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Feasibility Test Work Plan

GCOU RD/RA
Hagen Farm Site
Town of Dunkirk
Dane County, Wisconsin

Prepared for:

Waste Management of Wisconsin, Inc.

QUALITY
INTEGRITY
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RESPONSIVENESS

April 1995

RUST ENVIRONMENT & INFRASTRUCTURE

FEASIBILITY TEST WORK PLAN

For

HAGEN FARM SITE
GROUNDWATER CONTROL OPERABLE UNIT

STOUGHTON, WISCONSIN

Prepared For

Waste Management of Wisconsin, Inc.

April 1995

Rust Environment & Infrastructure
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Project No. 71803

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1.0 INTRODUCTION

The following Feasibility Test Work Plan has been prepared by Rust Environment & Infrastructure (Rust E&I) to study the feasibility of re-introducing treated groundwater into the aquifer as part of the Groundwater Control Operable Unit (GCOU) for the Hagen Farm Superfund site. The GCOU remedy includes extraction and treatment of groundwater by aerobic biodegradation followed by clarification (Treatment Technology Proposal, Rust E&I, September 1994). This Feasibility Test Work Plan was prepared for Waste Management of Wisconsin, Inc. (WMWI) in accordance with the Remedial Design/Remedial Action (RD/RA) Scope of Work (SOW) Item II.B.2.b.(9). It is being submitted to the United States Environmental Protection Agency (USEPA) and the Wisconsin Department of Natural Resources (WDNR) for evaluation and approval prior to implementation of the proposed feasibility test.

1.1 FEASIBILITY TEST OBJECTIVE

The purpose of performing this proposed test is to examine the feasibility of re-introducing groundwater from the Hagen Farm GCOU treatment system (effluent) into the aquifer via an infiltration gallery. The infiltrration gallery would include a series of horizontally installed perforated pipes located beneath the ground surface to allow the effluent to flow by gravity back to the aquifer. The results of the feasibility test would be used to size the infiltration gallery to be used in a full-scale system. The feasibility test will also evaluate whether re-introduction of treated Hagen Farm groundwater into the on-site aquifer will enhance biodegradation of the contaminants in the aquifer. The feasibility test will consist of modeling to evaluate the physical, chemical, and biological effects of the proposed system and a pilot scale re-injection study to calibrate the results of the computer modeling performed. Results from the pilot scale study will then be used to adjust the input parameters of the computer model of groundwater flow which will be used to evaluate the size of the infiltration gallery that would be required for a full-scale operation.

1.2 WORK PLAN ORGANIZATION

This Work Plan is divided into eight sections as follows.

- Section 2.0 describes the site background and discusses the site characteristics that relate to this feasibility test.
- Section 3.0 describes the component(s) of the Remedial Action (RA) that are being evaluated in this feasibility test.
- Section 4.0 describes the components and objectives of the Feasibility Study.
- Section 5.0 discusses the computer models and modeling procedures to be used in conducting the feasibility test.
- Section 6.0 describes the conceptual pilot scale test to be conducted at the site.

- Section 7.0 discusses the format of the feasibility test report that will be produced to present the results of the computer modeling and pilot scale test.

- Section 8.0 describes the schedule for conducting and documenting the feasibility test.

2.0 PROJECT DESCRIPTION

The following sections present a brief overview of the Hagen Farm site background and the characteristics of the site that are to be used in the Feasibility Test evaluation.

2.1 SITE BACKGROUND

The Hagen Farm Site is located at 2318 County Highway A, approximately 1 mile east of the City of Stoughton in Dane County, Wisconsin. The site is located in a rural setting in the Yahara River watershed outside the 100-year floodplain of the river. The Yahara River is located approximately 1.3 miles west of the site and flows in a southerly direction. The general drainage and groundwater flow at the site is toward the southwest. An on-property drainage ditch located in the southeast corner of the property flows to a wetland south of the site. The Hagen Farm site property comprises a total of 28 acres, of which 10 acres were utilized as disposal areas. The main disposal area, which encompasses 5.5 acres, is the location where a variety of municipal and industrial wastes were disposed. The site was used for waste disposal from the late 1950s until the mid-1960s.

Various assessments and investigations were performed at the site during the early to mid-1980s. The Remedial Investigation (RI) for the site was initiated in July 1988 and the final report for the RI was produced in November 1991. The investigations indicated the presence of organic compounds in the site groundwater including: benzene, ethyl benzene, THF, toluene, and xylenes. These compounds were measured at some site wells at levels which exceed Chapter NR 140 Wisconsin Administrative Code groundwater quality standards.

Two operable units have been defined for the site: the Source Control Operable Unit (SCOU) which addresses the wastes and sub-surface soils in the main disposal area; and the Groundwater Control Operable Unit (GCOU) which addresses on-property and off-property groundwater at the Hagen Farm site. "On-property groundwater" is defined as contaminated groundwater on and in the immediate vicinity of the main disposal area. "Off-property groundwater" is defined as contaminated groundwater within the containment plume at any location other than in contact with or in the immediate vicinity of the main disposal area.

SCOU construction was completed in December 1993. Operation of the SCOU is ongoing.

The Feasibility Study (FS) report for the site was finalized in April 1992, and the GCOU Record of Decision (ROD) for the Hagen Farm Site was issued in September 1992.

The major components of the GCOU ROD remedy included:

- Groundwater extraction.
- On-property groundwater treatment.
- Off-property groundwater treatment.
- Discharge of treated groundwater to the wetlands south of the site or to the Yahara River, or re-injection of the treated groundwater on-property.

On June 30, 1994, WMWI proposed an alternative approach to the implementation of the ROD. WMWI's alternative approach, which included biological treatment or other equivalent technology treatment of on-property groundwater, and further evaluation of off-property groundwater during on-property groundwater treatment and implementation of the Hagen Farm GCOU remedy, was accepted in August 1994. More detailed information about the site and the remedial action are contained in the following reports:

- Warzyn Inc., November 1991. Final Remedial Investigation Report, Groundwater Control Operable Unit, Hagen Farm Site, Town of Dunkirk, Wisconsin.
- Warzyn Inc., April 1992. Final Feasibility Study, Groundwater Control Operable Unit, Hagen Farm Site, Town of Dunkirk, Wisconsin.
- USEPA, September 1992. Record of Decision, Hagen Farm Site, Groundwater Control Operable Unit, Town of Dunkirk, Wisconsin.
- Rust E&I, July 1994a. Technical Report, Groundwater Control Operable Unit, Remedial Action/Remedial Design, Hagen Farm Site, Town of Dunkirk, Wisconsin.
- Rust E&I, July 1994b. Treatment Technology Proposal, Groundwater Control Operable Unit, Remedial Design/Remedial Action (RD/RA), Hagen Farm, Stoughton, Wisconsin.
- Rust E&I, August 1994. Preliminary (30 Percent) Design Report, Groundwater Control Operable Unit, Hagen Farm, Stoughton, Wisconsin.
- Rust E&I, September 1994. Addendum to the Preliminary (30 Percent) Design Report, Groundwater Control Operable Unit, Hagen Farm, Stroughton, Wisconsin.
- Rust E&I, December 1994. Prefinal (95 Percent) Design Report, Groundwater Control Operable Unit, Hagen Farm, Stoughton, Wisconsin.

