18/2024
HLW Engineering Group	CGWP:	

BOUWER-RICE SLUG TEST ANALYSIS

SITE
Monona County Sanitary Landfill

CLIENT
Monona County Sanitary Landfill
Job/Account: 6036 2024

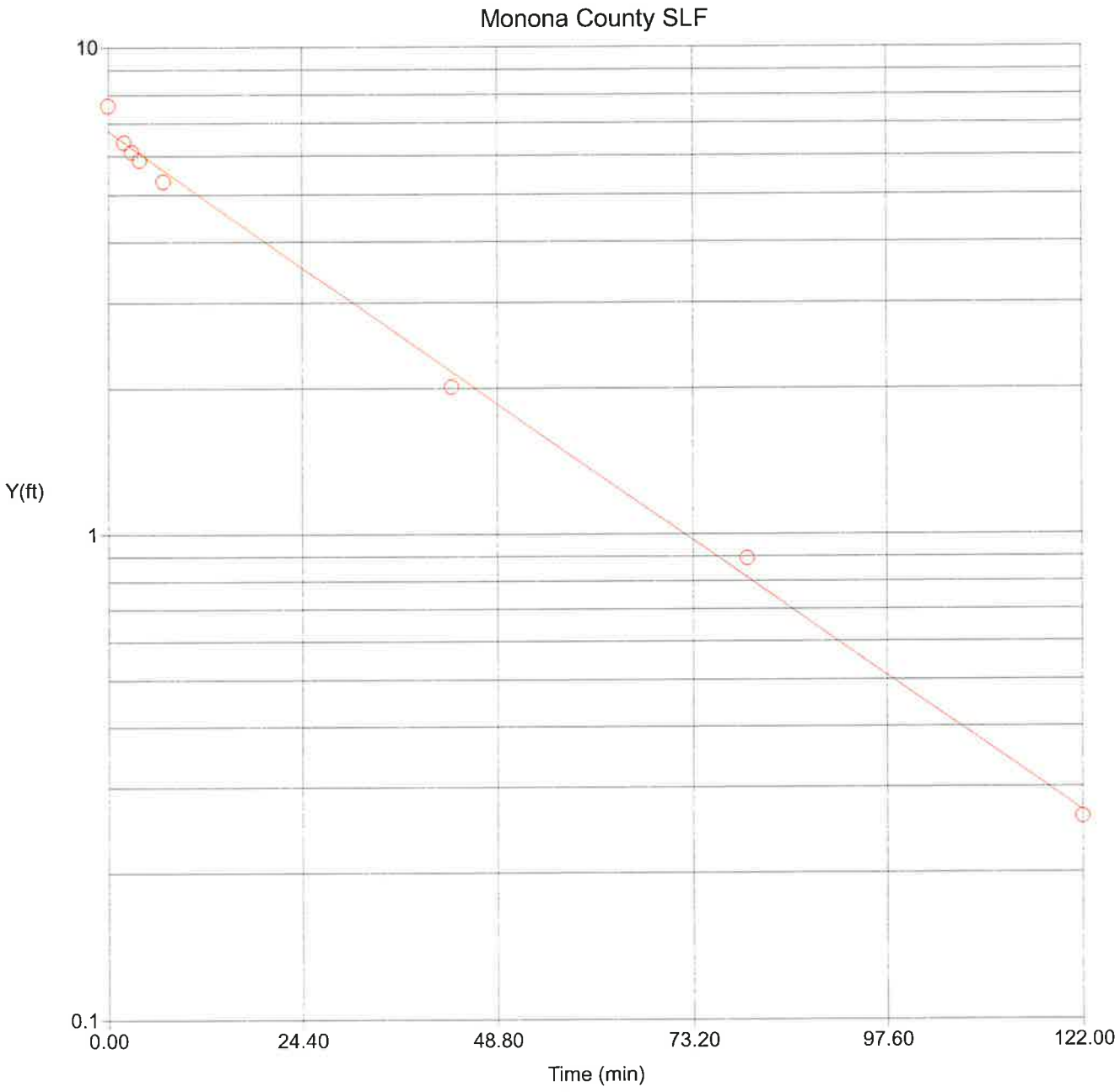
CONSULTANT
HLW Engineering Group

SLUG TEST
Hydraulic Conductivity: 3.26e-05 cm/sec
Monitoring Well: MW-3R
Test Date: 04/18/2024
Field Testing by: TDW
Test Analysis by: TDW

WELL GEOMETRY
H: 25.49 ft
Lw: 15.49 ft
Le: 15.0 ft
dw: 0.66667 ft, rw: 0.333 ft
dc: 0.16667 ft, rc: 0.0833 ft
Drained Filter Pack Porosity (%): 20
Effective Radius (re): 0.167 ft
Slug Volume(L):

