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FIFTH QUARTERLY STATUS REPORT FOR BIOSLURPING IMPLEMENTATION AT SITE 6

NCBC GULFPORT MS

3/3/2003

BATTELLE

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March 3, 2003

Naval Facilities Engineering Command
Southern Division
2155 Eagle Drive
P.O. Box 190010
North Charleston, SC 29419-9010

Attention: Mr. Art Conrad

Dear Mr. Conrad:

CONTRACT NO. N47408-01-D-8207, TASK ORDER 003
5th QUARTERLY STATUS REPORT FOR BIOSLURPER IMPLEMENTATION AT NAVAL CONSTRUCTION BATTALION CENTER (NCBC) GULFPORT, MS

5th Quarterly Status Report

1.0 INTRODUCTION

Battelle was contracted to install and operate a full-scale bioslurper system to remediate Site 6, a former fire-fighting training area, located at Naval Construction Battalion Center (NCBC) Gulfport, MS. Startup of the system was performed November 1, 2001. A description of the bioslurper system and the first nine months of operation are summarized in the four previous quarterly reports dated February 18, 2002, May 17, 2002, August 16, 2002, and November 15, 2002.

This 5th Quarterly Status Report describes the activities performed and operational results during the third quarter of operation (August 1 through October 31). An analysis of the data and appropriate conclusions and recommendations are provided.

2.0 ACTIVITIES PERFORMED

Operation of the bioslurper system had been discontinued October 25, 2002. At least 1,550 gallons of light, non-aqueous phase liquid (LNAPL) had been recovered during the first year of operation. During the months of September and October 2002 the water table at the site had increased to a very high level (about 25 feet msl). Typically, as was observed at Site 6, when the water table at a site increases, product recovery decreases because the LNAPL becomes trapped within the aqueous phase. Beginning September 15, 2002, the drop tubes inside the extraction wells were lowered 5 feet beneath the oil/water interface to try to improve LNAPL recovery by depressing the water table at various areas of the site.

However, success was limited because of water discharge requirements. To maintain the water flowrate beneath the regulatory requirement of 25 gpm (36,000 gpd), extraction was performed from only three wells at a time. Hence, the site could not be adequately dewatered. Therefore, a decision was made to discontinue bioslurper operation until the groundwater table elevation decreased. Groundwater levels and LNAPL thicknesses were measured biweekly during system shutdown. Based on decreasing groundwater table elevation and increasing LNAPL thickness during the months of January and February, a decision was made to restart the system. System startup was performed February 19, 2003. Baseline data prior to startup are provided in this report.

2.1 Operation and Monitoring

- Restarted the bioslurper system on February 19, 2003. Baseline measurements and operating parameters measured during the first few days of operation are included in Attachment 1. Initially, three wells (EW-7, EW-14, and EW-15) were extracted.

- Collected biweekly LNAPL thickness and groundwater table elevation measurements in site wells during system shutdown. The resulting data are plotted in Attachment 2.

- Collected water samples from the effluent of the oil/water separator (OWS) on February 21. Samples were analyzed for diesel range organics (DRO). Analytical results are not available at this time; they will be included in the next quarterly report.

- Collected water samples from the effluent of the air stripper for analysis of pH (EPA Method 150.1) and BTEX (EPA Method 602) on February 21. Analytical results are not available at this time; they will be included in the next quarterly report.

- Collected an off-gas sample from the stack of the liquid ring pump (LRP) on February 28. The samples were collected in a Summa™ canister and sent to Air Toxics, Inc., for total petroleum hydrocarbon (TPH) analysis using method TO-3. Analytical results are not available at this time; they will be included in the next quarterly report.

- Measured soil-gas concentrations (oxygen, carbon dioxide, and TPH) on February 18 prior to restarting the bioslurper system. Results are included in Attachment 3.

2.2 Maintenance

- Prior to the winter, after the bioslurper system had been shut down, the process water was drained from the equipment to prevent damage resulting from freezing. Quarter-inch-diameter holes were drilled at various locations in the manifold to ensure that the manifold was adequately drained of process water.

- Upon priming and shakedown of the bioslurper system (performed February 16) several large diameter holes were noted in the coils of the heat exchanger. Although the heat exchanger had been properly drained after shutdown to prevent damage resulting from freezing water, it is possible that some residual water froze causing damage to the already corroded coils. The heat exchanger was removed from the system. The seal water tank was plumbed directly to the LRP. The temperature of the seal water will be controlled by adding additional makeup water as required.

- Removed and cleaned all float switches prior to restarting the bioslurper system.

2.3 Reporting

- Prepared the 4th *Quarterly Status Report for Bioslurper Implementation at Naval Construction Battalion Center (NCBC) Gulfport, MS* (Battelle, 2002). This letter report, which was submitted to the Navy on November 15, documents the third quarter of full-scale operation.

3.0 RESULTS

The primary objective of the bioslurper system is to remove LNAPL to the maximum extent practicable in accordance with Mississippi guidelines. Progress toward meeting this objective was tracked by monitoring the mass of contaminants removed from the subsurface, the LNAPL remaining in site wells, and operating and maintenance costs. In addition, system operation was closely monitored to ensure that the system was operating according to design and in compliance with the permit requirements. Results are discussed in this section.

3.1 Contaminant Removal

Hydrocarbon contamination is removed in the form of LNAPL, as well as emulsified/dissolved oil in the aqueous discharge stream and in the vapor phase in the off-gas. Hydrocarbon removal remains essentially the same as that reported in the 4th Quarterly Report because the system was in operation for only a short time during this reporting period (4 days). An additional 96 gallons of LNAPL was recovered. The mass of hydrocarbons recovered in the aqueous phase and off-gas will be determined upon receipt of analytical data and will be included in the next quarterly report. The mass removed in each stream is summarized in Table 1.

Table 1. Hydrocarbon Removal

Process Stream	Hydrocarbons Removed (lb)		
	Present (Aug 1 – Oct 31)	**Previous Quarter**	**Cumulative**
LNAPL[a]	500 (69 gallons)	667 (92 gallons)	11,731 (1,547 gallons)
Dissolved/Emulsified Hydrocarbons	NA	189	2,446
Off-Gas	NA	21	408
Total:	**500**	**877**	**14,585**

NA – Analytical data not available at this time. Results will be included in the next quarterly report
a) A specific gravity of 0.87 was used to estimate the mass of LNAPL recovered.

3.2 LNAPL Thickness

During this reporting period, biweekly measurements of LNAPL thickness and groundwater table elevation were collected in extraction wells. The resulting data along with data collected during the first year of system operation is plotted in Figure 1. The resulting plots for individual wells are included as Attachment 2. Based on these data it is observed that the water table elevation has been decreasing and LNAPL is appearing in the majority of the extraction wells. During the monitoring event performed February 18 just prior to restarting the bioslurper system, LNAPL was observed in 17 of the 33 wells measured.