2.2 SITE CHARACTERISTICS

The following sections discuss the expected physical, chemical, and biological characteristics of the anticipated location of the infiltration gallery. The physical and hydraulic characteristics of the vadose zone and aquifer location at the proposed infiltration gallery is on-site and upgradient of the SCOU. The information was obtained from the previous (referenced) reports to establish the Hagen Farm site conditions expected where the re-introduction of treated groundwater is proposed to occur.

2.2.1 Hydrogeology

The feasibility of re-introducing treated Hagen Farm groundwater upgradient of the SCOU and the groundwater extraction system's ability to capture the groundwater plume which could be affected by the re-introduced water, will be dependent on the hydrogeology of the site. Groundwater flow at the Hagen Farm site is slightly downward and southward to southeastward and in the glacial

deposits and the underlying bedrock. The glacial deposits and bedrock are hydraulically connected and act as a single hydrostratigraphic unit. Infiltration of water from the site area moves downward to the water table which is located within the glacial deposits. The water table surface is within the glacial deposits and ranges in elevation from 862 feet above mean sea level (MSL) at the north end of the site to 851 feet MSL approximately 3,000 feet south of the site. Depending on the ground surface topography, the groundwater table elevation is 0 to 25 feet below the ground surface. According to the RI report (Warzyn, 1991), the horizontal hydraulic gradient varies from 0.0008 to 0.003 ft/ft. At the proposed pilot test location, the vadose zone thickness is approximately 30 feet. Flow away from the site area is horizontal to slightly downward and southward to southeastward toward Sundby's Pond.

The saturated thickness of the glacial aquifer increases from 25 feet beneath the Hagen Farm SCOU to 75 feet south of Sundby's Pond. A low hydraulic conductivity layer of silty sand and clayey sand at the base of the glacial deposits forms a localized aquitard that separates the glacial and bedrock aquifers at some locations, such as near Sundby's Pond.

Based on information contained in the RI (Warzyn, 1991), vertical gradients at the Hagen Farm site are generally slightly downward; however, the size and direction of vertical gradients are dependent on location within the flow system. North of the site, a higher vertical gradient (-0.08 ft/ft, e.g., downward) is found. This vertical gradient is related to a groundwater recharge area associated with this topographically higher area. South of the Hagen Farm site, the vertical gradient is smaller (-0.03 to +0.0008 ft/ft), which indicates a generally horizontal groundwater flow direction towards a discharge area.

Aquifer Charactristics

The aquifer characteristics of the glacial aquifer in the Hagen Farm site area have been determined through two aquifer pump tests. A test of well RW01, which is located on-site southeast of the Hagen Farm disposal area, was performed in 1990 (Warzyn, November 1991). An aquifer pumping test of well RW02, which is located south of the Hagen Farm site near Sundby's Pond, was performed in 1993 (Rust E&I, April 1994).

RW01 is 35 feet deep and is installed in glacial deposits consisting of sand with a small amount of silt. The bedrock and glacial deposits are interconnected in the RW01 area. The aquifer transmissivity value calculated from the RW01 pumping test data is assumed to represent both the bedrock and the glacial deposits for this area. The aquifer transmissivity estimated from the RW01 pumping test is 25,000 gpd/ft and the estimated hydraulic conductivity is 1.8×10^{-2} cm/sec. The hydraulic conductivity is based on an assumed effective thickness of the aquifer at the RW01 location of 65 feet, including 25 feet of glacial outwash and 40 feet of sandstone. The vertical hydraulic conductivity of the bedrock was estimated from the RW01 pumping test at 4×10^{-4} cm/sec. However, the anisotropy of the glacial deposits, comparing the horizontal and vertical hydraulic conductivity calculated from the RW01 pumping test data, ranged from 4 to 70.

The 1993 Hagen Farm pump test was conducted at RW02. RW02 is 65 feet deep and penetrates glacial deposits consisting primarily of silty sand. The discharge rate of RW02 during the pumping

test was 13 gpm (Rust E&I, April 1994). Transmissivity values calculated from observation well data obtained during the RW02 pumping test gave different results than the previous (RW01) pumping test due to variability in the Hagen Farm off-property aquifer materials. The estimated aquifer characteristic values for transmissivity, storage coefficient, and hydraulic conductivity in the area of RW02 are provided in Table 2-1.

2.2.2 Background Groundwater Chemistry

The feasibility of re-introducing treated groundwater to the on-site aquifer will be impacted by the chemistry of the groundwater into which the treated groundwater would be added. The background Hagen Farm groundwater chemistry was evaluated from groundwater samples collected upgradient of the contaminated plume. Upgradient wells include MW1, MW21, MW31, MW14, P14B, MW20, and MW15. Metals and indicator parameter data from these wells is shown in Table 2-2.

2.2.3 Estimated Chemistry of the Treated Groundwater

The chemistry of the treated Hagen Farm groundwater has been estimated based on data from the Hagen Farm Treatability Study (Rust E&I, July 1994b). A fixed-film bioreactor treatability study was performed and the effluent was analyzed for metals and indicator parameters. However, this treatability study only evaluated one component, the fixed film bioreactor effluent, of the multiple component Hagen Farm groundwater treatment system that will be used at the site. Therefore, an estimate of the Hagen Farm groundwater treatment system effluent has been made based on the treatability study data and the expected removal efficiencies of the additional clarification steps in the complete treatment system. Table 2-3 shows the anticipated metals and indicator parameter effluent data, estimated for the Hagen Farm groundwater treatment system from the treatability study.

2.2.4 Biological Characteristics of the Aquifer

Contaminant biodegradation appears to be occurring in the Hagen Farm off-property area. During the installation of the Hagen Farm off-property groundwater monitoring wells and RW02, the subsurface conditions necessary to support natural biodegradation processes were measured. The presence of a microbial population and favorable soil and groundwater conditions necessary for the biodegradation of THF, combined with THF's susceptibility to being remediated through aerobic biodegradation, supports the conclusion that the natural biodegradation of contaminants is occurring. Information on the natural biodegradation process was presented in the Hagen Farm Technical Report (Rust E&I, July 1994a).

Comparative Enumeration Assays (CEA), nutrient analyses, and soil analyses were conducted to assess the Hagen Farm off-property subsurface for the presence of microorganisms capable of degrading organic compounds. Sampling for these tests was conducted during soil boring and monitoring well installation activities which were conducted as a part of the Hagen Farm Baseline Groundwater Monitoring Report (Rust E&I, January 1994).

TABLE 2-1

ESTIMATED AQUIFER CHARACTERISTICS FROM THE 1993 PUMP TEST

Parameter	Symbol	Range of Values		
		Maximum	Minimum	Geometric Mean
Transmissivity	T	75000 gpd/ft (7.0 ft^2/min)	8600 gpd/ft (0.8 ft^2/min)	23000 gpd/ft (2.1 ft^2/min)
Storage Coefficient	S	0.1	0.003	0.02
Hydraulic Conductivity*	K	0.066 cm/sec (0.13 ft/min)	0.0076 cm/sec (0.015 ft/min)	0.019 cm/sec (0.038 ft/min)

NOTE:

*Based on a 55-foot saturated thickness.