BOUWER-RICE COEFFICIENTS
Le/rw: 45.0
A: 2.82
B: 0.425
C: 2.47
Ln(Re/rw): 2.62

LEAST SQUARES BEST FIT
Ln(Y)-cm versus Time-sec
Slope: -4.41e-04
Intercept: 5.33



LUST No.:	Site Name: Monona County Sanitary Landfill	
Hydraulic Conductivity: 3.26e-05 cm/sec	Well: MW-3R	Slug Test Date: 04/18/2024
HLW Engineering Group	CGWP:	

BOUWER-RICE SLUG TEST ANALYSIS

SITE
Monona County Sanitary Landfill

CLIENT
Monona County Sanitary Landfill
Job/Account: 6036 2024

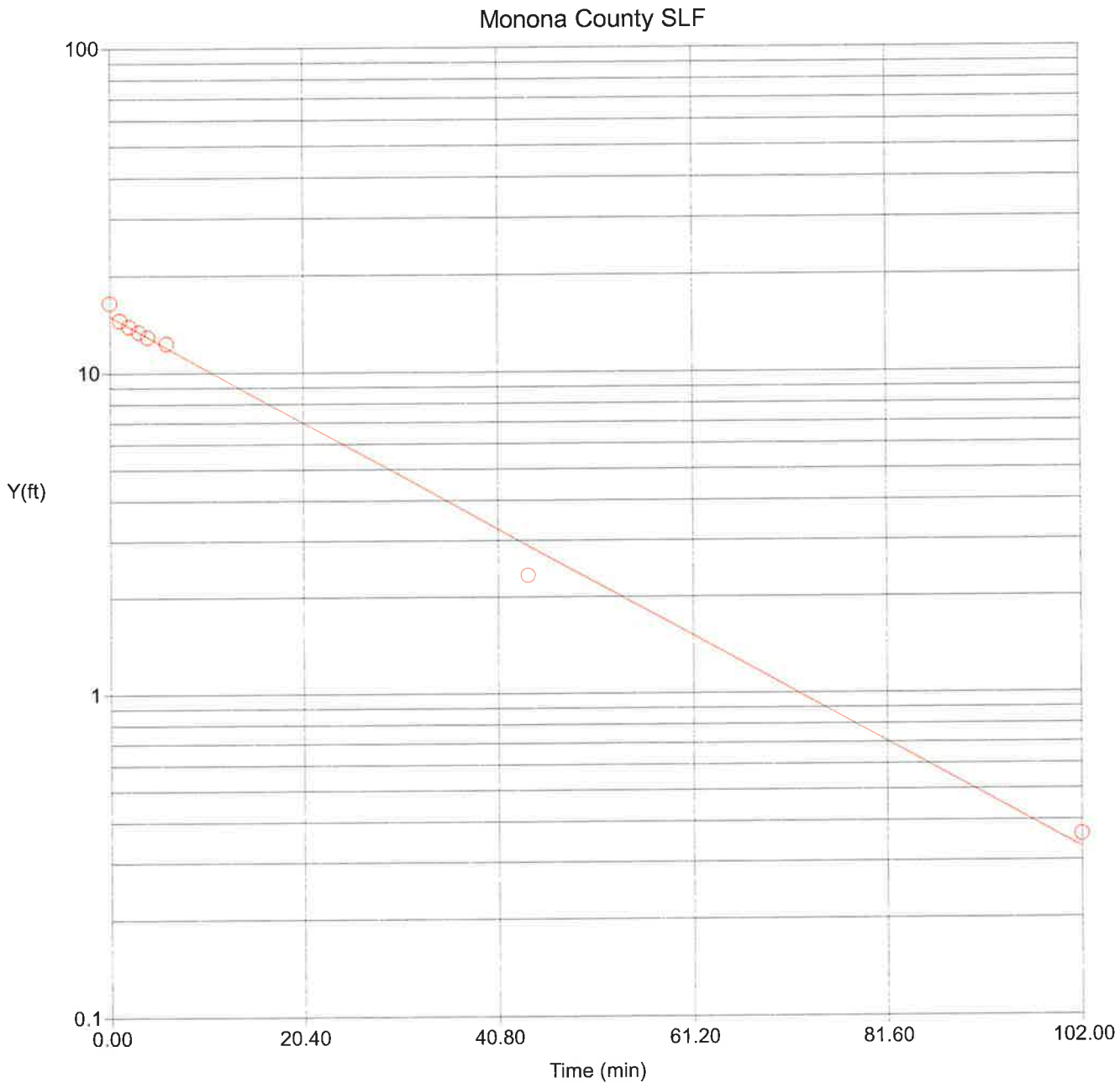
CONSULTANT
HLW Engineering Group

SLUG TEST
Hydraulic Conductivity: 4.92e-05 cm/sec
Monitoring Well: MW-4
Test Date: 04/18/2024
Field Testing by: TDW
Test Analysis by: TDW

WELL GEOMETRY
H: 31.78 ft
Lw: 21.78 ft
Le: 15.0 ft
dw: 0.66667 ft, rw: 0.333 ft
dc: 0.16667 ft, rc: 0.0833 ft
Drained Filter Pack Porosity (%): 20
Effective Radius (re): 0.167 ft
Slug Volume(L):

