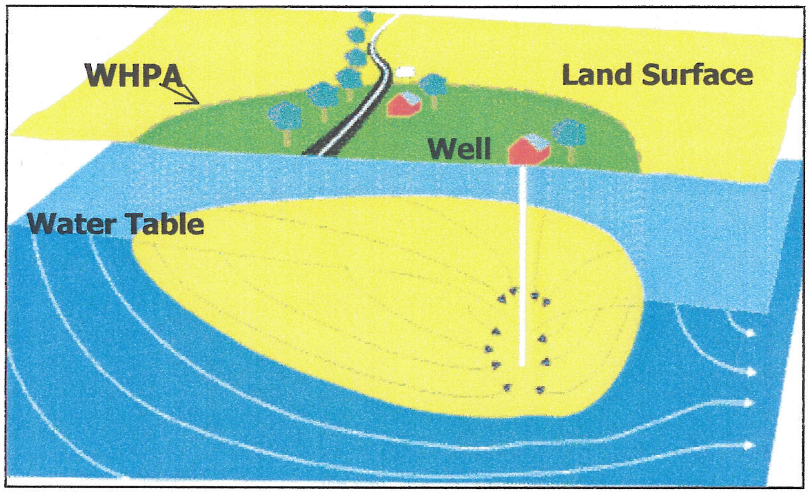
SOURCE WATER ASSESSMENT

for

TOWN OF CLEAR SPRING

Washington County, MD



Prepared By
Water Management Administration
Water Supply Program
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MDE

TABLE OF CONTENTS

SUMMARY

The Maryland Department of the Environment's Water Supply Program (MDE-wsp) has conducted a Source Water Assessment for the Town of Clear Spring. The required components of this report as described in Maryland's Source Water Assessment Program (SWAP) are 1) delineation of an area that contributes water to the source, 2) identification of potential sources of contamination, and 3) determination of the susceptibility of the water supply to contamination. Recommendations for protecting the drinking water supply conclude this report.

The source of Clear Springs's water supply is an unconfined carbonate fractured rock aquifer. Clear Spring currently uses three wells (A, B, and C). A fourth well (D) and two spring supplies are not in use. The Source Water Assessment area was delineated for the Town of Clear Spring using U.S. EPA approved methods specifically designed for each source.

Potential point sources of contamination within the assessment area were identified from MDE contaminant inventory databases. The Maryland Department of Planning's 2002 land use map for Washington County was used to identify non-point sources of contamination. Well information and water quality data were also reviewed.

The susceptibility analysis is based on a review of the existing water quality data for the Clear Spring water system, the presence of potential sources of contamination in the WHPA, well integrity, and the inherent vulnerability of the aquifer. It was determined that the Clear Spring water supply is presently susceptible to contamination by microbiological contaminants. A filtration plant has been installed in order to treat for the microbiological contamination. This water supply is not presently susceptible to contamination by volatile organic compounds, inorganic compounds, radionuclides, or synthetic organic compounds.

INTRODUCTION

The Town of Clear Spring is located approximately 5 miles west of the City of Hagerstown, in Washington County. Clear Spring's water supply system serves a population of 499 and has 180 service connections. Clear Spring presently obtains its water supply from three wells (Nos. A, B, and C). One other well (D) and two springs are not in use.

This document summarizes information from various studies and activities and also contains the required components of Maryland's Source Water Assessment Plan: delineation, contaminant source inventory, and susceptibility analysis.

WELL AND SPRING INFORMATION

A review of the well completion reports and sanitary surveys of Clear Spring's water system indicate that all wells, except well D, were installed prior to the implementation of the 1973 well construction regulations. Table 1 contains a summary of the well construction data. Visual inspections (well bore video camera) completed by ARRO Consulting (April 2001) indicated that Wells B and C were in relatively good physical condition. Well A was in relatively poor condition, due to a relatively shallow casing (24 feet), although there was a solid casing seal to bedrock. Well D was in poor condition due to large holes in the casing at 38 feet. The location of the wells and springs are shown in Figure 1.

PLANT ID	SOURCE ID	USE CODE	WELL NAME	PERMIT	TOTAL DEPTH	CASING DEPTH	YEAR DRILLED
01	01	PRODUCTION	Well A	WA-05-2934	185	25	1963
01	02	PRODUCTION	Well B	WA-05-2935	280	60	1963
01	03	PRODUCTION	Well C	WA-67-0072	285	55	1966
01	04	UNUSED	Well D	FR-73-6399	305	55	1978
01	05	UNUSED	Upper Spring				
01	06	UNUSED	Lower Spring				

Table 1. Town of Clear Spring Well and Spring Information

The Town has a ground water appropriation permit (WA1967G001) issued for a daily average of 200,000 gallons on a yearly basis and 300,000 gpd during the month of maximum use. Based on the semi-annual pumpage reports (1979-2004), water use has varied from 156,225 gpd avg in 1985 (estimated per capita use-290 gpdpc) to 85,536 in 2002 (estimated-179 gpdpc), and was last reported in 2004 as 131,974 gpd avg (estimated-264 gpdpc). The high per capita demand, temporal variation in use, and age of the system suggest that there may be substantial leakage in the system. Part of the leakage may be in the distribution system and some may be from the old in-ground concrete reservoir. The recently completed filtration plant/storage tank should help determine how much water was leaking from the old reservoir. A water audit and leak detection would be needed to assess the potential leaks from the distribution system.

It was reported that the springs went dry during the winter of 1991-92, which was attributed to interference from the town's wells. The sustained yield of the well field is unknown. The maximum reported use under dry conditions was 186,569 in July 1988 and under wet conditions was 296,345 gpd during November 1985. During these periods, the best information is that well D and the springs were still in service. Also, there probably is substantial interference between the existing wells in service.

HYDROGEOLOGY

There have been various interpretations of the aquifer from which the Clear Spring wells and springs draw water. The first five appropriation permits indicated that the aquifer was the Oriskany Sandstone. The MGS Basic Data Report 18 (1983) and the active appropriation permit indicate that the wells were in the limestone rock Heldersburg Formation. A subsequent interpretation by MGS (M. Duigon letter of 1 Aug 2002) indicated that the wells were in the Wills Creek Shale. All of the formations indicated above are in the potential recharge area for the wells and springs; however, the well completion reports for wells C and D indicate that those wells were drilled into a gray/brown limestone, most likely in the Heldersburg Formation. All of the rock formations that may contribute water to the wells are susceptible to contamination; the consolidated sedimentary rocks, due to a thin regolith and highly fractured bedrock, and the limestone, due to dominant flow through shallow epi-karst zones.

In 2000 MDE determined that the town's springs were under the influence of surface water. In 2001, MDE determined that wells A, B, and C were under the influence of surface water. At that time, it was assumed that well D would be disconnected, so no determination was made for that well. In May 2005, the town completed construction and testing of a filtration plant for the water supply.