Table 2-2
Background Groundwater Metals and Indicator Parameters

SAMPLE ID:		MW01	MW01	MW14	MW14	MW20	MW20
DEPTH:		-	-	-	-	-	-
AGENCY SAMPLE ID:		MW1	MW1	MW14	MW14	MW20	MW20
DATE SAMPLED:		17-NOV-93	20-APR-94	07-SEP-89	07-SEP-89	16-NOV-93	22-NOV-93
COMPOUND							
Metals							
Aluminum, Dissolved	mg/l	1 U	.200 ND				.200 U
Antimony, Dissolved	mg/l	.0600 U	.0600 ND J				.0600 U
Arsenic, Dissolved	mg/l	.0100 U	.0100 ND				.0100 U
Barium, Dissolved	mg/l	.200 U	.200 ND				.200 U
Barium, Total	mg/l			.0361 J			
Beryllium, Dissolved	mg/l	.0120 U	.0050 ND				.0050 U
Cadmium, Dissolved	mg/l	.0250 U	.0050 ND				.0050 U
Calcium, Dissolved	mg/l	103	106				59.9
Calcium, Dissolved	mg/l	103					59.9
Calcium, Total	mg/l		96.5				
Chromium, Dissolved	mg/l	.0500 U	.0100 ND				.0100 U
Cobalt, Dissolved	mg/l	.100 U	.0200 ND				.0200 U
Copper, Dissolved	mg/l	.125 U	.0250 ND				.0250 U
Iron, Dissolved	mg/l	.360 U	.100 ND				.100 U
Lead, Dissolved	mg/l	.0049	.00300 ND J				.00300 U
Lead, Total	mg/l			.0 U			
Magnesium, Dissolved	mg/l	55.8	60.1				28.7
Magnesium, Dissolved	mg/l	55.8					28.7
Magnesium, Total	mg/l		54.4				
Manganese, Dissolved	mg/l	.0500 U	.0100 ND				.0100 U
Mercury, Dissolved	mg/l	.00020 U	.00020 ND				.00020 U
Mercury, Total	mg/l			.00 U			
Nickel, Dissolved	mg/l	.100 U J	.0200 ND				.0200 U
Potassium, Dissolved	mg/l	5 U	5 ND				5 U
Selenium, Dissolved	mg/l	.0050 U	.0050 ND				.0050 U J
Silver, Dissolved	mg/l	.0250 U	.0250 ND				.0250 U
Sodium, Dissolved	mg/l	8 U	5 ND				5.11
Thallium, Dissolved	mg/l	.0100 U	.0100 ND				.0100 U
Vanadium, Dissolved	mg/l	.0960 U	.0500 ND				.0500 U
Zinc, Dissolved	mg/l	2.18	.598				.0200 U
Miscellaneous Parameters							
Nitrate/Nitrite	mg/l	6.90	7.56			.22	
Alkalinity, Total	mg/l	415	388 J		823	266	
Chemical Oxygen Demand	mg/l	10. U	10. ND			17	
Chloride	mg/l	15.6	11.8		20.6	1.1	
Cyanide, Total	mg/l	0.010 U	0.010 ND				0.010 U
Hardness, Total as CACO3	mg/l	487					268
Hardness	mg/l		465				
Nitrogen, Ammonia	mg/l	0.020 U	0.020 ND			0.020 U	
Nitrogen, Total Kjeldahl	mg/l	0.2 U J	0.2 ND			0.2 U J	

Table 2-2
Background Groundwater Metals and Indicator Parameters

SAMPLE ID:		MW01	MW01	MW14	MW14	MW20	MW20
DEPTH:		-	-	-	-	-	-
AGENCY SAMPLE ID:		MW1	MW1	MW14	MW14	MW20	MW20
DATE SAMPLED:		17-NOV-93	20-APR-94	07-SEP-89	07-SEP-89	16-NOV-93	22-NOV-93
COMPOUND							
Miscellaneous Parameters							
Orthophosphate	mg/l	0.050 U	0.050 ND			.17	
Sulfate	mg/l	62.6	52.8		21.9	10.1	
Total Dissolved Solids	mg/l	516	480				288
Field							
Dissolved Oxygen	mg/l						0 NA
Specific Conductance, Field	umhos/cm	857	824			439	486
Temperature, Field	deg C	10.5	16.0			8.0	11.0
pH, Field	units	6.88	7.32			7.14	7.59

Table 2-2
Background Groundwater Metals and Indicator Parameters

SAMPLE ID:		MW21	MW21	MW31	P14B	P14B	P14B
DEPTH:		-	-	-	-	-	-
AGENCY SAMPLE ID:		MW21	MW21	MW31	P-14B	P-14B	P-14B
DATE SAMPLED:		08-SEP-89	08-SEP-89	17-NOV-93	07-SEP-89	07-SEP-89	07-SEP-89
COMPOUND							
Metals							
Aluminum, Dissolved	mg/l			1 U			
Antimony, Dissolved	mg/l			.0600 U			
Arsenic, Dissolved	mg/l			.0100 U			
Barium, Dissolved	mg/l			.200 U			
Barium, Total	mg/l	.0408 J			.0355 J		.0364 J
Beryllium, Dissolved	mg/l			.0120 U			
Cadmium, Dissolved	mg/l			.0250 U			
Calcium, Dissolved	mg/l			61.0			
Calcium, Dissolved	mg/l			61			
Chromium, Dissolved	mg/l			.0500 U			
Cobalt, Dissolved	mg/l			.100 U			
Copper, Dissolved	mg/l			.125 U			
Iron, Dissolved	mg/l			.360 U			
Lead, Dissolved	mg/l			.0039			
Lead, Total	mg/l	.0 U			.0 U		.0 U
Magnesium, Dissolved	mg/l			28.8			
Magnesium, Dissolved	mg/l			28.8			
Manganese, Dissolved	mg/l			.0500 U			
Mercury, Dissolved	mg/l			.00020 U			
Mercury, Total	mg/l	.00 U			.00 U		.00 U
Nickel, Dissolved	mg/l			.100 U J			
Potassium, Dissolved	mg/l			5 U			
Selenium, Dissolved	mg/l			.0050 U			
Silver, Dissolved	mg/l			.0250 U			
Sodium, Dissolved	mg/l			8 U			
Thallium, Dissolved	mg/l			.0100 U			
Vanadium, Dissolved	mg/l			.0960 U			
Zinc, Dissolved	mg/l			.0840 U			
Miscellaneous Parameters							
Nitrate/Nitrite	mg/l			6.25			
Alkalinity, Total	mg/l		177	235		314	
Chemical Oxygen Demand	mg/l			43			
Chloride	mg/l		4.1	14.0		13.3	
Cyanide, Total	mg/l			0.010 U			
Hardness, Total as CACO3	mg/l			271			
Nitrogen, Ammonia	mg/l			0.020 U			
Nitrogen, Total Kjeldahl	mg/l			0.2 U J			
Orthophosphate	mg/l			.13			
Sulfate	mg/l		15.2	12.0		30.6	
Total Dissolved Solids	mg/l			321			

Table 2-2
Background Groundwater Metals and Indicator Parameters

SAMPLE ID:		MW21	MW21	MW31	P14B	P14B	P14B
DEPTH:		-	-	-	-	-	-
AGENCY SAMPLE ID:		MW21	MW21	MW31	P-14B	P-14B	P-14B
DATE SAMPLED:		08-SEP-89	08-SEP-89	17-NOV-93	07-SEP-89	07-SEP-89	07-SEP-89
COMPOUND							
Miscellaneous Parameters							
Field							
Specific Conductance, Field	umhos/cm			441			
Temperature, Field	deg C			11.0			
pH, Field	units			7.18			

