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HEAVY METAL CONTAMINATION IN TIMS BRANCH SEDIMENTS (U)

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DISCLAIMER

SAVANNAH RIVER SITE

REACTOR MATERIALS

TOTAL QUALITY

326034

~~OPS-RMT-90-XXXX*~~

WESTINGHOUSE SAVANNAH RIVER COMPANY

OPS-RMT-900200

INTER-OFFICE MEMORANDUM

June 25, 1990

TO: W. L. McDOWELL, 735-A
SRL, ENVIRONMENTAL TECHNOLOGY SECTION

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REACTOR MATERIALS ENGINEERING AND TECHNOLOGY

HEAVY METAL CONTAMINATION IN TIMS BRANCH SEDIMENTS

BACKGROUND

The Environmental Technology Section (ETS) of the Savannah River Laboratory is currently preparing a number of reports for the site Radiological Assessment Program (RAP). The Radiological Assessment Program was requested by the Savannah River Department of Energy (SR-DOE). One of the sections of the RAP is a report, "Uranium in the SRS Environment" and Chapter 2 of the report will include surface water transport of uranium, including Steed's Pond and Tims Branch.

The objective of this memorandum is to summarize results of previous sediment studies on Tims Branch and Steed's Pond conducted by Health Protection (HP) and by the Savannah River Laboratory (SRL) in conjunction with Reactor Materials Engineering & Technology (RMET). The results for other heavy metals, such as lead, nickel, copper, mercury, chromium, cadmium, zinc, and thorium are also summarized.

The data indicate that each of the heavy metals is substantially elevated in the sediments of Tims Branch, downstream of the confluence with the influent discharge ditches from the 300/700 Areas (outfalls A-014, A-011, and A-008). It is assumed that the high concentrations of metals are mainly due to M-Area discharges to the Tims Branch System from ~1952 to 1973, at which time the discharge from Building 313-M was diverted to the M-Area Settling Basin. It may be noted that the types of constituents, and their relative concentrations, are similar to the characterization of the sludge and sediments associated with the M-Area Settling Basin (Reference 1).

SCOPE

The scope of this report is limited to those studies which have been reported by Health Protection or to studies conducted by SRL - under an M-Area RTA (Request for Technical Assistance). This report is not intended to be an exhaustive study of the Tims Branch system, but to provide a summary for the RAP report preparation. This report also contains the results of sediment analyses conducted by SRL/RMET in 1985/1986, which have not been previously published in an internal memorandum.

* Document No. OPS-RMT-900200 assigned July 18,1990.

RESULTS

1967 Steed's Pond Data (HP)

The Health Protection Department(HP) conducted a study of the sediments in Steed's Pond in 1967 (Reference 2). In 1966, deterioration of the spillway of the old farm pond had allowed the pond to drain, and as the pond drained, vegetation rapidly covered portions of the sediments as they became exposed. Eighteen inch deep core samples were collected from 4 acres of unvegetated area and a total of 1.1 curies of uranium was calculated to be present. If the concentration in the remainder of the grassy region (9 acres) is similar, then the entire 13 acres would contain 3-4 curies of uranium (20,000 to 26,000 lbs of natural uranium). Since both the vegetated and unvegetated areas had been covered by the water in the pond, it is a not unreasonable assumption that both areas would have similar sediment concentrations.

This may be compared to the total of 9.3 curies of uranium that was monitored in the M-Area releases to Tims Branch from 1955 thru 1966 (Reference 3).

A map of the Tims Branch and Steed's Pond system is given in Figure 1.

Uranium Releases thru 1975 (HP)

In 1977, it was reported in the Final Environment Impact Statement, "Waste Management Operations for the Savannah River", (Reference 4), that a total of 24 (23.6) Ci (~86,000 lbs) of natural uranium had been released to Tims Branch from the 300-M area through 1975.

1977 Radiological Survey with Tims Branch - Steed's Pond (HP)

In 1977 a radiological survey of Tims Branch and Steed's Pond was conducted by the Health Protection Department (Reference 5). The data indicated no detectable levels of thorium and uranium in the Tims Branch System above its confluence with the 300-M effluent discharges ditch. Cores from the 300-M effluent ditch, and from the braided streams in Tims Branch downstream of the 300-M effluent confluence, contained from 10 to 27 pci/gm sediment (30 to 85 ppm) of natural uranium, and from 4 to 13 pci/gm (36 to 117 ppm) of natural thorium.

