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April 15, 2002

Mr. John Feeney
Wisconsin Department of Natural Resources
4041 North Richards Street
P.O. Box 12436
Milwaukee, WI 53212-0436

Subject: Remedial Action Workplan
Tecumseh Products Company
Grafton, Wisconsin (WDNR FID# 24009170, BRRTS# 02-46000751

Dear Mr. Feeney:

The purpose of this letter is to provide the Wisconsin Department of Natural Resources (WDNR) with a workplan for enhanced bioremediation of soil and groundwater impacted with trichloroethene (TCE) and 1,1,1-trichloroethane (TCA), at the Tecumseh Products Company facility in Grafton, Wisconsin. Based on the findings reported in the Subsurface Investigation Report for Tecumseh Products Company (RMT, Inc., 1997) and the Bioremediation Treatability Study Results (RMT, Inc., 1999), the selected remedial action approach is *in situ* enhanced bioremediation at both the West Dock and the Southeast Degreaser and Recycling Dock Areas. In addition, approximately 200 cy of soil will be excavated from within the West Dock Area, and will be characterized for disposal. This workplan has been prepared by RMT, Inc. (RMT), on behalf of Tecumseh Products Company (Tecumseh).

Executive Summary

RMT, Inc. (RMT), on behalf of Tecumseh Products Company (Tecumseh) in Grafton, Wisconsin, has prepared this remedial action workplan. The workplan is for *in situ* enhanced bioremediation of soil and groundwater impacted with trichloroethene (TCE) and 1,1,1-trichloroethane (TCA) within the West Dock and Southeast Degreaser and Recycling Dock Areas at the Tecumseh site. Findings reported in the Subsurface Investigation Report (RMT, 1997) and the Bioremediation Treatability Study Results (RMT, 1999) indicate that anaerobic biodegradation of groundwater impacted with TCE, TCA, and their breakdown products is occurring within both areas, and will be accelerated using lactate enhancements. Lactate infiltration trenches will be constructed in the West Dock Area, and injection wells will be installed in the Southeast Degreaser and Recycling Dock Area. In addition, as part of the trench construction in the West Dock Area, petroleum and/or polycyclic aromatic hydrocarbon (PAH)–impacted soil will be excavated and characterized for proper disposal.

The remediation goal for the West Dock and the Southeast Degreaser and Recycling Dock Areas is to reduce the TCE and its daughter product concentrations in the source area groundwater to 50 percent of the concentrations measured during the sampling round that will take place in 2002, prior to the first lactate enhancement. Enhancements will occur until the remediation goal is met within each area, or for up to 5 years, whichever comes first. TCA and its daughter products will also be degraded, although the potential decrease is unknown at this time.

On behalf of Tecumseh, RMT requests the comments and approval of the Wisconsin Department of Natural Resources for the remedial action workplan by 22 April 2002, so that planning for construction and remedial action startup, which is to take place during the summer of 2002, may begin shortly thereafter.

Bioremediation Background

The anaerobic biodegradation of TCE, and similar compounds, can occur by a process known as reductive dehalogenation. This process is a redox reaction consisting of the reduction of an electron acceptor, TCE, by the replacement of a chlorine atom with a hydrogen atom, and the oxidation of an electron donor (organic substrate). This process is mediated by microorganisms that are able to obtain energy from reductive dehalogenation, making the process favorable. The electron donor that will be used at this site is lactate, a buffered form of lactic acid. When lactate is anaerobically degraded, other volatile fatty acids, such as acetic acid, and hydrogen are generated. Hydrogen is believed to be the actual electron donor in reductive dechlorination. Lactate is an innocuous food grade material that has been used successfully at other sites. Specifically, this process was used by RMT in Sun Prairie, Wisconsin, and Steve Ales was the WDNR Remediation Project Manager. The results of that project were recently presented at the Batelle *In Situ* and On-site Bioremediation Symposium held in 2001(Rice et al., 2001) (see attachment).

During the Bioremediation Treatability Study at the Tecumseh Grafton facility, laboratory studies were conducted to determine whether dehalogenation is occurring in the Southeast Degreaser and Recycling Dock and West Dock Areas. Soil and groundwater samples were collected beneath the Recycling Dock Area, also representative of the West Dock Area, and bench-scale microcosms were set up using these samples under unspiked (natural), spiked, and abiotic conditions. Anaerobic conditions were maintained throughout the 83 days of observation in the natural and spiked samples. The volatile fatty acid (VFA) results in the natural and spiked condition bottles showed decreases in acetic acid (acetate), butyric acid (butyrate), and some propionic acid (propionate), demonstrating that they are being utilized. Under these conditions, anaerobic fermentation by methanogens and likely reductive dehalogenation is occurring in the Southeast Degreaser and Recycling Dock and West Dock Areas. TCE and its breakdown products were fully degraded in the natural and spiked bottles of the extended study (+3 months). The chlorinated ethanes (TCA and its breakdown products) were not observed to significantly degrade in the laboratory studies. However, field observations do indicate that degradation of chloroethanes is occurring in both areas, and this is supported by other studies in the literature.

Treatment Performance Goals

The enhanced bioremediation system is intended to accelerate the process of biodegradation of TCE, TCA, and their respective breakdown products at the West Dock Area and the Southeast Degreaser and Recycling Dock Areas. The performance goals have been set based, in part, on the results of the Biotreatability Study performed in 1999 (RMT, 1999). In that study, intrinsic bioremediation rates were estimated for TCE and cis-dichloroethene (cis-DCE). While enhancements with lactate were not

performed in the study, our experience at the Sun Prairie site and the published experience of others, indicates that degradation rates will increase with the addition of lactate. It is estimated that, with increased biodegradation rates, groundwater concentrations in the source areas can be decreased by 50 percent over a 5-year period.

West Dock Area

Background

Plant maintenance operations were conducted at the West Dock Area, as depicted on Figures 1 through 3, from 1952 until approximately 1966. The primary solvent used for machine maintenance and cleaning during that time was TCE. The extent of the TCE impacts is shown on Figures 2 and 3. The TCE impacts in the soil extend both underneath the building and outside the building wall. The vertical extent of the TCE is limited to a relatively narrow interval, located immediately above the water table surface. The water table is located at a depth of approximately 15 feet. PAH and petroleum-related contaminants were found to a limited horizontal extent within the upper 5 feet in the West Dock Area (see Figures 2 and 3). The PAH and petroleum impacts appear to be a result of activities within the area that took place post-1966, because these materials were not reported to have been used in the area prior to that time (RMT, 1997).

