The Largest AMD Treatment Plant in the World?

The Copper Basin Reclamation Project

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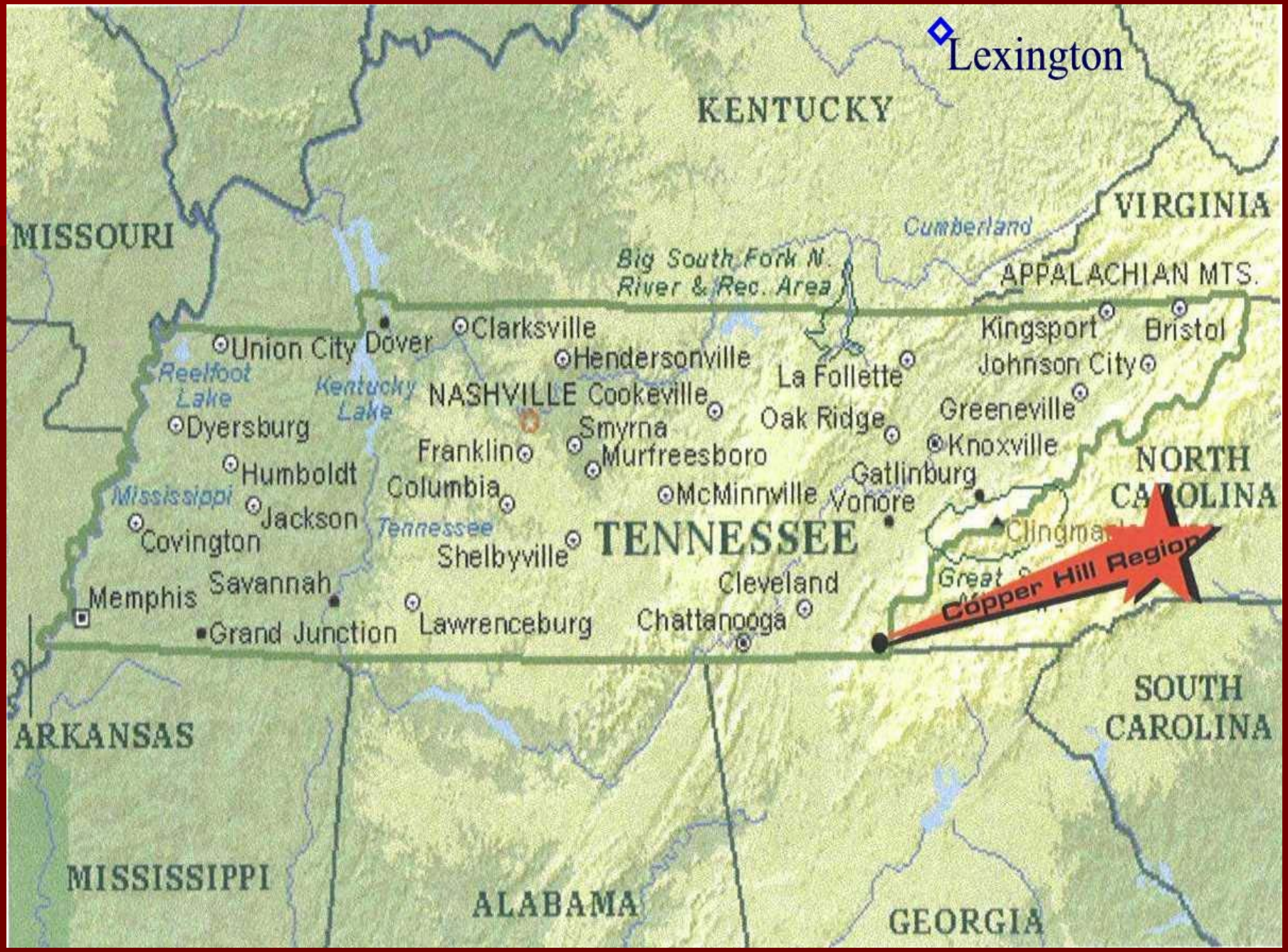
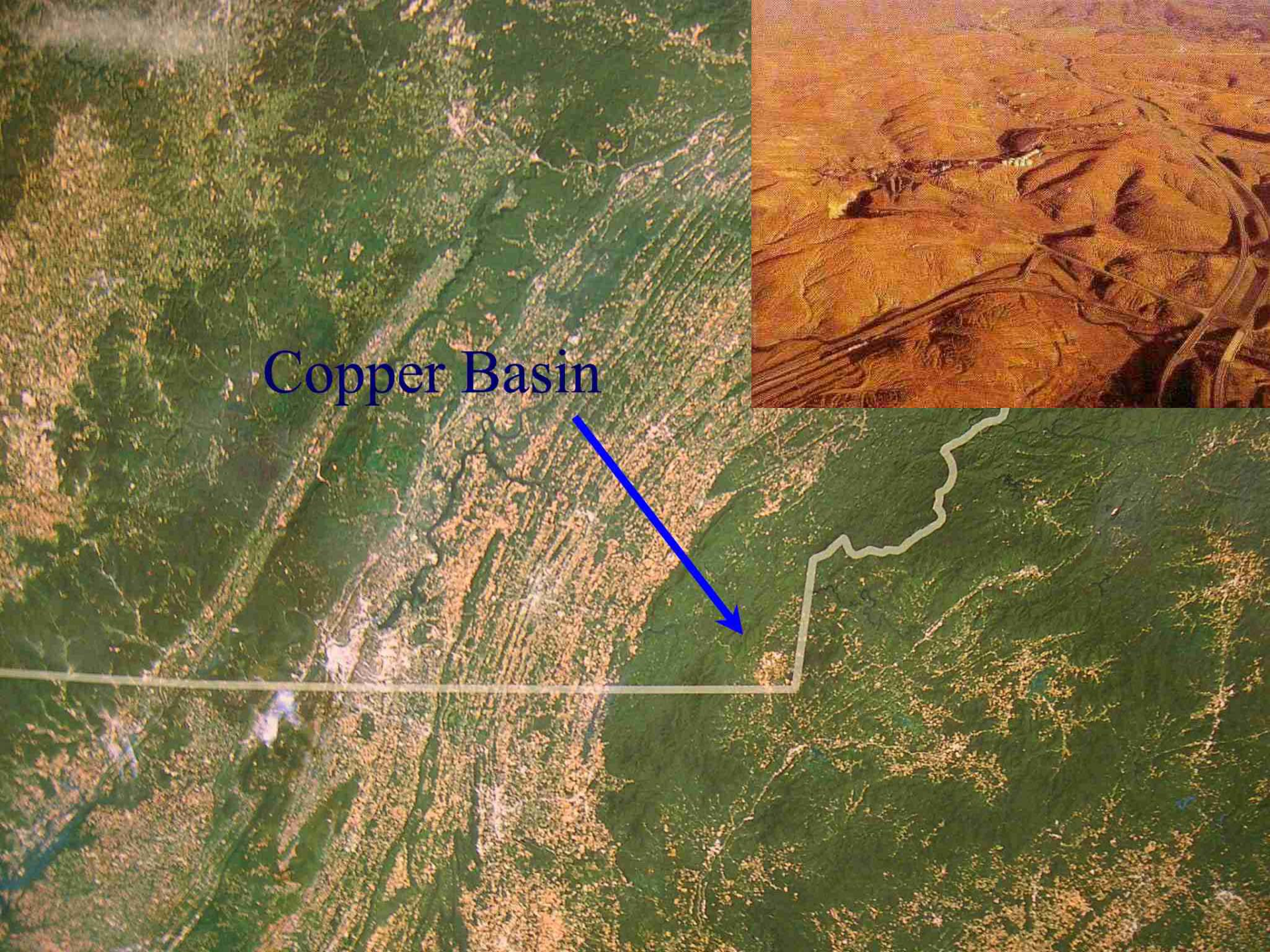
Frank Russell

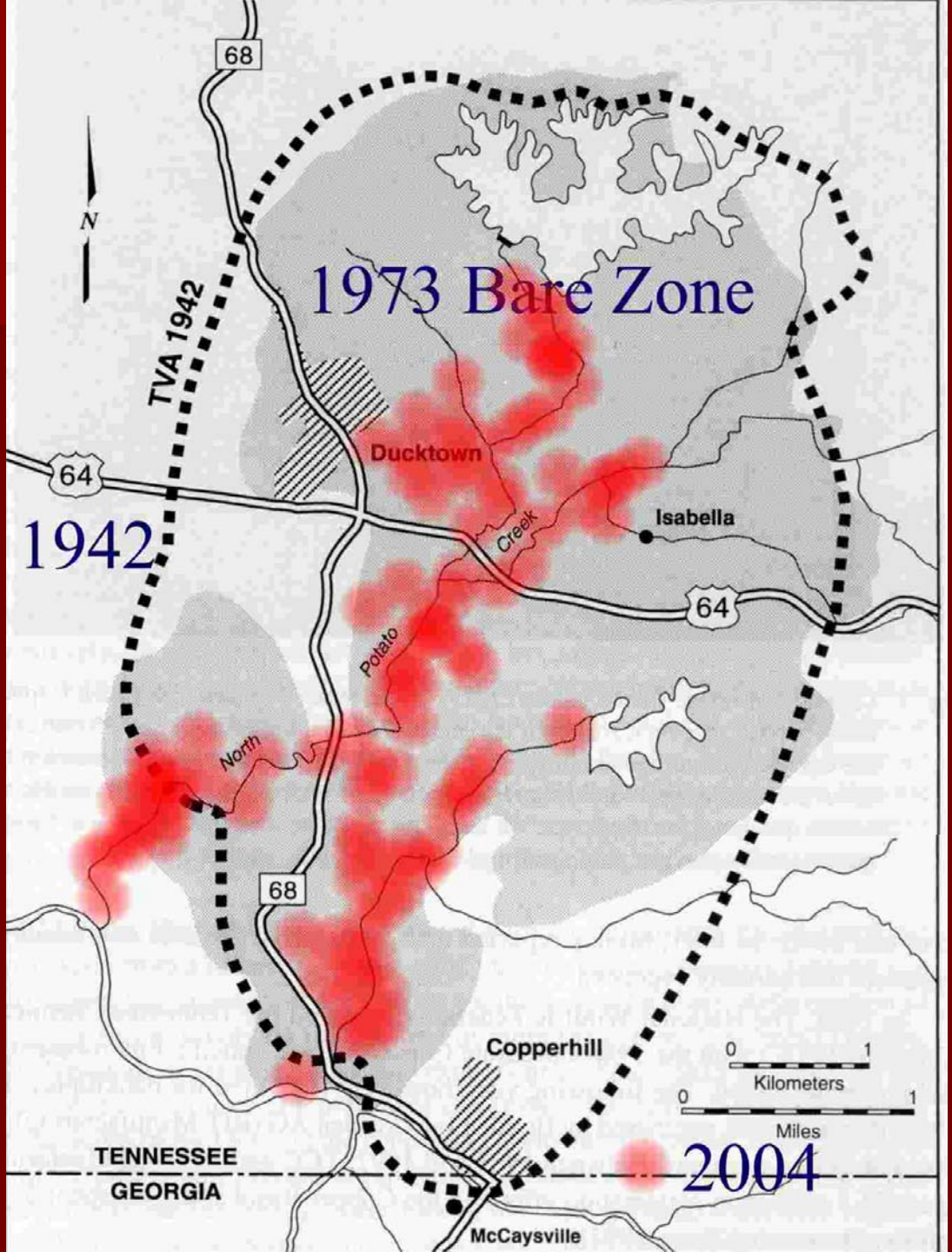
BWSC Barge Waggoner Sumner & Cannon, Inc.

OXY Glenn Springs Holdings, Inc.
A subsidiary of Occidental Petroleum

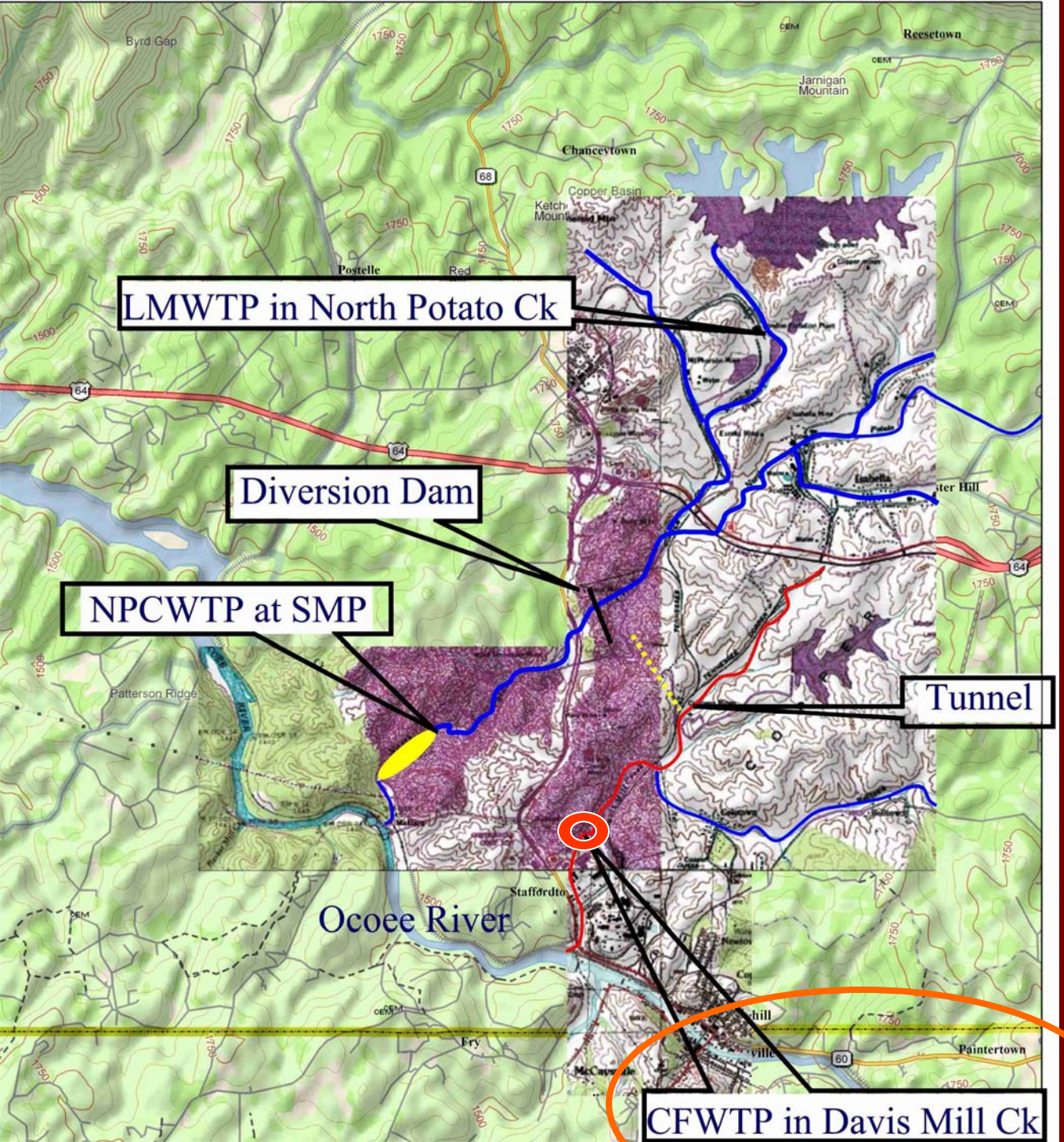
Presented at the 2005 WVSMDTF Symposium


Lexington
KENTUCKY
VIRGINIA
MISSOURI
Cumberland
Big South Fork N. River & Rec. Area
APPALACHIAN MTS.
Clarksville
Union City
Dover
Hendersonville
Kingsport
Bristol
Johnson City
La Follette
Reelfoot Lake
Kentucky Lake
NASHVILLE
Cookeville
Oak Ridge
Greeneville
Dyersburg
Smyrna
Knoxville
Franklin
Murfreesboro
Humboldt
Gatlinburg
NORTH CAROLINA
Columbia
McMinnville
Mississippi
Jackson
Tennessee
Vonore
Covington
TENNESSEE
Shelbyville
Cleveland
Savannah
Memphis
Grand Junction
Lawrenceburg
Chattanooga
Great
Copper Hill Region
SOUTH CAROLINA
ARKANSAS
MISSISSIPPI
ALABAMA
GEORGIA