Table 2-2
Background Groundwater Metals and Indicator Parameters

SAMPLE ID:	P14B
DEPTH:	-
AGENCY SAMPLE ID:	P-14B
DATE SAMPLED:	07-SEP-89

COMPOUND		
Miscellaneous Parameters		
Alkalinity, Total	mg/l	313
Chloride	mg/l	13.1
Sulfate	mg/l	31.2

TABLE 2-3

ESTIMATED TREATED GROUNDWATER CHARACTERISTICS METALS AND INDICATOR PARAMETERS

	Concentration (mg/l)
Arsenic	0.038
Barium	0.160
Cadmium	<0.0002
Copper	<0.025
Iron	3.745
Lead	<0.003
Manganese	0.022
Mercury	<0.0002
Nickel	0.0096
Zinc	0.0223
Alkalinity	534
Chloride	51.8
Ammonia Nitrogen	0.091
Nitrate Nitrogen	1.45
Nitrite Nitrogen	0.072
Orthophosphate	2.3
pH	8.39
Sulfate	3.7
NOTE: mg/l = milligrams per liter	

Three samples were submitted for analyses. All samples were taken from areas within the groundwater contaminant plume. The CEAs were conducted to assess aerobic and anaerobic microbial populations. The contaminant of concern, THF, is amenable to aerobic biodegradation (Bioremedial Technologies, 1993, and Warzyn, 1991). The nutrient analysis provided information regarding nutrient sources to support microbial growth. The soil analysis evaluated the ability of the subsurface soil to support microbial growth. The combination of these analytical results were used to determine whether or not the subsurface soil and groundwater conditions are capable of supporting microbial growth for biodegradation.

The results of these CEAs show the presence of a microbial population which would degrade VOCs and THF under aerobic conditions, the presence of sufficient nutrients, and the presence of soil types which support microbial growth. The results of these analyses were reported in the Baseline Groundwater Monitoring Report for the Hagen Farm Site (Rust E&I, January 1994).

According to the WDNR, there are proper levels of pH, dissolved oxygen (DO), and oxidation reduction potential (ORP) (WDNR Release News, April 1994, Vol. 4, No. 2) that are necessary to support micro-organism growth. These field parameters were measured at each of the Hagen Farm monitoring wells sampled during the November 1993 monitoring event. The pH measured at each of the wells sampled varied between 7.0 and 8.5. This value falls within the pH range of >6.0 and <9.5 which the WDNR generally considers favorable for aerobic biodegradation. The ORP of the groundwater measured to be greater than 50 millivolts at all of the site monitoring wells. These Hagen Farm ORP measurements fall above the WDNR specified minimum range of millivolt values where the WDNR feels that subsurface conditions are amenable for biodegradation. For aerobic biodegradation to take place, the WDNR feels that a DO level of greater than 1 mg/L must be present. The DO levels in the Hagen Farm groundwater that were measured in the November 1993 sampling event were all found to be above 1 mg/L.

3.0 REMEDIAL TECHNOLOGY DESCRIPTION

On-property and off-property contaminated groundwater from the Hagen Farm site will be extracted and treated using the system described in the Hagen Farm Technical Report (Rust E&I, July 1994a) and the Treatment Technology Proposal (Rust E&I, September 1994). Following treatment, it is currently proposed that the treated Hagen Farm groundwater will be piped approximately 1.5 miles from the Hagen Farm groundwater treatment plant to the Yahara River for discharge. An alternative to this discharge method would be to re-introduce the treated groundwater into the aquifer through the use of an infiltration gallery to be located on-site. One of the benefits of this discharge option would be that the discharge pipe would not have to be constructed. The construction has the potential to disrupt the local community during construction of the effluent force main to the Yahara River adjacent to CTH "A". Also, the re-introduction of the treated Hagen Farm groundwater to the aquifer is expected to enhance the natural biological degradation occurring within the aquifer and decrease the time necessary for the aquifer restoration.

4.0 FEASIBILITY TEST OBJECTIVES

The feasibility of utilizing an infiltration gallery for discharge of treated Hagen Farm groundwater will be investigated through four evaluations. Additional evaluations of subsurface conditions are necessary for several reasons:

1. Infiltration must flow vertically and then laterally through the geologic materials. Because these sediments have some layering and are laterally variable, vertical groundwater movement is expected to be slower then horizontal movement. The difference in vertical versus horizontal flow will be evaluated, along with the ability of the geologic materials to allow infiltration of the design effluent flow.

2. The chemistry of the treated water and natural groundwater will be different. Chemical reactions that could be detrimental to infiltration rates must be evaluated.

3. Biological degradation may be enhanced by this proposed discharge option and; therefore, may be more desirable. These conditions will be evaluated through groundwater flow modeling, groundwater chemistry modeling, biological modeling, and a pilot infiltration basin test.

This section describes the objectives of each of the four components of the Feasibility Test.

4.1 GROUNDWATER MODELING

The proposed remediation requires pumping of contaminated groundwater with a groundwater extraction system, treatment of groundwater, reintroduction of treated water into the ground through an infiltration basin, and capture of the existing and reintroduced groundwater. Groundwater modeling will be used to evaluate the feasibility of using an infiltration basin to discharge the treated groundwater and assuming the infiltration basin is feasible, modeling will be used to test the feasibility of using an infiltration basin in conjunction with groundwater extraction wells. The infiltration basin must be designed with a surface area that is capable of recharging water at the treatment facility discharge rate of 80 gallons per minute (gpm). The extraction system must be capable of maintaining a capture zone with the additional volume of the reintroduced groundwater.

The purpose of this feasibility study will be partly achieved through hydrological modeling using a simplified groundwater mounding computer model and a simplified groundwater flow model. The objectives of the test follow.

The first objective of the Hagen Farm injection groundwater computer modeling effort is to estimate the area required to infiltrate the treatment facility effluent flow. A groundwater mounding computer model, described in Section 5.1, will be used to estimate the minimum surface area for the full- scale infiltration gallery that can infiltrate steady state effluent flow.

The completion of the first objective will result in an estimate of the full-scale specific recharge rate which is the volumetric flow rate of the Hagen Farm groundwater treatment facility, divided by the surface area of the infiltration basin. This estimated specific recharge rate will be applied to a smaller scale infiltration area for the pilot test.

A second objective of the groundwater modeling effort is to estimate the groundwater mounding profile resulting from the pilot scale reintroduction. An estimate of the groundwater mounding profile is needed to locate observation wells within the area that may be affected by the mounding effects.

The model simulations to accomplish the first two objectives require an input parameter value for hydraulic conductivity. The hydraulic conductivity value will be based on results from past well slug tests and pump test(s).

A third objective of the hydrological modeling effort is to evaluate hydraulic conductivity measured during the pilot scale injection test. The model will be matched (calibrated) to water elevations observed during the pilot scale test.

The final objective of the hydrological modeling effort is to evaluate how the groundwater flow system would be affected by the groundwater infiltration/extraction system. A groundwater flow model, described in Section 5.1, will be used to define flow paths associated with infiltration and extraction and to assess capture efficiency of the proposed groundwater extraction system.

4.2 GROUNDWATER CHEMISTRY MODELING

The purpose of the chemical modeling is to evaluate whether the chemical characteristics of the treated Hagen Farm groundwater, when introduced into the aquifer upgradient of the SCOU using an infiltration gallery, would have adverse effects due to precipitate formation that could clog the aquifer pore spaces.