1740 yds³

Remedial Action

The remedial action will consist of constructing four lactate infiltration trenches (see Figures 2 and 3) throughout the area of highest TCE soil impacts, which will allow the lactate solution to infiltrate the unsaturated soil, and impact an estimated 47,000 cubic feet of soil, as well as the underlying groundwater. Initial groundwater concentrations will be established by sampling prior to the first infiltration in 2002. Two new 2-inch monitoring wells, MW-25 and MW-26, will be installed between trenches 1 and 2 and within the Tecumseh facility (Figures 1-3), respectively, in order to monitor the progress of the remediation system. The wells will be screened within the sandy soil that forms the shallowest aquifer beneath the site. The goal of the bioremediation is to reduce the TCE concentrations in the source area groundwater to 50 percent of the initial concentrations.

A lactate solution tank will be located within the Tecumseh Plant, and will supply the four trenches located west of the plant with the solution by means of gravity infiltration. Other additives in the lactate solution include yeast extract, used to provide micronutrients to the microorganisms, and sodium sulfide, used as an oxygen scavenger to ensure that an anaerobic environment is maintained. The system will operate continuously for 3 months, at an estimated flow rate of 0.5 gpm, after which time the soil is expected to be saturated. An estimated 70,000 gallons of solution will be injected over the 3 months. The system will then be shut off for 3 months to allow for biodegradation. The 6-month infiltration/biodegradation cycle will be repeated for up to 5 years, or until the remediation goal is met within the area.

with that much lactate and onto the soil?

Soil samples will be collected after each 6-month interval for the first year of operation to evaluate soil concentrations. Subsequent sampling will take place once per year. Two soil samples will be

collected during each sampling round, from locations in close proximity to previous soil borings SB5WD and SB7WD (see Figure 2). Monitoring wells MW-25 and MW-26 will also be sampled quarterly for the first year of operation. Subsequent sampling will take place at six-month intervals. Soil and groundwater collection and analysis are described below.

Infiltration Trench Construction

The infiltration trenches will be 5 feet deep and 5 feet wide. Gravel bedding and 3-inch PVC perforated pipe will be placed in the lower 2 feet of the trenches. The remaining 3 feet of trench will be backfilled and compacted with clean clay-rich soil brought to the site, to better seal the trenches. Filter fabric will be placed between the soil and gravel to keep small particles out of the gravel. Approximately 200 cubic yards of soil contaminated with PAH and petroleum-related constituents will be excavated in the vicinity of trenches 1 and 2, and will be characterized for disposal (see Figures 2 and 3). The lactate solution will be routed to each trench from the lactate solution tank(s) through a buried PVC pipe. The lactate solution tank(s) will be made of heavy-duty polyethylene. The tank will be refilled approximately once every 2 weeks during the injection periods by a maintenance technician.

Southeast Degreaser and Recycling Dock Area

Background

Parts degreasing was performed in the Southeast Degreaser and Recycling Dock Area, as depicted on Figures 1, 4, and 5, from the early 1960s to 1986. TCE, TCA, and dichloroethenes are the primary chlorinated compounds detected in the groundwater. The water table is at a depth of approximately 12 feet bgs in this area. The highest levels of TCE and TCA concentrations are located just above the water table. In general, TCE and TCA impacts extend from the ground surface to the water table. The groundwater flows to the east at a rate of 330 feet per year at this location.

Remedial Action

The remedial action will consist of constructing three 4-inch–diameter injection wells, LI-1, LI-2, and LI-3, just east of the dock (see Figures 4 and 5). Lactate solution will be injected at each well at an approximate rate of 3 gpm over a two day period (7,050 gallons per well), every 6 months for up to 5 years, or until the remediation goal is met within the area. The primary goal of the aquifer enhancement injections is to reduce the TCE concentrations in the source area groundwater to 50 percent of the concentrations measured during the sampling round that is to take place prior to startup in 2002. A temporary lactate solution tank made of polyethylene will be used during each injection, and the material will be metered into a pipe pressurized by on-site tap water downstream of a newly installed backflow prevention device, to dilute the solution to the desired concentration. The solution will be injected under pressure to the injection wells via temporary tubing set up prior to each injection. The wells will be constructed to an approximate depth of 20 feet, and will be screened from 10 to 20 feet below ground surface.

The wells will be constructed just east of the recycling dock in order to maximize the downgradient migration of the lactate solution through the impacted groundwater. Two new 2-inch–diameter monitoring wells, MW-23 and MW-24, will be constructed 40 feet and 80 feet downgradient from the injection wells, respectively, in order to monitor the progress of the system.

Depending on need and accessibility, less frequent injections may be performed upgradient of the recycling dock, utilizing existing monitoring wells MW-2 and MW-6. These injections will allow for increased biodegradation in this area of lower concentration.

Injection and Monitoring Well Construction

The wells will be constructed in accordance with NR 141. Figures 6 and 7 show the well details for the injection wells (LI-1, LI-2, and LI-3) and monitoring wells (MW-23, MW-24, MW-25, and MW-26) respectively. Waste cuttings generated during well drilling will be characterized and handled as either solid waste or characteristic hazardous waste in accordance with NR 141.

Permitting

Prior to remediation startup, the WPDES Permit for Contaminated Groundwater from Remedial Action Operations, WI-0046566-4, will be obtained. The permit will address injecting enhanced bioremediation additives into the groundwater (i.e., lactate, yeast extract, sodium sulfide).

Sampling Plan

The following protocol will be implemented to monitor the performance and confirm the effectiveness of the soil and groundwater treatment process:

- Prior to startup, water from MW-8, MW-8D, MW-3, MW-3D, MW-3BR, and the newly constructed wells MW-23, MW-24, MW-25, and MW-26 will be sampled for the following parameters:
  - Field parameters (water table elevations, dissolved oxygen, pH, oxidation-reduction potential, temperature, and specific conductivity)
  - Chlorinated VOCs (TCE, dichloroethenes, vinyl chloride, TCA, dichloroethane, and chloroethane)
  - Chloride
- After the initial injection, MW-8, MW-8D, MW-23, MW-24, MW-25, and MW-26 will be sampled quarterly for the first year of operation for the following parameters (subsequent monitoring will be performed at the 6-month interval):
  - Field parameters (same as above)
  - Chlorinated VOCs (same as above)
  - Chloride
  - Volatile fatty acids (to evaluate lactate metabolism)

- After each 6 month interval for the first year of operation, two soil samples will be collected in the West Dock Area and analyzed for chlorinated VOCs, to be compared to historical data. Subsequent sampling will take place once per year.