The two sediment cores collected from Steed's Pond in 1977 did not have U or Th concentrations above background. However, these cores were taken at the edge of the pond and would not have reflected deposition in the deeper portions of the pond. The sample locations are shown in Figure 2 (from Reference 5). The sediments from the deeper area of the pond were subsequently sampled in 1984 (see below).

Monitoring of Steed's Pond and Tims Branch in 1984 (HP)

A partial failure of the wooden dam at Steed's Pond occurred in August, 1984. Following the dam failure, special water and sediment samples were collected by HP to determine if radioactivity were migrating from the pond.

Concentrations of uranium (1.9 pCi/L) and nonvolatile beta (4.9 pCi/L) in the water from the mouth of Tims Branch were within the range of concentrations routinely

measured before the dam failure. Maximum concentrations in sediment in the pond bed were 490 pCi/g of uranium and 410 pCi/g of nonvolatile beta, (1984 Environment Report, Reference 6).

Additional analytical results on these sediment samples were included in the 1985 Environment Report (Reference 7). This report gave the concentrations of a number of heavy metals in addition to uranium, and are summarized below:

		Maximum Sediment Concentration	Southeastern USA(Ref. 8) Concentration	
			Average	Range
chromium	µg/g(ppm)	290*	38	11-60
copper		270	18	9-36
lead		65	13	3-26
nickel		5,300	10	3-18
sodium		160	220	<200-2,500
aluminum		72	25,000	900-46,000
uranium		6,100	2	1.6 - 5.5**
thorium		82	9	5-15***

* Excluding an anomalous value of 2100 ug/g.
** SRP results
*** Wyoming and Montana levels

The concentrations of all of the heavy metals tested were significantly higher than other soils on the SRP site, or in the upper soil horizons of the southeastern USA. Nickel and uranium were 500 to 3000 times higher, respectively, than "normal" soil concentrations. Cr, Cu, Pb, and Th were 5 to 10 times higher.

The higher concentrations of the heavy metals were usually found in the upper 6 to 18 inches of sediment, and the highest concentrations were found in the sediments in Steed's Pond nearest to the dam site. All of the data is presented in Table 3-54, Volume II of the 1985 Environmental Report (Reference 7).

A core sample taken immediately downstream of the Steed's Pond dam site indicated a uranium concentration of 3 pCi/g. This result indicates that most of the uranium released from the fuel preparation area was deposited in Tims Branch above Steed's Pond and in Steed's Pond.

Contaminant Transport Studies in Tims Branch (SRL)

A study was conducted by SRL in 1985 to determine the impact the Steed's Pond dam failure (in 1984) on the subsequent transport of contaminants downstream (Reference 9). The study showed that the amount of sediment transported to Upper Three Runs Creek (about 2 miles downstream of Steed's Pond) was about the same as in past years, prior to the collapse of the spillway. It was stated in the report that what little erosion that could occur in the exposed sediments of Steed's Pond would be reduced as revegetation of the sediments occurred. The results of the sediment transport study indicated that Steed's Pond could be left in a drained condition without affecting suspended solids concentrations or the associated uranium concentrations in Upper Three Runs Creek.

Uranium Releases thru 1985 (HP)

In 1986, it was reported in DPSPU-86-25-1 (Ref. 10) that a total of 24.6 Ci of uranium had been released to Tims Branch. This would be approximately a 1 Ci increase since 1975, and would represent ~ 6600 lbs of depleted uranium. The total amount through 1985 would therefore be approximately 92,000 lbs. of natural and depleted uranium. Uranium releases to Tims Branch have been negligible since 1985, due to the construction and operation of the M-Area Liquid Effluent Treatment Facility (LETF).

1985-1986 Tims Branch Chemical and Biological Study (SRL/RMET)

A chemical and biological study was conducted by SRL in 1985-1986 on the Tims Branch system, with the objective to determine the impacts of the effluents from M-Area's Dilute Effluent Treatment Facility (DETF) on the receiving stream.