A geochemical model, MINTEQA2®, will be used to determine the potential for plugging of the infiltration area by chemical scaling. Equilibria of carbonate species in the extracted Hagen Farm groundwater will shift as the groundwater undergoes aeration and biological treatment through the Hagen Farm groundwater treatment system. The model will be used to estimate what the new equilibrium condition will be, and whether a change in calcium solubility will occur as the water is allowed to percolate into the aquifer through the infiltration gallery. If scaling of the media is predicted, the model will assist in determining what additional treatment may be necessary to stabilize the treated Hagen Farm groundwater before infiltration.

4.3 BIOLOGICAL MODELING

The purpose of the biological modeling is to evaluate whether the infiltration of treated Hagen Farm groundwater will speed the restoration of the aquifer through enhanced biological degradation. The USEPA model Bioplume II® will be used in the feasibility test to examine the potential for biological degradation of tetrahydrofuran (THF) to be enhanced in the aquifer beneath the Hagen Farm site by

the infiltration of treated groundwater. The effects of this groundwater infiltration will be evaluated by modeling the degradation with and without treated groundwater infiltration. Infiltration should increase the oxygen content and nutrient levels in the aquifer due to the elevated oxygen and nutrient content of the water leaving the Hagen Farm groundwater treatment system. Bioplume II will estimate how much the infiltration of the treated groundwater may increase the biodegradation of site contaminants.

4.4 PILOT SCALE FIELD INFILTRATION TEST

The purpose of the pilot scale test is to determine the loading rate of the treated groundwater that can be discharged per unit of area. The specific objective of the pilot scale study is to measure water level changes in the on-site aquifer during the pilot scale test to determine the vertical hydraulic conductivity of the soil. Test pits will be excavated prior to construction of the pilot scale test infiltration gallery to identify the depth, thickness, and extent of low hydraulic conductivity soil layers that could restrict treated groundwater infiltration. The pilot scale test will assess potential impacts of groundwater mounding during continuous discharge of treated groundwater to the infiltration gallery. Groundwater mounding observed during the pilot scale test will be used to estimate the vertical hydraulic conductivity.

5.0 MODEL DESCRIPTIONS AND PROCEDURES

5.1 GROUNDWATER MODELING

5.1.1 Description

Two groundwater models will be utilized to fulfill the groundwater modeling objectives. The lack of complexity of the Hagen Farm natural geologic system coupled with the purpose of the models does not allow nor require a rigorous groundwater flow model. Therefore, the models developed for this feasibility test will be simplified to represent an idealized geologic/ hydrogeologic system. Actual system performance will be monitored after the Hagen Farm infiltration gallery design is constructed and implemented. Uncertainties caused by simplification of the modeled groundwater system will be considered by the safety factors inherent in the design of the Hagen Farm infiltration gallery.

A two-dimensional, numerical, finite difference plan view model developed by Colorado State University will be used to assess the development of the Hagen Farm groundwater mounding profile beneath the infiltration gallery. This model is the Colorado State University Pit and Well Model (CSUPAW). CSUPAW assumes homogenous and isotropic conditions and will be used to size the infiltration gallery and predict the localized groundwater table elevation rise associated with the recharge using an infiltration gallery.

FLOWPATH, a two-dimensional, numerical, finite difference plan view model developed by Waterloo Hydrogeologic Software will be used to assess the changes to the groundwater flow patterns associated with the groundwater infiltration/extraction systems. The model is capable of simulating heterogenous and isotropic conditions, steady state hydraulic heads, and time related path lines. FLOWPATH will be used to predict the water table elevations and resulting flow pathways taking into account the proposed treated groundwater infiltration and groundwater extraction. The extraction well capture efficiency will also be assessed.

5.1.2 Procedures

5.1.2.1 Introduction

The computer programs will be used to design the size of the pilot scale test and evaluate the feasibility of the proposed extraction well/infiltration gallery remedial design.

CSUPAW will be used to assess the feasibility of re-introducing treated groundwater through the infiltration gallery based on estimates of soil hydraulic conductivity. The model will estimate the surface area of the full-scale infiltration gallery that is required to accommodate effluent discharge from the Hagen Farm groundwater treatment facility. The predicted full-scale surface area will determine the specific recharge application rate, or the effluent flow rate divided by the infiltration gallery surface area for the pilot scale study. The pilot scale study infiltration gallery size will

accommodate 10 percent of the full-scale groundwater treatment system effluent flow (76 gpm^2 x .10 = 8 gpm).

The FLOWPATH model will be used to define the horizontal groundwater flow paths from the proposed groundwater infiltration gallery to the groundwater extraction wells. The capture efficiency of the groundwater extraction wells will be assessed.

CSUPAW Modeling - Pilot Scale Specific Recharge Rate

CSUPAW will be used to determine the size of the full-scale infiltration gallery by estimating the maximum infiltration rate that does not cause the on-site groundwater mound to reach the infiltration gallery bottom. Parameters necessary to estimate the on-site groundwater mound build-up will be based on groundwater treatment system design parameters, aquifer parameters estimated from previous field investigations or literature data. Following is a list of model input parameters and the source of the values to be used:

INPUT PARAMETERS	INPUT PARAMETER SOURCE
Effluent volume	Groundwater treatment system design
Time	Estimated time to reach steady state
Aquifer thickness	RI report
Aquifer K_v	R01 pump test
Transmissivity	Calculated from aquifer K and thickness
Storage	Estimated specific yield of soil types
Water table depth	Previous field information
Basin size	Variable to be tested

The application of this model represents simplified subsurface conditions. The model assumes that soil hydraulic conductivity is uniform as a function of space (homogenous) and direction (isotropic).

CSUPAW will be used to estimate the full-scale infiltration gallery surface area required to infiltrate an effluent discharge rate of 80 gallons per minute. Iterative model simulations will be conducted by adjusting the infiltration gallery surface area and estimating the on-site groundwater mound height until the on-site groundwater mound elevation is about one-foot from the bottom of the infiltration gallery. The proposed size of the pilot scale test infiltration gallery will accommodate 10 percent of the proposed full-scale infiltration gallery size.

Following determination of the full-scale infiltration gallery surface area, CSUPAW will be used to predict the profile height of the on-site groundwater mound for the pilot scale test. The predicted groundwater mound profile height will be used to locate the temporary observation wells that will be monitored to measure the on-site groundwater mound height throughout the pilot test study.

Following completion of the pilot test study CSUPAW will be used to simulate the observed groundwater mound profile by adjusting the model input parameter value for hydraulic conductivity. This evaluation will be conducted to determine if the proposed full-scale basin surface area is

capable of infiltrating the effluent flow that will be applied to the infiltration gallery. Groundwater infiltration must be planned so that the soil infiltration rate is not exceeded by the infiltration application rate.

FLOWPATH

A groundwater flow model will be used to predict steady state on-site groundwater table elevations and assess extraction well capture efficiency following the construction and operation of the Hagen Farm groundwater extraction/infiltration system.

The groundwater model FLOWPATH will be used to simulate two-dimensional plan view on-site groundwater elevations and flow paths. A model grid pattern will be constructed over the area to be modeled. Model boundary conditions and input parameters will be defined based on site hydrologic and physical conditions. Baseline model input parameters will be the same as those previously used in the CSUPAW model. They will include hydraulic conductivity, precipitation recharge, porosity, and aquifer bottom depth.