Remedial Action Schedule

The remediation system construction and well installations are scheduled to begin in July 2002. The initial lactate injections are targeted for August 2002. Initially, monitoring may be more frequent; but after the system parameters are established, monitoring will occur 6 months after each injection. The second injection to the system is estimated to begin in mid-February 2003, and then every 6 months thereafter.

I will contact you to discuss any questions you may have and to obtain the Department's approval of this plan.

Sincerely,

RMT, Inc.

for

Stacey A. Koch, P.E.
Project Engineer

Bernd W. Rehm, P.G.
Senior Consulting Hydrogeologist
Project Manager

Attachments: Figure 1 - Site Layout
Figure 2 - Lactate Infiltration Trench Layout
Figure 3 - Cross Section A-A' – Lactate Infiltration Trench Details
Figure 4 - Lactate Injection Well Layout
Figure 5 - Cross Section B-B' - Injection Well Details
Figure 6 - Injection Well Detail
Figure 7 - Monitoring Well Detail
"Enhanced Reductive Dechlorination of PCE" (Rice, et al., 2001)

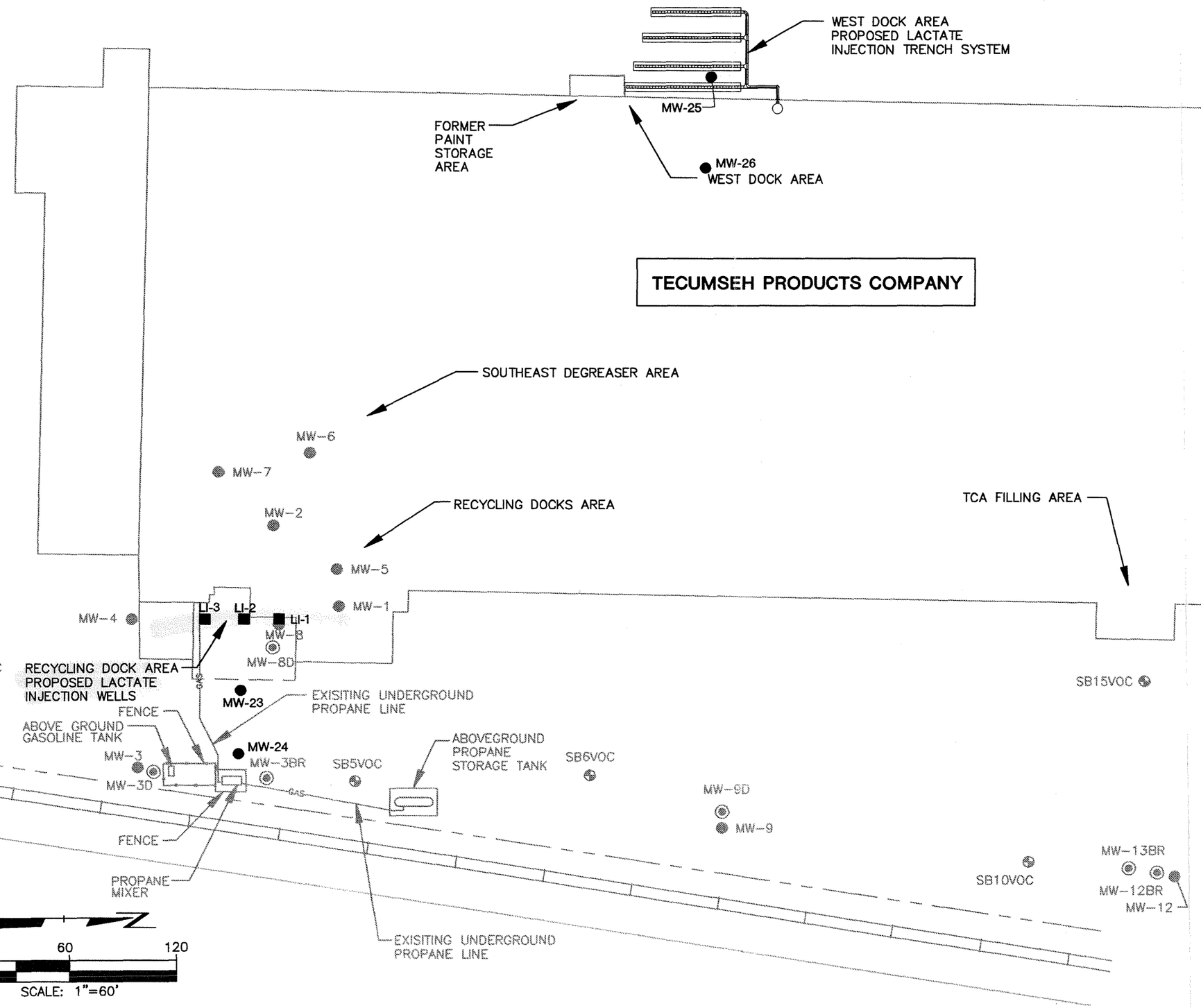
cc: Tecumseh Products Company – Glenn Elmer, Kerry DeKeyser, Bharat Shah
RMT – Randi Williams

References

RMT, Inc. 1997. Subsurface Investigation Report for Tecumseh Products Company Grafton

RMT, Inc. 1999. Bioremediation Treatability Study Results – Tecumseh Products Company, Grafton, Wisconsin. September 1999.

Rice, J.M. and S.A. Koch, 2001. "Enhanced Reductive Dechlorination of PCE." Anaerobic Degradation of Chlorinated Solvents, Batelle Sixth International *In situ* and On-Site Bioremediation Symposium. June 4-7, 2001.



LEGEND

MW-10	WATER TABLE WELL
MW-3BR	PIEZOMETER
SB8VOC	SOIL BORING
	RAILROAD
	PROPERTY LINE
LI-1	PROPOSED LACTATE INJECTION WELL LOCATION
MW-23	APPROXIMATE LOCATION OF PROPOSED LACTATE SYSTEM MONITORING WELL LOCATION

NOTES

1. FACILITY LAYOUT ADAPTED FROM DRAWINGS PROVIDED BY TECUMSEH PRODUCTS COMPANY.
2. MONITORING WELL LOCATIONS AND ELEVATIONS WERE SURVEYED BY RMT INC. ON 12/5/94.
3. BORING SB-11VOC IS LOCATED NEAR MONITORING WELL MW-12BR.