Sediment concentrations of various metals were determined monthly at 6 locations in Tims Branch and upper Three Runs Creek from June 1985 to June, 1986 (Ref. 11).

The sampling locations are shown in Figure 3. The locations TB-2 was the control sampling location as it was upstream of the confluence of the M-Area effluent discharge ditch and Tims Branch. Location TB-1 was downstream of the confluence of the outfall ditch and Tims Branch. TB-3 was approximately 100 yards downstream of the spillway from Steed's Pond and TB-4 was located on Tims Branch approximately 400 yards before its confluence with Upper Three Runs creek. TB-5 and TB-6 were in Upper Three Runs, upstream and downstream of the confluence with Tims Branch, respectively.

The sediment concentrations of all metals tested were highest at Site TB-1 (Table 1). The average concentration of uranium at the TB-1 sediment location was 1550 mg/kg (ppm), as compared with 0.21 ppm at the reference site, TB-2. Sediment uranium concentrations decreased progressively downstream; TB-3 and TB-4 had averages of 55 and 20 ppm, respectively. A similar situation existed regarding sediment nickel, as its average values increased from 2.4 ppm at TB-2 to 780 ppm at TB-1, then decreased to 29 and 25 ppm at TB-3 and TB-4, respectively.

The average sediment concentrations of metals other than uranium and nickel (Al, Cu, Pb, Hg, and Zn) were also highest at TB-1 (Table 1). However, the concentrations of these other metals appeared to be related to Total Organic Matter (TOM) in the sediment. A positive relationship between concentrations of metals and organic matter is not unexpected, because these metals may form stable complexes with organic matter or tend to be concentrated by the biota comprising the TOM.

Potential Groundwater Impact

A limited number of groundwater monitoring wells have been installed in the Tims Branch/Steed's Pond area, as a portion of the A/M-Area plume definition well system. These wells have been used to track the concentrations of chlorinated hydrocarbons, and heavy metal analyses have not been conducted. Contamination of the groundwater due to the deposition in the sediments of Tims Branch is, however, very unlikely, since Tims Branch is a "gaining stream". Eg., the water table outcrops into Tims Branch, which will therefore inhibit the transport of contaminants into the groundwater.