BOUWER-RICE COEFFICIENTS
Le/rw: 45.0
A: 2.82
B: 0.425
C: 2.47
Ln(Re/rw): 2.79

LEAST SQUARES BEST FIT
Ln(Y)-cm versus Time-sec
Slope: -6.24e-04
Intercept: 6.12



LUST No.:	Site Name: Monona County Sanitary Landfill	
Hydraulic Conductivity: 4.92e-05 cm/sec	Well: MW-4	Slug Test Date: 04/18/2024
HLW Engineering Group	CGWP:	

BOUWER-RICE SLUG TEST ANALYSIS

SITE
Monona County Sanitary Landfill

CLIENT
Monona County Sanitary Landfill
Job/Account: 6036 2024

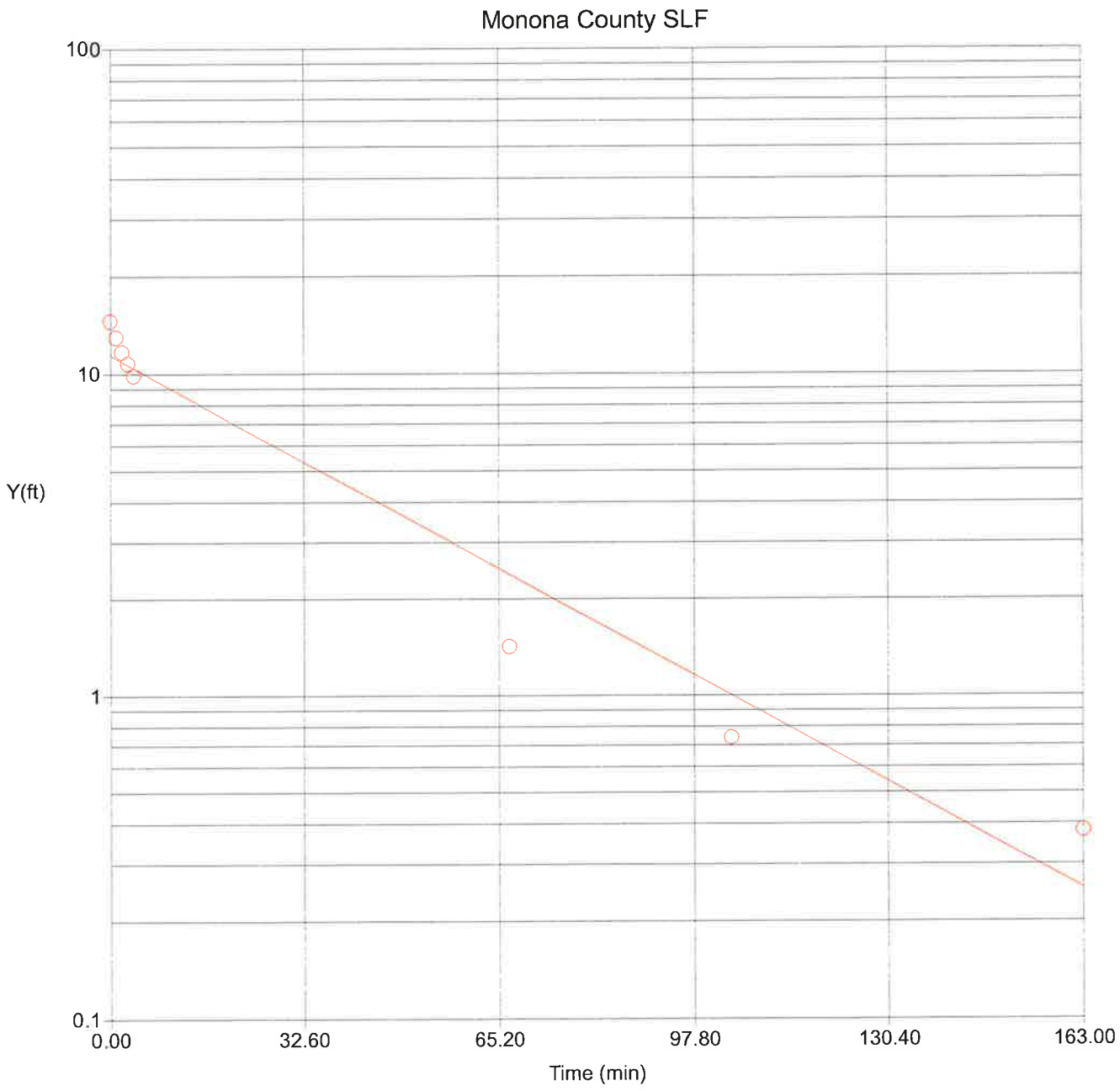
CONSULTANT
HLW Engineering Group

SLUG TEST
Hydraulic Conductivity: 3.03e-05 cm/sec
Monitoring Well: MW-5
Test Date: 04/18/2024
Field Testing by: TDW
Test Analysis by: TDW