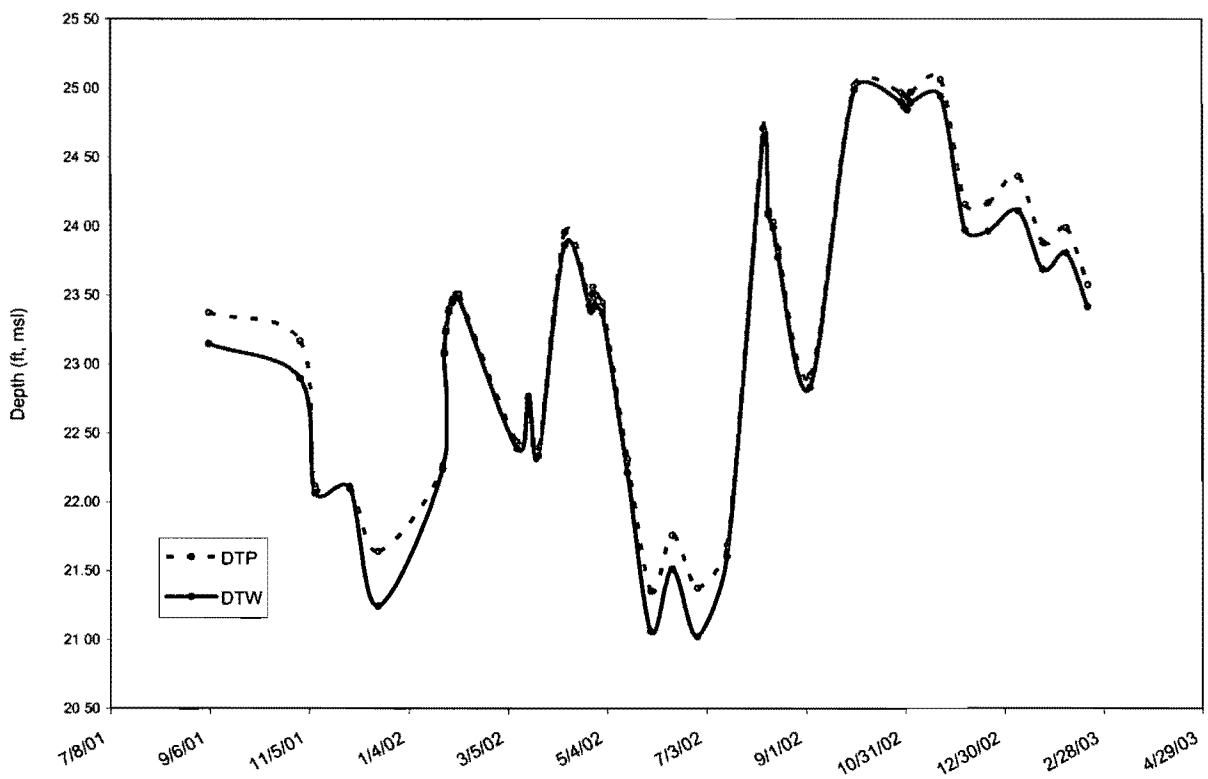
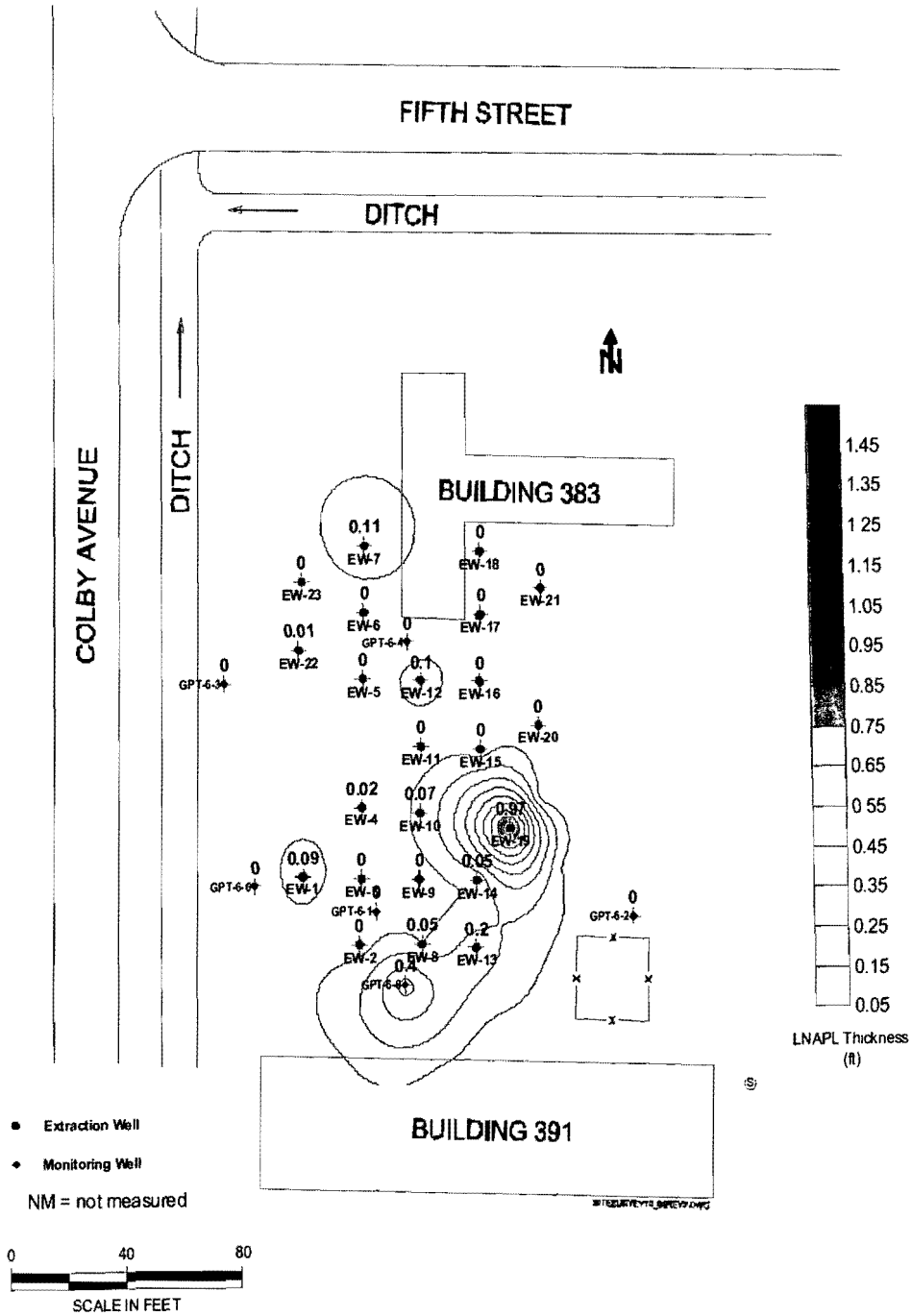


Figure 1. Average Product/Water Measurements in Site Wells

The thicknesses of LNAPL measured in the wells just after turning off the system in October 2002 were contoured using Surfer™ (Figure 2). Similarly, LNAPL thickness data collected just prior to restarting the system in February 2003 were contoured (Figure 3). As can be seen, significant rebound of LNAPL occurred during the three months of system shutdown. For comparison purposes, a plot of the baseline data collected prior to installing and operating the bioslurper system is included as Figure 4. It can be seen that substantially less LNAPL was present at the site after one year of bioslurper operation.

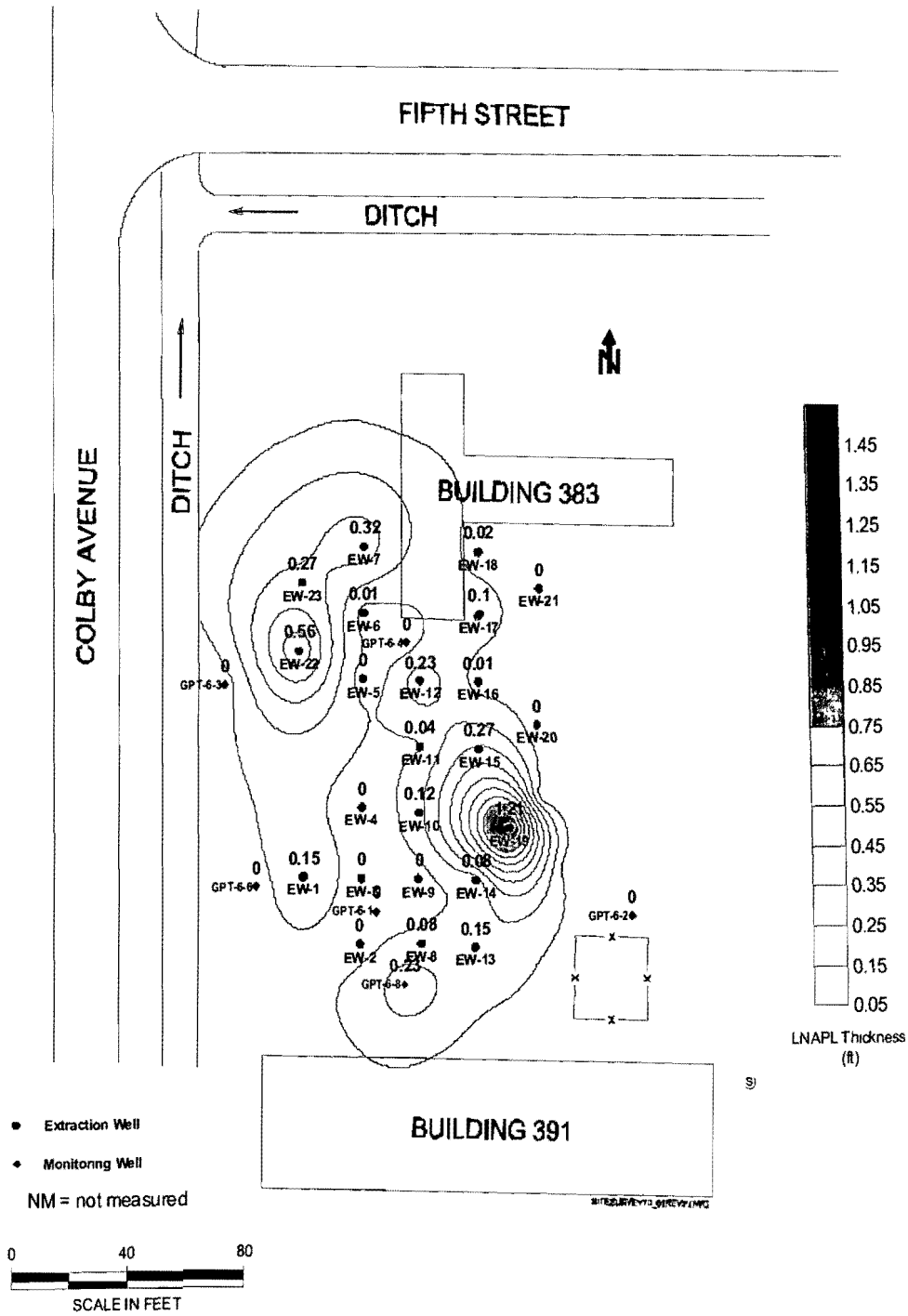
3.3 Soil-Gas Measurements

Concentrations of oxygen, carbon dioxide, and TPH were measured in vapor extracted from the soil-gas monitoring points prior to restarting the bioslurper system. The results are included in Attachment 3. The low oxygen readings and high carbon dioxide readings indicate that biodegradation of hydrocarbons in