SOURCE WATER ASSESSMENT AREA DELINEATION

For ground water systems, a Wellhead Protection Area (WHPA) is considered the source water assessment area for the system. The WHPA represents the area around a well in which any contaminant present could ultimately reach the well. The source water assessment area for public water systems using wells or springs in fractured-rock aquifers is the watershed drainage area that contributes to the well or spring. The WHPA could be modified in carbonate aquifers to account for inflow from other watersheds; however, in this case, there is no evidence of inter-basin flow.

The area should be modified to account for geological boundaries, ground water divides, and by annual average recharge needed to supply the well (MD SWAP, 1999). The capture zone for a well, however, will be greatest during a drought, because the zone has to expand due to the reduced recharge in order to supply the annual average demand.

The WHPA should cover an area large enough to supply water at the average appropriated amount using effective recharge. Drought year (10-yr return) base flow (effective recharge) in the Conococheague Creek Basin was estimated by MDE (Hammond, 2000, revised 2004) at 513 gpd/acre. The recharge area for the 3 wells in service during the 2002 drought (effective recharge 484 gpd/ac), using an average use of 85,540 gpd and the 2002 recharge value, would have been 177 acres. The WHPA boundaries for the water supply were extended to the nearest ridgeline, or topographic divide, to account for a possible up-gradient zone of contribution outside of the capture zone of the wells, figure 1. This produced a WHPA zone of 320 acres. The annual water use reports and effective recharge values in Conococheague Creek were reviewed to estimate the maximum capture zone or recharge area for the water supply. The greatest calculated area was 233 acres (130,000 gpd avg @ 558 gpd avg/ac in 1981). These data indicate that the zone of contribution is greater than the calculated recharge area and that the town should be able to meet existing demand during a moderately severe drought, but may have difficulty supplying water at the present appropriated use of 200,000 gpd avg.

POTENTIAL SOURCES OF CONTAMINATION

Potential sources of contamination are classified as either point or non-point sources. Examples of point sources of contamination are leaking underground storage tanks, landfills, discharge permits, large-scale feeding operations, and CERCLA sites. These sites are generally associated with commercial or industrial facilities that use chemical substances that may, if inappropriately handled, contaminate ground water via a discrete point location. Non-point sources of contamination are associated with certain types of land use practices such as use of pesticides, application of fertilizers or animal wastes, or septic systems that may lead to ground water contamination over a larger area.

Point Sources

A review of MDE contaminant databases indicated that there were no potential point sources of contamination within the WHPA. The closest point sources in the databases are located about ½ to one mile down-gradient of the WHPA.

Non-Point Sources

Based on the Maryland Department of Planning's 2002 Land Use map, the land use within Clear Spring's WHPA is primarily forested (90.6%) with a smaller proportion covered by pasture and residential areas (Fig. 2). The residential land use is in the southwestern part of the WHPA, and up-gradient of the wells and springs. Table 2 outlines the distribution of land use within the WHPA.

Land Use Code	Land Use Type	Total Acres	% WHPA
11	Low Density Residential	19.3	6.0
22	Pasture	10.7	3.3
41	Deciduous Forest	266.0	83.2
42	Evergreen Forest	23.8	7.4
	Total	319.8	100.0

Table 2. Land Use Summary of Clear Spring WHPA.

Pasture and residential areas are sources of microbiological pathogens and nitrates from animal and human wastes. Additionally, residential areas may be a source of nitrate and SOCs, if fertilizer, pesticides, and herbicides are not applied carefully to lawns and gardens.

The Maryland Department of Planning's 2002 digital sewer map of Washington County shows that the entire WHPA is in an area of the county that is not planned for service. All the residential dwellings were therefore served by on-site systems.

WATER QUALITY DATA

Water Quality data were reviewed from the Water Supply Program's database for Safe Drinking Water Act contaminants. All data reported is from the finished (treated) water unless otherwise noted.

SYSTEM	PLANT ID	TREATMENT	PURPOSE
WELLS A-D SPRINGS	01	FILTRATION	MICROBIAL REMOVAL
WELLS A-D SPRINGS	01	HYPOCHLORINATION	DISINFECTION

Table3. Treatment Methods in Clear Spring's Plant

The State's SWAP defines a threshold for reporting water quality data as 50% of the Maximum Contaminant Level (MCL). If a monitoring result is greater than 50% of a MCL, the written assessment will describe the sources of such a contaminant and if possible, locate the specific sources that are the cause of the elevated contaminant level. A review of the monitoring data since 1993 for Clear Spring's water supply indicates that only one result exceeds a 50% threshold and that may be a recording error. The only contaminants of concern were microbiological pathogens, as indicated by fecal coliform bacteria in raw water samples from all the wells and springs. A filtration system provides treatment for the microbial bacteria and other pathogens in the water supply.

	Plant 01	
Contaminant Group	No. of Samples Collected	No. of Samples > 50% of an MCL
Inorganic Compounds	26	1
Radiological Contaminants	4	0
Volatile Organic Compounds	10	0
Synthetic Organic Compounds	5	1

Table 4. Summary of Water Quality Samples for Clear Spring's Plant

Inorganic Compounds (IOCS)

The only IOC detected above 50% of an MCL was cadmium at 0.003 ppm in a sample collected on Jan. 31, 2004. Cadmium has an MCL of 0.005 ppm. The nitrate levels in the water supply fluctuate between 0.5 and 2.0 parts per million (ppm) and an average of 0.8ppm. The MCL for nitrate is 10 ppm.

Volatile Organic Compounds (VOCs)

A review of the data shows no VOCs above 50% of an MCL have been detected in Clear Srping's water supply, since 1993. p-Dichlorobenzene was detected once at a level of 0.4 micrograms per liter (ug/l) relative to a MCL of 75 ug/l. The only other detects have been for Bromodichloromethane (3.46 ug/l), Chloroform (5.25 ug/L) and Dibromochloromethane (2.29 ug/l). These are all disinfection byproducts (Trihalomethanes). The maximum total concentration detected was 11.0 ug/l (07/09/2003), which is well below the total Trihalomethane MCL of 80 ug/l.

Radionuclides

A review of the data shows that no radionuclides were detected above 50% of an MCL. There is currently no MCL for Radon-222, however EPA has proposed an MCL of 300 pCi/L or an alternate of 4000 pCi/L for community water systems if the State has a program to address the more significant risk from radon in indoor air. The EPA received many comments in response to their proposed rule, and promulgation may be delayed. Radon-222 results (a maximum of 105 pCi/L) for Clear Spring have been reported below the lower proposed MCL.

Synthetic Organic Compounds (SOCS)

The only IOC detected above 50% of an MCL was Di(2-ethylhexyl)phthalate, which has an MCL of 6 ppb. Two samples were reported above 50% of the MCL, one at 3.6 ppb and the other at 18.7 ppb. Di(2-ethylhexyl)phthalate was concurrently observed in laboratory blanks and the reported detections are therefore not believed to represent the actual water quality in the system. Results of two other samples were reported at 0.3 ppb and less than 0.5 ppb.

Microbiological Contaminants

The Town was notified by MDE in February 2000 that the springs were classified as "Ground Water Under the Direct Influence of Surface Water" (GWUDI) source as defined in COMAR and the Surface Water Treatment Rule. In September 2001, MDE notified the town that wells A-C were GWUDI sources. The determinations were based on the results of bacteriological sampling and the presence of surface water indicators. No determination was made for well D, since it has been MDE's understanding that the well has been disconnected from the system. With the holes in the casing, this well is a potential source of contamination and should be properly abandoned and sealed.