WELL GEOMETRY
H: 30.15 ft
Lw: 20.15 ft
Le: 15.0 ft
dw: 0.66667 ft, rw: 0.333 ft
dc: 0.16667 ft, rc: 0.0833 ft
Drained Filter Pack Porosity (%): 20
Effective Radius (re): 0.167 ft
Slug Volume(L):

BOUWER-RICE COEFFICIENTS
Le/rw: 45.0
A: 2.82
B: 0.425
C: 2.47
Ln(Re/rw): 2.76

LEAST SQUARES BEST FIT
Ln(Y)-cm versus Time-sec
Slope: -3.90e-04
Intercept: 5.85



LUST No.:	Site Name: Monona County Sanitary Landfill	
Hydraulic Conductivity: 3.03e-05 cm/sec	Well: MW-5	Slug Test Date: 04/18/2024
HLW Engineering Group	CGWP:	

BOUWER-RICE SLUG TEST ANALYSIS

SITE
Monona County Sanitary Landfill

CLIENT
Monona County Sanitary Landfill
Job/Account: 6036 2024

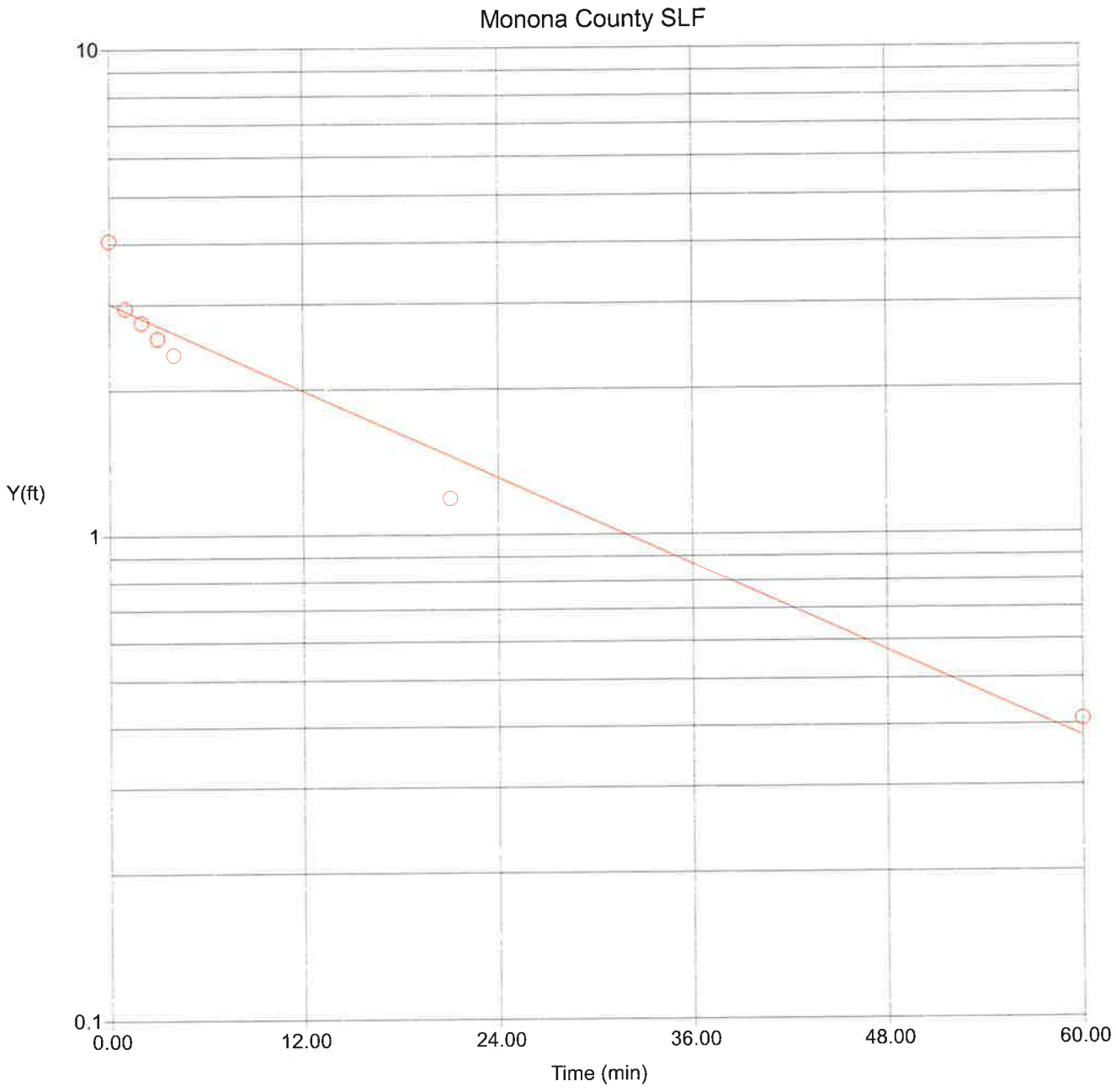
CONSULTANT
HLW Engineering Group

SLUG TEST
Hydraulic Conductivity: 6.70e-05 cm/sec
Monitoring Well: MW-7
Test Date: 04/18/2024
Field Testing by: TDW
Test Analysis by: TDW