Copper Basin


68
N
1973 Bare Zone
TVA 1942
Ducktown
64
1942
Isabella
Creek
64
Potato
North
68
Copperhill
0 1
Kilometers
0 1
Miles
TENNESSEE
GEORGIA
2004
McCaysville


Parksville Reservoir
Ocoee River
River and Reservoir Sediments?
Davis Mill Creek
Ocoee #3 Reservoir
North Potato Creek
Plant wastewater discharge
Fightingtown Creek
Upstream of Copperhill
Water Flow
55%
26%
This pie chart shows that Davis Mill Creek and North Potato Creek together contribute only 4 percent of total water flow in the Ocoee River



North Potato Creek
Davis Mill Creek

1. Cantrell Flats
2. London Mill
3. NPC South Mine Pit

Belltown Diversion - 3.5/5.0 sq. mile watershed diverted to 63” pipe

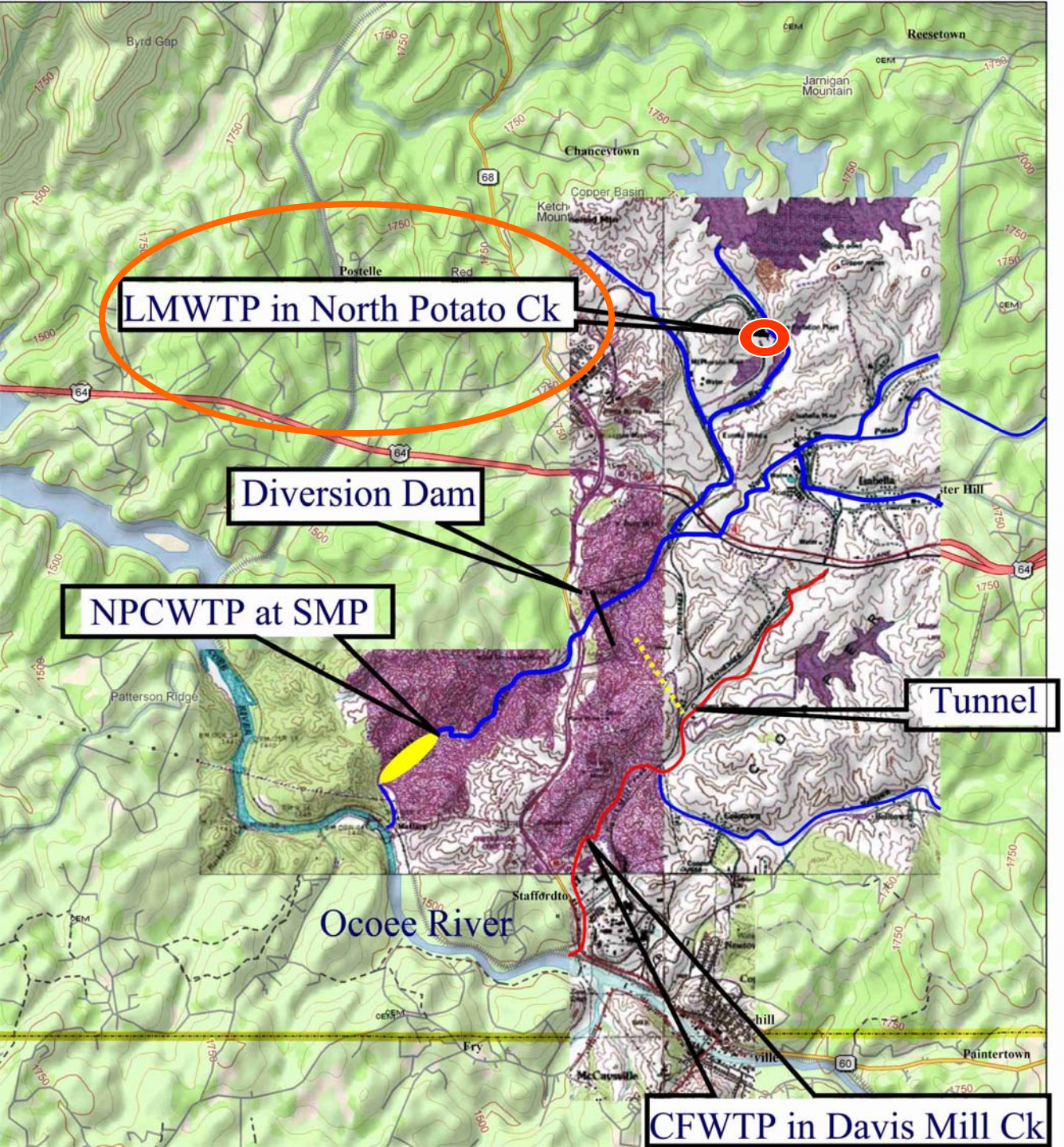

Belltown 63” pipe
diversion


Ocoee River
Cantrell Flats AMD Plant

Cantrell Flats WTP first 2 years:

- Removed over 4 million # iron from Davis Mill Creek, Ocoee River
- an additional 1 million # of other metals

  (Cu, Zn, Pb, Cd, Mn)
- Removed over 12 million # of acidity (17,400 #/day of acidity neutralized)
- Treated over 2 billion gallons (~71% DMC)