The purpose of the model, coupled with the relative lack of complexity in the on-site geology, does not require a rigorous groundwater flow model. However, during model setup, simulated on-site water table elevations will be compared to water table elevations reported during previously reported investigations. Model input parameters may be adjusted until the simulated on-site water table is similar to the measured historic water table. A sensitivity analysis will be conducted to test variations of input data, within their range of probability, on model results. Following sensitivity analyses, predictive simulations will be conducted. Model input parameters will be adjusted to simulate groundwater infiltration, predict groundwater flowpaths, and predict extraction well capture efficiency.

5.2 CHEMICAL MODELING

5.2.1 Description

MINTEQA2® is a geochemical equilibrium speciation model for dilute aqueous systems. The model was developed by the USEPA at the Athens Environmental Research Laboratory. The model can be used to calculate the mass distribution between dissolved, adsorbed, and multiple solid phases under a variety of conditions in an environmental setting. MINTEQA2® uses the thermodynamic database of the U.S. Geological Survey (USGS) WATEQ3 model.

5.2.2 Procedures

The data required to predict the chemical equilibrium conditions of the groundwater at the Hagen Farm site includes a chemical analysis of the sample to be modeled (i.e., the treated groundwater) giving the total dissolved concentrations of the components of interest, pH, and giving the partial pressures of gases of interest. The components of interest in this case are divalent cations, such as calcium and magnesium, that form insoluble carbonates or bicarbonates. The data set for this modeling can be reasonably established using the existing groundwater chemistry data and the

anticipated Hagen Farm groundwater treatment system effluent quality estimated from the treatability study.

Because the extracted Hagen Farm groundwater will be aerated during the pretreatment process to increase the dissolved oxygen content and oxidize soluble iron, the dissolved carbon dioxide content will be set at equilibrium with the atmospheric partial pressure of carbon dioxide, thus fixing the total carbonic species. Since this partial pressure will be valid within the top several feet of the infiltration gallery media, it is possible to predict the precipitation potential of both calcium and magnesium carbonate.

5.3 BIOLOGICAL MODELING

5.3.1 Description

Bioplume II® is a two-dimensional computer model which simulates the transport of dissolved contaminants under the influence of oxygen-limited biodegradation. Bioplume II allows for the incorporation of both extraction wells and infiltration. The model is based on the USGS MOC solute transport code. Bioplume II computes the changes in the contaminant concentration over time due to convection, dispersion, mixing, and biodegradation. Bioplume II uses convection, dispersion, and mixing to estimate how oxygen and contaminants move through the aquifer. Biodegradation is used to model the removal of dissolved oxygen and volatile organic compounds from the aquifer.

5.3.2 Procedures

The following variables will be input to the Bioplume II model: the physical and chemical characteristics of the existing Hagen Farm groundwater and soil, the THF biological half life (degradation rate), the oxygen-THF stoichiometric ratio, the Hagen Farm groundwater extraction rates and locations, the proposed location and flow rate of the infiltration system, the location of the observation wells to be utilized, and the initial Hagen Farm groundwater levels. Given these inputs, the model will produce a map of the oxygen and THF concentrations and the head distribution. Additionally, for any observation points requested from the model, the THF and oxygen concentrations over time can be predicted.

Several iterations of Bioplume II will be run to investigate the sensitivity of the THF concentrations to the THF half life and oxygen concentrations, and to investigate the effects of the proposed infiltration system on the Hagen Farm groundwater plume. The first run of the model will not include infiltration. Thus, Bioplume II will be run assuming that the treated Hagen Farm groundwater is discharged off-site instead of being re-introduced into the aquifer, as described in the Pre-Final (95%) Design Report (Rust E&I, December 1994). The second run of the model will include infiltration as a part of the feasibility test described in the Hagen Farm SOW. The groundwater infiltration rate shall initially be set at the expected Hagen Farm groundwater treatment system operating rate (76 gpm), although the sensitivity analysis shall consider other flow rates including a maximum infiltration rate of 136 gpm. This will allow for comparison of the expected biodegradation rate at the site with and without the infiltration of treated Hagen Farm groundwater.

The sensitivity analysis will be provided by further runs of the model. The effect of changing the THF half life, treated groundwater injection rates, and the oxygen concentration will be evaluated.

Several data sources will be used to provide input values for the Bioplume II model. Data will be used from the Hagen Farm Treatability Study Report (Rust E&I, July 1994b), the Hagen Farm Baseline Groundwater Monitoring Report (Rust E&I, January 1994), the Pumping Test Report (Rust E&I, April 1994), and the Pre-Final (95 percent) Remedial Design Report (Rust E&I, December 1994). Values for variables which were not determined at the site will be estimated from values at similar sites as found through literature searches. Such data sources shall include, but not be limited to, "Groundwater" (Freeze and Cherry, 1979), Groundwater Chemicals Desk Reference (Montgomery, 1991), "A Critical Review of Data on Field-Scale Dispersion in Aquifers" (Gelhar et al., 1992), as well as professional companies which specialize in providing biodegradation services and research.

6.0 PILOT SCALE INFILTRATION TEST

This section will be completed as an addendum to this work plan following the completion of the modeling tasks. It provides a general overview of the procedures to be followed. However, specific requirements may change based on the groundwater flow modeling.

6.1 DESIGN

The design of the Hagen Farm pilot scale test will simulate the full-scale operation of an infiltration gallery. The pilot scale test system will be sized to test re-introduce approximately 10 percent of the Hagen Farm groundwater treatment system design effluent (1/10x76 gpm=7.6 gpm). The procedure to size the pilot scale test system is provided in Section 5.1.2 of this work plan.

The Hagen Farm pilot scale test infiltration system will be comprised of an infiltration gallery (seepage cell), water tank, and monitoring points. The infiltration gallery will be an infiltration pit that will be excavated approximately 6 feet into the unsaturated zone. The bottom 2 feet of the excavated infiltration gallery will be filled with a noncarbonate granular media. A water distribution system will be placed on top of the granular media to evenly distribute water over the area of the infiltration gallery. An additional 1 foot of granular media will be placed on top of the water distribution system to stabilize the piping during the pilot scale test. Water will be pumped or gravity fed via the distribution piping, into the infiltration gallery at a rate of approximately 7 to 8 gallons per minute. This infiltration rate is approximately 10 percent of expected effluent flow rate of the Hagen Farm groundwater treatment system. Water table monitoring points in the area of the pilot scale test will be measured to provide groundwater data to evaluate the aquifer response to the infiltration of treated groundwater.

The pilot scale test will be conducted in the area of the Hagen Farm site where the full-scale infiltration gallery has been conceptually placed. The pilot scale test and conceptual infiltration system location are upgradient of the Hagen Farm SCOU.

6.2 PROCEDURES

After the area requirements for the pilot scale infiltration gallery have been determined by computer modeling, the gallery will be constructed using standard excavating techniques. The infiltration gallery will need to be excavated to a depth of approximately 6 feet below grade. During the excavation of the infiltration gallery, the soil profile will be evaluated. The soil profile will be evaluated to determine whether there are soil layers present in this area that could potentially restrict infiltration near the ground surface. Once the pilot scale infiltration gallery has been excavated and the soil profile have been evaluated, the excavation will be filled with 2 feet of granular media. The water distribution piping will then be installed and covered with an additional foot of granular media.