WELL GEOMETRY
H: 17.15 ft
Lw: 7.15 ft
Le: 7.15 ft
dw: 0.66667 ft, rw: 0.333 ft
dc: 0.16667 ft, rc: 0.0833 ft
Drained Filter Pack Porosity (%): 20
Effective Radius (re): 0.167 ft
Slug Volume(L):

BOUWER-RICE COEFFICIENTS
Le/rw: 21.4
A: 2.18
B: 0.307
C: 1.58
Ln(Re/rw): 1.96

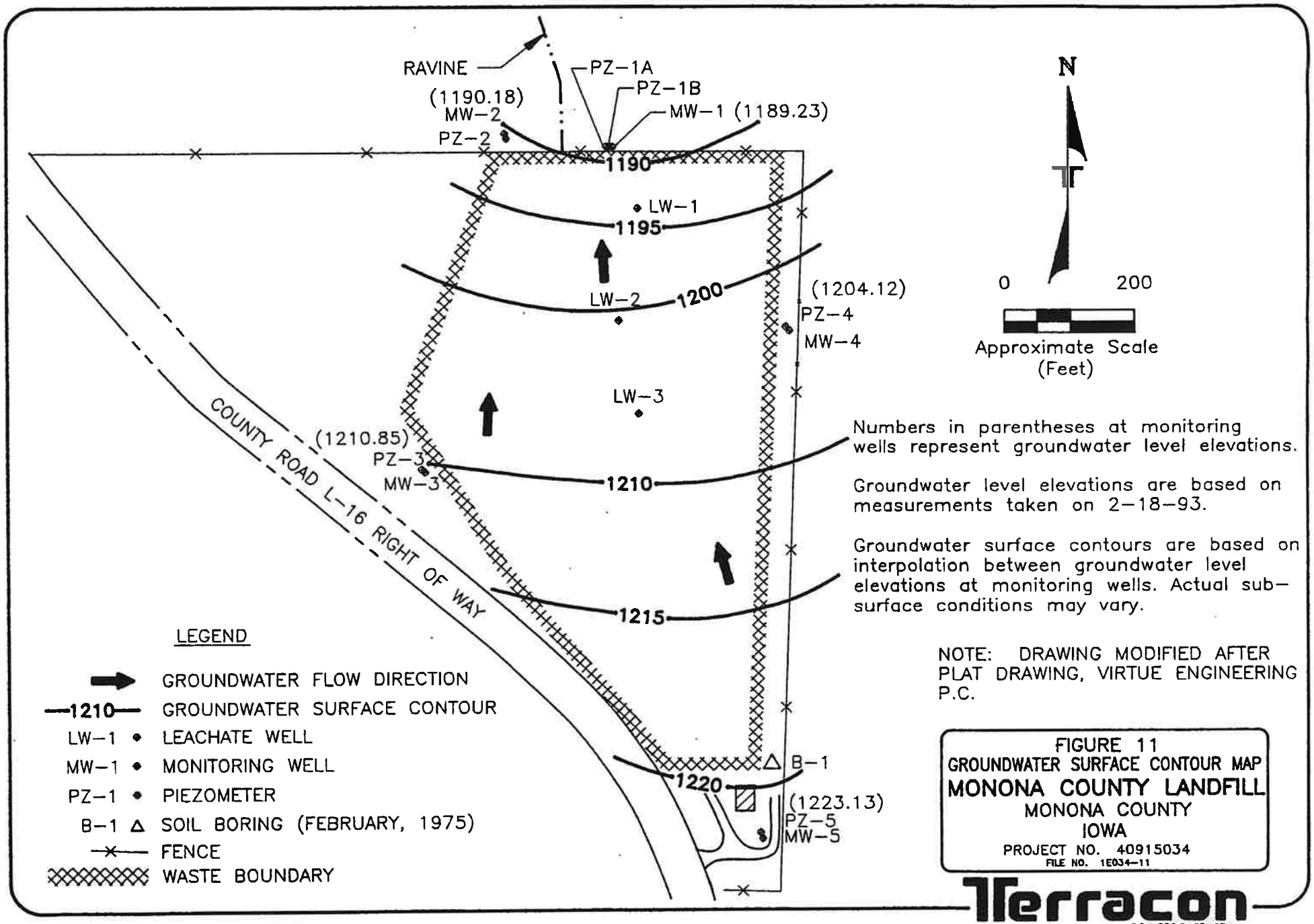
LEAST SQUARES BEST FIT
Ln(Y)-cm versus Time-sec
Slope: -5.76e-04
Intercept: 4.52



LUST No.:	Site Name: Monona County Sanitary Landfill	
Hydraulic Conductivity: 6.70e-05 cm/sec	Well: MW-7	Slug Test Date: 04/18/2024
HLW Engineering Group	CGWP:	

APPENDIX C

Historic Groundwater Contour Maps (1993 & 2011 & 2019)



Numbers in parentheses at monitoring wells represent groundwater level elevations.