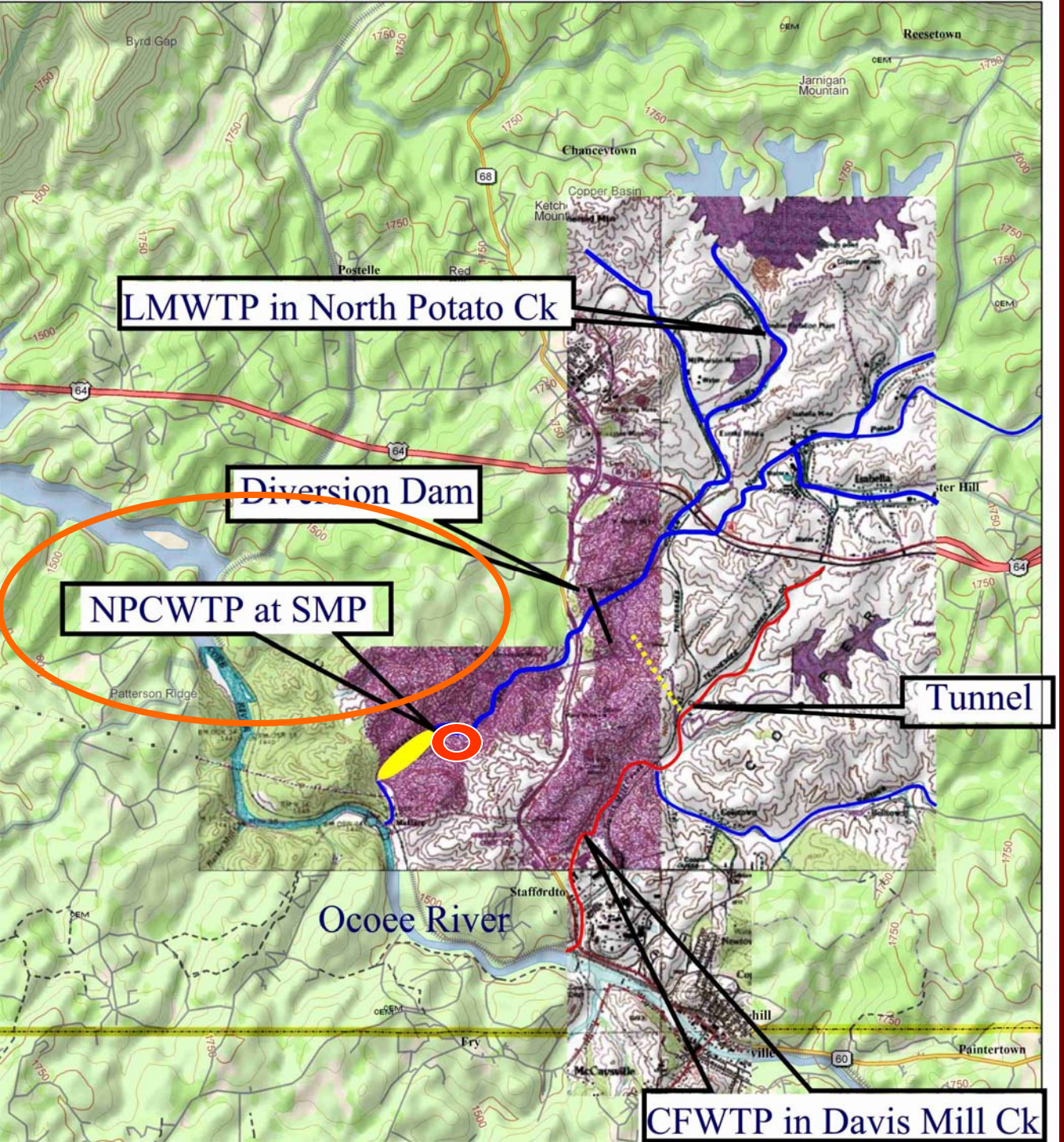


North Potato Creek
Davis Mill Creek

1. Cantrell Flats
2. London Mill
3. NPC South Mine Pit

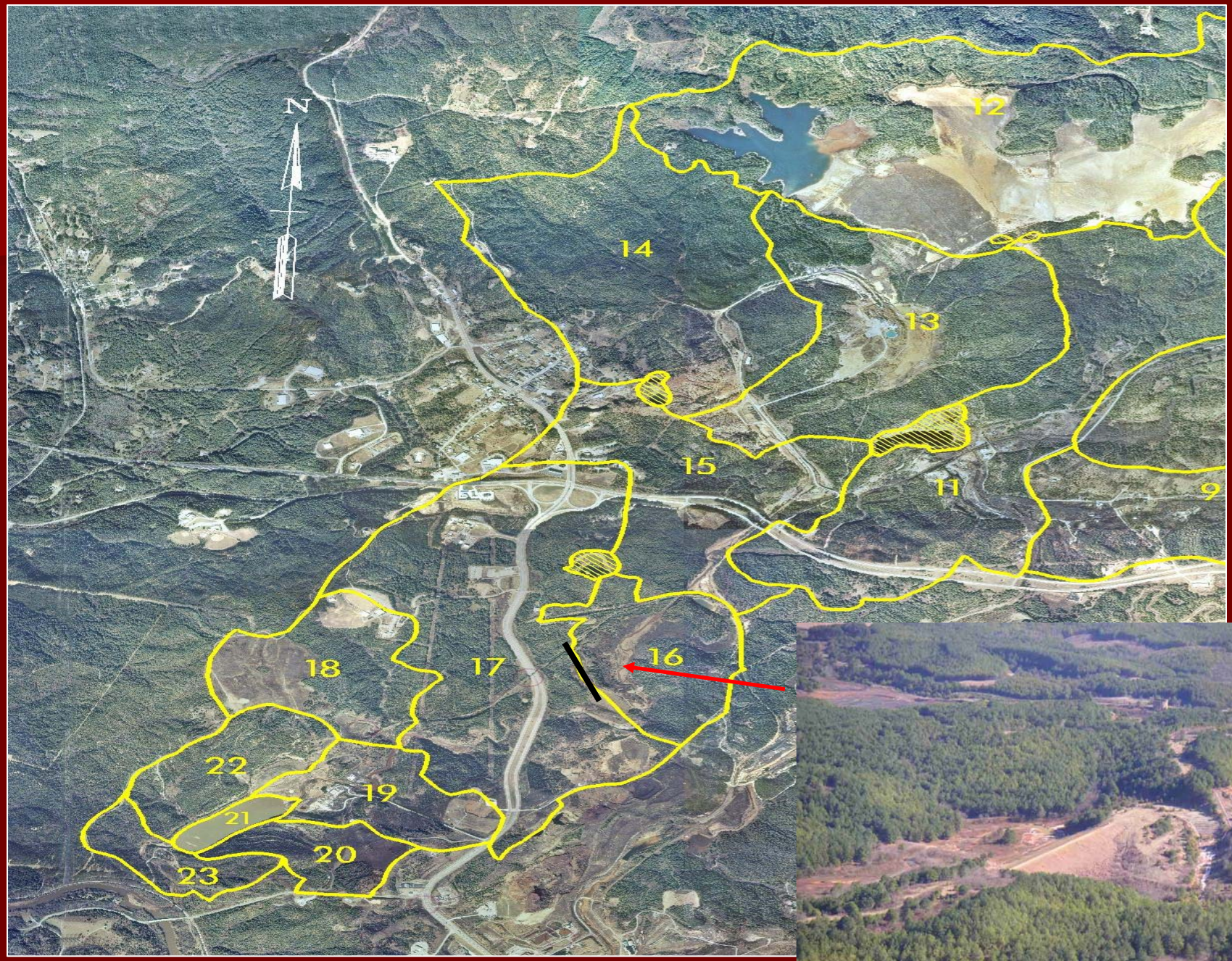

London Mill
WTP

London Mill WTP treats: McP mine, Isabella Mine, Waste Drainage

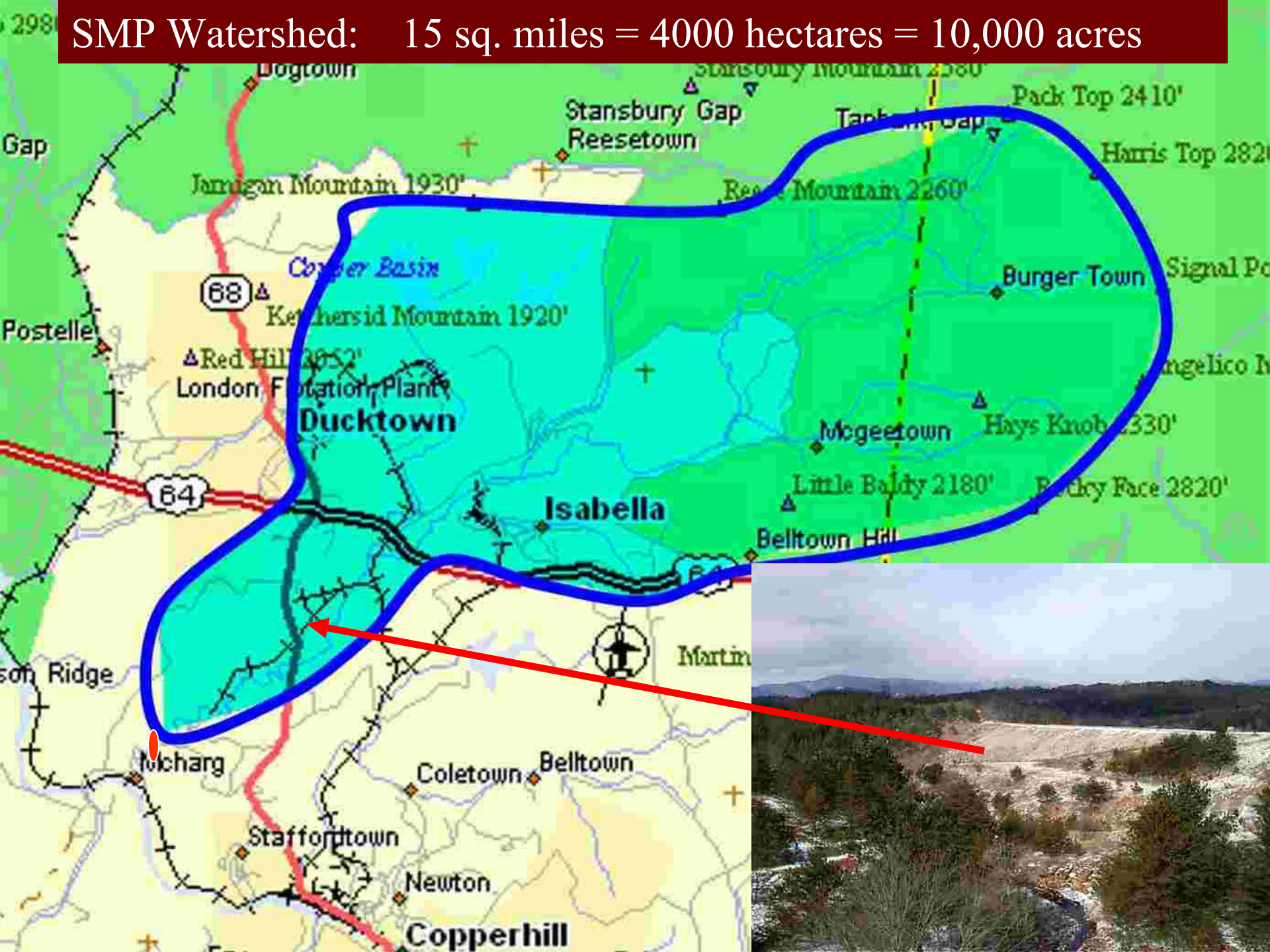


North Potato Creek
Davis Mill Creek

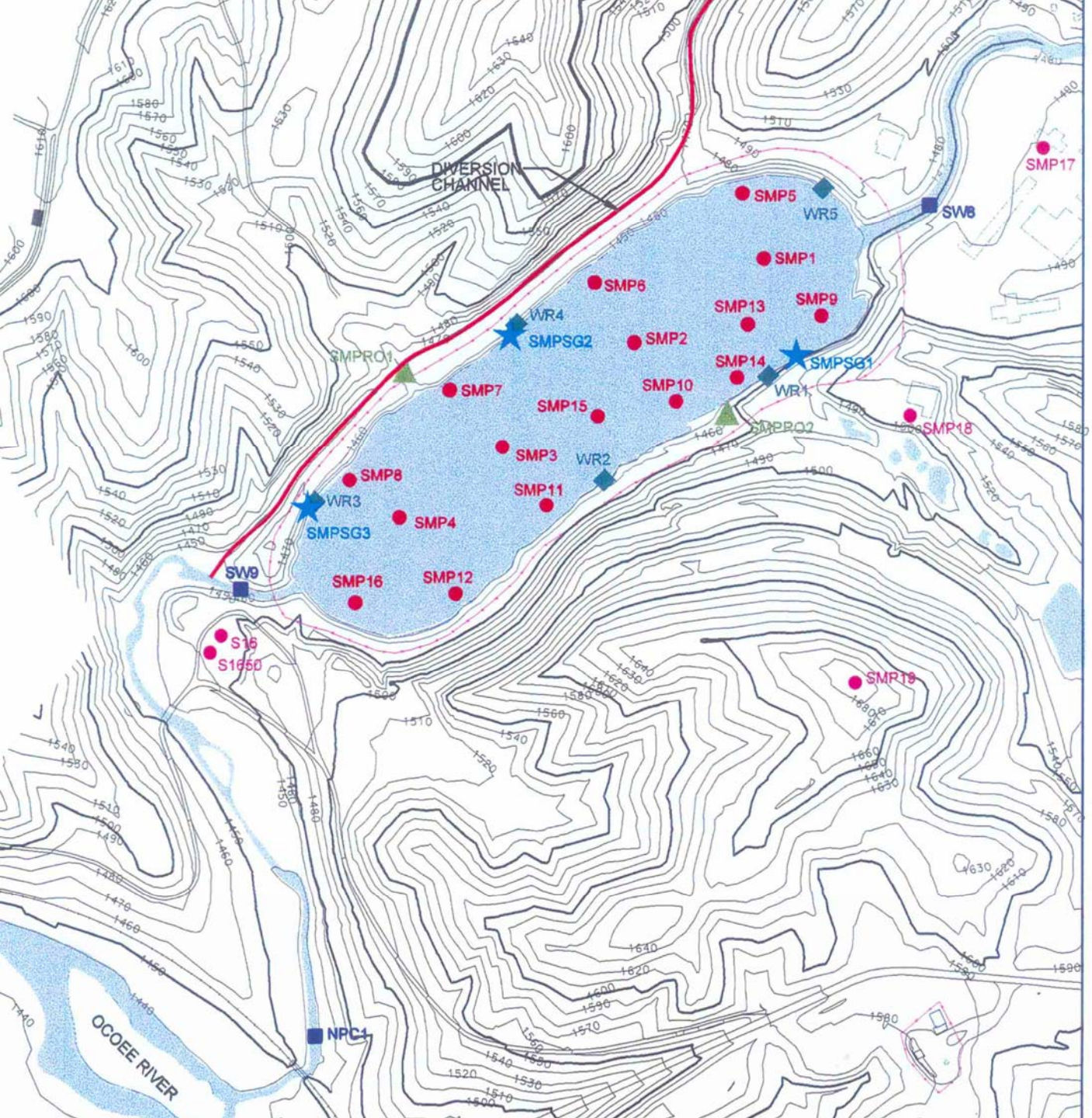
1. Cantrell Flats
2. London Mill
3. NPC South Mine Pit


N
12
14
13
15
11
9
18
17
16
22
19
21
20
23

SMP Watershed: 15 sq. miles = 4000 hectares = 10,000 acres




Ocoee River
NPCWTP



North Potato Creek

South Mine Pit

EE/CA sampling

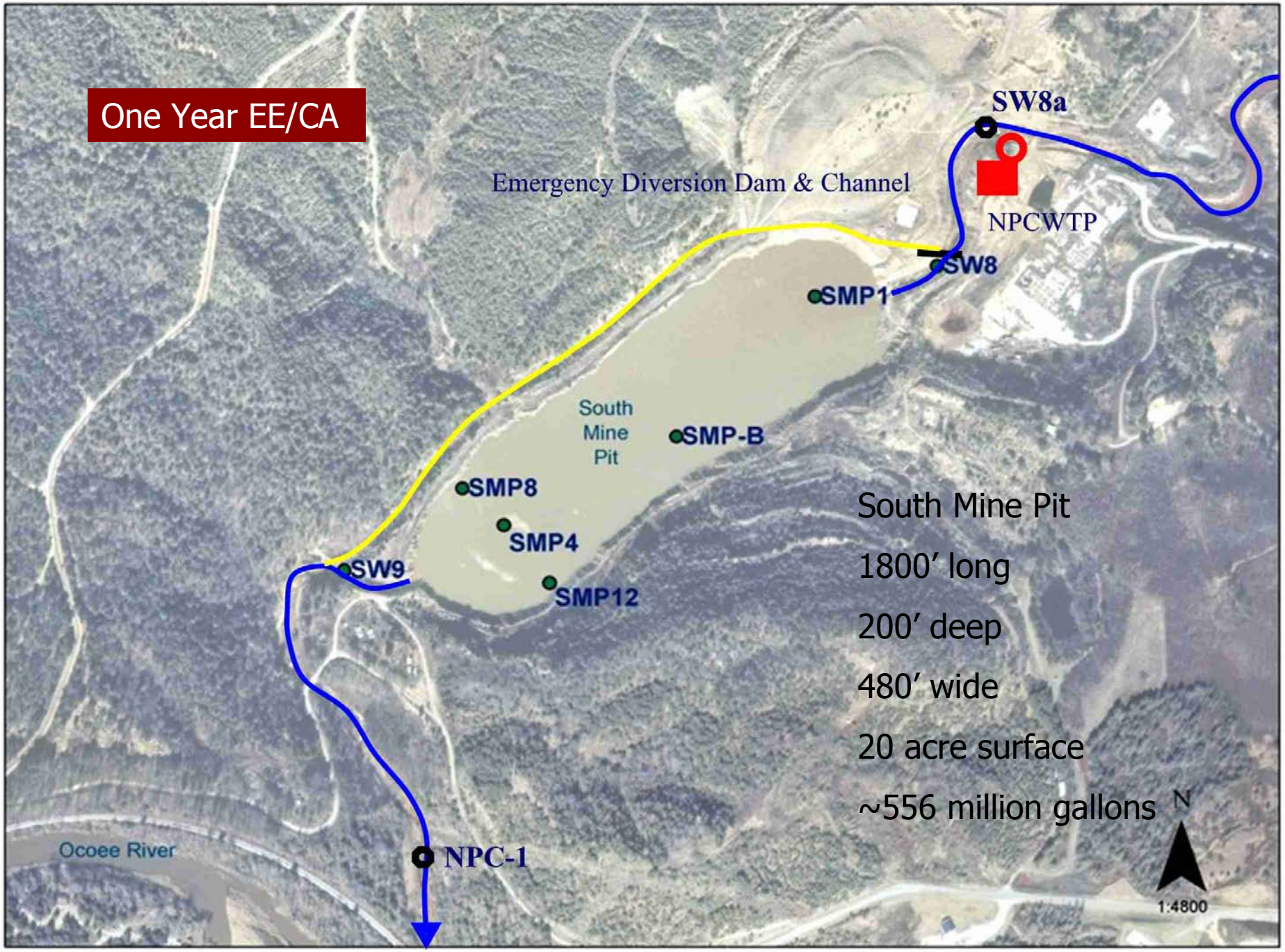
Locations:

16 chemocline

3 analytical plus

Inlet, outlet, runoff

5 wells/deep mines


One Year EE/CA
SW8a
Emergency Diversion Dam & Channel
NPCWTP
SW8
SMP1
South
Mine
Pit
SMP-B
SMP8
SMP4
SW9
SMP12
South Mine Pit
1800’ long
200’ deep
480’ wide
20 acre surface
~556 million gallons
N
Ocoee River
NPC-1
1:4800

Average values over 12 month period
2001-2002 EE/CA at South Mine Pit

Location	gpm	Field pH	Acidity (mg/L)	Dissolved iron (mg/L)
Pit inlet	8,160	5.0	23	10
Pit outlet	8,920	3.3	37	3.6

Streamlined Eco Risk Assessment identified COPECS EcoHQs:

- ***pH***
- ***Aluminum 13.3***
- Cadmium 1.6
- Cobalt 1.1
- ***Copper 6.6***
- ***Iron 3.5***
- Manganese 1.2
- Lead 1.1
- ***Zinc 2.7***

➢ No human health risks; ***primary drivers***

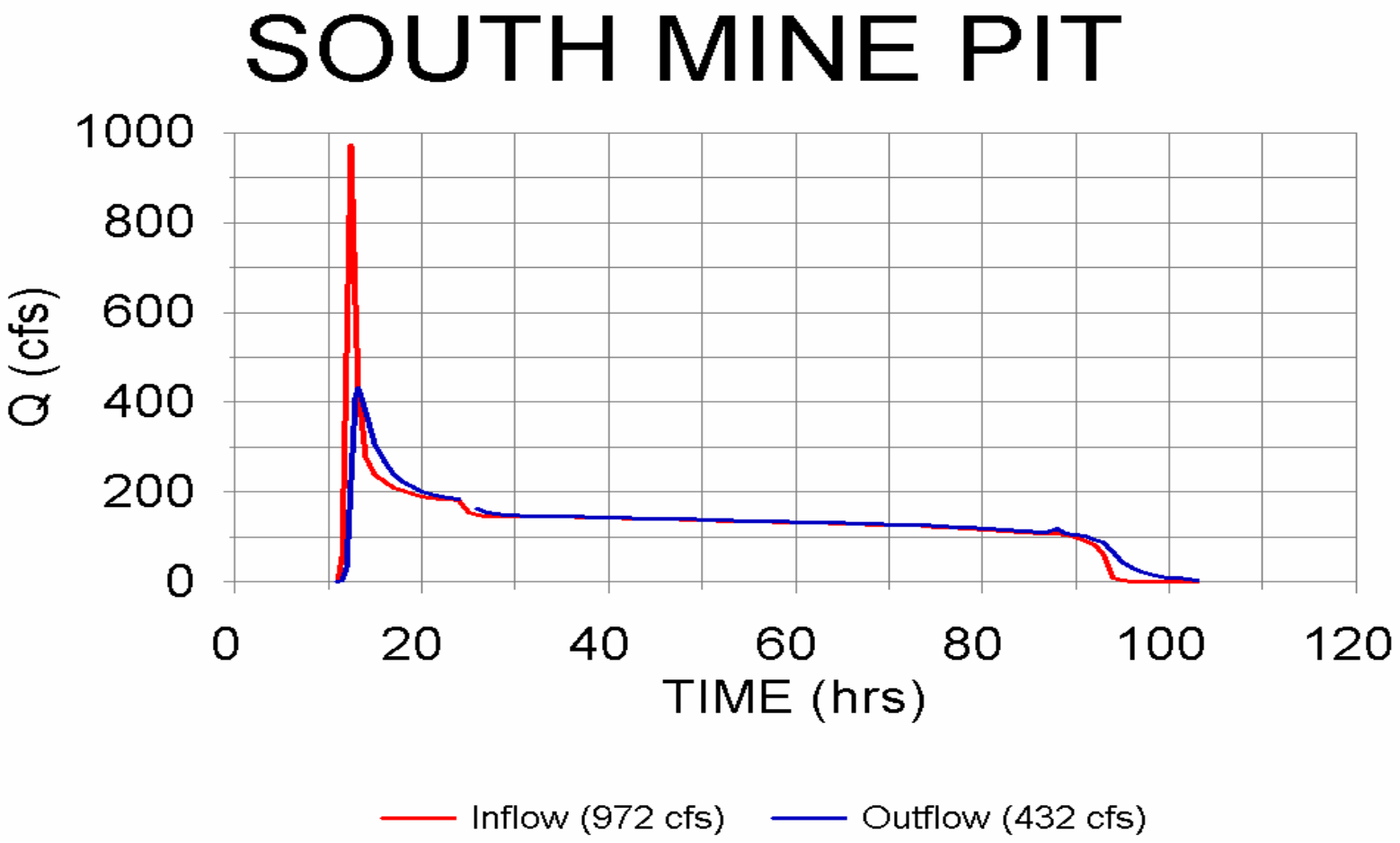
Objectives of NPC WTP

- Adequately treat groundwater flow into the SMP & flow in NPC attributable to a 10yr/24 hr storm
- Address and alleviate contaminant discharge from the NPC into the Ocoee River