SOURCE	RAIN DATE	RAIN AMT	REMARK	SAMPLE DATE	TOTAL COLIFORM	FECAL COLIFORM
WELL A	23-Jan-98	0.5	WET 1	23-Jan-98	8.1	-1.1
WELL A	23-Jan-98	0.5	WET 1	24-Jan-98	8.1	8
WELL A	23-Jan-98	0.5	WET 1	25-Jan-98	8.1	4.6
WELL A	23-Jan-98	0.5	WET 1	26-Jan-98	8.1	2.6
WELL A	1-May-98	0.7	WET 2	3-May-98	8	4.6
WELL A	1-May-98	0.7	WET 2	4-May-98	8	-1.1
WELL A	1-May-98	0.7	WET 2	5-May-98	4.6	-1.1
WELL A	1-May-98	0.7	WET 2	6-May-98	8	-1.1
WELL A	10-Sep-98	0	DRY	10-Sep-98	2.6	-1.1
WELL A	11-Nov-98	0	DRY	11-Nov-98	8.1	-1.1
WELL A	5-May-01	0	DRY	5-May-01	-1.1	-1.1
WELL A	22-May-01	1.7	WET SET	22-May-01	8	1.1
WELL A	22-May-01	1.7	WET SET	23-May-01	8.1	8.1
WELL A	22-May-01	1.7	WET SET	24-May-01	4.6	1.1
WELL A	22-May-01	1.7	WET SET	25-May-01	2.6	1.1
WELL A	6-Jun-01	1	MPA RESULTS = MODERATE RISK	7-Jun-01		
WELL A	6-Jun-01	1	MPA RESULTS = MODERATE RISK	8-Jun-01		
WELL A	12-Aug-01	2.5	WET SET	12-Aug-01	8.1	8.1
WELL A	12-Aug-01	2.5	WET SET	13-Aug-01	8.1	8.1
WELL A	12-Aug-01	2.5	WET SET	14-Aug-01	8.1	8.1
WELL A	12-Aug-01	2.5	WET SET	15-Aug-01	8.1	8.1
WELL A	9-Dec-01	0.5	1st WET SET AFTER WELL REHAB	9-Dec-01	-1.1	-1.1
WELL A	9-Dec-01	0.5	1st WET SET AFTER WELL REHAB	10-Dec-01	-1.1	-1.1

Continued RAIN AMT = inches TOTAL AND FECAL COUNT = 100 Col/ml (-1.1 = not detected) ***Table 5a. GWUDI data Clear Spring Well A***

WELL A	9-Dec-01	0.5	1st WET SET AFTER WELL REHAB	11-Dec-01	1.1	1.1
WELL A	9-Dec-01	0.5	1st WET SET AFTER WELL REHAB	12-Dec-01	-1.1	-1.1
WELL A	18-Mar-02	2.25	2ND WETSET AFTER REHAB	18-Mar-02	-1.1	-1.1
WELL A	18-Mar-02	2.25	2ND WETSET AFTER REHAB	19-Mar-02	-1.1	-1.1
WELL A	18-Mar-02	2.25	2ND WETSET AFTER REHAB	20-Mar-02	8.1	8
WELL A	18-Mar-02	2.25	2ND WETSET AFTER REHAB	21-Mar-02	8.1	8.1

RAIN AMT = inches TOTAL AND FECAL COUNT = 100 Col/ml (-1.1 = not detected)

Table 5a. GWUDI data Clear Spring Well A

SOURCE	RAIN DATE	RAIN AMT	REMARK	SAMPLE DATE	TOTAL COLIFORM	FECAL COLIFORM
WELL B	23-Jan-98	0.5	WET 1	23-Jan-98	8.1	2.6
WELL B	23-Jan-98	0.5	WET 1	24-Jan-98	8.1	2.6
WELL B	23-Jan-98	0.5	WET 1	25-Jan-98	8	-1.1
WELL B	23-Jan-98	0.5	WET 1	26-Jan-98	4.6	-1.1
WELL B	10-Apr-98	0.9	WET 2	10-Apr-98	2.6	2.6
WELL B	10-Apr-98	0.9	WET 2	11-Apr-98	-11	-11
WELL B	10-Apr-98	0.9	WET 2	12-Apr-98	-1.1	-1.1
WELL B	10-Apr-98	0.9	WET 2	13-Apr-98	2.6	-1.1
WELL B	10-Sep-98	0	DRY	10-Sep-98	-1.1	-1.1
WELL B	11-Nov-98	0	DRY	11-Nov-98	-1.1	-1.1
WELL B	30-Apr-01	0	DRY	30-Apr-01	1.1	-1.1
WELL B	22-May-01	1.7	WET SET	22-May-01	8.1	-1.1
WELL B	22-May-01	1.7	WET SET	23-May-01	8.1	8.1
WELL B	22-May-01	1.7	WET SET	24-May-01	8.1	1.1
WELL B	22-May-01	1.7	WET SET	25-May-01	8	-1.1
WELL B	6-Jun-01	1	MPA RESULT = LOW RISK	7-Jun-01		
WELL B	6-Jun-01	1	MPA RESULT = LOW RISK	8-Jun-01		
WELL B	12-Aug-01	2.5	WET SET	12-Aug-01	8.1	-1.1
WELL B	12-Aug-01	2.5	WET SET	13-Aug-01	8.1	8.1
WELL B	12-Aug-01	2.5	WET SET	14-Aug-01	8.1	8.1
WELL B	12-Aug-01	2.5	WET SET	15-Aug-01	8.1	8
WELL B	18-Mar-02	2.25	WET SET AFTER-REHAB	18-Mar-02	-1.1	-1.1
WELL B	18-Mar-02	2.25	WET SET AFTER-REHAB	19-Mar-02	8.1	2.6
WELL B	18-Mar-02	2.25	WET SET AFTER-REHAB	20-Mar-02	4.6	-1.1
WELL B	18-Mar-02	2.25	WET SET AFTER-REHAB	21-Mar-02	8.1	8.1

RAIN AMT = inches TOTAL AND FECAL COUNT = 100 Col/ml (-1.1 = not detected)