Groundwater level elevations are based on measurements taken on 2-18-93.

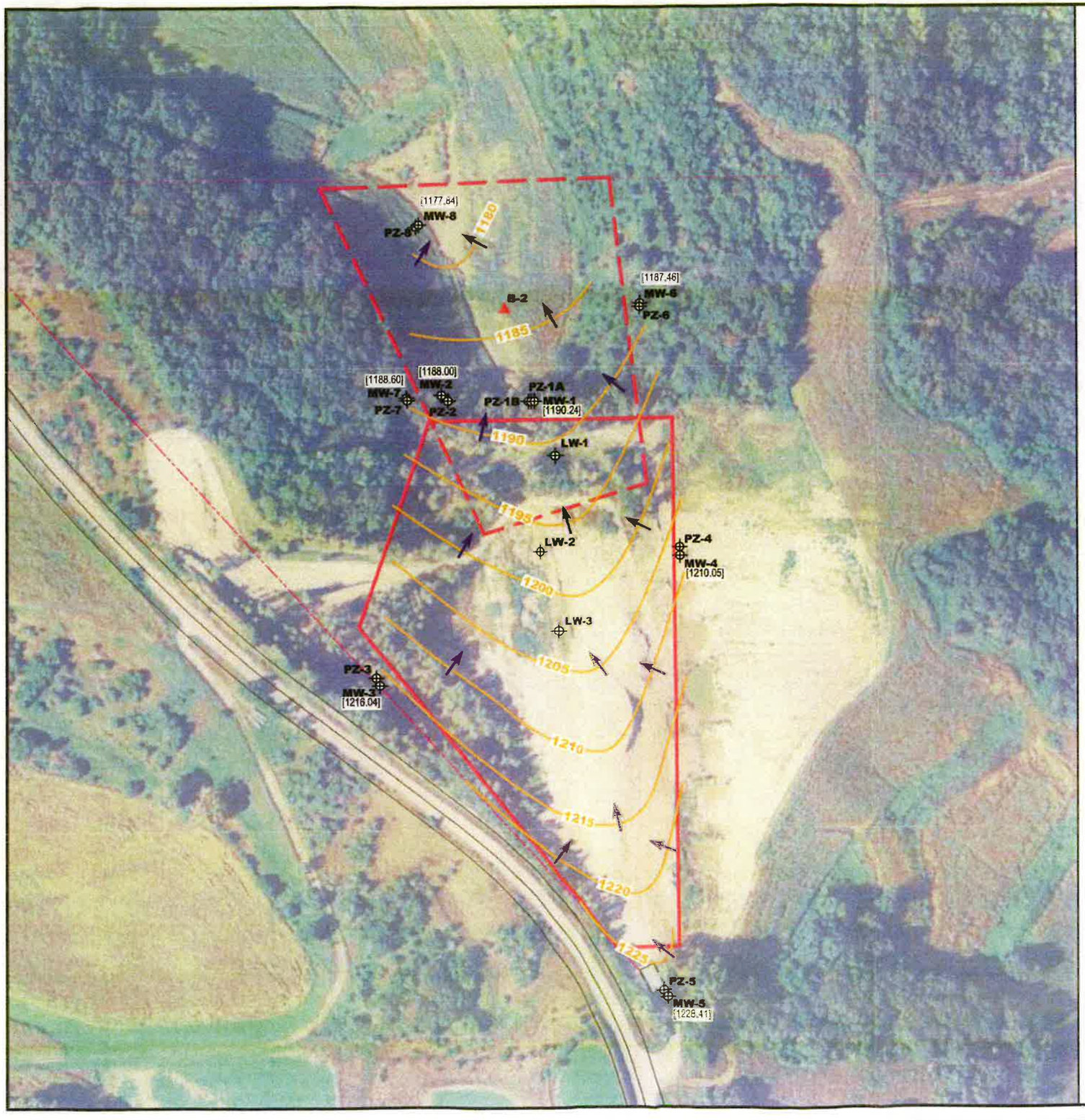
Groundwater surface contours are based on interpolation between groundwater level elevations at monitoring wells. Actual sub-surface conditions may vary.

NOTE: DRAWING MODIFIED AFTER PLAT DRAWING, VIRTUE ENGINEERING P.C.