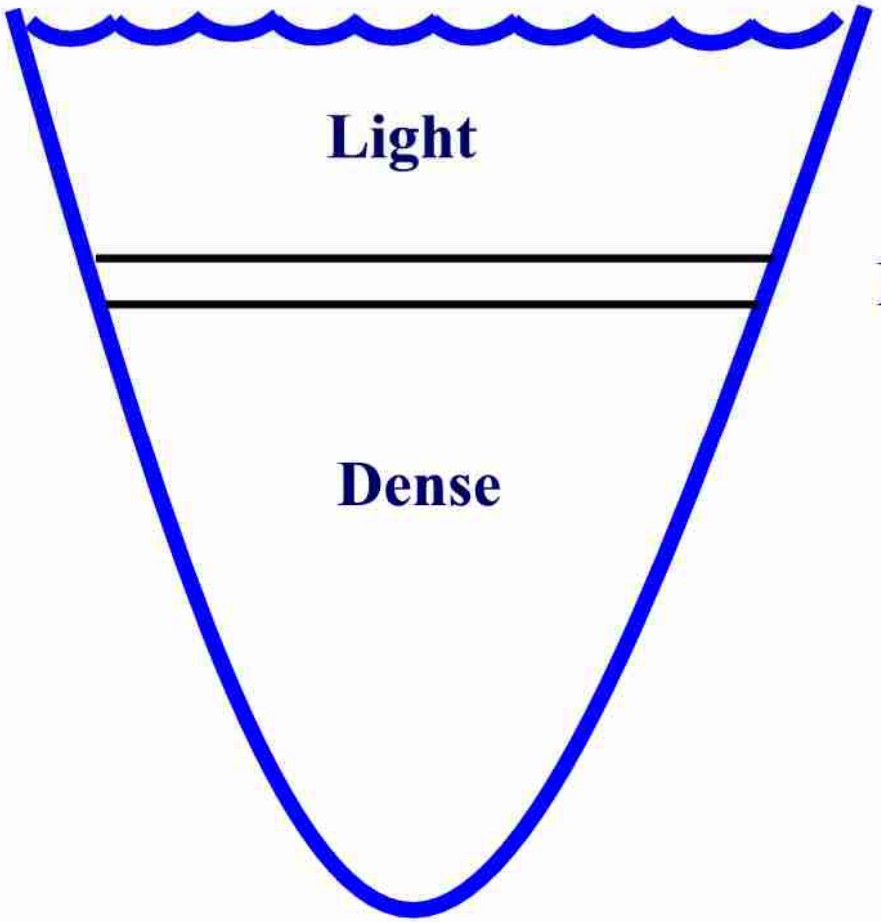

N
12
14
13
15
11
9
Diversion Dam
18
17
16
22
19
21
20
23
South Mine Pit

Attenuation of 10 yr/24 hr Flow to South Mine Pit

by 30” pipe outlet of Diversion Dam



Thermal (or Chemical) Stratification



Epilimnion

Metalimnion

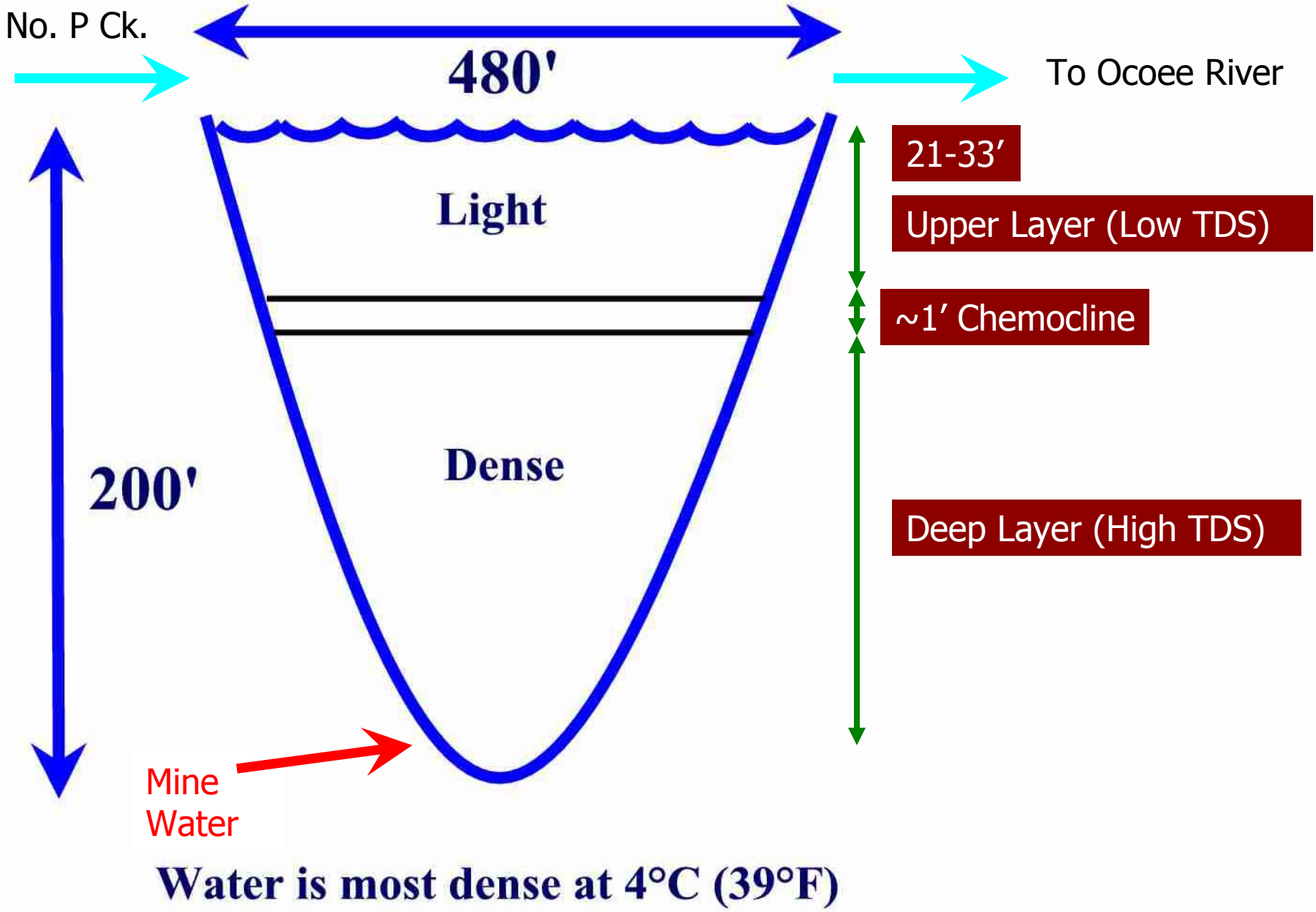
Thermocline

Chemocline

Hypolimnion

Water is most dense at 4°C (39°F)

Stratification in South Mine Pit

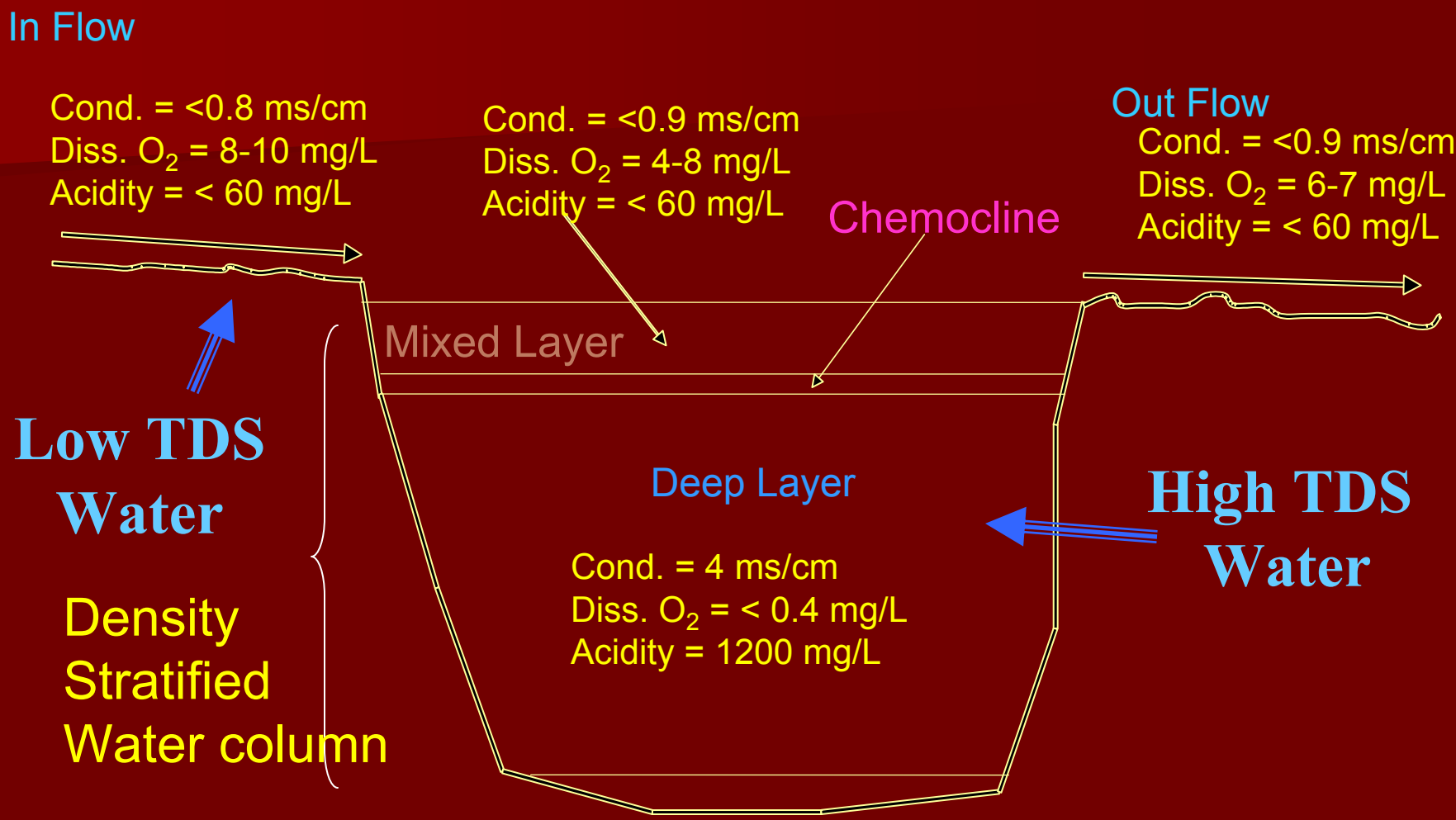


Water is most dense at 4°C (39°F)

Shallow and Deep Water Quality in South Mine Pit (EE/CA values)

	pH	s.c.	Acidity mg/L	Al µg/L	Cd µg/L	Co µg/L	Cu µg/L	Fe mg/L	Mn mg/L	Pb µg/L	Zn µg/L	SO_4 mg/L
shallow	3.37	660	30	1147	0.69	25	108	3.6	2.5	5.5	605	262
deep	4.64	3860	1140	995	0.3	68	18	551	37	0.6	876	2895

Representative Field Chemistry



Bench-Scale Treatability Study

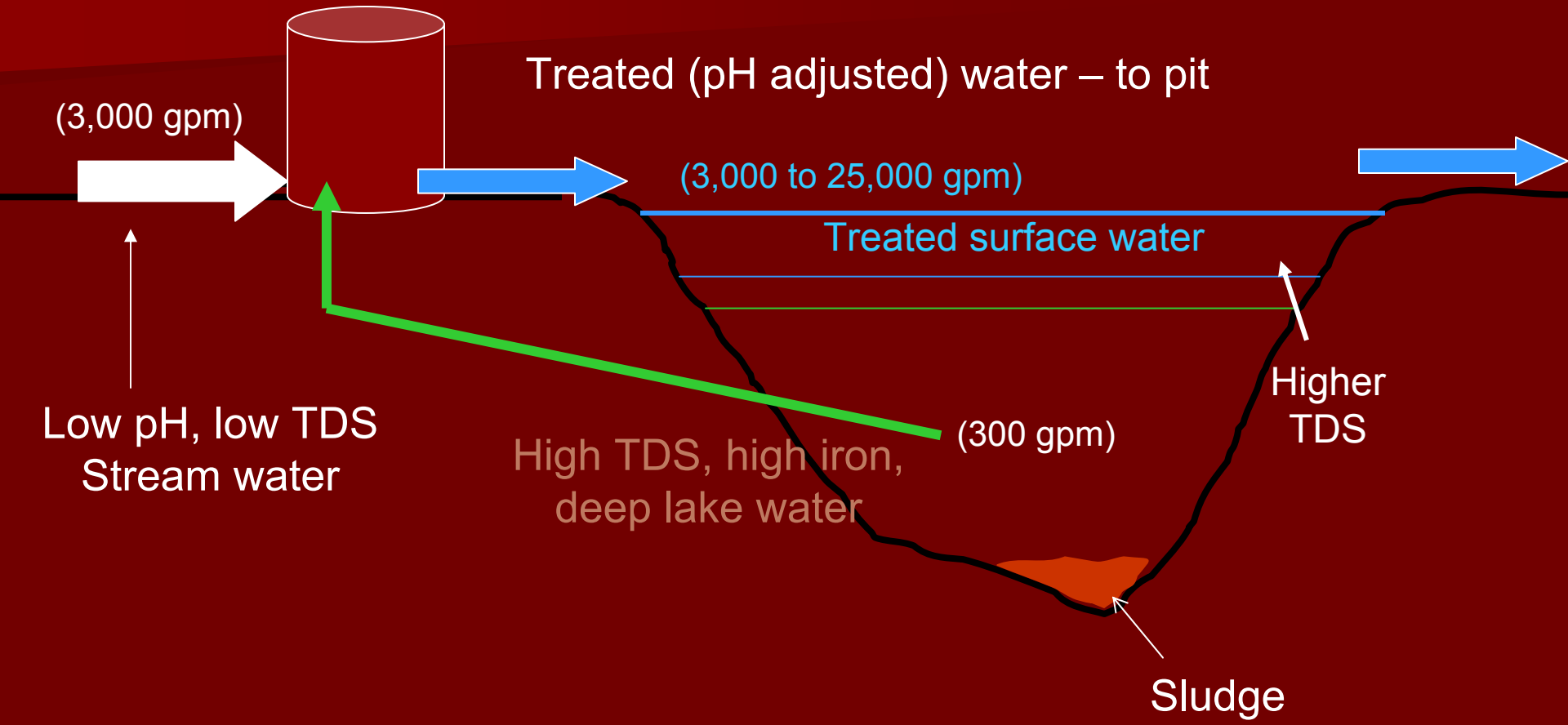
Bench-Scale Iron Hydroxide Settling Experiments