PROJECT: **TECUMSEH PRODUCTS COMPANY**
LACTATE INJECTION SYSTEMS
GRAFTON, WISCONSIN

SHEET TITLE: **SITE PLAN**

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APPROVED BY: BWR	DATE PRINTED:	**FIGURE 1**
DATE: APRIL 2002		

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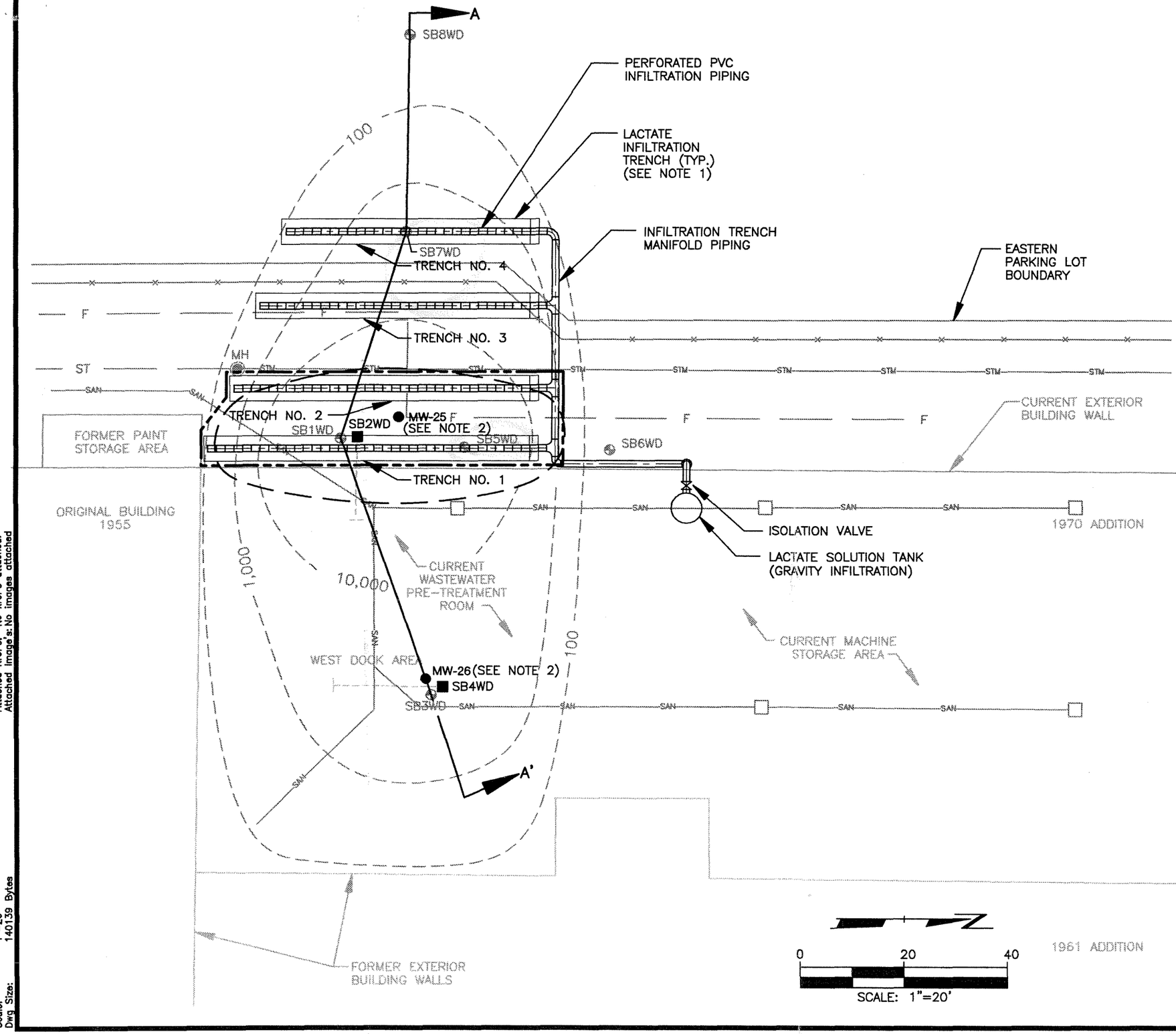

LEGEND

- SB8WD — EXISTING VERTICAL SOIL BORING
- SB4WD — EXISTING ANGLE SOIL BORING
- MW-25 — PROPOSED MONITORING WELL LOCATION
- EXISTING FENCE
- TRAJECTORY OF ANGLE SOIL BORING
- F — FIRE LOOP
- STM — UNDERGROUND STORM SEWER
- SAN — UNDERGROUND SANITARY SEWER
- MANHOLE
- FLOOR DRAIN
- +,000 — ESTIMATED EXTENT OF TCE, ISOCONCENTRATION IN SOIL (ug/kg) (DASHED WHERE INFERRED)
- ESTIMATED EXTENT OF PAH AND PETROLEUM-RELATED COMPOUNDS IN SOIL
- GEOLOGIC CROSS SECTION LOCATION
- LIMITS OF SOIL TO BE EXCAVATED FOR DISPOSAL

NOTES

1. LACTATE INFILTRATION TRENCHES TO BE 5 FEET WIDE AND 5 FEET DEEP. PROVIDE 12" OF GRAVEL BEDDING AND 12" OF GRAVEL COVER FOR PERFORATED 3" SCH. 80 PVC LACTATE INFILTRATION PIPING. COVER WITH 3 FEET OF CLAY FILL. EXISTING EXCAVATED MATERIAL FROM TRENCH 3 & 4 CAN BE REUSED, AS WELL AS CONTRACTOR SUPPLIED CLEAN CLAY FILL.
2. STORM SEWER, FIRE LOOP, AND SANITARY SEWER LINE LOCATIONS SHOWN ARE APPROXIMATE. ACTUAL LOCATIONS ARE TO BE FIELD LOCATED BY CONTRACTOR, PRIOR TO EXCAVATION ACTIVITIES.
3. UTILITIES SUCH AS THE FIRE LOOP, ETC. MAY NEED TO BE RELOCATED FOR PROPOSED TRENCHING PURPOSES.