FIGURE 11
GROUNDWATER SURFACE CONTOUR MAP
MONONA COUNTY LANDFILL
MONONA COUNTY
IOWA
PROJECT NO. 40915034
FILE NO. 1E034-11

Terracon

RO RBC 2-23-93



LEGEND

- LIMIT OF FILL FOR EXISTING CELL
- LIMIT OF FILL FOR PROPOSED NEW CELL
- EXISTING MONITORING POINT
- EXISTING BORING
- 1205 — GROUNDWATER ELEVATION CONTOUR LINE
- [1210.05] — GROUNDWATER ELEVATION (FEET)
- INFERRED GROUNDWATER FLOW DIRECTION

NOTES:

1) THE AERIAL IMAGE WAS OBTAINED FROM A 2010 IOWA GEOLOGIC MAP SERVER.
2) THE TOPOGRAPHIC IMAGE WAS GENERATED FROM IDNR LIDAR DATA COLLECTED IN 2008.
3) GROUNDWATER ELEVATION CONTOURS ARE BASED ON INTERPOLATION BETWEEN WATER LEVELS MEASURED IN MONITORING WELLS ON OCTOBER 18, 2011.

N

0 50 100 200
SCALE IN FEET

DESIGNED BY:	STW
DRAWN BY:	PM
APPRO. BY:	DMS
SCALE:	AS SHOWN
DATE:	1/4/12
JOB NO.	05117092
ACAD NO.	05117092C01
FIGURE NO.:	6A

GROUNDWATER CONTOUR MAP

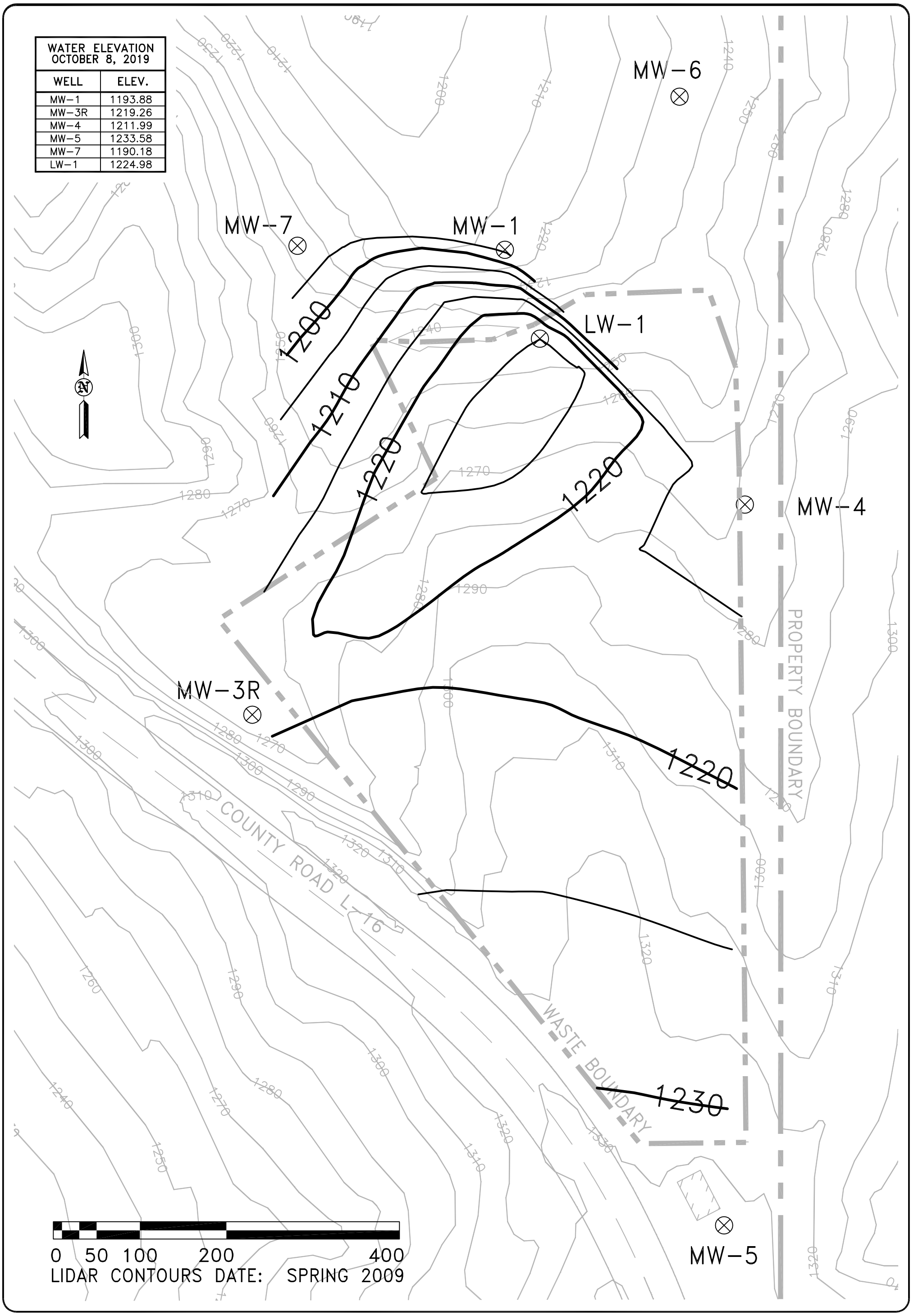
MONONA COUNTY LANDFILL LATERAL EXPANSION
MONONA COUNTY SOILD WASTE AGENCY
MONONA COUNTY IOWA