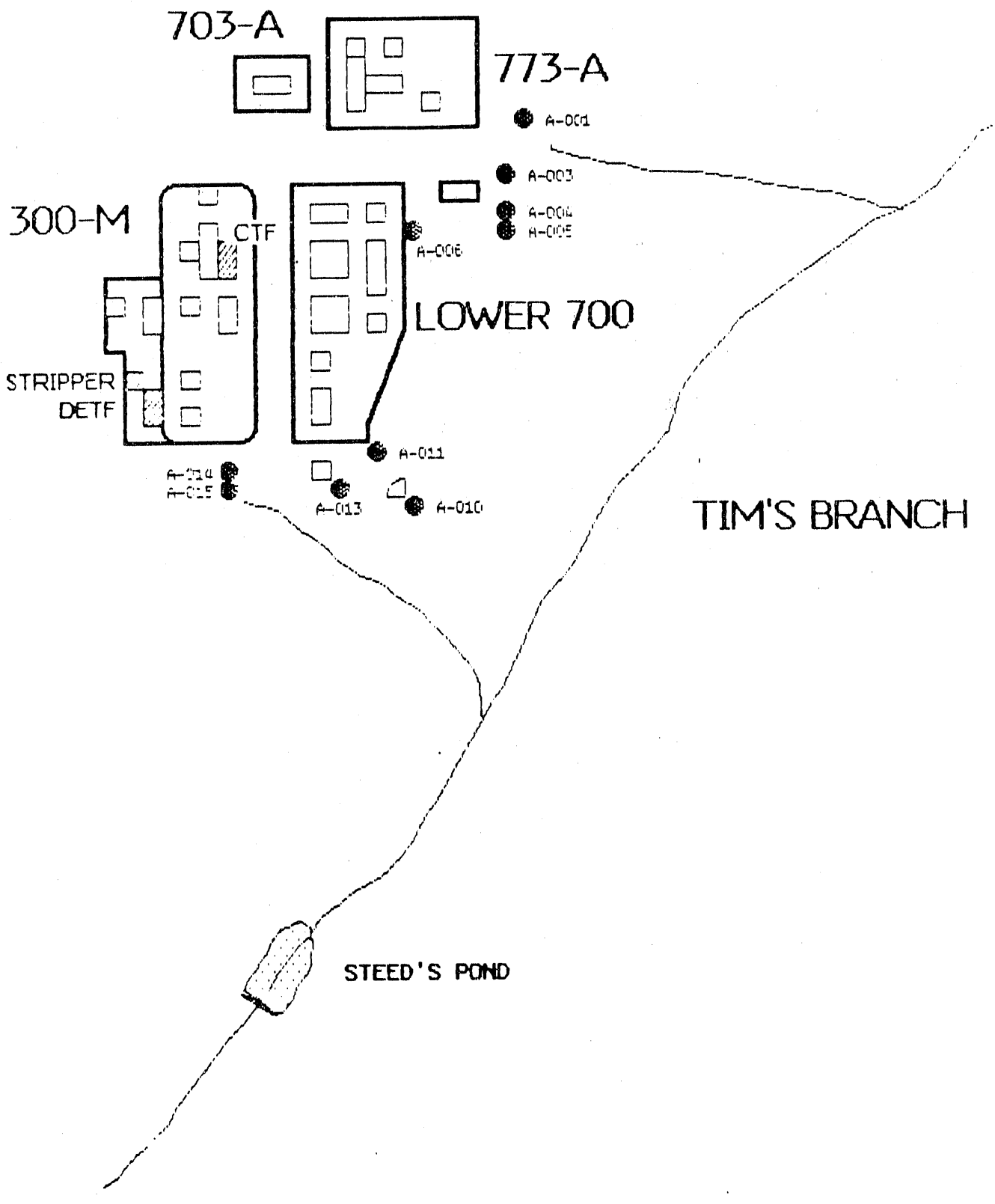

Figure 1. 300/700 Area Map

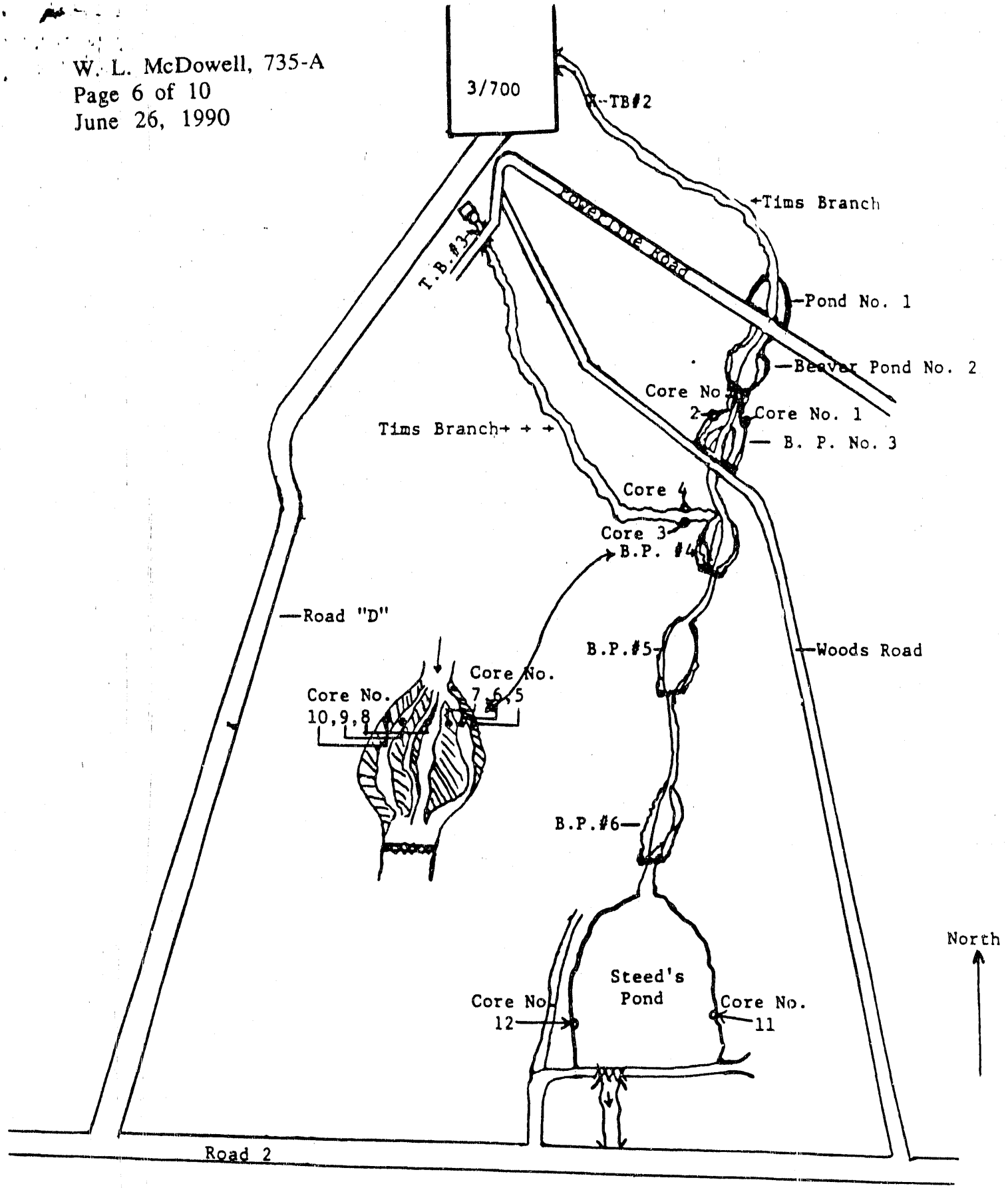

Figure 2. Sampling Locations, 1977 HP Survey

Not To Scale

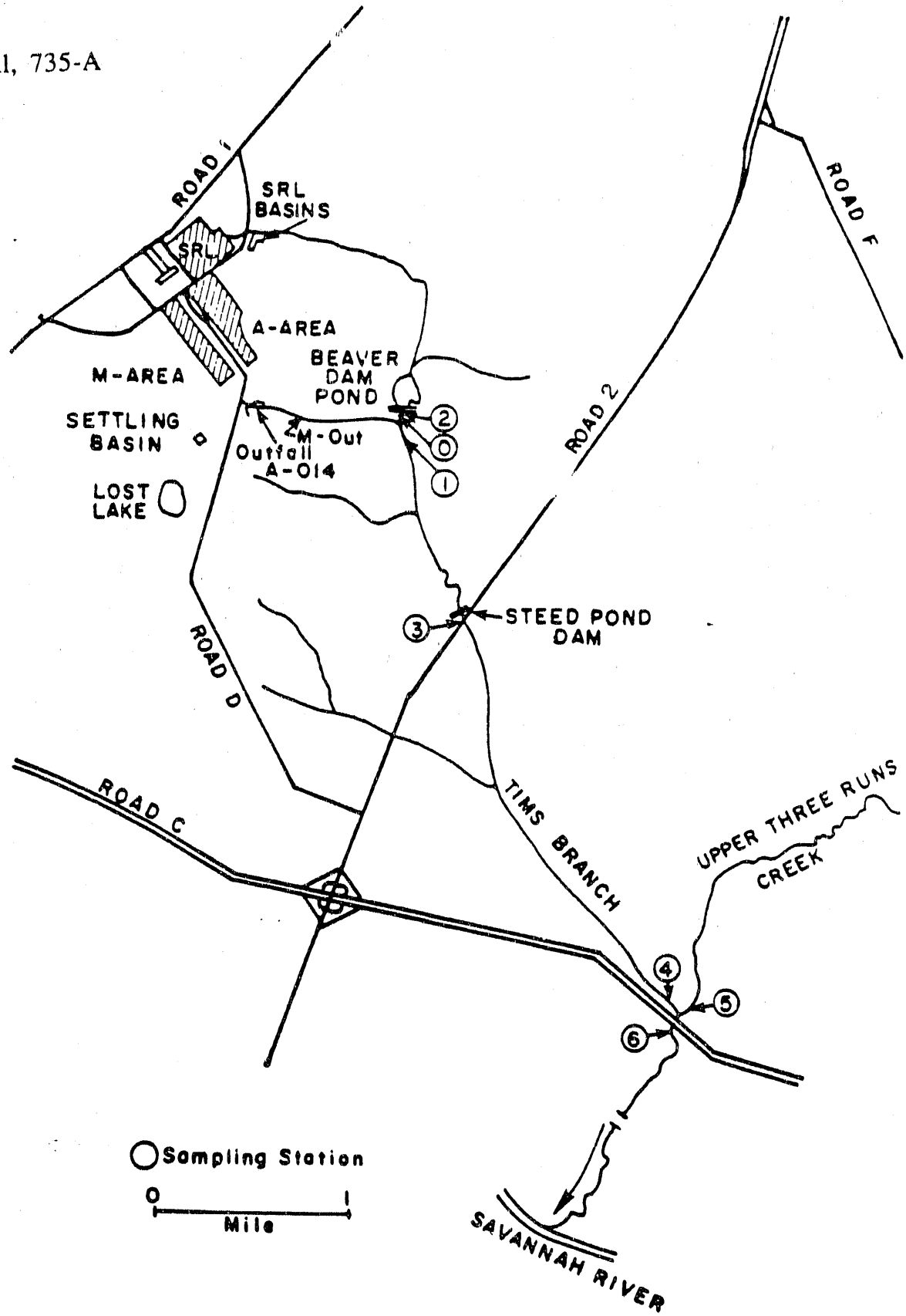

Figure 3. Sampling Locations, 1985-1986 Tims Branch Study

TABLE 1

SEDIMENT CHEMICAL RESULTS AT SITES ON TIMS BRANCH
JUNE 1985 - JUNE 1986

CONSTITUENT mg/kg=ppm)		SAMPLING LOCATION					
		TB-2 Background	TB-1 After confluence	TB-3 Below Steed's Pond	TB-4 Before Upper 3 Runs	TB-5 Upstream on U3R	TB-6 Downstream on U3R