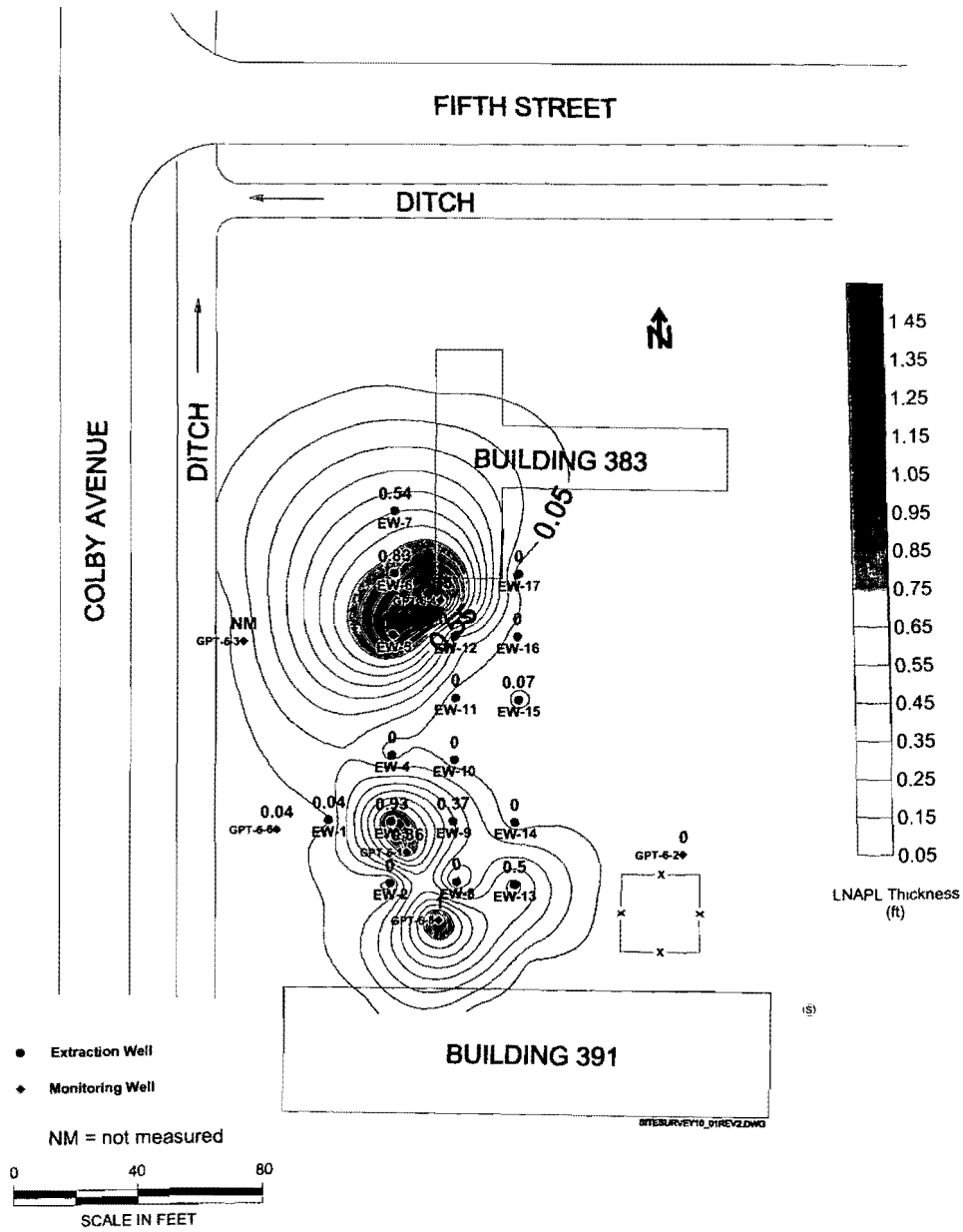
LNAPL Thickness (ft)
10/30/02
NCBC Gulfport, Site 6

Figure 2. LNAPL Plume (October 30, 2002)



LNAPL Thickness (ft)
2/18/03
NCBC Gulfport, Site 6

Figure 3. LNAPL Plume (February 18, 2003)



LNAPL Thickness (ft)
10/30/01
NCBC Gulfport, Site 6
Before Bioslurper Start-Up

Figure 4. LNAPL Plume (Baseline)

the vadose zone has occurred since the system was shut down in October. The oxygen concentration was less than 5 in all points that could be measured, indicating an oxygen-limited environment. Biodegradation of hydrocarbons in the vadose zone will be stimulated by introducing fresh air into the vadose zone during operation of the vadose zone. Measurements will be collected on a monthly basis and compared to the baseline value to determine how well the bioslurper system is aerating the subsurface.

3.4 Operating Cost

Operating costs were not calculated during this reporting period because the system was only operational for four days.

3.5 Percent Operating Time

The bioslurper system operated 100% of the time since it was restarted on February 19.

3.6 Water and Off-Gas Discharge

Water and off-gas samples were collected on February 21 and February 27, respectively. Analytical results were not available from the laboratory at the time this status report was prepared. Results will be included in the following status report.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The bioslurper system has been successful at recovering free product. A total of 1,547 gallons of LNAPL have been recovered at the time this report was prepared. There is a strong correlation between water table elevation and LNAPL recovery. As discussed in Section 3.2, during periods of high water table elevation, LNAPL thickness has been observed to decrease significantly. The bioslurper system was shut down for about three months. LNAPL thickness and groundwater elevation measurements showed a rebound of LNAPL in site wells as the groundwater table decreased. However, even after three months of monitoring, significantly less LNAPL appeared in site wells compared to levels observed prior to installing and operating the bioslurper system for about a year. The system was restarted on February 19. Operation and monitoring should be continued until it is no longer cost-effective to recover LNAPL and/or the LNAPL thickness remaining in site wells can no longer be effectively reduced using the bioslurper technology.

5.0 EXIT STRATEGY DEVELOPMENT

Successful site closure will require a demonstration that groundwater has not been adversely impacted; or, if a dissolved-phase plume does exist at the site, that the plume is controlled by natural attenuation processes.

The following available site documents were reviewed to begin to develop a conceptual model for the site:

- Closure Plan for Site 6, NCBC Gulfport, Gulfport, Mississippi (TetraTech, 2000a)
- Draft Letter Report of Findings NCBC Gulfport – Site 6 (TetraTech, 2000b)
- Construction Completion Report (Morrison Knudson, 1995a)
- Operation and Maintenance Manual, Site 6, Gulfport, Mississippi (Morrison Knudson, 1995b)

Based on the literature review, additional data are needed to determine if the groundwater in the vicinity of Site 6 has been impacted and to evaluate the status of the dissolved-phase contaminant plume, if it exists. These data gaps are presented in Table 2. Additional groundwater monitoring wells would be installed at strategic locations to perform time-series sampling and analysis simultaneously with the source recovery effort. This approach will ensure that the appropriate data is collected to demonstrate that free product has been removed to the "maximum extent practicable" as required by the Mississippi Department of Environmental Quality.

Table 2. Additional Data Needed to Assess Dissolved-Phase Contamination

Data Category	Parameter(s)	Purpose
Groundwater chemistry data	Historical data on presence and concentration of contaminants of potential concern such as VOCs and TPH.	Assess presence/extent of dissolved-phase contamination
	Electron acceptors, metabolic byproducts, alkalinity	Assess whether dissolved fuel constituents are undergoing intrinsic biodegradation
	General field water quality parameters (redox, dissolved oxygen, temperature, specific conductance)	Indicators of general biological conditions (i.e., aerobic/anaerobic)
	Dissolved gases (ethane, ethene, methane)	Biological degradation products of chloroethenes (ethane, ethene); indicator of anaerobic biodegradation (methane)
Hydrogeology[a]	Stratigraphy (geologic cross sections, borehole logs, etc.)	Identify principal water-bearing zones and their lateral extent
	Water table maps	Assess direction of groundwater movement
	Hydraulic conductivity data for the impacted aquifer(s)	Assess groundwater velocity
	Physical properties of the aquifer (porosity, bulk density, total organic carbon)	Determine chemical retardation factors

(a) Hydrogeologic information may be necessary only if the plume is expanding and subsurface contaminant transport is to be modeled.

6.0 FUTURE ACTIVITIES

The following activities will be performed during the next quarter:

- Continue operating the bioslurper system.
- Develop a groundwater sampling and monitoring plan for the site.

7.0 REFERENCES

Battelle. 2002. 4th Quarterly Status Report for Bioslurper Implementation at Naval Construction Battalion Center (NCBC) Gulfport, MS. Letter report. Prepared for Naval Facilities Engineering Command. Contract No: N47408-01-D-8207. October 15.

Morrison Knudsen Corporation. 1995a. *Draft Construction Completion Report, Site 6 – Fire Fighting Training Area, Naval Construction Battalion Center Gulfport, Mississippi*. Prepared for Southern Division Naval Facilities Engineering Command Contract No. N62467-93-D-1106. November.

Morrison Knudsen Corporation. 1995b. *Operation and Maintenance Manual, Site 6, Gulfport, Mississippi*. Prepared for Southern Division Naval Facilities Engineering Command Contract No. N62467-93-D-1106. September.