Terracon
Consulting Engineers and Scientists
2226 NORTH 206 STREET, SUITE B LINCOLN, NE 68521
PH. (402) 466-3911 FAX. (402) 466-0811

REV.	DATE	BY	DESCRIPTION

P:\2011\05117092\PROJECT DOCUMENTS\Reports\Letters-Drafts To Clients\Drawings\05117092C01.dwg

WATER ELEVATION OCTOBER 8, 2019	
WELL	ELEV.
MW–1	1193.88
MW–3R	1219.26
MW–4	1211.99
MW–5	1233.58
MW–7	1190.18
LW–1	1224.98



HLW Engineering Group
204 West Broad Street, P.O. Box 314
Story City, Iowa 50248
Phone: (515) 733-4144
FAX: (515) 733-4146

WATER TABLE MAP

MONONA COUNTY SANITARY LANDFILL
MONONA COUNTY, IOWA

FIGURE: 2

REVISION	NO.	DATE
DRAWN DRA	PROJECT NO. 6036–14A	DATE 10–13–19

APPENDIX D

Historic Water Table Elevations

Water Elevation Data
Monona County Landfill
67-SDP-1-75P

Well/TOC	MW-1	1219.73	MW-3R	1266.2	MW-4	1271.62	MW-5	1335.73	MW-7	1236.98
	Water Depth	Water Elevation	Water Depth	Water Elevation	Water Depth	Water Elevation	Water Depth	Water Elevation	Water Depth	Water Elevation
04/01/13	NT	NT	NT	NT	65.70	1205.92	104.45	1231.28	NT	NT
05/01/13	15.00	1204.73	NT	NT	64.50	1207.12	104.80	1230.93	NT	NT
06/01/13	15.00	1204.73	NT	NT	64.45	1207.17	104.65	1231.08	NT	NT
07/01/13	15.10	1204.63	NT	NT	64.45	1207.17	104.66	1231.07	NT	NT
08/01/13	18.30	1201.43	NT	NT	64.40	1207.22	104.65	1231.08	NT	NT
09/01/13	18.85	1200.88	50.90	1215.30	64.55	1207.07	104.80	1230.93	NT	NT
10/01/13	19.94	1199.79	51.11	1215.09	64.61	1207.01	104.78	1230.95	NT	NT
04/16/14	30.35	1189.38	52.20	1214.00	64.40	1207.22	105.00	1230.73	49.80	1187.18
10/21/14	29.15	1190.58	46.35	1219.85	64.70	1206.92	105.20	1230.53	49.30	1187.68
04/15/15	29.10	1190.63	48.50	1217.70	64.70	1206.92	105.25	1230.48	49.30	1187.68
10/07/15	28.45	1191.28	49.00	1217.20	65.45	1206.17	105.00	1230.73	49.00	1187.98
04/12/16	27.67	1192.06	50.07	1216.13	64.55	1207.07	105.00	1230.73	48.27	1188.71
10/11/16	27.40	1192.33	50.10	1216.10	63.51	1208.11	104.33	1231.40	47.82	1189.16
04/10/17	28.25	1191.48	50.80	1215.40	63.92	1207.70	104.04	1231.69	47.32	1189.66
10/12/17	28.00	1191.73	51.03	1215.17	62.20	1209.42	103.47	1232.26	48.20	1188.78
04/10/18	28.25	1191.48	50.10	1216.10	61.70	1209.92	103.10	1232.63	48.30	1188.68
10/04/18	27.68	1192.05	48.81	1217.39	61.20	1210.42	103.03	1232.70	48.15	1188.83
04/15/19	28.25	1191.48	50.10	1216.10	60.33	1211.29	102.32	1233.41	47.32	1189.66
10/08/19	25.85	1193.88	46.94	1219.26	59.63	1211.99	102.15	1233.58	46.80	1190.18
04/08/20	25.07	1194.66	46.22	1219.98	58.47	1213.15	101.66	1234.07	46.41	1190.57
10/02/20	25.53	1194.20	46.27	1219.93	57.91	1213.71	101.65	1234.08	46.26	1190.72
04/12/21	25.90	1193.83	46.90	1219.30	56.87	1214.75	101.05	1234.68	46.38	1190.60
10/26/21	26.25	1193.48	47.41	1218.79	55.89	1215.73	100.44	1235.29	46.56	1190.42
04/12/22	26.43	1193.30	47.65	1218.55	55.50	1216.12	99.81	1235.92	46.36	1190.62
10/07/22	26.89	1192.84	49.09	1217.11	56.25	1215.37	100.50	1235.23	47.17	1189.81
04/19/23	26.67	1193.06	48.62	1217.58	57.45	1214.17	99.80	1235.93	46.70	1190.28
10/25/23	27.15	1192.58	50.30	1215.90	56.36	1215.26	100.60	1235.13	47.30	1189.68