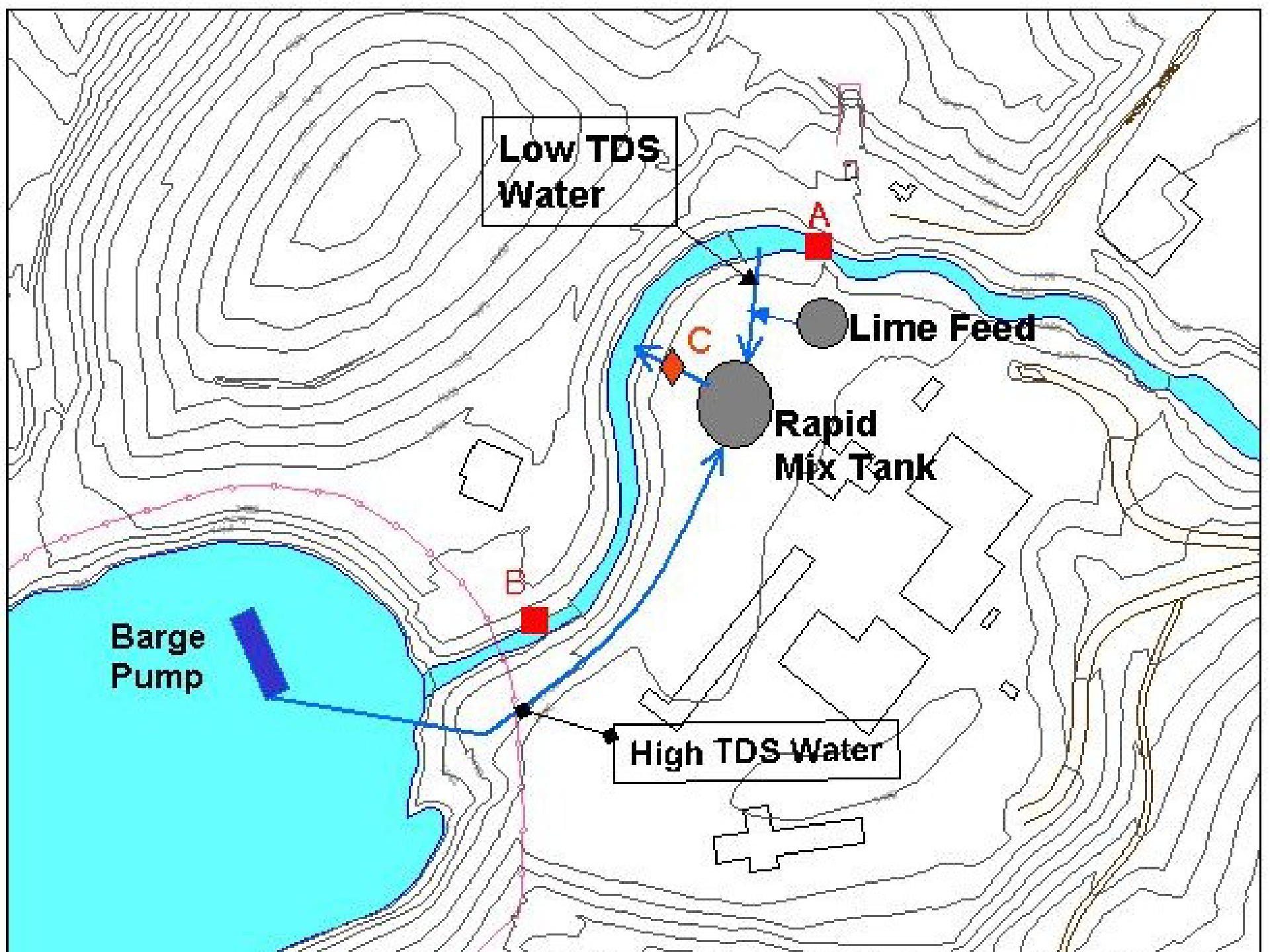
1 minute

3 minutes

7 minutes

Field Treatability Demonstration

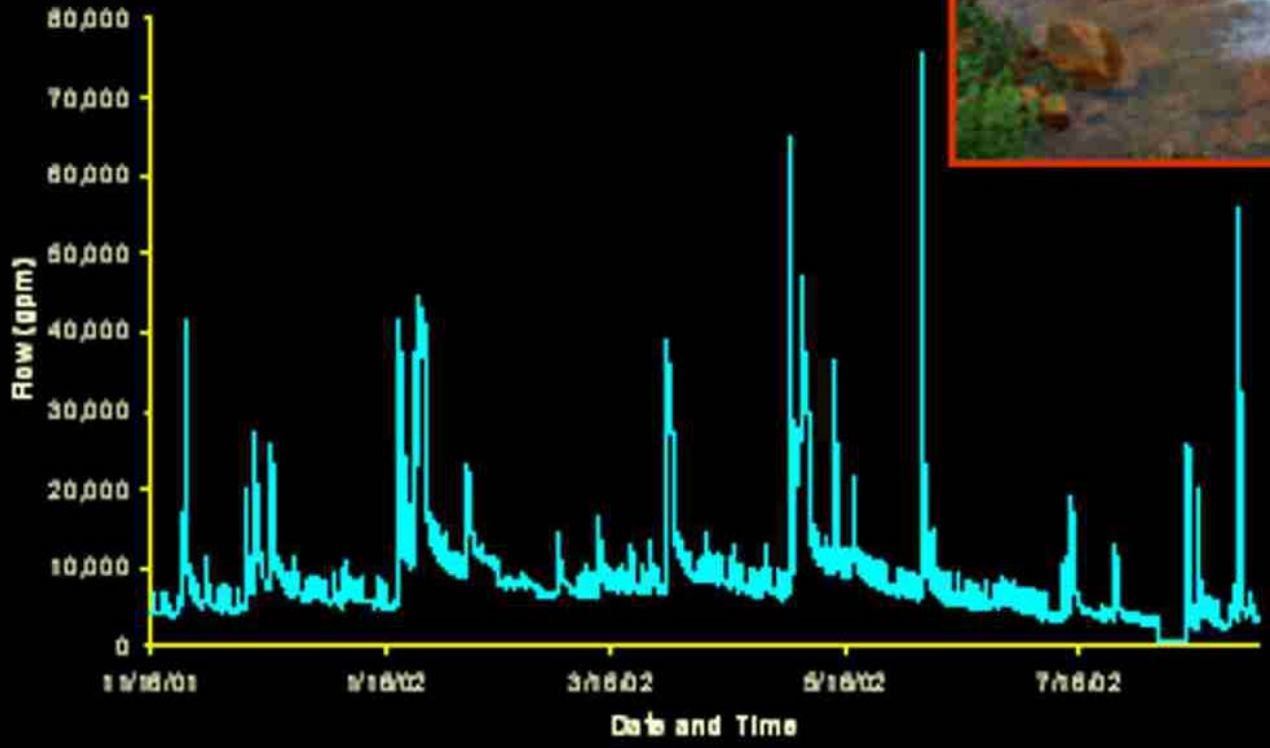


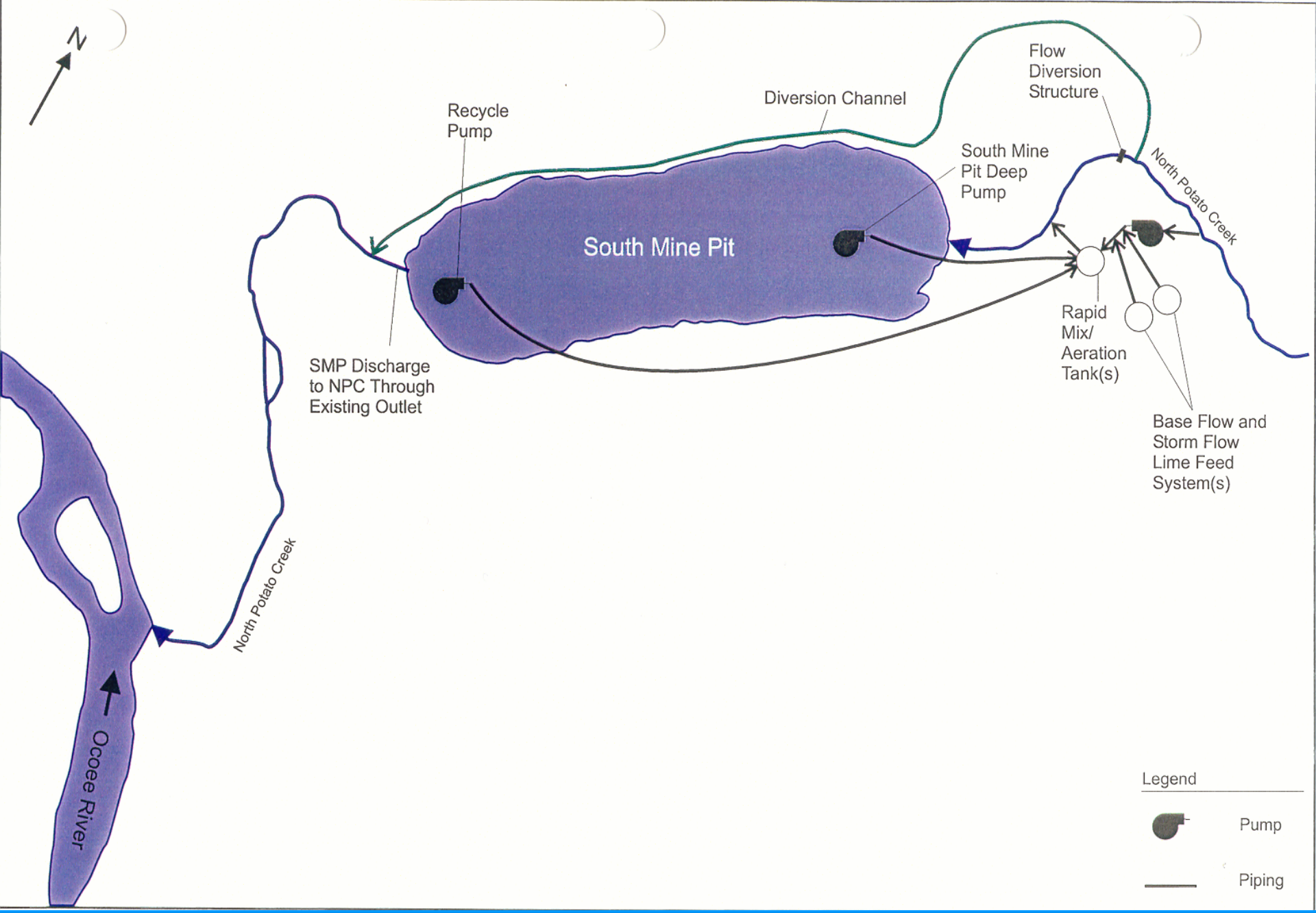

Low TDS
Water
A
Lime Feed
C
Rapid
Mix Tank
B
Barge
Pump
High TDS Water

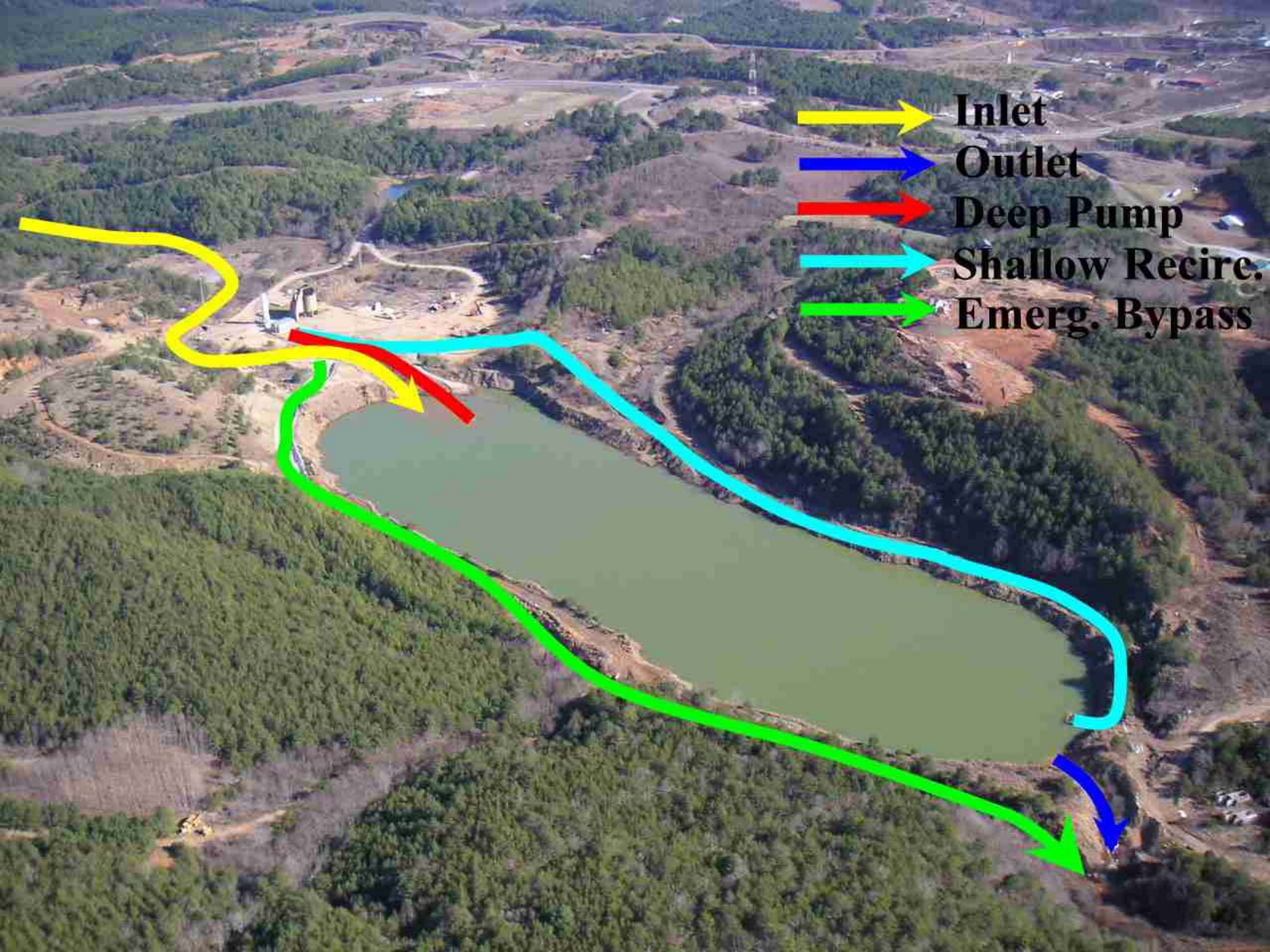

07 31 2002 16:00-17:00

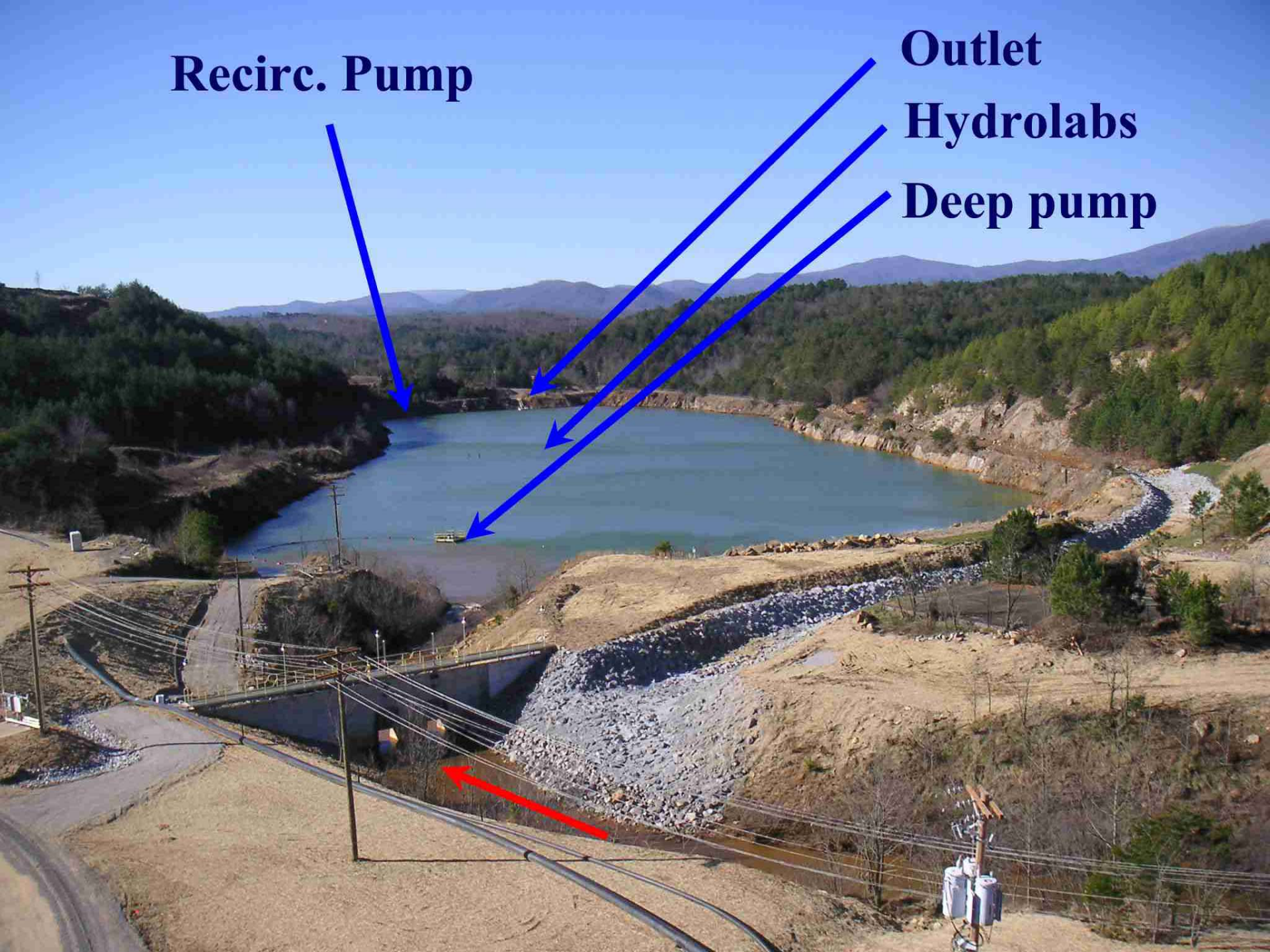
EXTENT OF IRON SLUDGE PLUME IN PIT AFTER THE TREATMENT PLANT WAS IN OPERATION FOR APPROXIMATELY 3.5 HOURS

October 2001 to September 2002




N
Recycle Pump
Diversion Channel
Flow Diversion Structure
South Mine Pit Deep Pump
North Potato Creek
South Mine Pit
SMP Discharge to NPC Through Existing Outlet
Rapid Mix/ Aeration Tank(s)
Base Flow and Storm Flow Lime Feed System(s)
North Potato Creek
Ocoee River
Legend
Pump
Piping


Inlet
Outlet
Deep Pump
Shallow Recirc.
Emerg. Bypass


Recirc. Pump
Outlet
Hydrolabs
Deep pump

S:_Mine_Pit | SOUTH MINE PIT | 5:56:18 PM | 1/24/2005

NORTH POTATO CREEK WATER TREATMENT PLANT

SOUTH MINE PIT

NORTH POTATO CREEK

P-303 LOC | P-304 REM | P-301 REM | P-302 REM | REM | REM

TO OCOEE RIVER

SW-9
14092 GPM
6.8 pH
0.6 mS/cm

TREND

SW-8
15282 GPM
7.2 pH
0.6 mS/cm

DIVERSION STRUCTURE
0.0 % MAN

359 GPM

FROM RAPID MIX TANK

TO RAPID MIX TANK

RECYCLE PUMPS

DEEP PIT PUMPS

TREND

DEEP HYDROLAB	SHALLOW HYDROLAB
4.9 pH	6.5 pH
3.5 mS/cm	0.6 mS/cm
0.0 mg/l	10.3 mg/l
130 mV	60 mV