TetraTech NUS, Inc. 2000a. Draft Letter Report of Findings NCBC Gulfport – Site 6. Prepared for Southern Division Naval Facilities Engineering Command under CLEAN contract No. N62467-94-D0888, Contract Task Order No. 0125.

TetraTech NUS, Inc. 2000b. Closure Plan for Site 6, NCBC Gulfport, Gulfport, MS. Prepared for Southern Division Naval Facilities Engineering Command. Contract No: N62467-94-D-0888. November.

Please contact me at (614) 424-7289 or rosansky@battelle.org, or Lydia Cumming at (614) 424-7778 or Cummingl@battelle.org, with any questions.

Sincerely,

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G.B. Wickramanayaka for LC

Lydia Cumming
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Environmental Restoration Dept.

CC:kl

cc: Mr. Dan Wadill, NAVFAC Southern Division (1 copy)
Mr. Gordon Crane, NCBC Gulfport (3 copies)
Mr. Joe Della-Volle, NCBC Gulfport (1 copy)

ATTACHMENT 1
SYSTEM OPERATING PARAMETERS

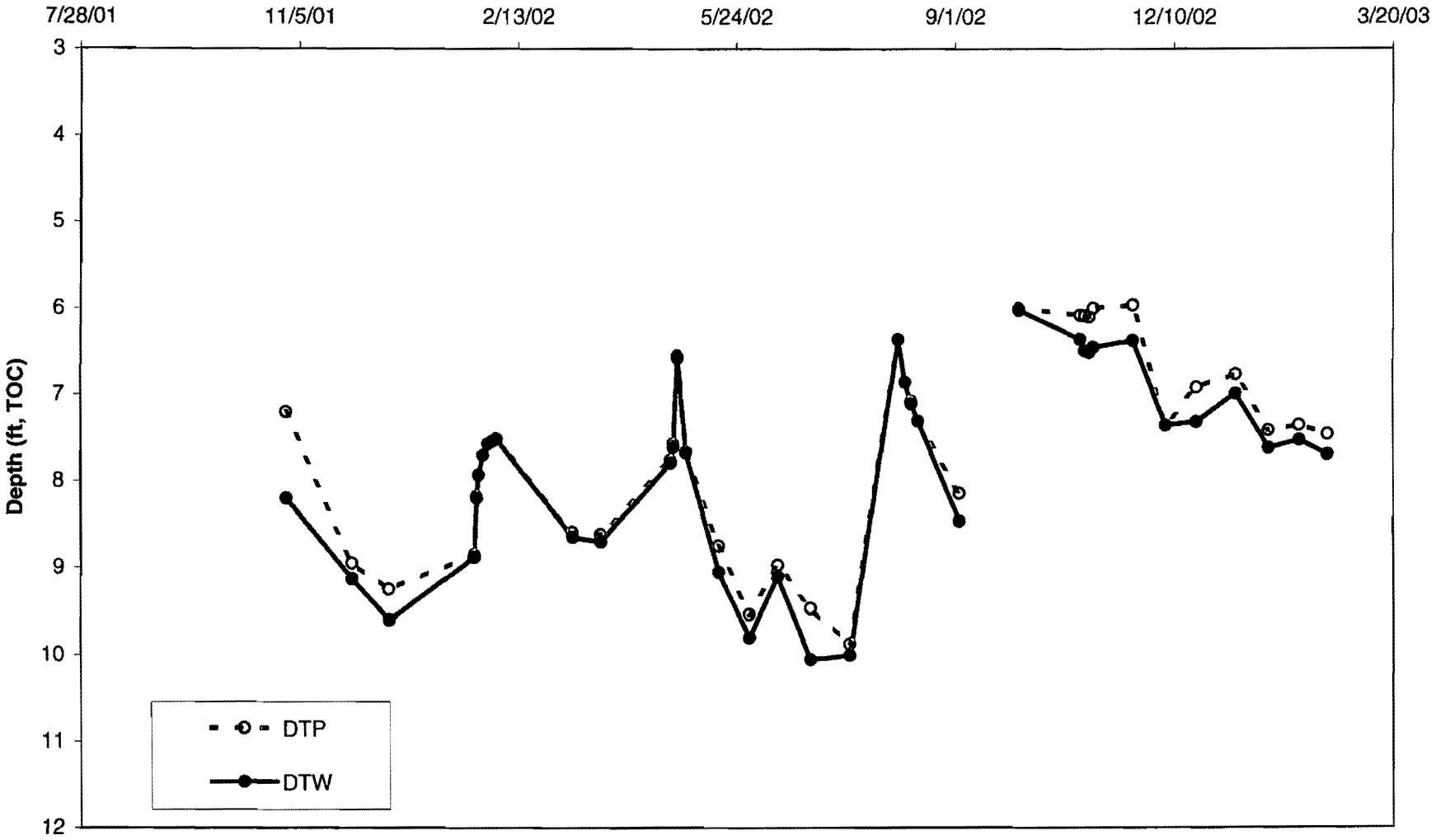
Process Parameters, Gulfport, Site 6, MS

Date	02/19/2003	02/20/2003	02/23/2003
Time	15:11	10:53	9:40
LRP Timer	6475.8	6502.2	6573
LRP Vacuum (in Hg)	NA	26	24
Seal Water Temperature (°F)	65	68.4	74.8
Seal Stack Temperature (°F)	65	117.3	118.8
Seal Water Level (ok, +, -)	ok	ok	ok
LRP Oriface Plate ("H2O)	NA	0.01	0.1
Off-Gas Flowrate (SCFM)	NA	12	36
ALS Vacuum (in Hg)	NA	21	20
PCP Pressure (psi)	NA	1.4	1.2
PCP Cycles (cycles/hour)	NA	11	20
PCP Flow Control Setting	NA	0.8	0.8
Stack Gas TPH (ppm)	NA	450	200
Stack Gas O2 (%)	NA	20	19.8
Stack Gas CO2 (%)	NA	2	1.9
Water Totalizer (gallons)	5,463,698	5,482,394	5,526,240
Average Water Flowrate (gpm)	NA	11.8	10.3
Discharge pump flowrate (gpm)	NA	NR	10.3
Cooling water feed rate (ok, +, -)	NA	ok	ok
No. of active extraction wells	0	3	3
(Oil tank) DTP (in):	20.375	13.5	15.5
DTW (in):	36	33	36
Volume (gallons):	220	275	289

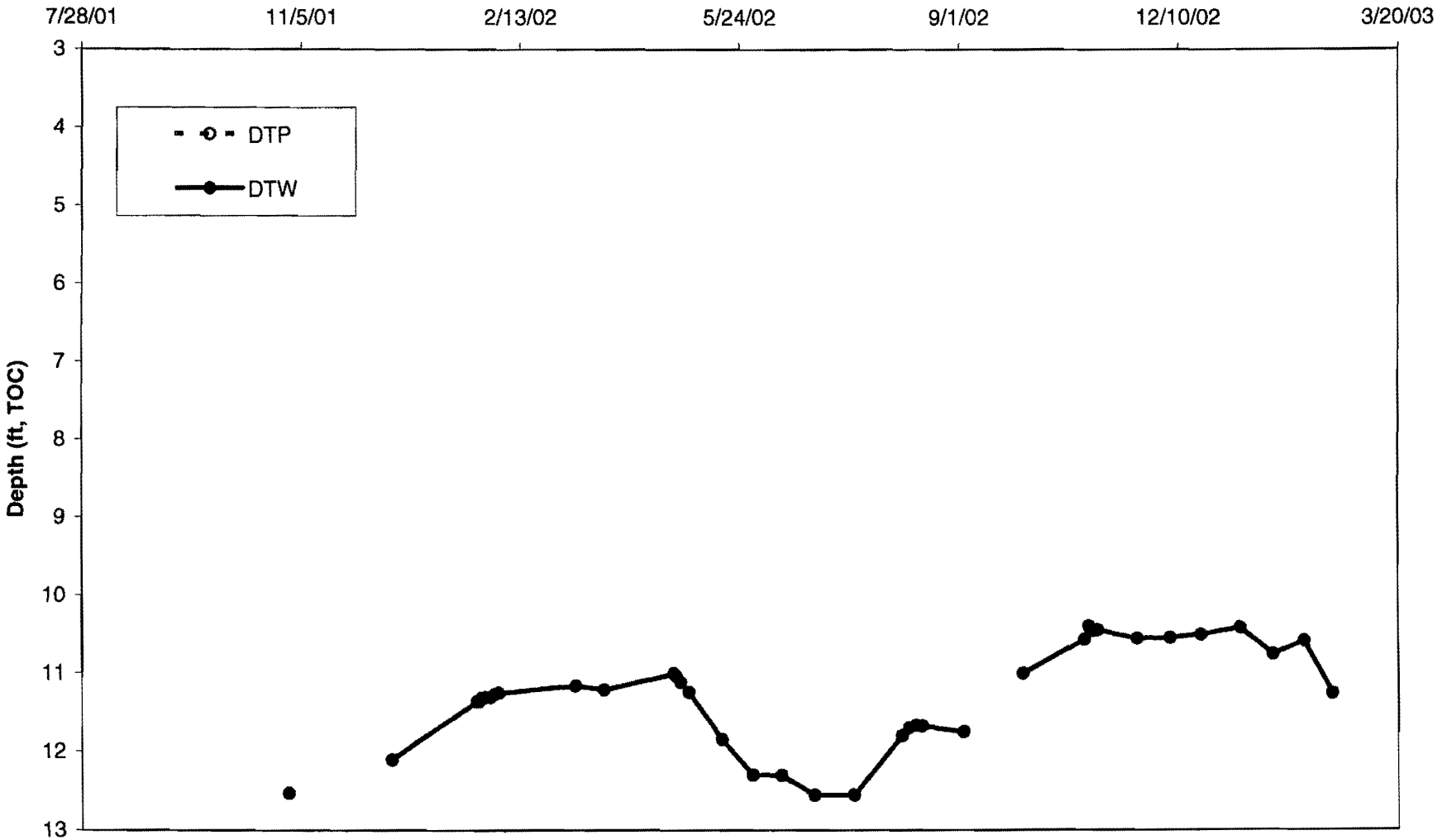
Notes:
NR = Not recorded
NA = Not applicable
Calculate volume of fuel in tank = [{Height of tank (36.0 in) - DTP (in)} - {Height of tank (36.0 in)-DTW(in)}] X 14.1(gal/in)
System shutdown on 10/25/2002 to collect quarterly oil/water measurements and was not operating through 2/18/03