Temporary groundwater monitoring points may need to be installed to measure the groundwater levels near the pilot scale infiltration gallery. These temporary groundwater monitoring points will

be point-driven wells installed downgradient and sidegradient of the infiltration gallery. These wells will be used to measure the groundwater elevation changes as described in Section 6.4.2.

Clean water obtained from the City of Stoughton Water Treatment Unit, will be discharged into the pilot scale test infiltration gallery at a rate of 7 to 8 gallons per minute. This infiltration rate is approximately 10 percent of the estimated effluent flow rate from the Hagen Farm groundwater treatment system. The clean water will be staged in a holding tank near the pilot scale test infiltration gallery. Water will be introduced into the gallery by gravity or, if necessary, by pumping to obtain the required infiltration rate.

The procedures for monitoring the groundwater levels before, during, and after the pilot scale injection test are provided in Section 6.4.2.

At the completion of the pilot scale test, the data collected will be examined to determine whether or not the infiltration of treated on- and off-property groundwater at the Hagen Farm site will be feasible. This evaluation will include the computer model verification described in Chapter 5 of this work plan.

6.3 DATA COLLECTION

6.3.1 Test Pits

The soil profiles will be exposed to a depth of approximately 6 feet during the installation of the pilot scale test water distribution system. These pits will be excavated within the proposed location of the pilot scale test and full-scale infiltration system to determine if soil layers could potentially restrict infiltration occur near the ground surface.

6.3.2 Groundwater Elevation Monitoring

Three temporary groundwater monitoring points will be needed adjacent to the pilot scale test area to monitor groundwater elevations during the five-day pilot scale test. Groundwater elevations in the temporary monitoring points and selected existing water table wells will be measured three days prior to initiation of and during the pilot scale test. These monitoring wells and points will be measured at a minimum of 4-hour intervals prior to commencement of the pilot scale test. Some of the chosen monitoring points/wells will be measured at a minimum of 10-minute intervals for the remaining 5 days of the recharge period and for a 2-day period following the cessation of recharge. The remaining monitoring points/wells will be measured, but on a less frequent basis.

6.4 DATA ANALYSIS AND INTERPRETATION

6.4.1 Field Survey Of Low Hydraulic Conductivity Soil Layers

The soil profiles of the test pits will be described as soil texture, color, depth, thickness, and extent of layer(s) that could potentially restrict vertical flow. The soil profiles will be visually examined to determine if soil characteristics associated with restriction of downward infiltration (mottling,

gluing) occur. If a potential restrictive layer is identified, soil samples from the layer may be selected for grain size analysis. The grain size analysis may be needed to determine the appropriate depth of the pilot scale system.

6.4.2 Groundwater Elevation Monitoring

The groundwater level measurements from the monitoring points/wells will be evaluated to assess the height and geometric profile of mounded groundwater. The size of the full-scale infiltration gallery may have to be increased if the height of the groundwater mound is measured to be near the base of the infiltration gallery during the pilot scale test.

As discussed in Section 5.1.2, the observed groundwater mounding elevations from the pilot scale test will be simulated by adjusting the hydraulic conductivity input parameters of the groundwater mounding model to assess the hydraulic conductivity of the pilot scale test area. An evaluation of the pilot scale test results and the model determined hydraulic conductivity of the pilot scale test area will determine the full-scale infiltration system feasibility and the appropriate size of the full-scale infiltration gallery.

6.5 HEALTH AND SAFETY

Health and safety procedures described in the approved Remedial Design Work Plan, Groundwater Control Operable Unit, Hagen Farm, Town of Dunkirk, Wisconsin (Warzyn, July 1993) will be followed during all activities while at the site.

7.0 REPORT

The Feasibility Test Report will document the results of the modeling and pilot scale test as described in Sections 5 and 6. A draft Feasibility Test Report outline is shown in Figure 7-1.

FIGURE 7-1

DRAFT FEASIBILITY TEST REPORT OUTLINE

1.0 INTRODUCTION
- 1.1 Site Background
  - 1.1.1 Site Name and Location
  - 1.1.2 History of Operations
- 1.2 Remedial Technology Description
  - 1.2.1 Treatment Process and Scale
  - 1.2.2 Operating Features
- 1.3 Site Characteristics
  - 1.3.1 Hydrogeology
  - 1.3.2 Background Groundwater Chemistry
  - 1.3.3 Estimated Chemistry of Treated Groundwater
  - 1.3.4 Biological Characteristics of Aquifer

2.0 FEASIBILITY TEST APPROACH
- 2.1 Test Objectives and Rationale
- 2.2 Hydrological Modeling
  - 2.2.1 Objectives
  - 2.2.2 Procedures
- 2.3 Chemical Modeling
  - 2.3.1 Objectives
  - 2.3.2 Procedures
- 2.4 Biological Modeling
  - 2.4.1 Objectives
  - 2.4.2 Procedures
- 2.5 Pilot Scale Re-injection Study
  - 2.5.1 Design and Procedures
  - 2.5.2 Equipment and Materials
  - 2.5.3 Data Collection
  - 2.5.4 Data Management
- 2.6 Deviations From the Work Plan

3.0 RESULTS AND DISCUSSION
- 3.1 Hydrological Modeling
  - 3.1.1 Results
  - 3.1.2 Sensitivity Analysis
- 3.2 Chemical Modeling
  - 3.2.1 Results
  - 3.2.2 Sensitivity Analysis