PROJECT: **TECUMSEH PRODUCTS COMPANY LACTATE INJECTION SYSTEMS GRAFTON, WISCONSIN**

TITLE: **LACTATE INFILTRATION TRENCH LAYOUT AND CROSS SECTION LOCATOR WEST DOCK AREA**

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DATE: APRIL 2002		

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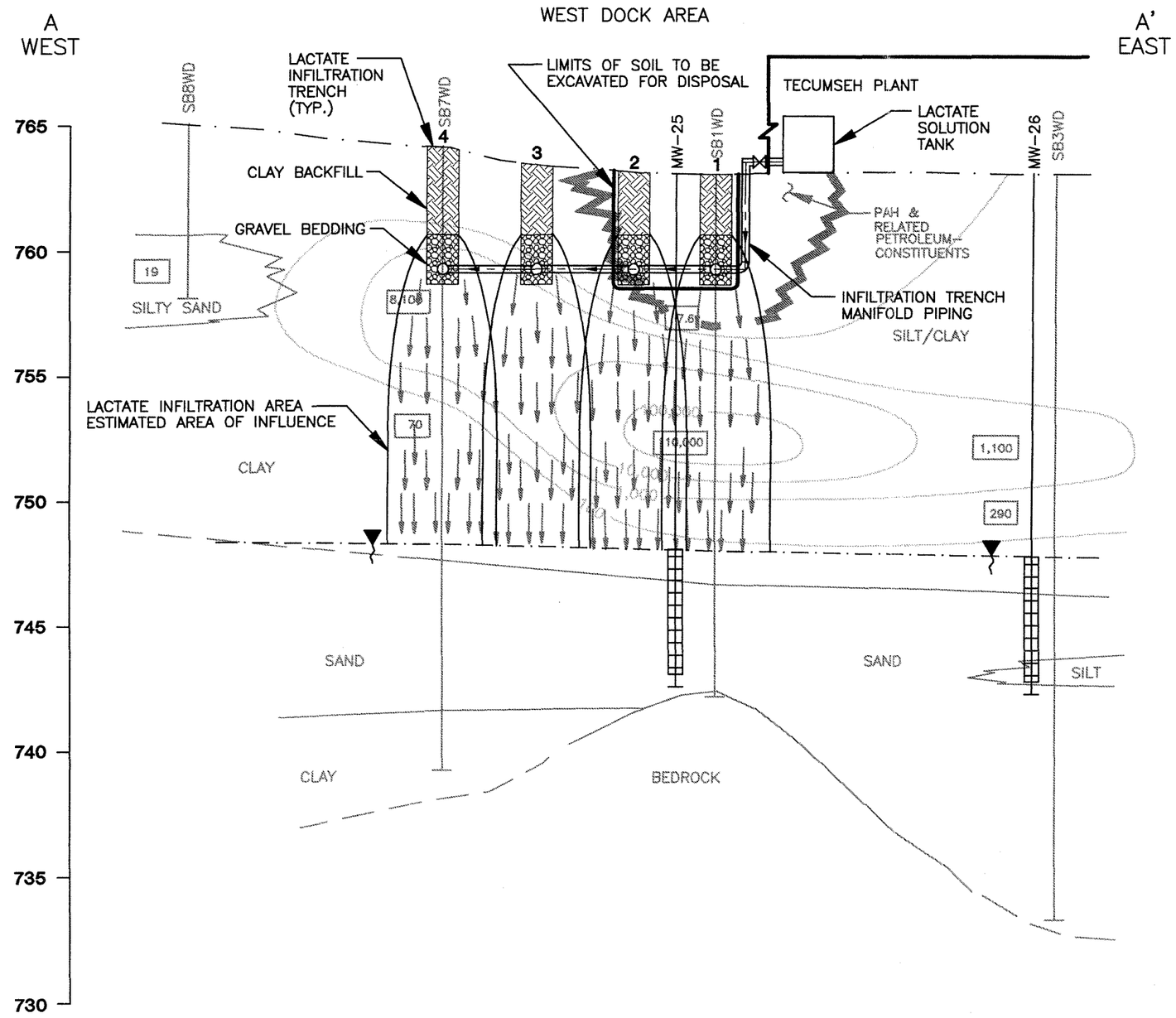

SCALE

HORIZ.: 1"=20'
VERT.: 1"=5'
(EXAGGERATION=4X)

LEGEND

- NA — NOT ANALYZED
- ND — NOT DETECTED
- 19 — LABORATORY RESULTS FOR TCE IN SOIL (ug/kg)
- ESTIMATED EXTENT OF PAH AND PETROLEUM-RELATED COMPOUNDS IN SOIL
- ESTIMATED EXTENT OF TCE, ISOCONCENTRATION IN SOIL(ug/kg)
- APPROXIMATE WATER TABLE SURFACE
- 3 — PROPOSED TRENCH NUMBER
- PROPOSED WELL CASING
- PROPOSED WELL SCREEN INTERVAL
- PROPOSED BOTTOM OF WELL