ATTACHMENT 2
OIL AND WATER LEVEL ELEVATION PLOTS

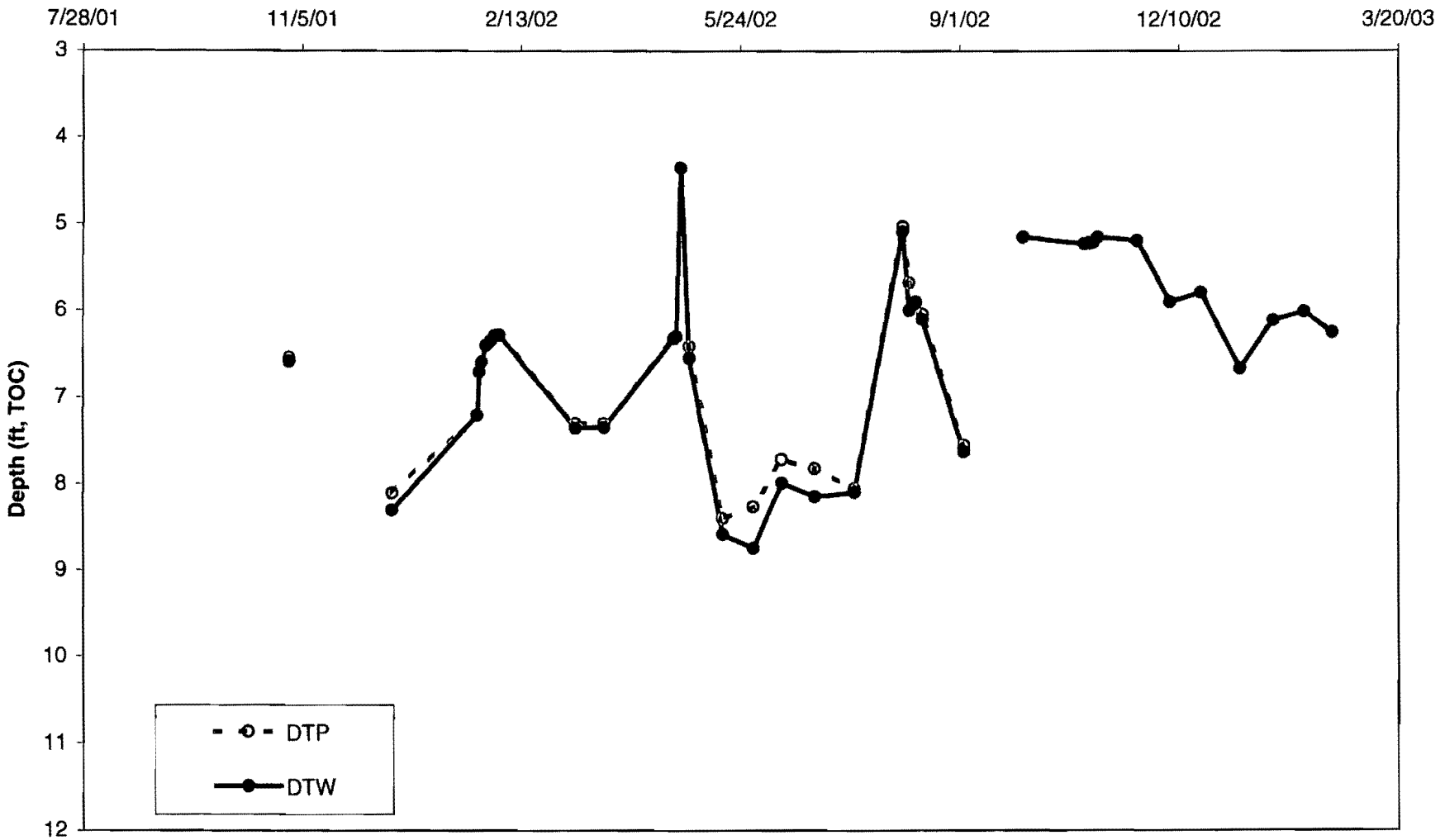
Oil/Water Data, NCBC Gulfport Site 6
GPT-6-8



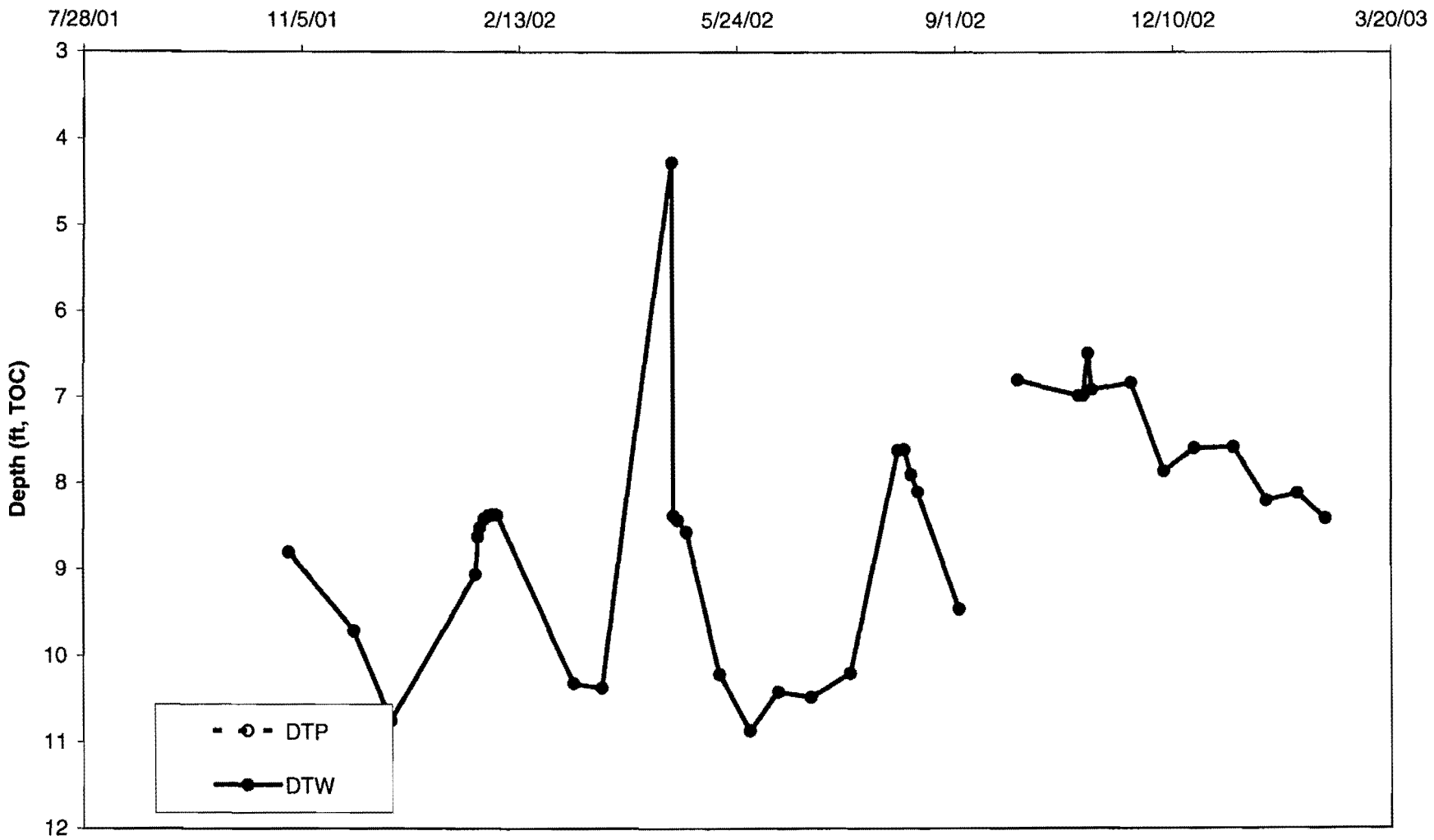
Oil/Water Data, NCBC Gulfport Site 6
GPT-6-7 (Deep Well)