3.3 Biological Modeling
3.3.1 Results
3.3.2 Sensitivity Analysis
3.4 Pilot Scale Re-injection Study

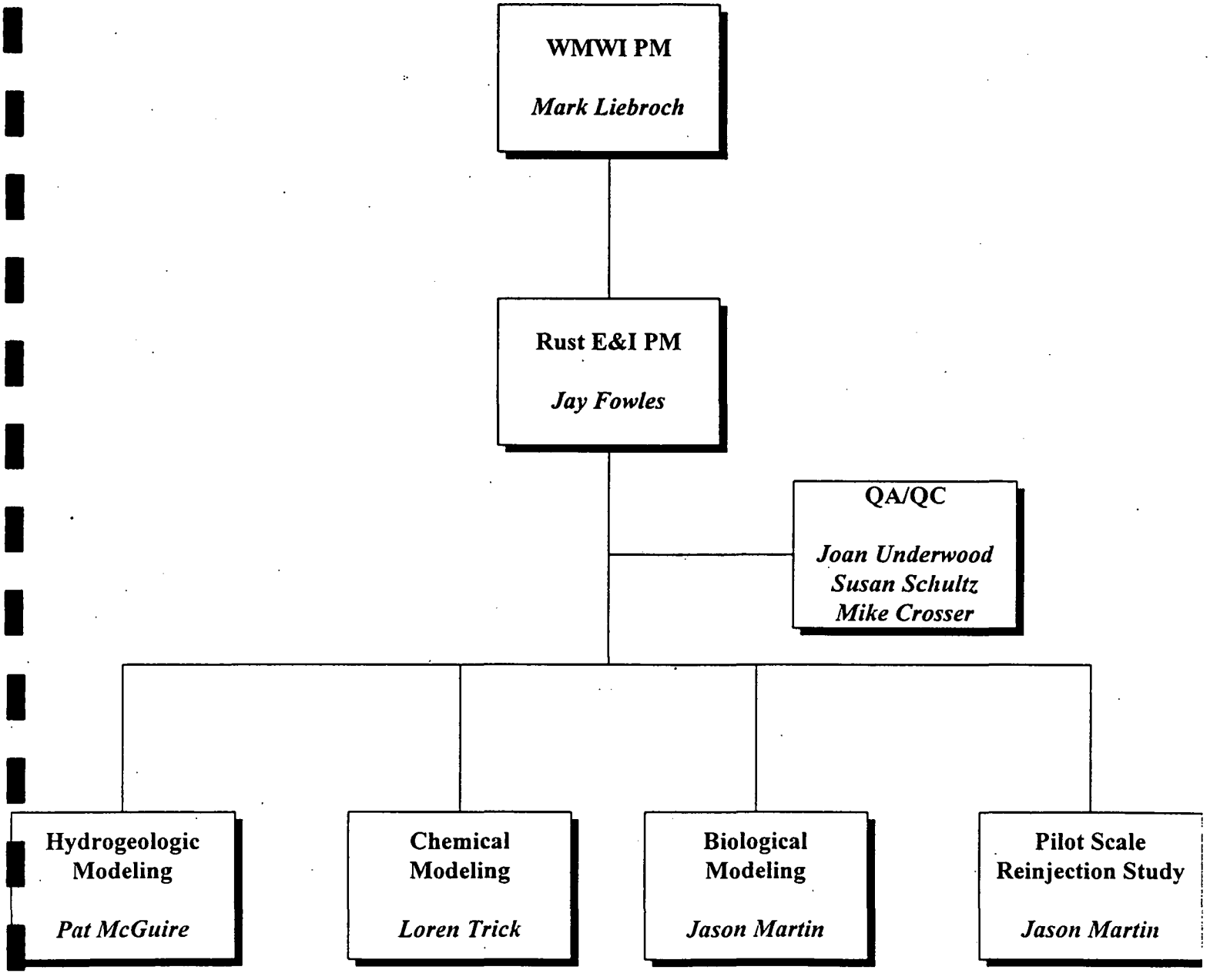
4.0 CONCLUSIONS AND RECOMMENDATIONS

8.0 SCHEDULE

The schedule for conducting the modeling and pilot scale injection test will be provided after USEPA and WDNR approval of this work plan.

FIGURE 8-1

PROJECT ORGANIZATION



D:\HAGNFRM1\FEASWP1\FIG8-1

Hagen Farm
Feasibility Test Schedule

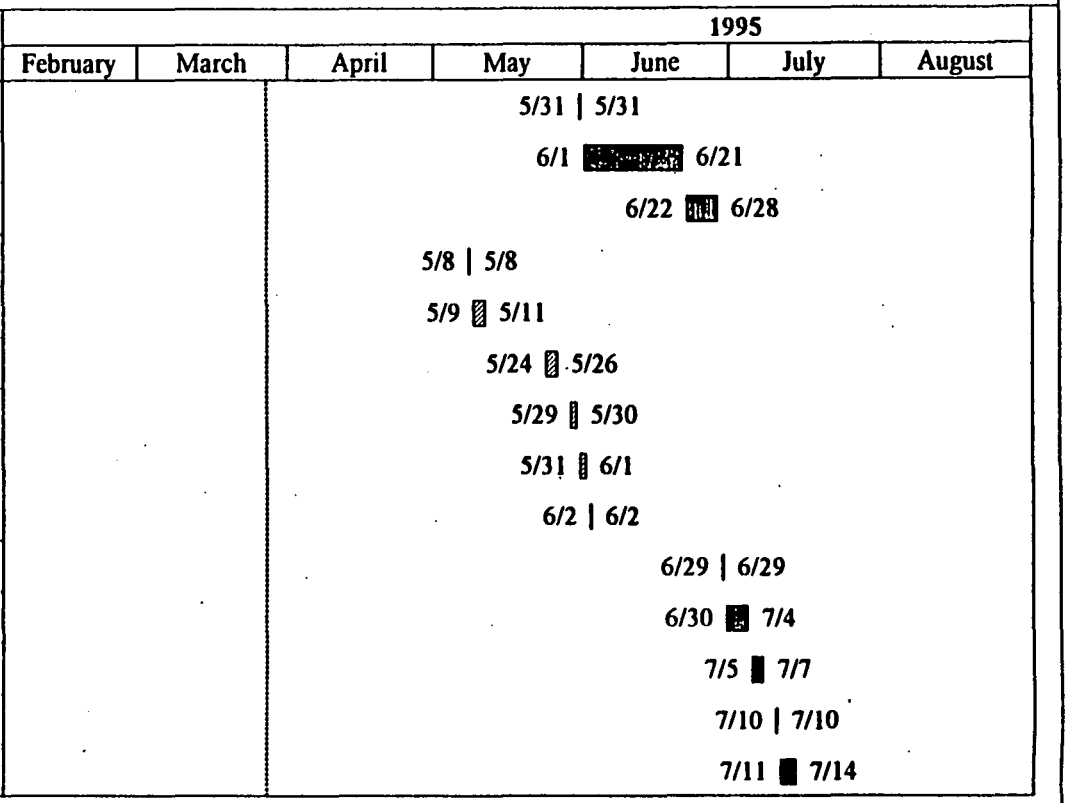
ID	Name	Dur.	1995 February	March	April	May	June	July	August
1	Develop Work Plan Tasks	2d	2/27	2/28					
2	Identify Data Needs	1d	2/28	2/28					
3	Coordinate Data Sources	1d	3/1	3/1					
4	Provide Work Plan Structure	1d	3/2	3/2					
5	Write Work Plan	1d	3/3	3/4					
6	QC and Print Work Plan	1d	3/17	3/17					
7	Obtain WMWI Approval of WP	5d	3/20	3/24					
8	Obtain Agency Approval of WP	10d	3/27	4/7					
9	Implement Work Plan	1d	4/10	4/10					
10	Data Collection - MINTEQA2	1d	4/11	4/11					
11	Gather Data & Write Tech. Memo	2d	4/11	4/12					
12	Run MINTEQA2 & Write Up Results	2d	4/13	4/14					
13	Run CSU Model to Get Area	1d	4/13	4/13					
14	Analyze Reinj./ Adjust Parameters	1d	4/14	4/14					
15	QC Results (MINTEQA2)	1d	4/17	4/17					
16	Run CSU Model to Est. Mound Profile	1d	4/17	4/17					
17	Excavate Soil Pits	1d	4/18	4/18					
18	Analyze for Restrictive Layers	1d	4/19	4/19					
19	Construct Pilot Test Cell & Obs. Wells	5d	4/20	4/26					
20	Conduct Pilot Test	9d	5/8	5/18					
21	Evaluate Pilot Test Results	3d	5/19	5/23					
22	Run Flowpath/Do Sensitivity Analysis	15d	5/24	6/13					

Karen Miller
3/27/95

Critical | Noncritical | Milestone ◆ | Progress

Hagen Farm
Feasibility Test Schedule

ID	Name	Dur.
23	Estimate New Recharge Area Based on New k Value	1d
24	Write up Pilot and Model Results	15d
25	QC Pilot and Model Results	5d
26	Bioplume Data Collection	1d
27	Data Organization	3d
28	Run Bioplume	3d
29	Format and Interpret Results	2d
30	Write up BioPlume Results	2d
31	QC BioPlume Results	1d
32	Develop Recommendations	1d
33	Finalize Report	3d
34	QC and Print Report	3d
35	Submit to WMWI	1d
36	Submit to Agencies	4d



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3/27/95

Critical Noncritical Milestone ◆ Progress