Table 5b. GWUDI data Clear Spring Well B

SOURCE	RAIN DATE	RAIN AMT	REMARK	SAMPLE DATE	TOTAL COLIFORM	FECAL COLIFORM
WELL C	23-Jan-98	0.5	WET 1	23-Jan-98	4.6	-1.1
WELL C	23-Jan-98	0.5	WET 1	24-Jan-98	8	-1.1
WELL C	23-Jan-98	0.5	WET 1	25-Jan-98	4.6	2.6
WELL C	23-Jan-98	0.5	WET 1	26-Jan-98	4.6	1.1
WELL C	1-May-98	0.7	WET 2	3-May-98	4.6	-1.1
WELL C	1-May-98	0.7	WET 2	4-May-98	-1.1	-1.1
WELL C	1-May-98	0.7	WET 2	5-May-98	1.1	-1.1
WELL C	1-May-98	0.7	WET 2	6-May-98	-1.1	-1.1
WELL C	10-Aug-98	1.8	WET	10-Aug-98	2.6	-1.1
WELL C	11-Nov-98	0	DRY	11-Nov-98	1.1	-1.1
WELL C	5-May-01	0	DRY	5-May-01	-1.1	-1.1
WELL C	22-May-01	1.7	WET SET	22-May-01	8	-1.1
WELL C	22-May-01	1.7	WET SET	23-May-01	8.1	8.1
WELL C	22-May-01	1.7	WET SET	24-May-01	8	-1.1
WELL C	22-May-01	1.7	WET SET	25-May-01	8.1	1.1
WELL C	6-Jun-01	1	MPA RESULT = LOW RISK	7-Jun-01		
WELL C	6-Jun-01	1	MPA RESULT = LOW RISK	8-Jun-01		
WELL C	12-Aug-01	2.5	WET SET	12-Aug-01	8.1	-1.1
WELL C	12-Aug-01	2.5	WET SET	13-Aug-01	8.1	8.1
WELL C	12-Aug-01	2.5	WET SET	14-Aug-01	8.1	2.6
WELL C	12-Aug-01	2.5	WET SET	15-Aug-01	8.1	2.6
WELL D	23-Jan-98	0.5	WET 1	23-Jan-98	4.6	-1.1
WELL D	23-Jan-98	0.5	WET 1	24-Jan-98	1.1	1.1
WELL D	23-Jan-98	0.5	WET 1	25-Jan-98	4.6	1.1
WELL D	23-Jan-98	0.5	WET 1	26-Jan-98	4.6	1.1
WELL D	1-May-98	0.7	WET 2	3-May-98	2.6	-1.1
WELL D	1-May-98	0.7	WET 2	4-May-98	4.6	-1.1
WELL D	1-May-98	0.7	WET 2	5-May-98	-1.1	-1.1
WELL D	1-May-98	0.7	WET 2	6-May-98	-1.1	-1.1
WELL D	10-Sep-98	0	DRY	10-Sep-98	-1.1	-1.1
WELL D	11-Nov-98	0	DRY	11-Nov-98	8.1	-1.1

RAIN AMT = inches TOTAL AND FECAL COUNT = 100 Col/ml (-1.1 = not detected)

Table 5c. GWUDI data Clear Spring Wells C and D

SOURCE	RAIN DATE	RAIN AMT	REMARK	SAMPLE DATE	TOTAL COLIFORM	FECAL COLIFORM
UPPER SPRING	23-Jan-98	0.5	WET 1	23-Jan-98	8.1	-1.1
UPPER SPRING	23-Jan-98	0.5	WET 1	24-Jan-98	8.1	8.1
UPPER SPRING	23-Jan-98	0.5	WET 1	25-Jan-98	8	8
UPPER SPRING	23-Jan-98	0.5	WET 1	26-Jan-98	4.6	-1.1
UPPER SPRING	10-Apr-98	0.9	WET 2	10-Apr-98	8.1	8.1
UPPER SPRING	10-Apr-98	0.9	WET 2	11-Apr-98	-11	-11
UPPER SPRING	10-Apr-98	0.9	WET 2	12-Apr-98	-11	-11
UPPER SPRING	10-Apr-98	0.9	WET 2	13-Apr-98	2.6	-1.1
UPPER SPRING	10-Aug-98	1.8	WET	10-Aug-98	8.1	4.6
UPPER SPRING	11-Nov-98	0	DRY	11-Nov-98	8	-1.1
LOWER SPRING	23-Jan-98	0.5	WET 1	23-Jan-98	8.1	-1.1
LOWER SPRING	23-Jan-98	0.5	WET 1	24-Jan-98	-1.1	-1.1
LOWER SPRING	23-Jan-98	0.5	WET 1	25-Jan-98	-1.1	-1.1
LOWER SPRING	23-Jan-98	0.5	WET 1	26-Jan-98	-1.1	-1.1
LOWER SPRING	10-Apr-98	0.9	WET 2	10-Apr-98	8	1.1
LOWER SPRING	10-Apr-98	0.9	WET 2	11-Apr-98	1.1	-1.1
LOWER SPRING	10-Apr-98	0.9	WET 2	12-Apr-98	1.1	1.1
LOWER SPRING	10-Apr-98	0.9	WET 2	13-Apr-98	4.6	-1.1
LOWER SPRING	10-Sep-98	0	DRY	10-Sep-98	-1.1	-1.1
LOWER SPRING	11-Nov-98	0	DRY	11-Nov-98	-1.1	-1.1

RAIN AMT = inches TOTAL AND FECAL COUNT = 100 Col/ml (-1.1 = not detected)

Table 5d. GWUDI data Clear Spring Upper and Lower Springs

Dye Trace Study (June 2004)

Evans and Holt (2004) conducted a dye trace study to evaluate the potential sources of the bacteriological contamination of Clear Spring's wells A-C. From 11:20 to 11:50 on 4/13/2004, 6L of 40% Florescein (Acid Yellow 73) was injected into three residential septic systems (2L each), 2L of 20% Rhodamine WT (Acid Red 388) was injected into Stream 1, and 1L of Rhodamine WT was injected into Stream 2. The locations of the injection points relative to the wells is not clear, except the septic systems appear to be about 2000 feet west of the wells.

The results of the study are shown in figures 3a-c. The wells were operated intermittently and grab or automated water samples were collected only when the wells were pumping. As a result of the infrequent sampling, multiple injection points, and variable pumping rates, aliasing (the distortion of the frequency of a signal by inadequate sampling) probably occurred, producing misleading breakthrough curves. This would make it difficult to determine the ground water flow controlling mechanism(s) for the system.

No calibration curve was constructed in the Evans and Holt study for the spectroflourophotometer used to analyze the data.

Standards were prepared and a calibration curve was developed for the instrument in a subsequent study (Field, 2004). Using that calibration curve, several approximate concentrations of the dyes are indicated on figures 3a-c. These data indicate that substantially more Rhodamine WT was recovered than Flourescein. There are a number of possible reasons for this difference. The Flourescein dye appears to have discharged into the stream(s) sometime after injection into the septic systems and, since Flourescein exhibits high photochemical decay, that and other chemical degradation effects may have reduced the final concentrations. The Rhodamine WT was injected directly into the streams, which would probably have produced faster overall travel times. The initial relative concentrations of Rhodamine WT were higher during the first and second days of the test, indicating that it may have arrived first.

The data collected during the Evans and Holt study allow a qualitative assessment of ground water characteristics to be made. The higher intensity levels and the shorter overall recovery interval (about 150 hours) in well A suggest that the controlling mechanism for that well is one of more conduit flow. Conversely, the intensity levels and longer recovery period (>300 hours) for wells B and C would indicate that the controlling mechanisms in those cases are ones of more diffuse ground water flow.