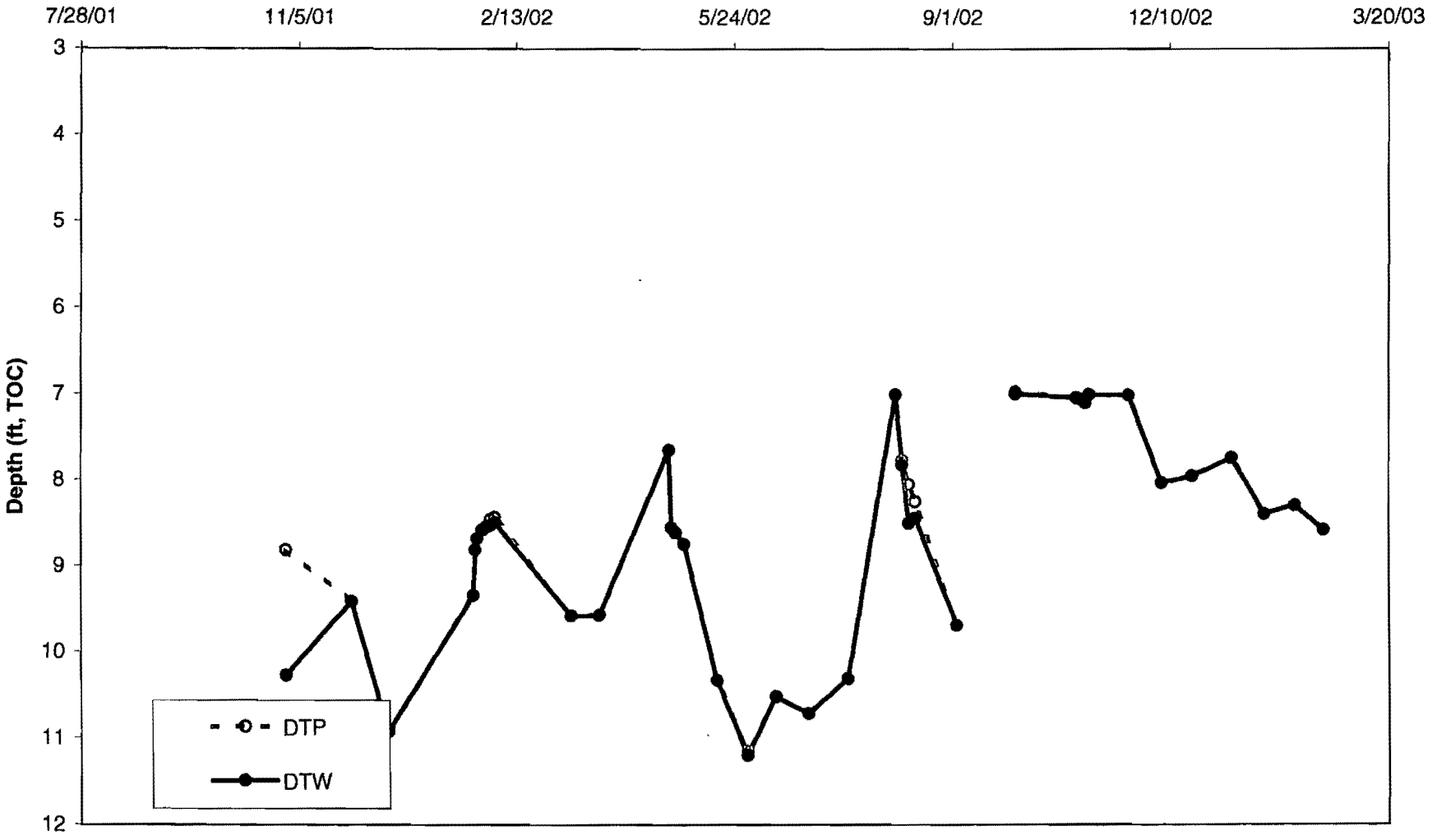
Oil/Water Data, NCBC Gulfport Site 6
GPT-6-6



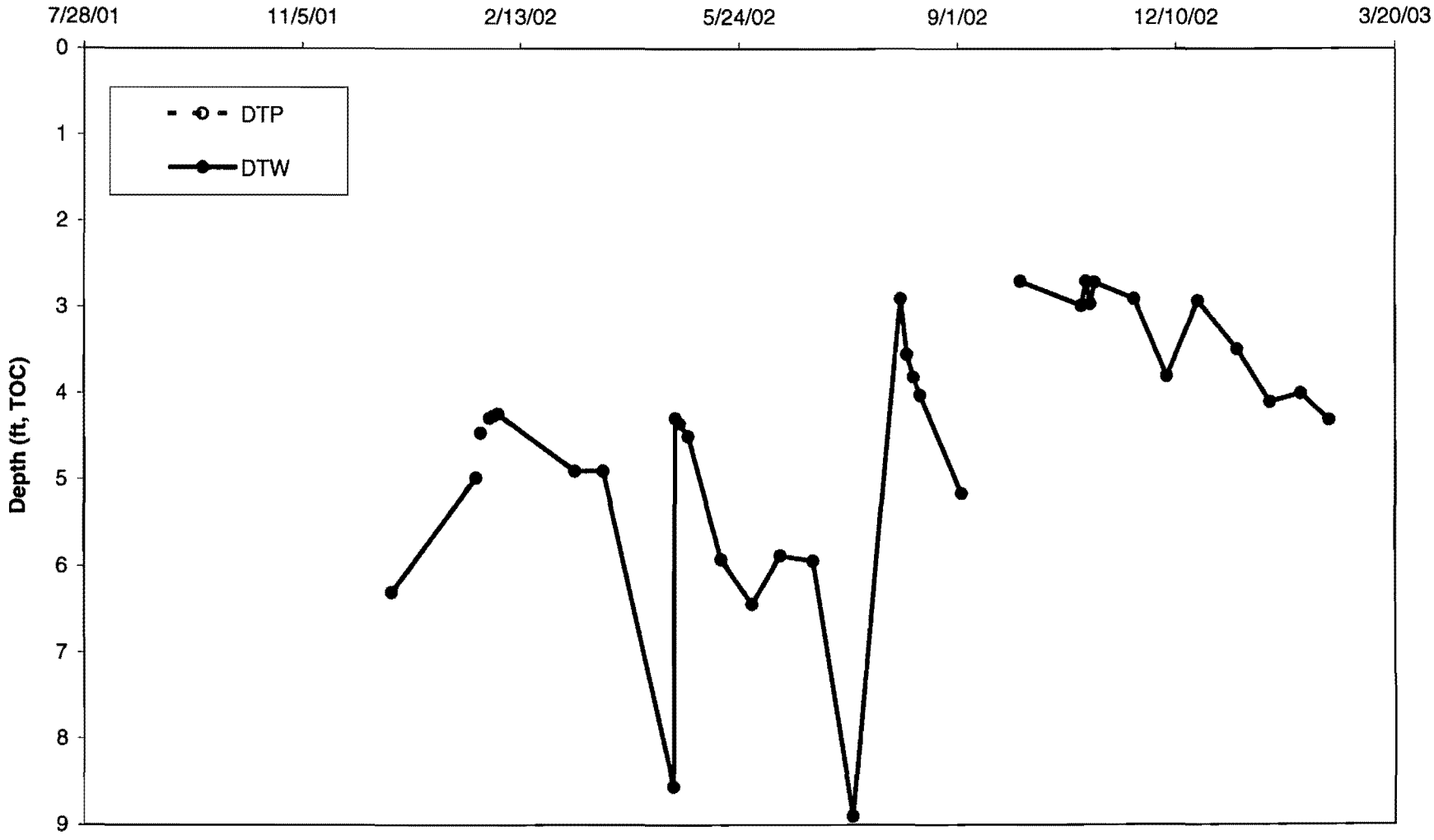
Oil/Water Data, NCBC Gulfport Site 6
GPT-6-5