11.1 deg C	6.0 deg C

TREND | TREND

P-303 RUN TIME
86 HOURS

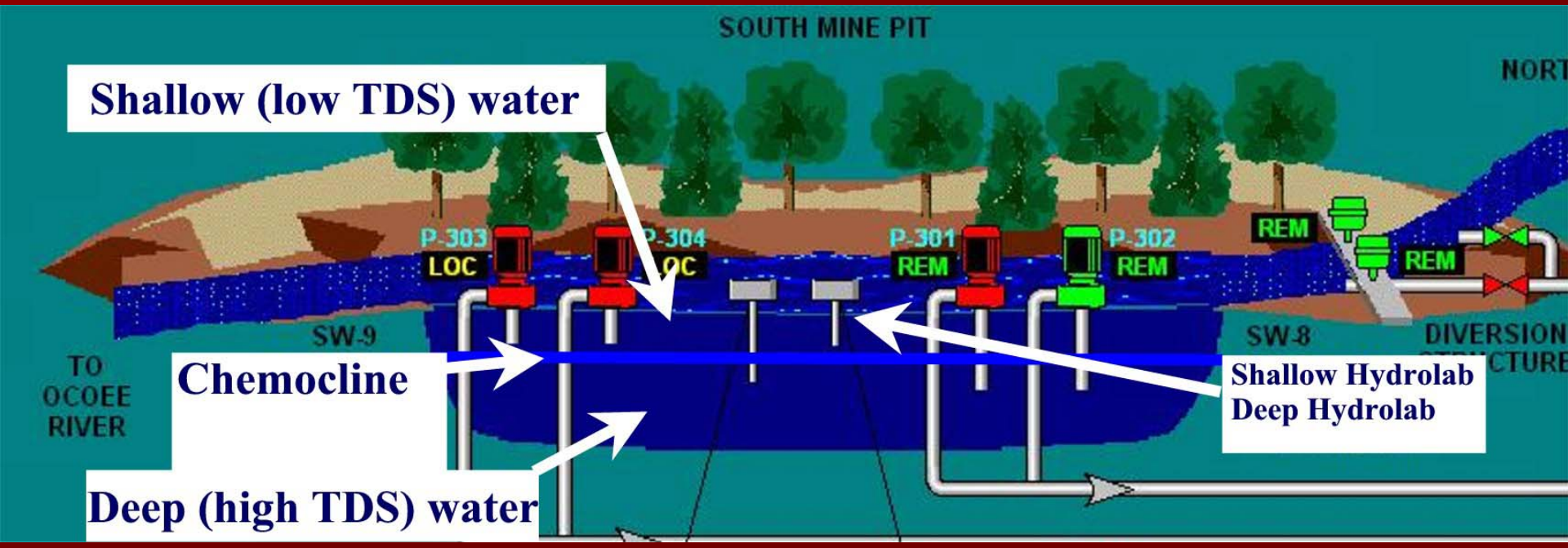
P-301 RUN TIME
44 HOURS

P-302 RUN TIME
301 HOURS

Description

Rapid Mix Tank Overflow pH

Influent pH


SOUTH MINE PIT
Shallow (low TDS) water
P-303
LOC
P-304
LOC
P-301
REM
P-302
REM
REM
REM
SW-9
SW-8
TO
OCOEE
RIVER
Chemocline
Shallow Hydrolab
Deep Hydrolab
Deep (high TDS) water

NORTH POTATO CREEK
WATER TREATMENT PLANT

LIME SILO	NPC P/S	RAPID MIX TANK	SW-8	DEEP PIT PUMPS	HYDROLABS		SW-9
					DEEP	SHALLOW	
18.0 %	1 GPM	0.0 pH	7.2 pH	359 GPM	4.9 pH	6.5 pH	6.8 pH
	684 GALLONS		0.6 uMHOS	225027 GALLONS	3.5 mS/cm	0.6 mS/cm	0.6 uMHOS
			15085 GPM		0.1 mg/l	11.0 mg/l	14076 GPM
					120 mV	60 mV	
					11.1 deg C	5.9 deg C	

LONDON MILL

INFLUENT 11.4 pH
EFFLUENT 9.9 pH

SCADA PLC COMM STATUS:	NORMAL
LIME SILO PLC COMM STATUS:	NORMAL
DEEP HYDROLAB RF LINK:	FAULT
DEEP HYDROLAB BATTERY:	13.3 VOLTS
SHALLOW HYDROLAB RF LINK:	NORMAL
SHALLOW HYDROLAB BATTERY:	13.2 VOLTS
RECYCLE/SW-9 RF LINK:	NORMAL

CURRENT FLOW TOTALS

NPC TO RAPID MIX TANK
684 GALLONS

DEEP PIT TO RAPID MIX TANK
225039 GALLONS

PREVIOUS FLOW TOTALS

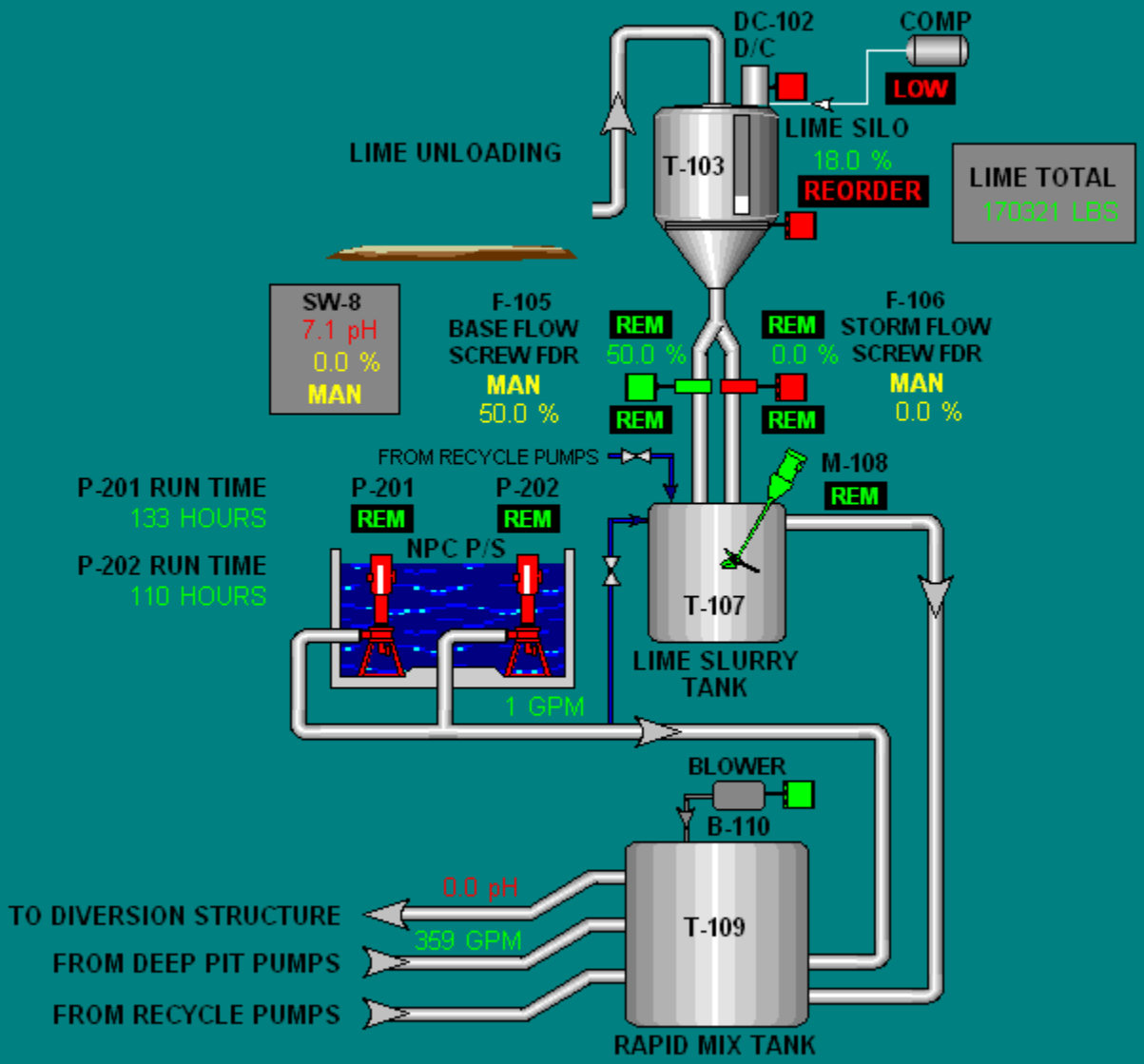
NPC TO RAPID MIX TANK
888 GALLONS

DEEP PIT TO RAPID MIX TANK
521283 GALLONS

LONDON MIL
LIME PRE
S. MINE PI
ALARMS

Time In	Time Last	Tagname	Description	Status	Value
16:43:44.046	17:08:45.000	AI109	Rapid Mix Tank Overflow pH	LO	0.