SUSCEPTIBILITY ANALYSIS

The wells and (disconnected) springs serving the Clear Spring water supply draw water from unconfined fractured-rock aquifers. Wells in unconfined aquifers are generally vulnerable to any activity on the land surface that occurs within the wellhead protection area. Therefore, continued monitoring of contaminants is essential in assuring a safe drinking water supply. The *susceptibility* of the source to contamination is determined for each group of contaminants based on the following criteria: 1) the presence of potential contaminant sources within the WHPA, 2) water quality data, 3) well integrity, and 4) the aquifer conditions. Table 9 summarizes the susceptibility of Clear Spring's water supply to each of the groups of contaminants.

Inorganic Compounds

Cadmium was the only IOC detected above 50% of its MCL. Since it has not been detected in other samples, it does not appear to be of concern. The high percentage (90%) of forested lands within the WHPA reduces the potential impact the smaller percentage of residential and pasture lands can have on inorganic contaminant levels. Should the amount of residential land significantly increase, then the water supply could be susceptible to inorganic contamination. The water supply sources are not susceptible to inorganic compounds at this time.

Radionuclides

The water supply is **not** susceptible to radionuclides. The source of radionuclides in ground water is the natural occurrence of uranium in rocks. Based on the low levels detected in the water supply, the aquifer is not a source of these contaminants in this area.

Volatile Organic Compounds

The water supply is not presently susceptible to contamination by VOC's and there are no known sources of contaminant sources in the WHPA. VOC's have not been detected at a level of concern.

Synthetic Organic Compounds

The wells are **not** presently susceptible to synthetic organic compounds. Potential sources of SOCs in the WHPA may be pesticide or herbicide use in agricultural and residential areas.

Microbiological Contaminants

The presence of fecal coliform bacteria and in the wells and springs of the Clear Spring water supply indicate their susceptibility to pathogenic microorganisms. Additionally dye-tracing work has shown that there are hydraulic or hydrogeological connections between the stream or streams in the WHPA and wells A-C. Flourescein was detected in a stream in the immediate vicinity of one of the injected septic systems, indicating that it was a possible source of contamination. Pathogenic protozoa, viruses, and bacteria normally associated with surface water can contaminate the wells through these connections. Sources of these pathogens are generally improperly treated wastewater, waste material from mammals, and urban runoff in developed areas. Pastureland and discharges from septic systems are the most likely sources fecal contamination in the WHPA. As GWUDI sources, the water supply is susceptible to bacteria, viruses, protozoa, and increased turbidity. A filtration system has been installed to treat for the microbiological contaminants.

Contaminant Group	Are Contaminant Sources Present in WHPA?	Are Contaminants Detected Above 50% of MCL?	Is Well Integrity a Factor?	Is the Aquifer Vulnerable?	Is the System Susceptible?[1]
Nitrate	YES	NO	NO	YES	NO
Inorganic Compounds (except nitrate)	NO	NO	NO	YES	NO
Radiological Compounds	NO	NO	NO	NO	NO
Volatile Organic Compounds	NO	NO	NO	YES	NO
Synthetic Organic Compounds	YES	NO	NO	YES	NO
Microbiological Contaminants	YES	YES	YES	YES	YES

Table 6. Susceptibility Analysis Summary.

[1]. At present time.

MANAGEMENT OF THE WHPA

With the information in this report, Clear Spring is in a position to protect its water supply by staying aware of the area delineated for wellhead protection, keeping track of potential contaminant sources, and evaluating future development and land use planning. Specific management recommendations for consideration are listed below:

Form a Local Planning Team

- Clear Spring should form a local planning team to begin to implement the Town's wellhead protection plan. The team should represent all the interests in the community, such as the water supplier, home association officers, the County Health Department, local planning agencies, local business, developers, farmers and residents within and near the WHPA. The team should work to reach a consensus on how to protect the water supply.

- MDE has grant money available for Wellhead Protection projects, such as developing and implementing wellhead protection ordinances, digitizing layers that would be useful for wellhead protection (such as geology), and developing additional protection strategies. An application can be obtained from the water supply program.

Public Awareness and Outreach

- The Consumer Confidence Report should list that this report is available to the general public through their county library, by contacting the Division or MDE.
- Conduct educational outreach to the facilities and residents of the community focusing on activities that may present potential contaminant sources. Important topics include: (a) compliance with MDE and federal guidelines for gasoline and heating oil UST's, (b) monitoring well installation and maintenance of UST's, (c) appropriate use and application of fertilizers and pesticides, and (d) hazardous material disposal and storage.
- Road signs at the WHPA boundary are an effective way of keeping the relationship of land use and water quality in the public eye, and help in the event of spill notification and response.

Well Maintenance

- Well D should be properly abandoned and sealed as it is no longer used and can provide a pathway for contaminants to reach the production wells.

Local Ordinace

- As the recharge area is outside the Town limits, Clear Spring should work with Washington County Planning and Zoning to ensure the long-term protection of the forested recharge area above its sources. The County may consider local zoning or an overlay zone for protecting the town's water supply.

Monitoring

- Continue to monitor for all Safe Drinking Water Act contaminants as required by MDE.

Land Acquisition/Easements

- Loans are available for the purchase of property or easements for protection of the water supply. Eligible property must lie within the designated WHPA. Loans are currently offered at zero percent interest and zero points. The Town should Contact the Water Supply Program for more information.

Contingency Plan

- Clear Spring should have a Contingency Plan for its water system. COMAR 26.04.01.22 requires all community water systems to prepare and submit for approval a plan for providing a safe and adequate drinking water supply under emergency conditions.
- Develop a spill response plan in concert with the Fire Department and other emergency response personnel.

Contaminant Source Inventory Updates/ Inspections

- Clear Spring should conduct their own field survey of the source water assessment area to ensure that there are no additional potential sources of contamination.
- Periodic inspections and a regular maintenance program for the supply wells (and springs) will ensure their integrity and protect the aquifer from contamination..

Changes in Use

- Clear Spring is required to notify MDE if new sources are to be put into service. Drilling a new well outside the current WHPA would modify the area; therefore the Water Supply Program should be notified if a new well is being proposed.

REFERENCES

ARRO Consulting, 2001, Water Supply Evaluation for Lear Spring, Maryland, Preliminary Desktop Analysis, April 2001. 23 p.

Duigon, M. and Dine, J., 1991, Water Resources of Washington County, Maryland Geological Survey Bulletin 36, 109 p.

Evans, W. and Holt, D., 2004, Clear Spring Source Water Assessment, Maryland Department of the Environment, Compliance Monitoring Division, 15 p.

Field, M., 2004, Results of Frederick, MD tracer tests conducted by EPA/NCEA, memo dated November 30, 2004. U.S. Environmental Protection Agency/National Center for Environmental Assessment, 7 p.

Grace, J., 2000, 021-0005, Town Clear Spring, Surface Water Treatment Rule, letter dated February 10, 2000, Maryland Department of the Environment, Water Supply Program, 4 p.

Grace, J., 2001, 021-0005, Town Clear Spring, Surface Water Treatment Rule, letter dated September 21, 2000, Maryland Department of the Environment, Water Supply Program, 4 p.

MDE, Water Supply Program, 1999, Maryland's Source Water Assessment Plan, 36 p.