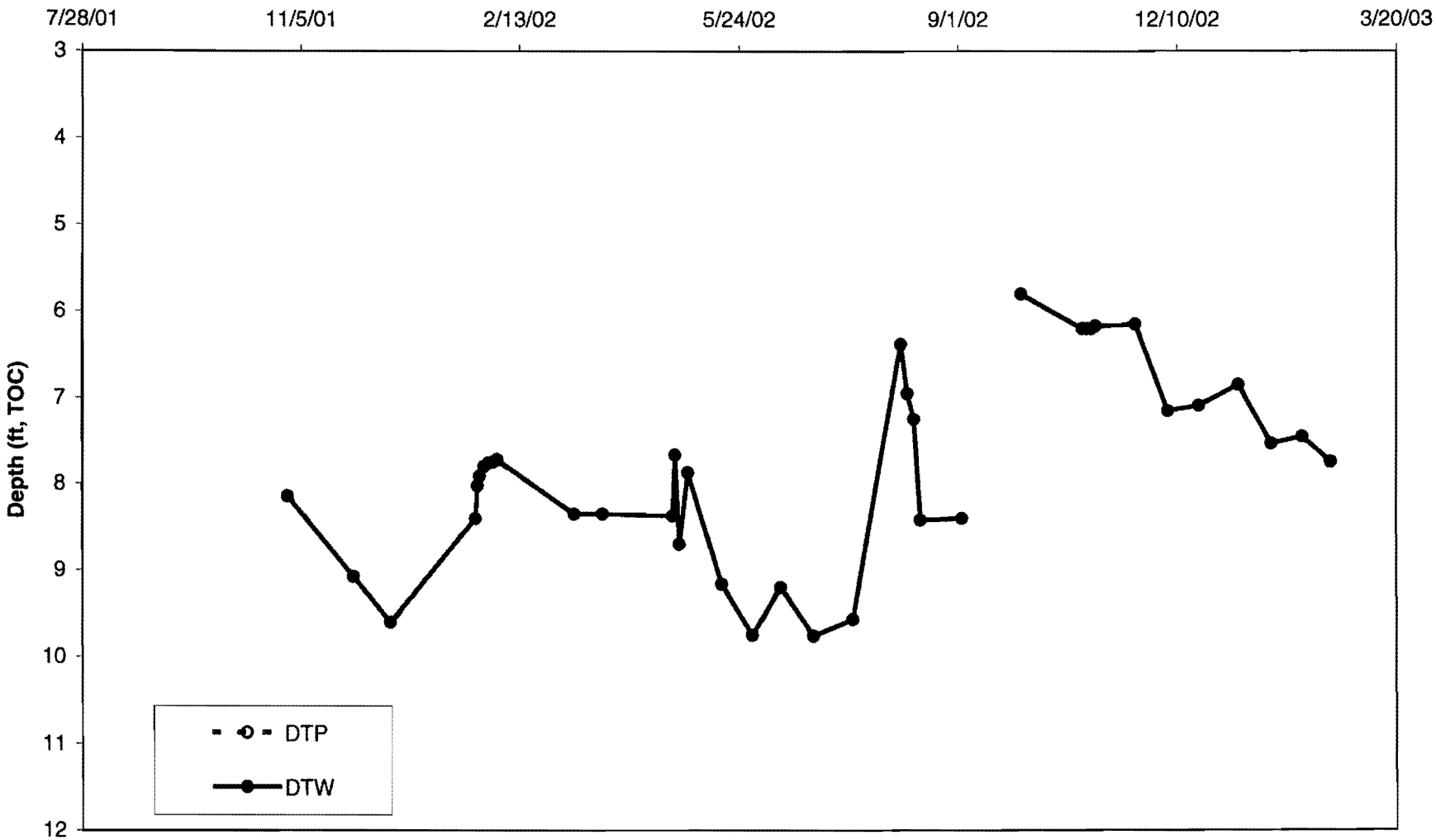
Oil/Water Data, NCBC Gulfport Site 6
GPT-6-4



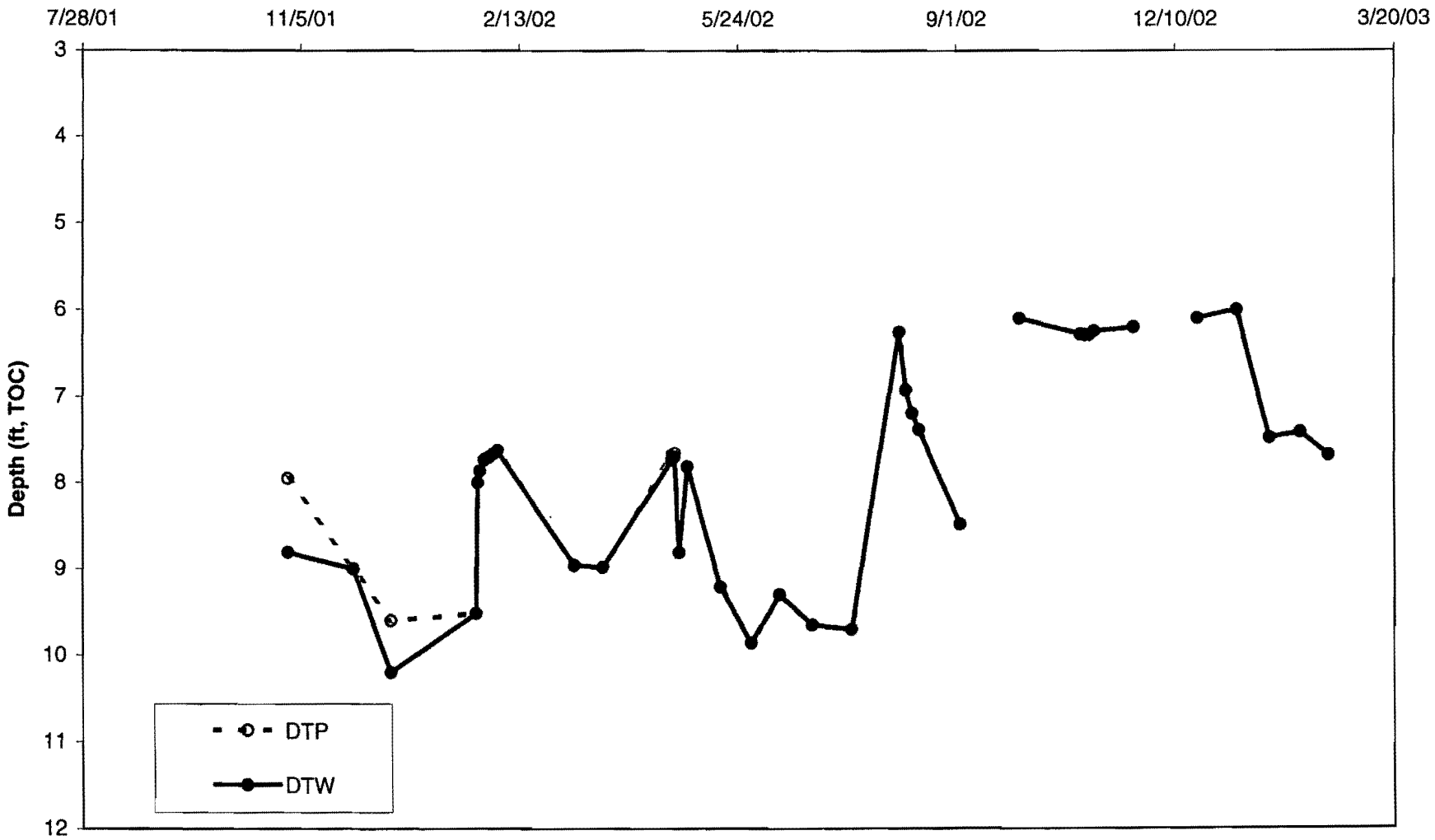
Oil/Water Data, NCBC Gulfport Site 6
GPT-6-3



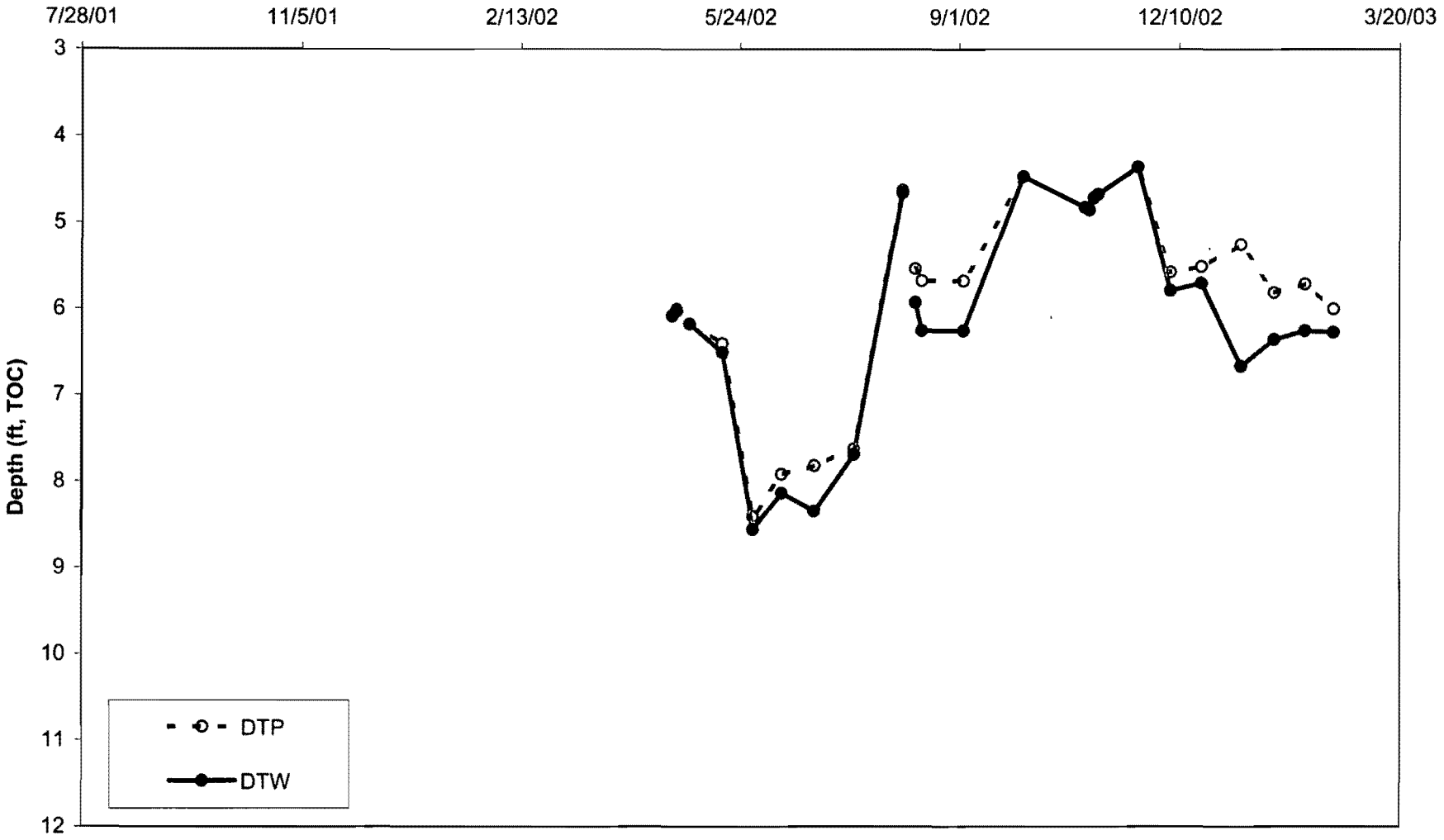
Oil/Water Data, NCBC Gulfport Site 6
GPT-6-2