NORTH POTATO CREEK WATER TREATMENT PLANT



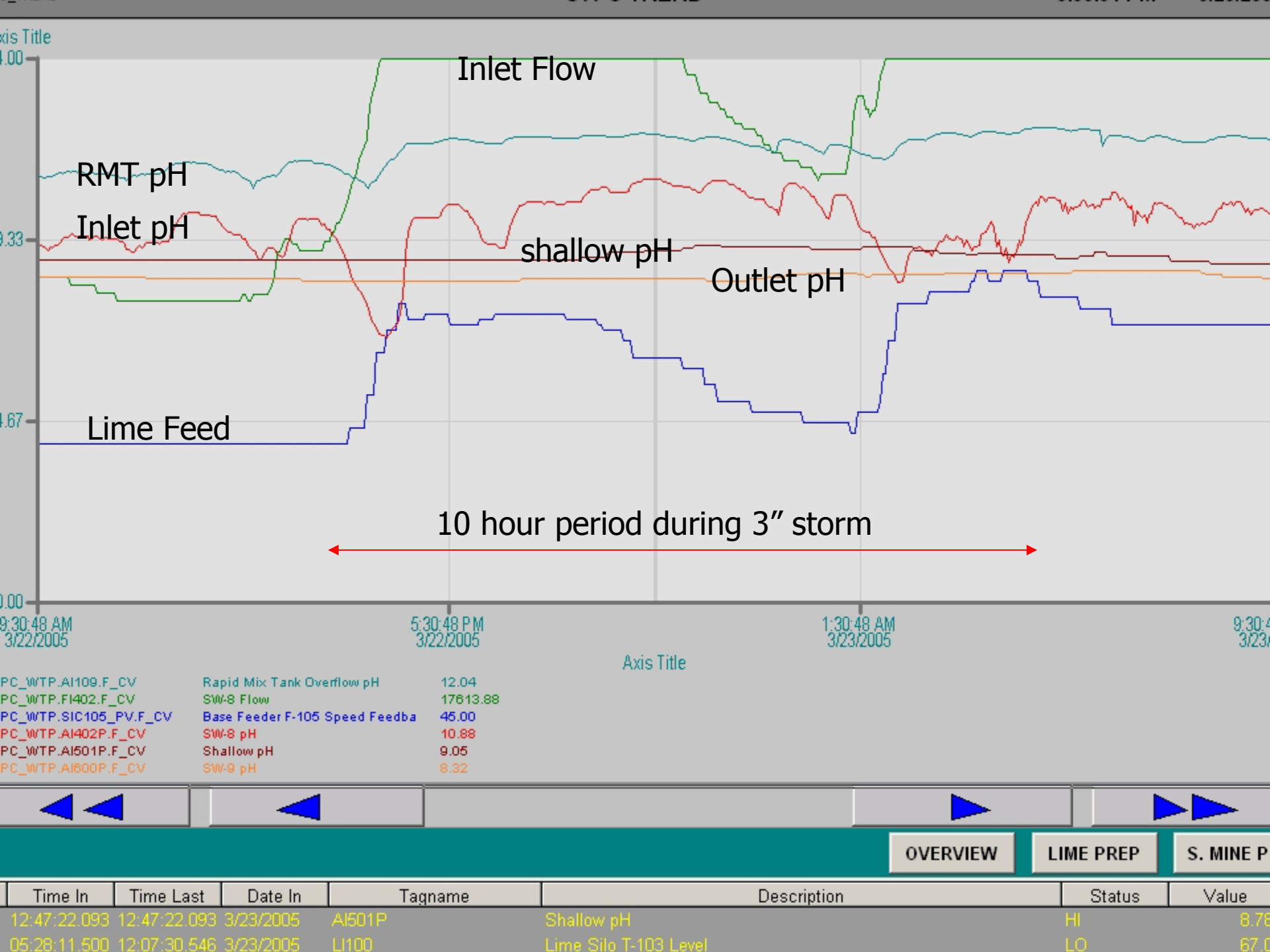
TREND

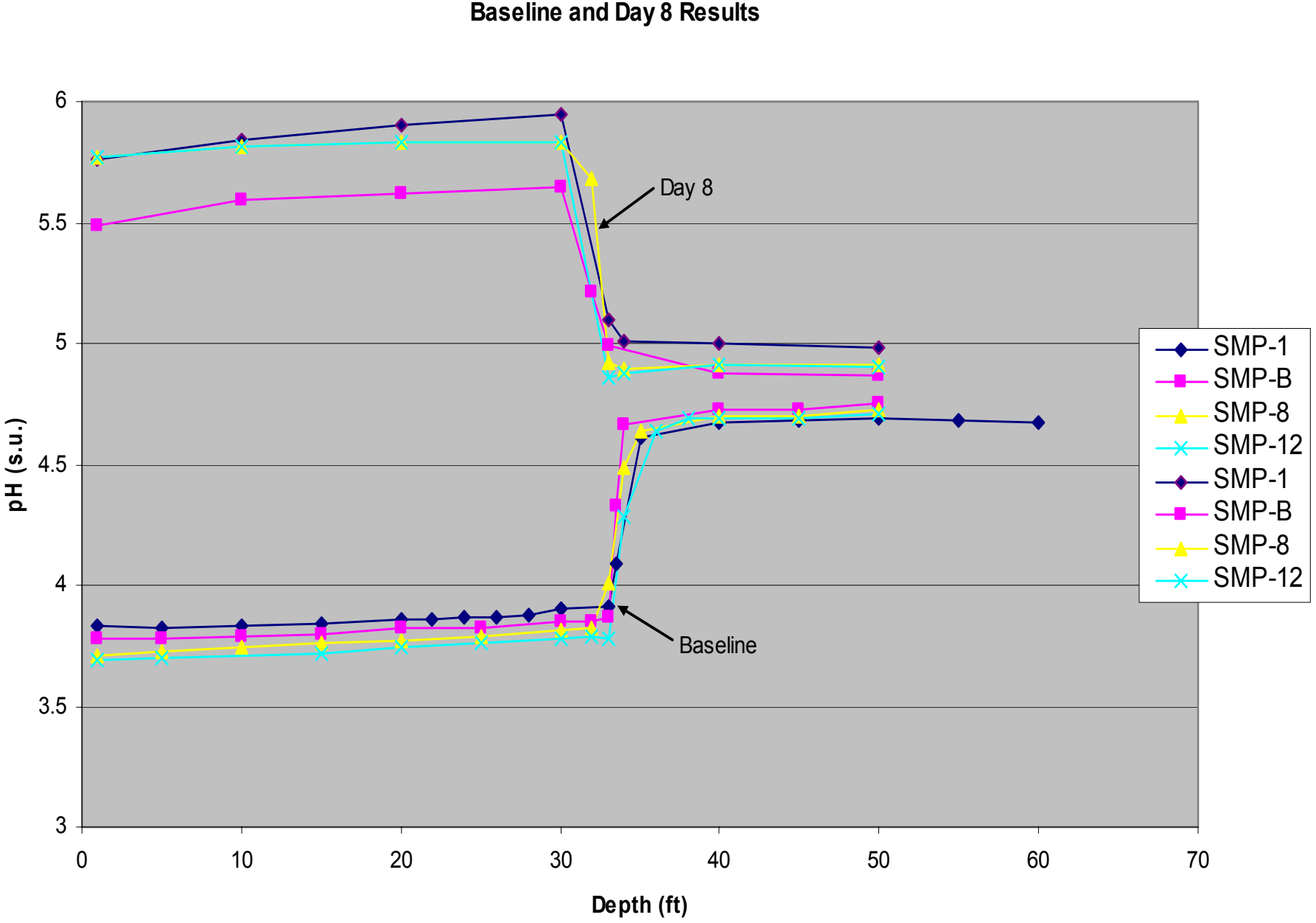
OVERVIEW

S. MINE PI

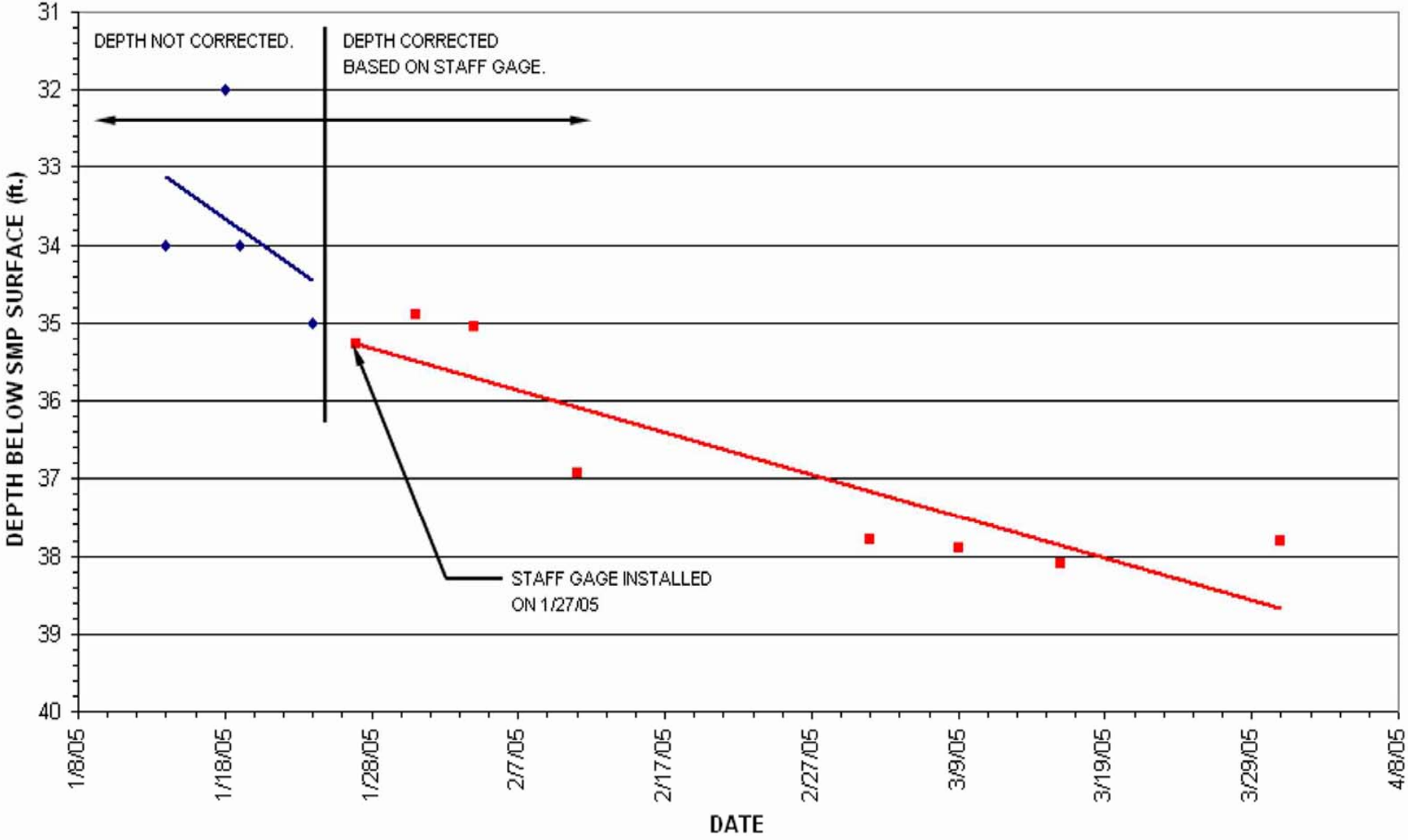
ALARMS

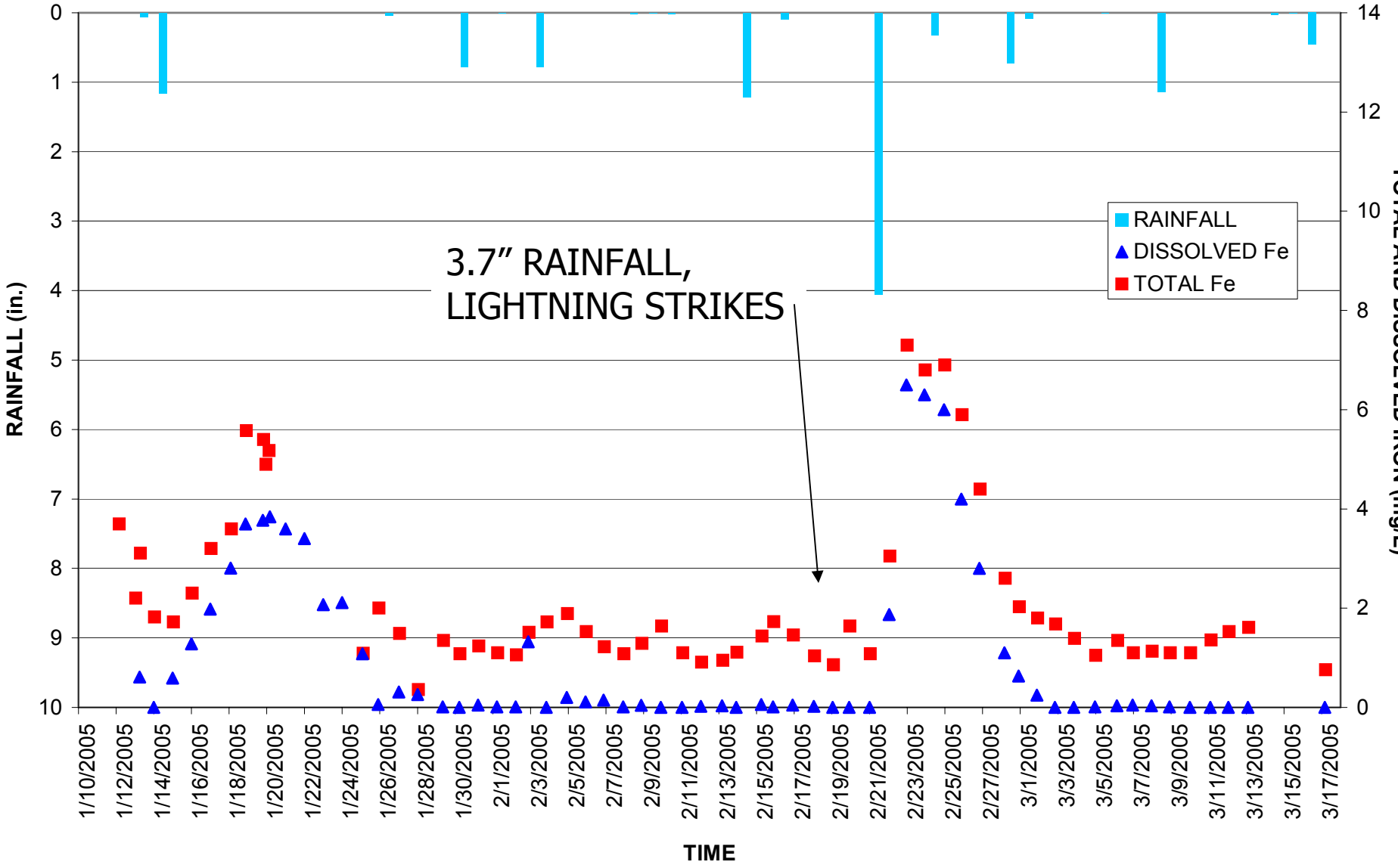
Time In	Time Last	Tagname	Description	Status	Value
16:43:44.046	17:08:45.000	AI109	Rapid Mix Tank Overflow pH	LO	0.