Putka, C., 2003, Clear Spring, Maryland Pilot Report, KINETICO, 11 p.

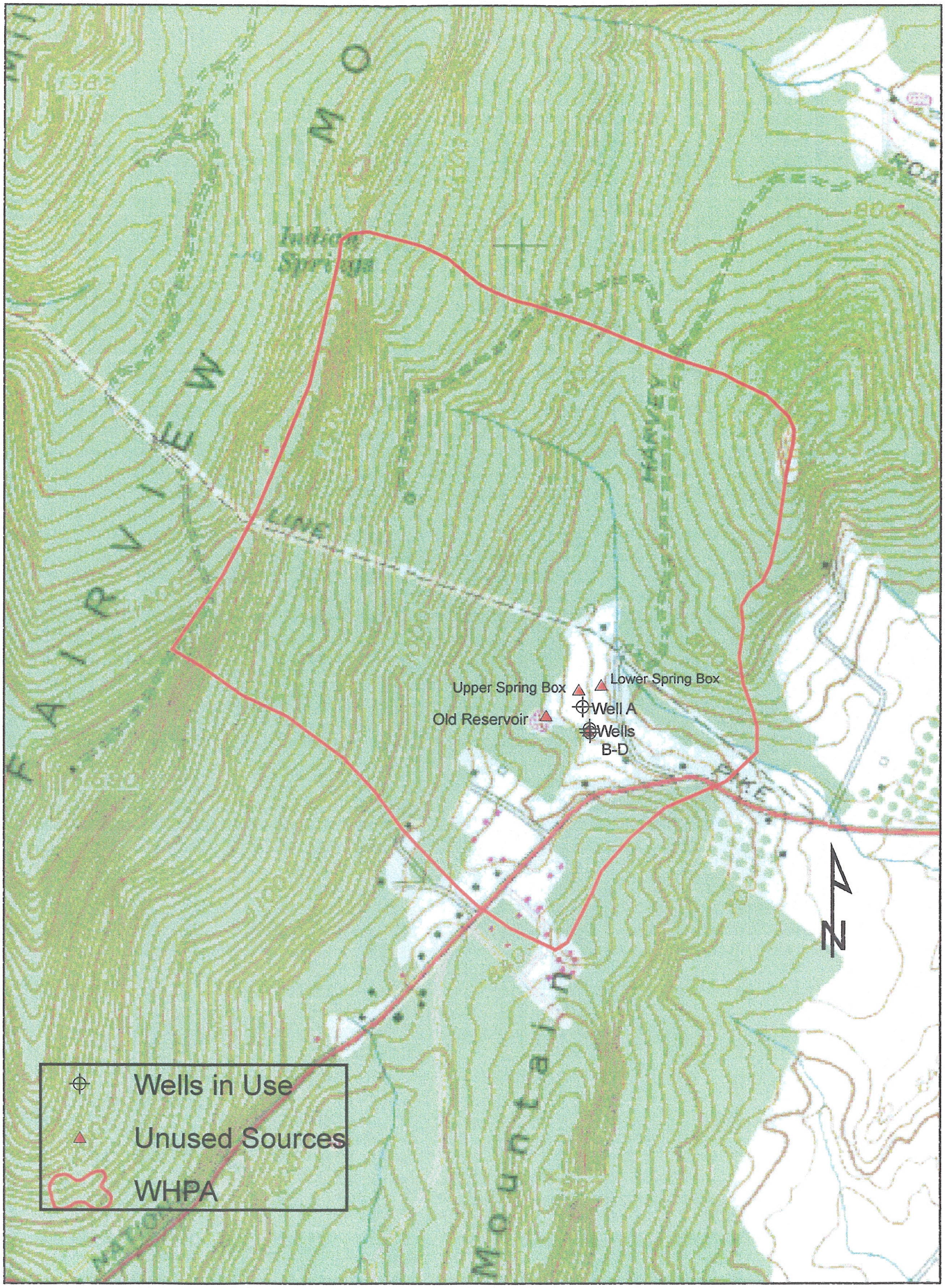
U.S. Environmental Protection Agency, 1991, Delineation of Wellhead Protection Areas
in Fractured Rocks: Office of Ground Water and Drinking Water, EPA/570/9-91-009, 144 pp.

OTHER SOURCES OF DATA

Water Appropriation and Use Permit No. WA1967G001
Public Water Supply Inspection Reports
MDE Water Supply Program Oracle® Database
MDE Waste Management Sites Database
USGS Topographic 7.5 Minute Clear Spring Quadrangle
Maryland Office of Planning 2002 Frederick County Digital Land Use Map
Maryland Office of Planning 2002 Frederick County Digital Sewer Map