PROJECT: **TECUMSEH PRODUCTS COMPANY**
LACTATE INJECTION SYSTEM
GRAFTON, WISCONSIN

SHEET TITLE: **CROSS SECTION A-A'**
LACTATE INFILTRATION TRENCH DETAILS
WEST DOCK AREA

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DATE: APRIL 2002		

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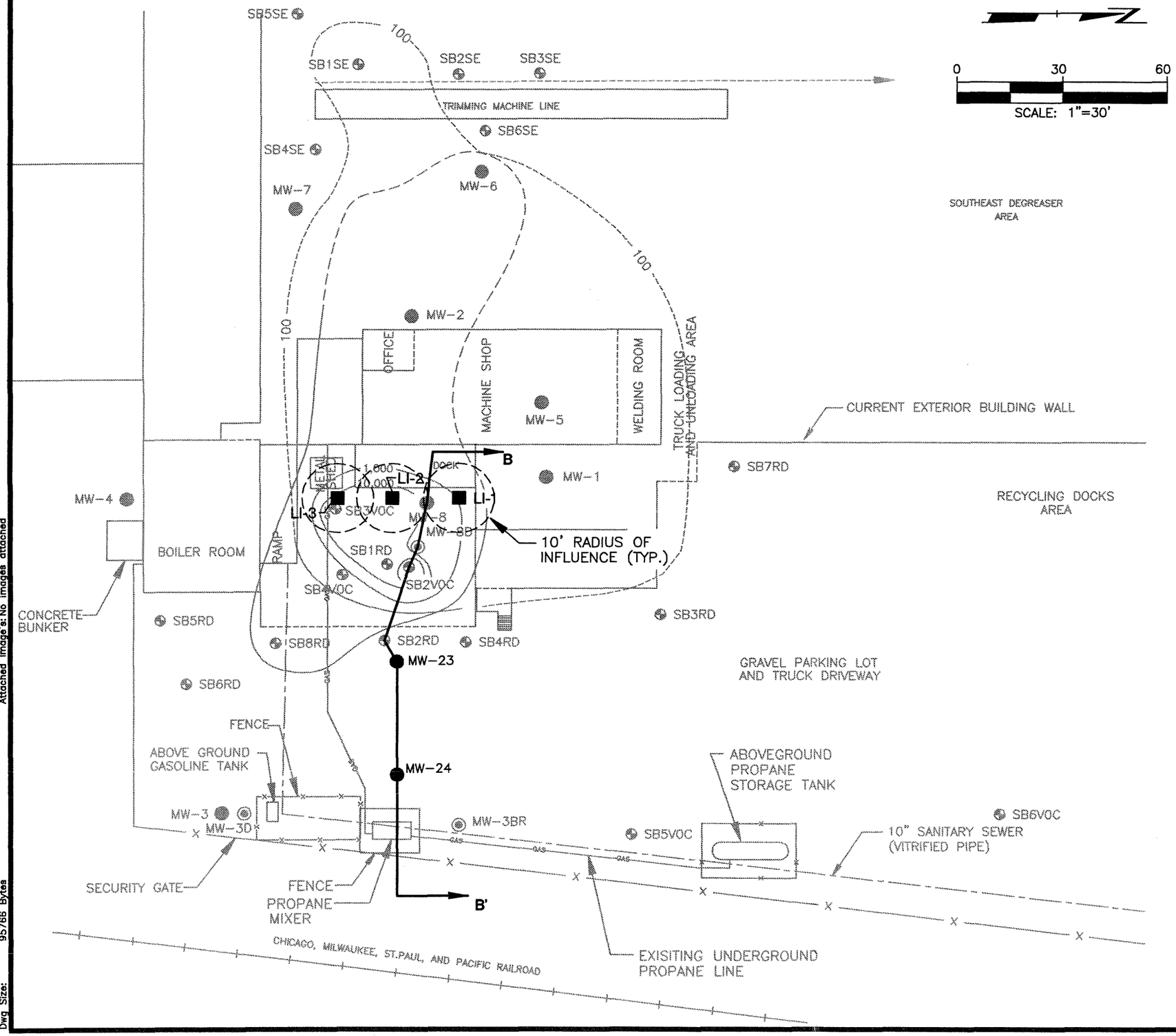

LEGEND

MW-3	WATER TABLE WELL
MW-3D	PIEZOMETER
SB3VOC	SOIL BORING (PREVIOUS INVESTIGATIONS)
SB2RD	SOIL BORING (RECYCLING DOCKS AREA)
SB2SE	SOIL BORING (SOUTHEAST DEGREASER AREA)
	DOORWAY
	FLOOR DRAIN
100	ESTIMATED EXTENT OF TCA, ISOCONCENTRATION IN SOIL (ug/kg) (DASHED WHERE INFERRED) ALSO SEE NOTE 2
	ESTIMATED EXTENT OF PAH'S, HEAVY FUEL, AND PETROLEUM-RELATED COMPOUNDS IN SOIL
GAS	EXISTING UNDERGROUND PROPANE LINE
	GEOLOGIC CROSS SECTION LOCATION
LI-1	PROPOSED LACTATE INJECTION WELL

NOTES

1. THE EXTENT OF TCE IN THE SOIL IS SIMILAR TO THE EXTENT OF TCA EXCEPT THE CONCENTRATIONS ARE GENERALLY LOWER.
2. LACTATE INJECTION SETUP REQUIRES (1) BACKFLOW PREVENTER, (3) FLOW METERS, AND (1) TOTALIZER.

PROJECT: **TECUMSEH PRODUCTS COMPANY LACTATE INJECTION SYSTEMS GRAFTON, WISCONSIN**

SHEET TITLE: **INJECTION WELL LAYOUT AND CROSS SECTION LOCATOR RECYCLING DOCKS AREA**

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APPROVED BY: BWR	DATE PRINTED:	**FIGURE 4**
DATE: APRIL 2002		

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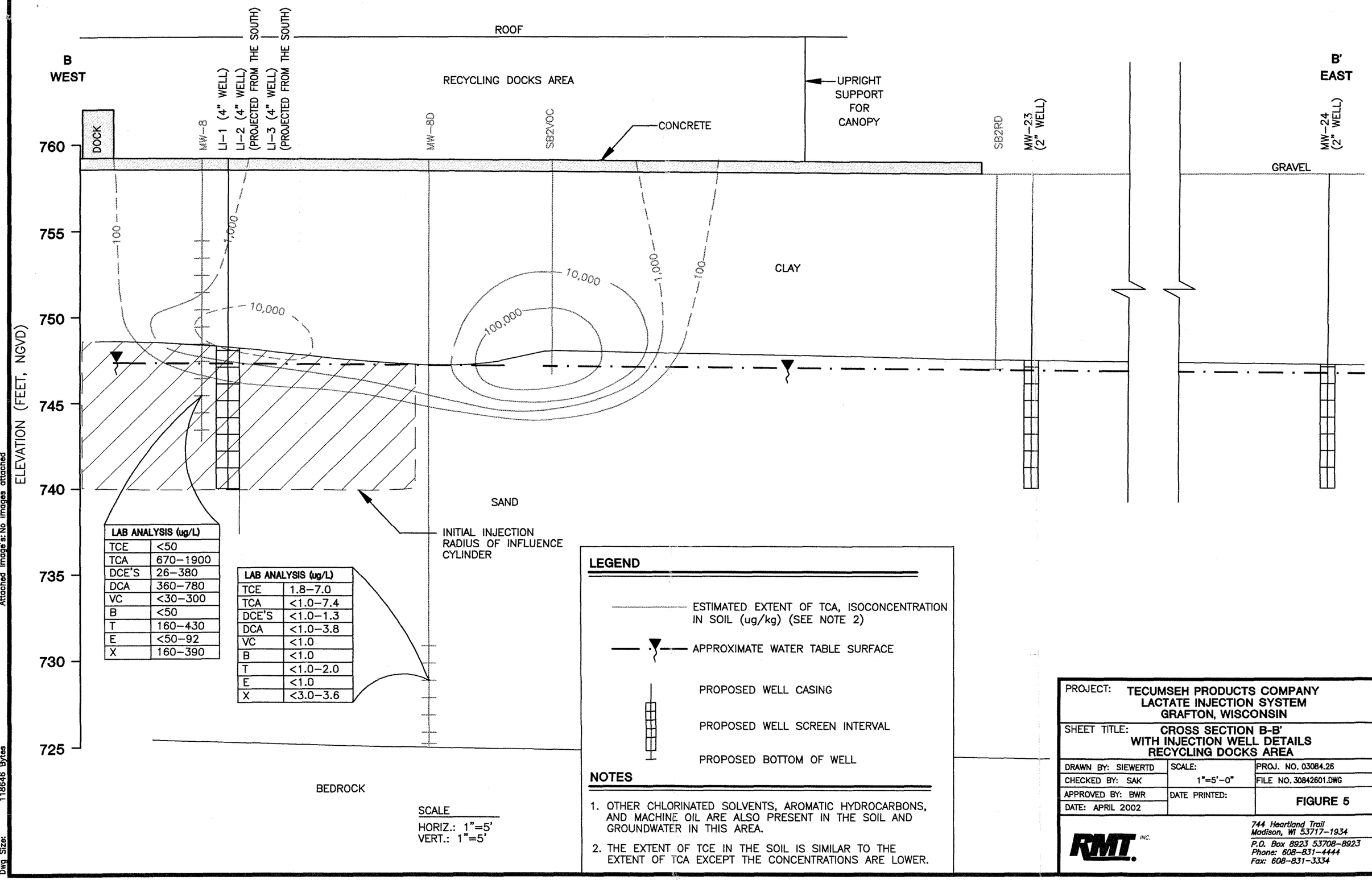