Inlet Flow
RMT pH
Inlet pH
shallow pH
Outlet pH
Lime Feed
10 hour period during 3” storm
9:30:48 AM 3/22/2005
5:30:48 PM 3/22/2005
1:30:48 AM 3/23/2005
Axis Title
PC_WTP.AI109.F_CV Rapid Mix Tank Overflow pH 12.04
PC_WTP.FI402.F_CV SW-8 Flow 17613.88
PC_WTP.SIC105_PV.F_CV Base Feeder F-105 Speed Feedba 45.00
PC_WTP.AI402P.F_CV SW-8 pH 10.88
PC_WTP.AI501P.F_CV Shallow pH 9.05
PC_WTP.AI600P.F_CV SW-9 pH 8.32
OVERVIEW
LIME PREP
S. MINE P
Time In | Time Last | Date In | Tagname | Description | Status | Value
12:47:22.093 12:47:22.093 3/23/2005 AI501P Shallow pH HI
05:28:11.500 12:07:30.546 3/23/2005 LI100 Lime Silo T-103 Level LO

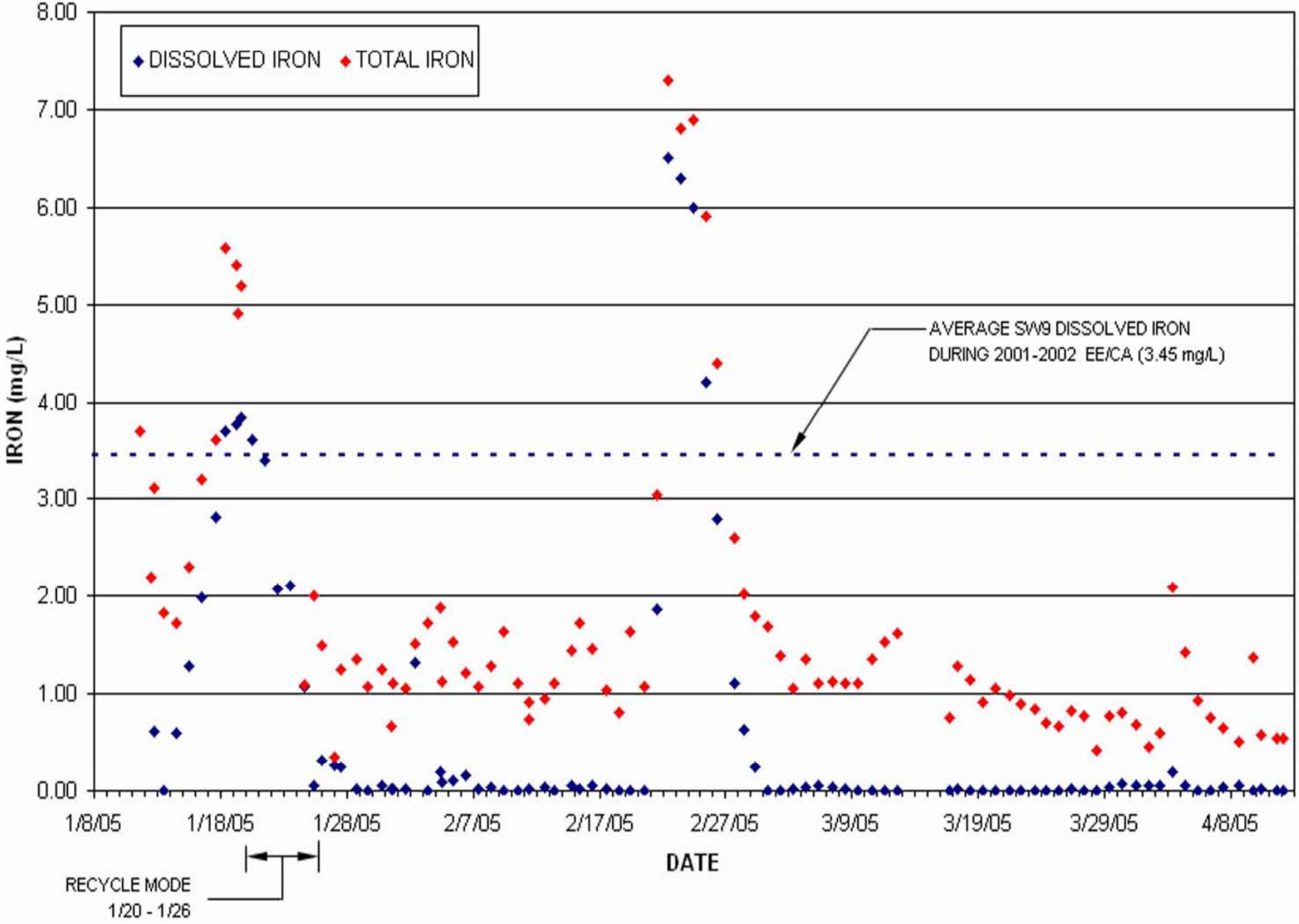

Baseline and Day 8 Results
6
5.5
5
4.5
4
3.5
3
pH (s.u.)
0
10
20
30
40
50
60
70
Depth (ft)
Day 8
Baseline
SMP-1
SMP-B
SMP-8
SMP-12
SMP-1
SMP-B
SMP-8
SMP-12

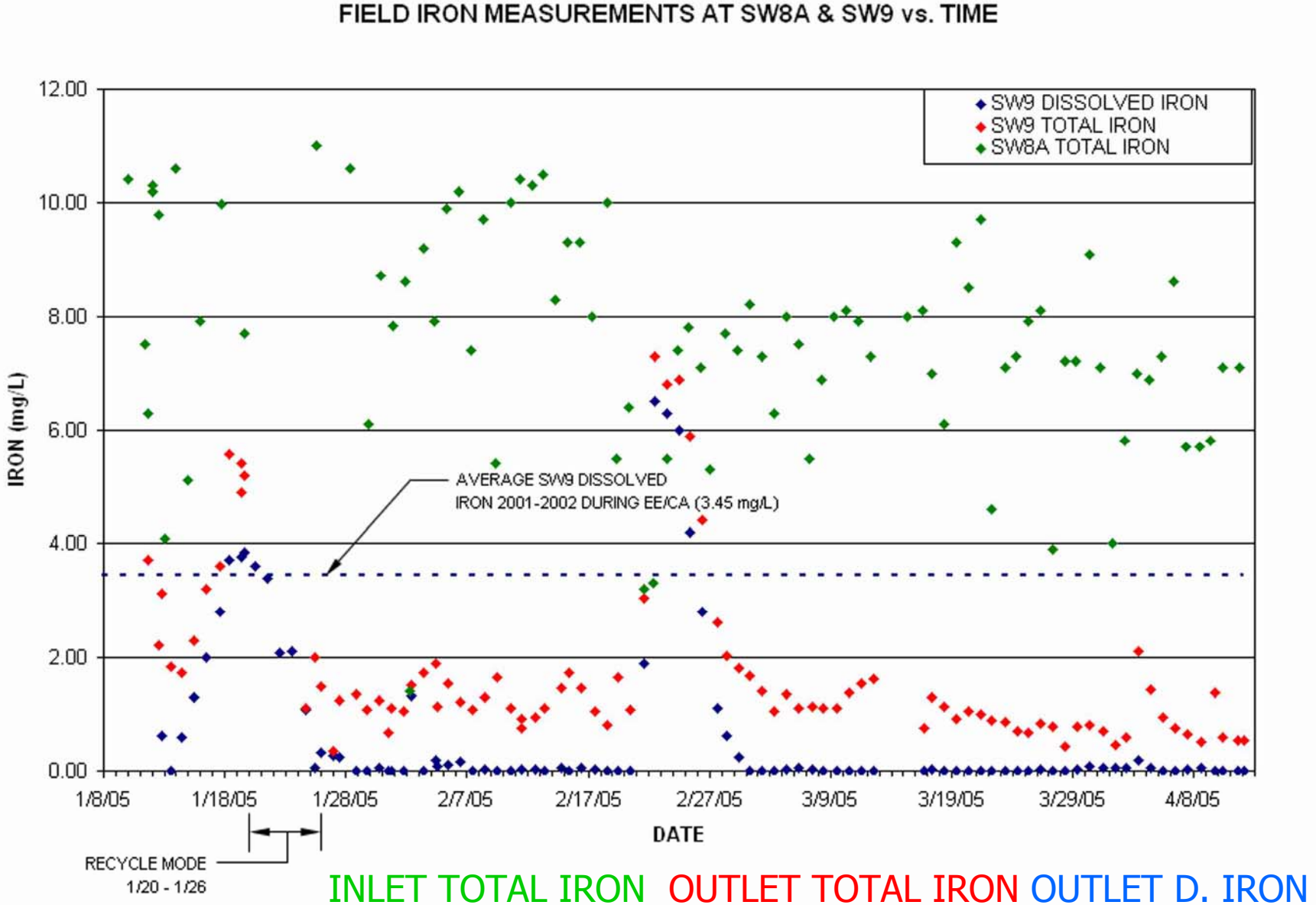
CHEMOCLINE DEPTH TREND VS. TIME
(BASED ON SPECIFIC CONDUCTIVITY)
LOCATION: SMP-4




RAINFALL, TOTAL & DISSOLVED IRON AT SW9 vs. TIME
RAINFALL (in.)
TOTAL AND DISSOLVED IRON (mg/L)
TIME
RAINFALL
DISSOLVED Fe
TOTAL Fe
3.7" RAINFALL,
LIGHTNING STRIKES
0
1
2
3
4
5
6
7
8
9
10
14
12
10
8
6
4
2
0
1/10/2005
1/12/2005
1/14/2005
1/16/2005
1/18/2005
1/20/2005
1/22/2005
1/24/2005
1/26/2005
1/28/2005
1/30/2005
2/1/2005
2/3/2005
2/5/2005
2/7/2005
2/9/2005
2/11/2005
2/13/2005
2/15/2005
2/17/2005
2/19/2005
2/21/2005
2/23/2005
2/25/2005
2/27/2005
3/1/2005
3/3/2005
3/5/2005
3/7/2005
3/9/2005
3/11/2005
3/13/2005
3/15/2005
3/17/2005

FIELD IRON MEASUREMENTS AT SW9 vs. TIME



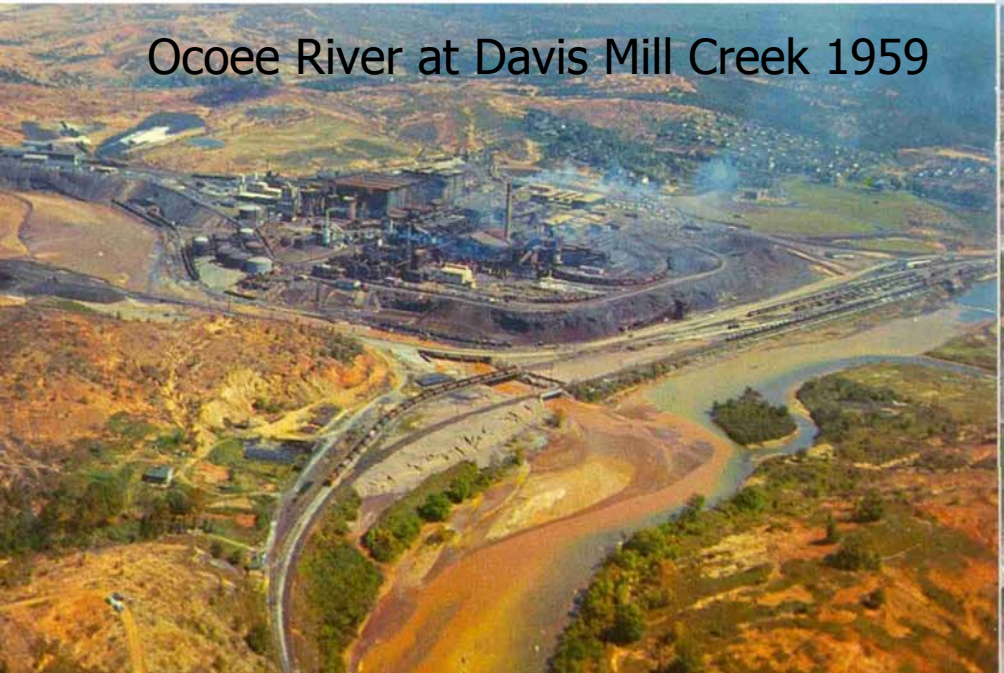

FIELD IRON MEASUREMENTS AT SW8A & SW9 vs. TIME
SW9 DISSOLVED IRON
SW9 TOTAL IRON
SW8A TOTAL IRON
IRON (mg/L)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
AVERAGE SW9 DISSOLVED
IRON 2001-2002 DURING EE/CA (3.45 mg/L)
1/8/05
1/18/05
1/28/05
2/7/05
2/17/05
2/27/05
3/9/05
3/19/05
3/29/05
4/8/05
DATE
RECYCLE MODE
1/20 - 1/26
INLET TOTAL IRON
OUTLET TOTAL IRON
OUTLET D. IRON

Since treatment of NPCk. @ SMP:

- pH to the Ocoee River increased, remains >6
- Acidity has been eliminated
- Aluminum, Cadmium, Cobalt, Copper, Lead, Zinc have decreased and are not < chronic Eco SV
- Iron has dramatically decreased, affected by storms and instrument failure, and has since been < chronic Eco SV
- Manganese remains near the chronic Eco SV

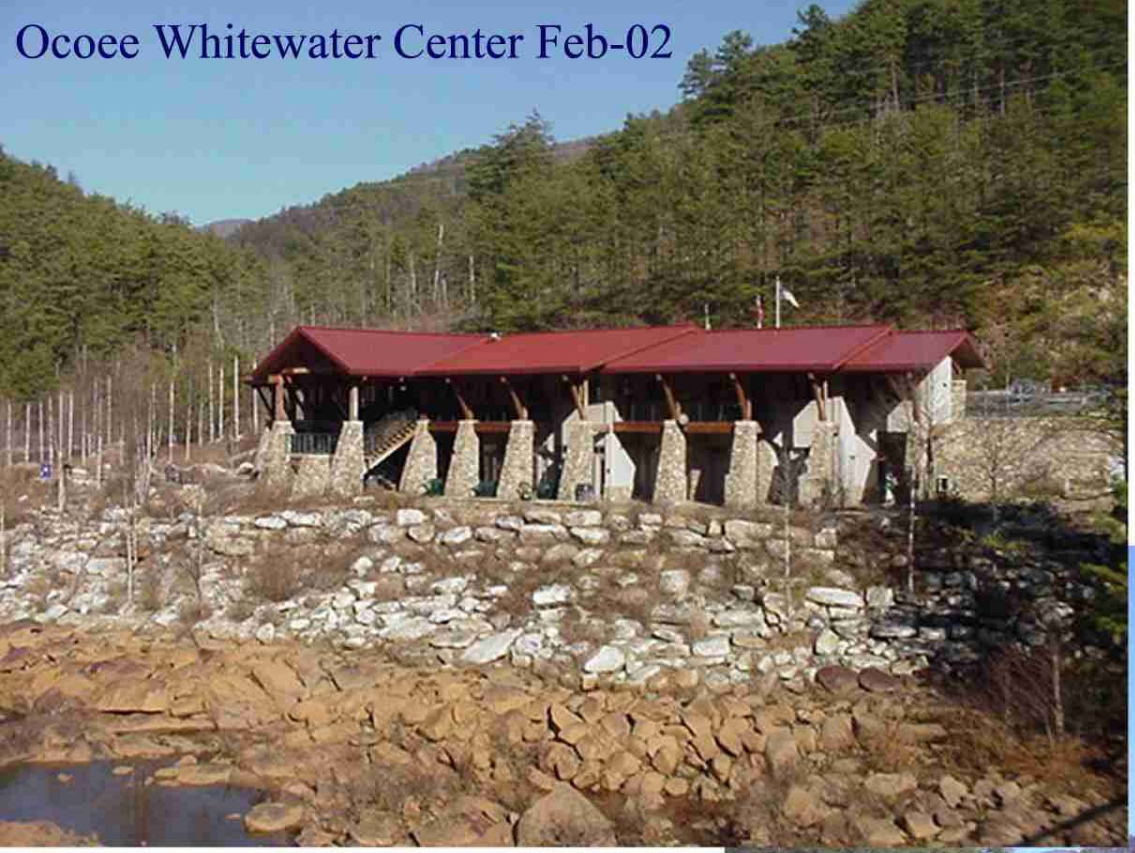
Ocoee River at North Potato Creek 2005

Ocoee River at Davis Mill Creek 1959



2005

Ocoee Whitewater Center Feb-02



Ocoee Whitewater Center Feb-05

Summer 03