FIGURES

Clear Spring Sources and WHPA



0 1,000 2,000 Feet

Figure 1

Clear Spring Land Use Map

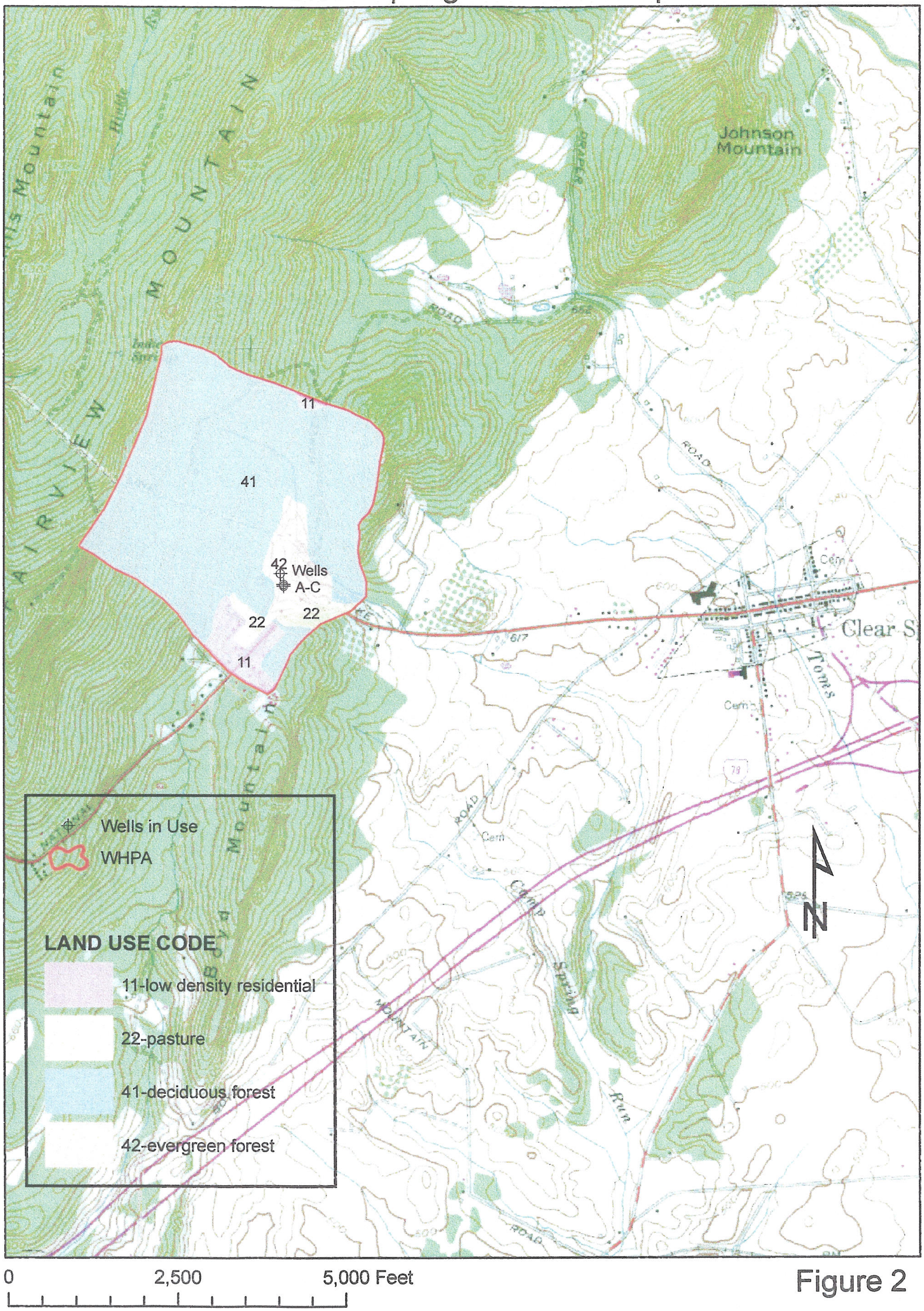


Figure 2

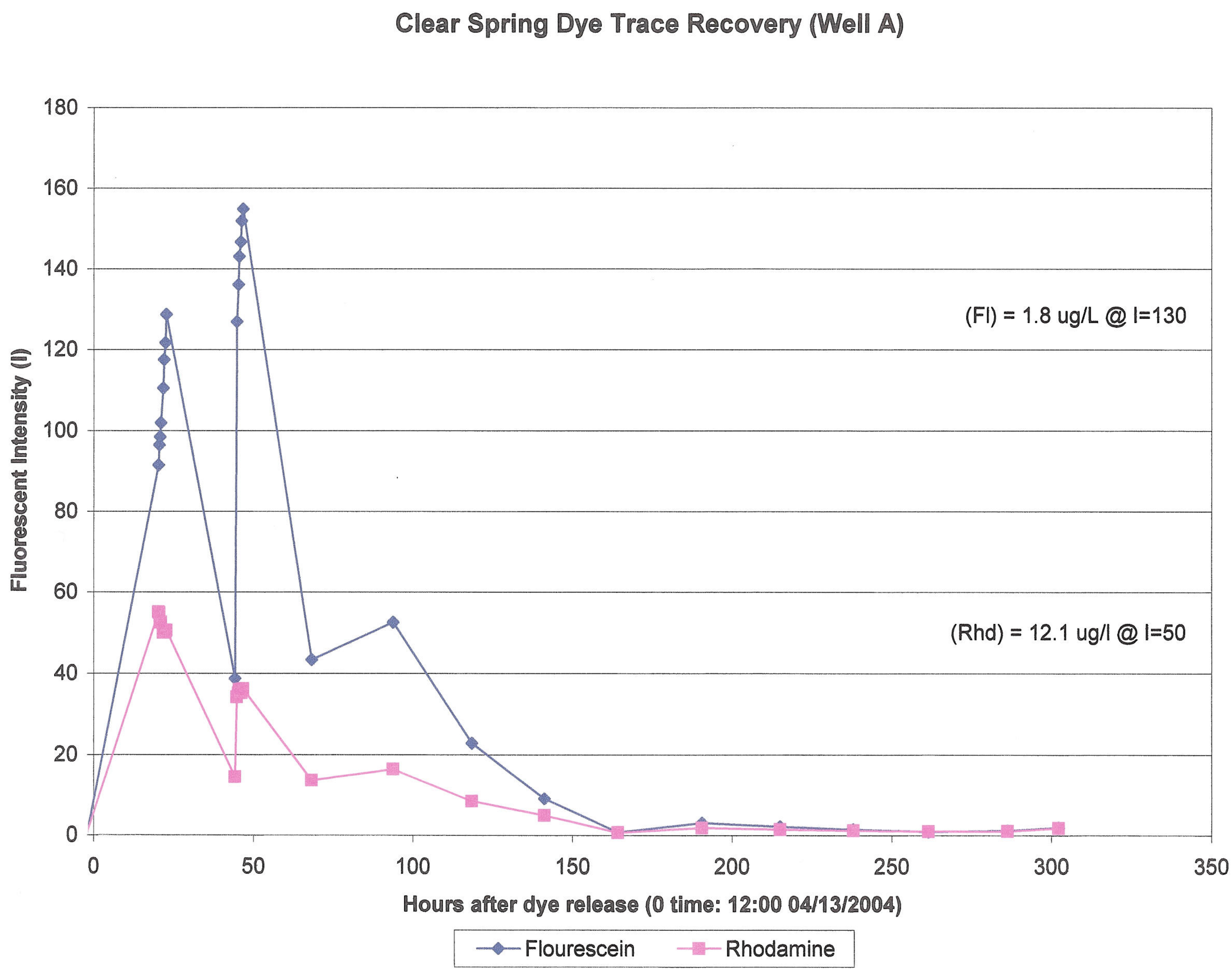

Clear Spring Dye Trace Recovery (Well A)
Fluorescent Intensity (I)
Hours after dye release (0 time: 12:00 04/13/2004)
(Fl) = 1.8 ug/L @ I=130
(Rhd) = 12.1 ug/l @ I=50
Flourescein
Rhodamine
0
20
40
60
80
100
120
140
160
180
0
50
100
150
200
250
300
350