SCALE

HORIZ.: 1"=5'
VERT.: 1"=5'

LEGEND

- ESTIMATED EXTENT OF TCA, ISOCONCENTRATION IN SOIL (ug/kg) (SEE NOTE 2)
- APPROXIMATE WATER TABLE SURFACE
- PROPOSED WELL CASING
- PROPOSED WELL SCREEN INTERVAL
- PROPOSED BOTTOM OF WELL

NOTES

1. OTHER CHLORINATED SOLVENTS, AROMATIC HYDROCARBONS, AND MACHINE OIL ARE ALSO PRESENT IN THE SOIL AND GROUNDWATER IN THIS AREA.
2. THE EXTENT OF TCE IN THE SOIL IS SIMILAR TO THE EXTENT OF TCA EXCEPT THE CONCENTRATIONS ARE LOWER.

PROJECT: TECUMSEH PRODUCTS COMPANY
LACTATE INJECTION SYSTEM
GRAFTON, WISCONSIN

SHEET TITLE: CROSS SECTION B-B'
WITH INJECTION WELL DETAILS
RECYCLING DOCKS AREA

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DATE: APRIL 2002		

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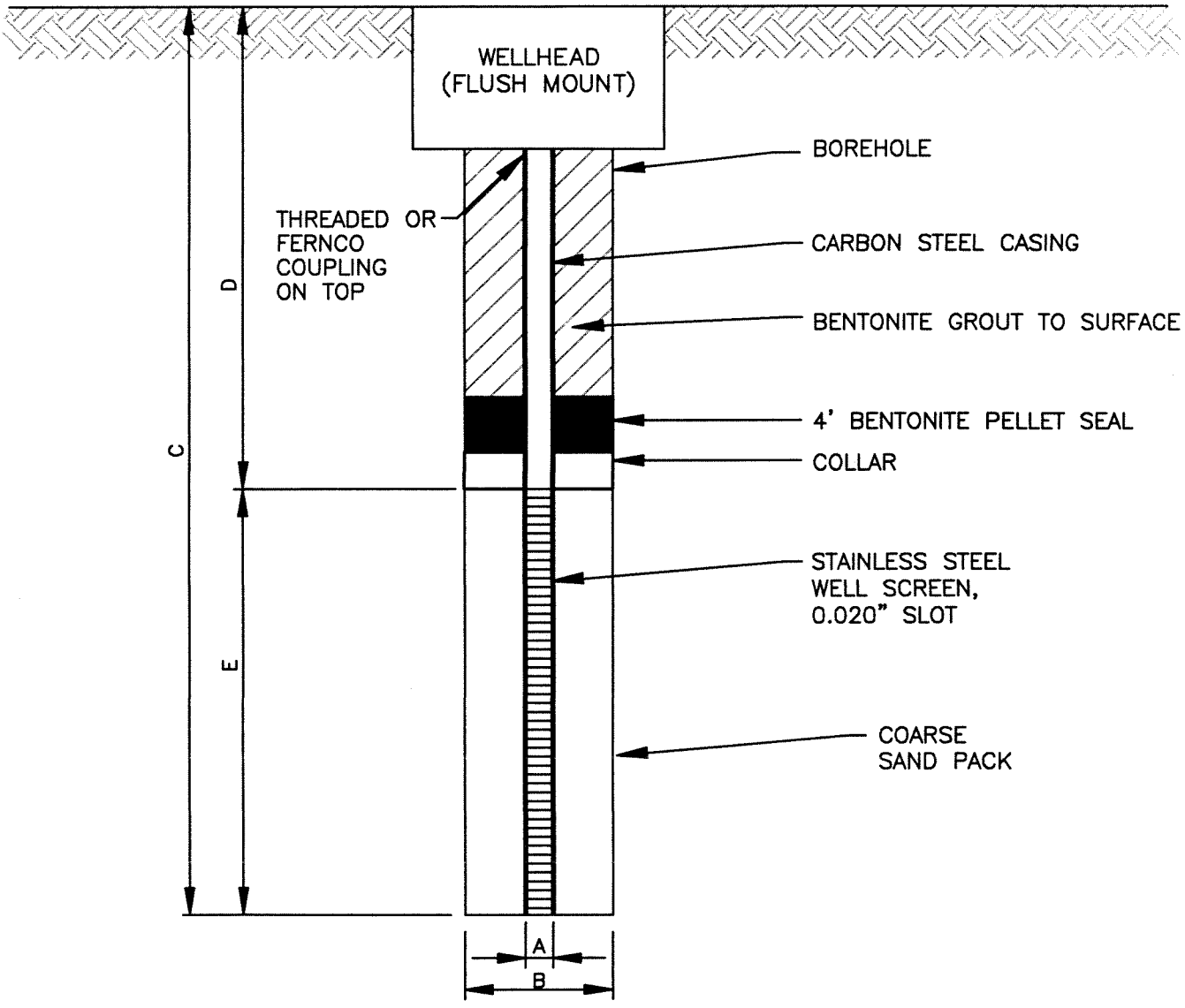

WELL NUMBER	(A) CASING DIA., IN.	(B) BOREHOLE DIA., IN.	(C) BORING DEPTH, FT.	(D) DEPTH TO SCREEN, FT.	(E) SCREEN LENGTH, FT.	DEPTH TO BEDROCK (FT.)
LI-1	4	6	21.5	11	10	45
LI-2	4	6	21.5	11	10	45
LI-3	4	6	21.5	11	10	45

NOTES:

1. WELL DESIGN MAY BE MODIFIED BASED ON FIELD OBSERVATIONS.

RMT INC.