U	mean	0.21	1547.4	55.25	19.86	11.26	12.39
	SE	0.12	266.2	10.10	4.47	3.38	2.51
	n	8	8	8	8	8	8
Ni	mean	2.40	783.0	28.87	24.67	9.58	13.09
	SE	0.51	228.9	6.08	6.33	2.28	1.20
	n	8	8	8	8	8	8
Cu	mean	3.19	74.71	2.11	1.39	10.02	6.13
	SE	0.64	15.45	0.29	0.45	2.74	1.14
	n	8	8	8	8	8	8
Al	mean	6010	46761	2739	1563	9099	7046
	SE	1181	4009	434	243	1436	1183
	n	8	8	8	8	8	8
Fe	mean	5707	52425	7402	2743	5165	5083
	SE	1439	8063	1076	577	677	1034
	n	8	8	8	8	8	8
Hg	mean	0.025	0.402	0.017	0.010	0.048	0.039
	SE	0.009	0.029	0.005	0.002	0.008	0.003
	n	8	8	8	8	8	8
Cr	mean	7.21	80.21	5.50	3.24	14.48	11.61
	SE	0.59	8.65	0.49	0.54	2.22	2.27
	n	8	8	8	8	8	8
Cd	mean	0.122	1.51	0.079	0.077	0.75	0.40
	SE	0.035	0.22	0.015	0.016	0.28	0.07
	n	8	8	8	8	8	8
Zn	mean	13.90	128.2	6.51	5.21	29.75	19.56
	SE	2.32	11.4	1.17	1.14	5.73	6.00
	n	8	8	8	8	8	8
Pb	mean	2.02	33.72	1.69	1.68	6.73	3.90
	SE	0.19	5.74	0.23	0.14	1.12	3.78
	n	8	8	8	8	8	8
TOM(%L.O.I.)*	mean	2.66	25.07	1.01	2.12	6.32	7.72
	SE	0.28	0.87	0.18	0.34	0.77	0.56
	n	31	31	31	31	31	31

*TOM = Total Organic Matter, % loss on ignition

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