Figure 3a

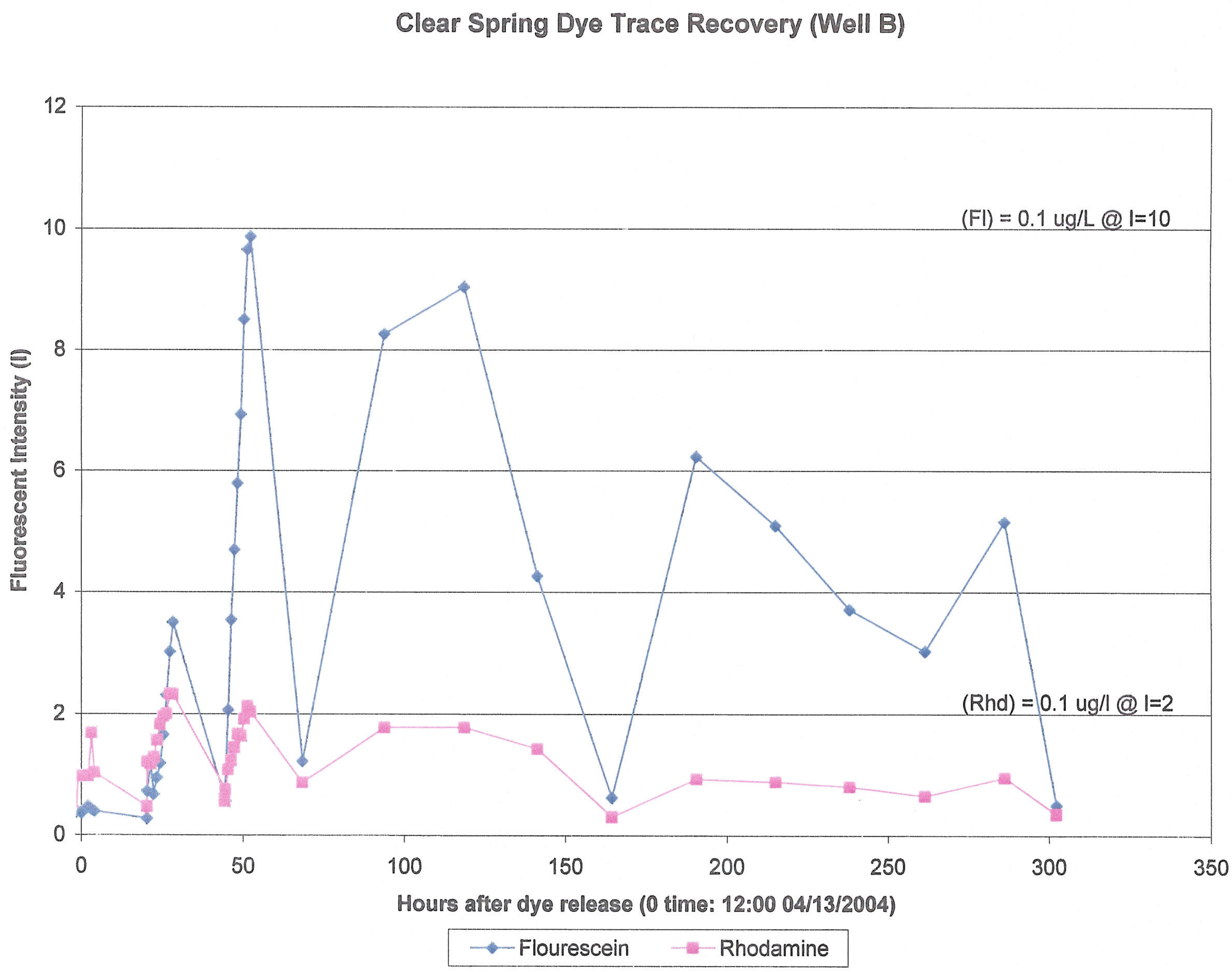

Clear Spring Dye Trace Recovery (Well B)
(Fl) = 0.1 ug/L @ I=10
(Rhd) = 0.1 ug/l @ I=2
Fluorescent Intensity (I)
0
2
4
6
8
10
12
0
50
100
150
200
250
300
350
Hours after dye release (0 time: 12:00 04/13/2004)
Flourescein
Rhodamine

Figure 3b

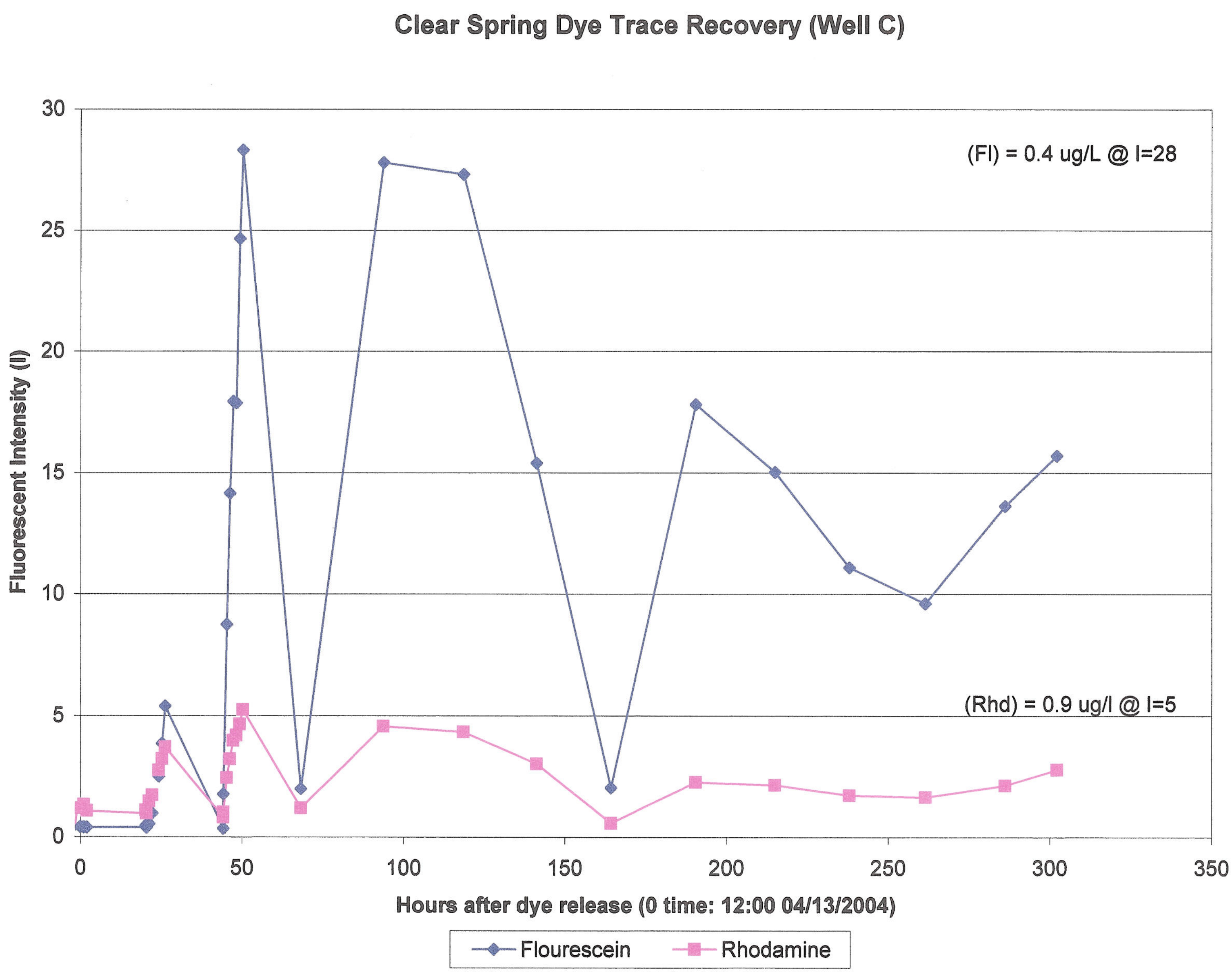

Clear Spring Dye Trace Recovery (Well C)
(Fl) = 0.4 ug/L @ I=28
(Rhd) = 0.9 ug/l @ I=5
Fluorescent Intensity (I)
30
25
20
15
10
5
0
0
50
100
150
200
250
300
350
Hours after dye release (0 time: 12:00 04/13/2004)
Flourescein
Rhodamine

Figure 3c