TECUMSEH PRODUCTS COMPANY
LACTATE INJECTION SYSTEMS
GRAFTON, WISCONSIN

PROPOSED DESIGN FOR
INJECTION WELLS LI-1, LI-2, AND LI-3
RECYCLING DOCKS AREA

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APPROVED BY:	BWR
PROJECT NO.	03084.26
FILE NO.	30842606.DWG
DATE:	APRIL 2002

FIGURE 6

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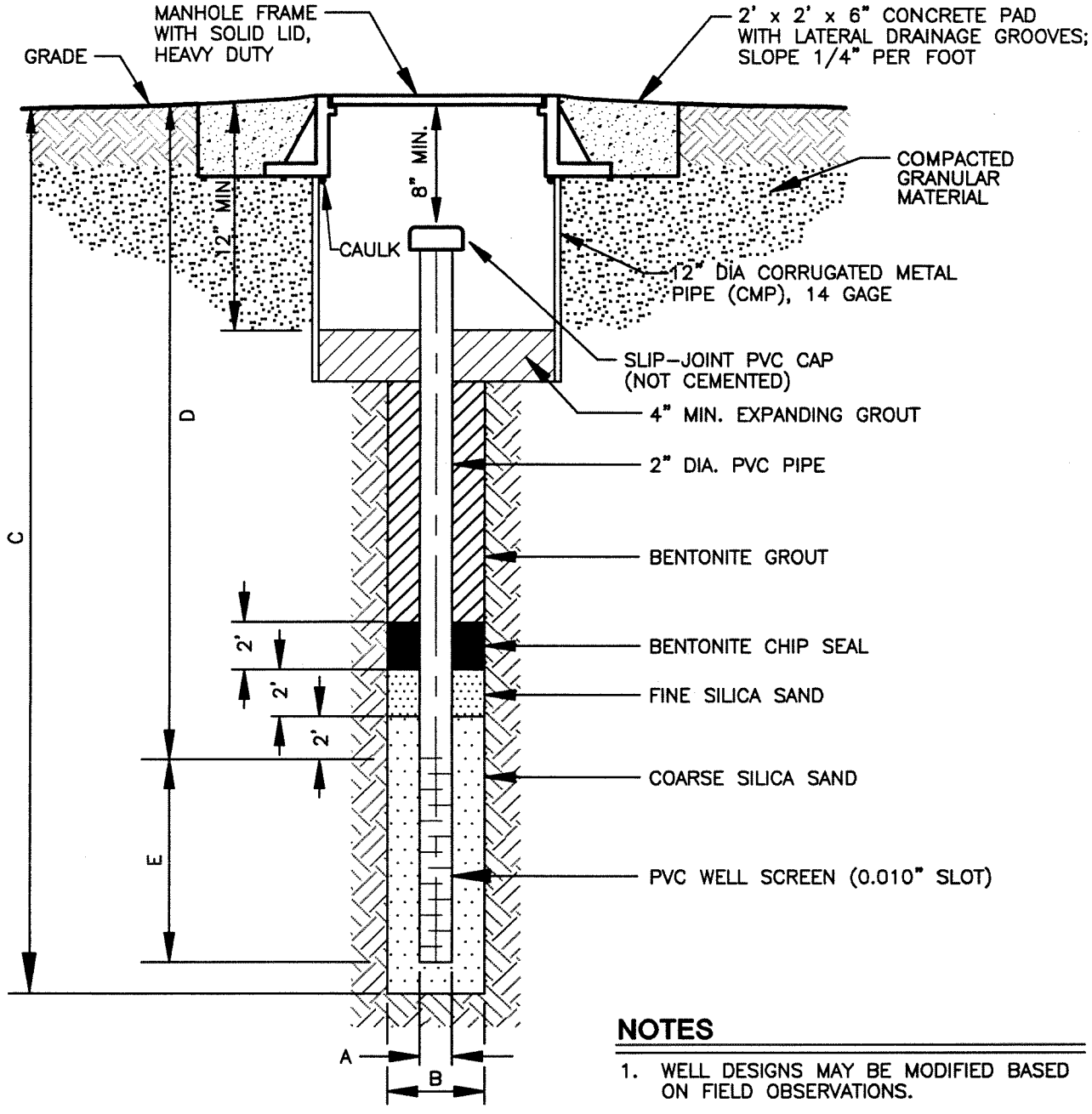

NOTES

1. WELL DESIGNS MAY BE MODIFIED BASED ON FIELD OBSERVATIONS.

WELL NUMBER	(A) CASING DIA., IN.	(B) BOREHOLE DIA., IN.	(C) BORING DEPTH, FT.	(D) DEPTH TO SCREEN, FT.	(E) SCREEN LENGTH, FT.	DEPTH TO BEDROCK (FT.)
MW-23	2	6	20.5	10	10	45
MW-24	2	6	20.5	10	10	45
MW-25	2	6	20.5	15	5	21
MW-26	2	6	20.5	15	5	30

RMT INC.

TECUMSEH PRODUCTS COMPANY
LACTATE INJECTION SYSTEMS
GRAFTON, WISCONSIN

PROPOSED DESIGN FOR MONITORING WELLS
MW-23, MW-24, MW-25, AND MW-26
WEST DOCK & RECYCLING DOCK AREAS

DRAWN BY:	SIEWERTD
APPROVED BY:	BWR
PROJECT NO.	03084.26
FILE NO.	30842605.DWG
DATE:	APRIL 2002

FIGURE 7

PLOT DATA
Drawing Name: J:\03084\26\30842605.dwg
Operator Name: SIEWERTD
Scale: 1"=1'
Dwg Size: 132259 Bytes
Plot Date: Tuesday, January 22, 2002
Plot Time: 10:36.22 AM
Attached Xref's: No xref's attached.
Attached Image's: No images attached