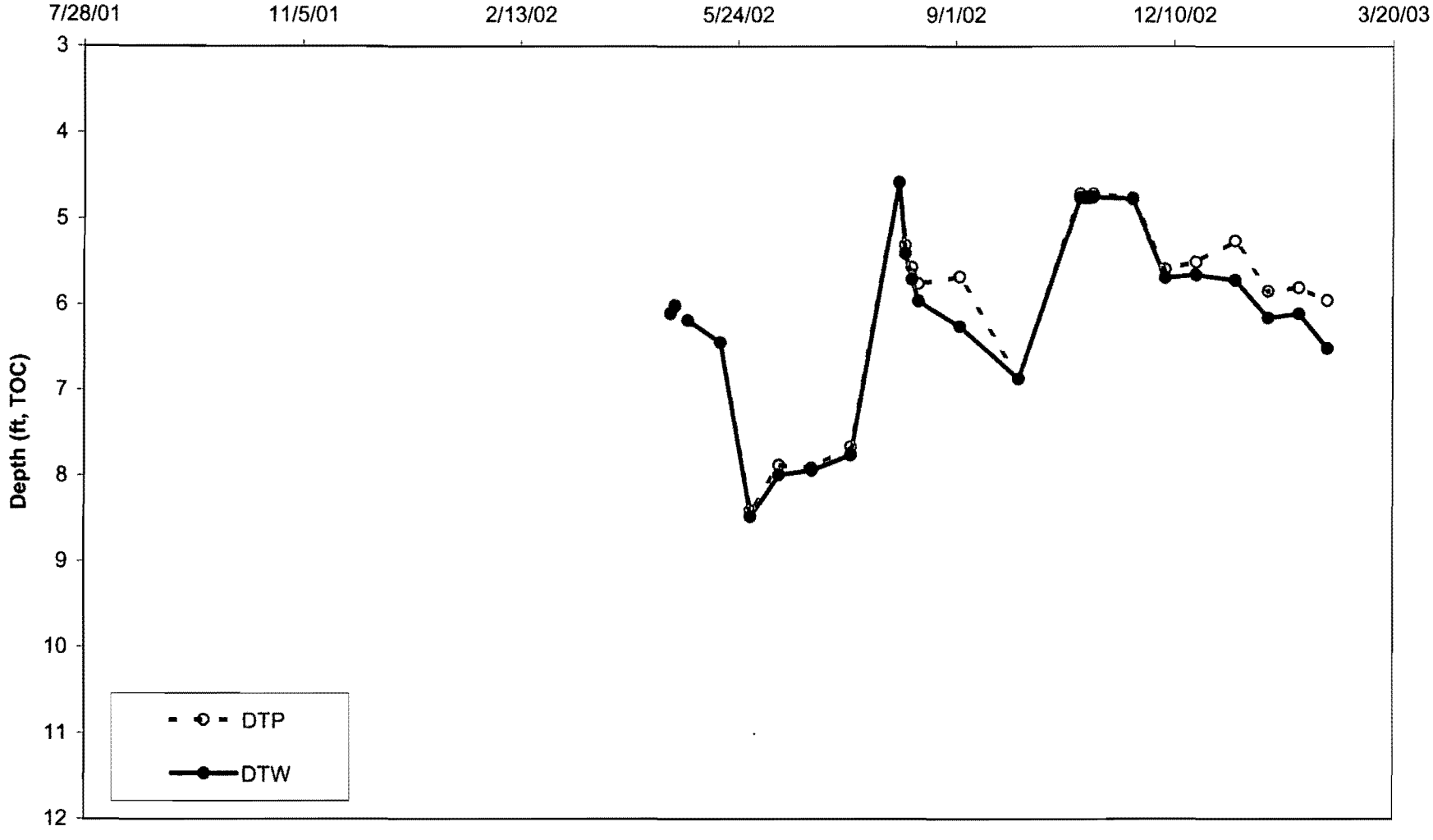
Oil/Water Data, NCBC Gulfport Site 6
GPT-6-1



Oil/Water Data, NCBC Gulfport Site 6
EW-23



Oil/Water Data, NCBC Gulfport Site 6
EW-22



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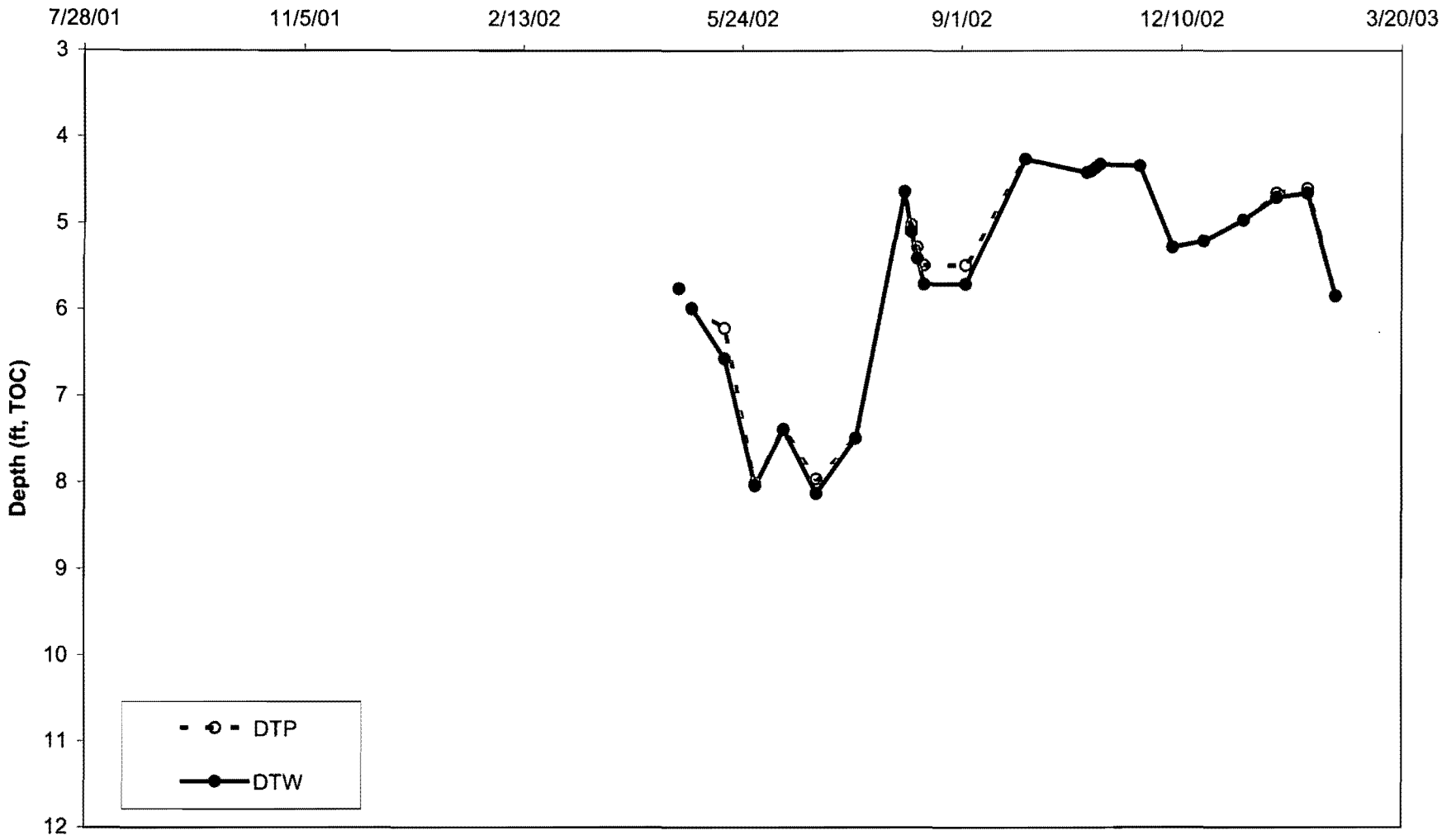

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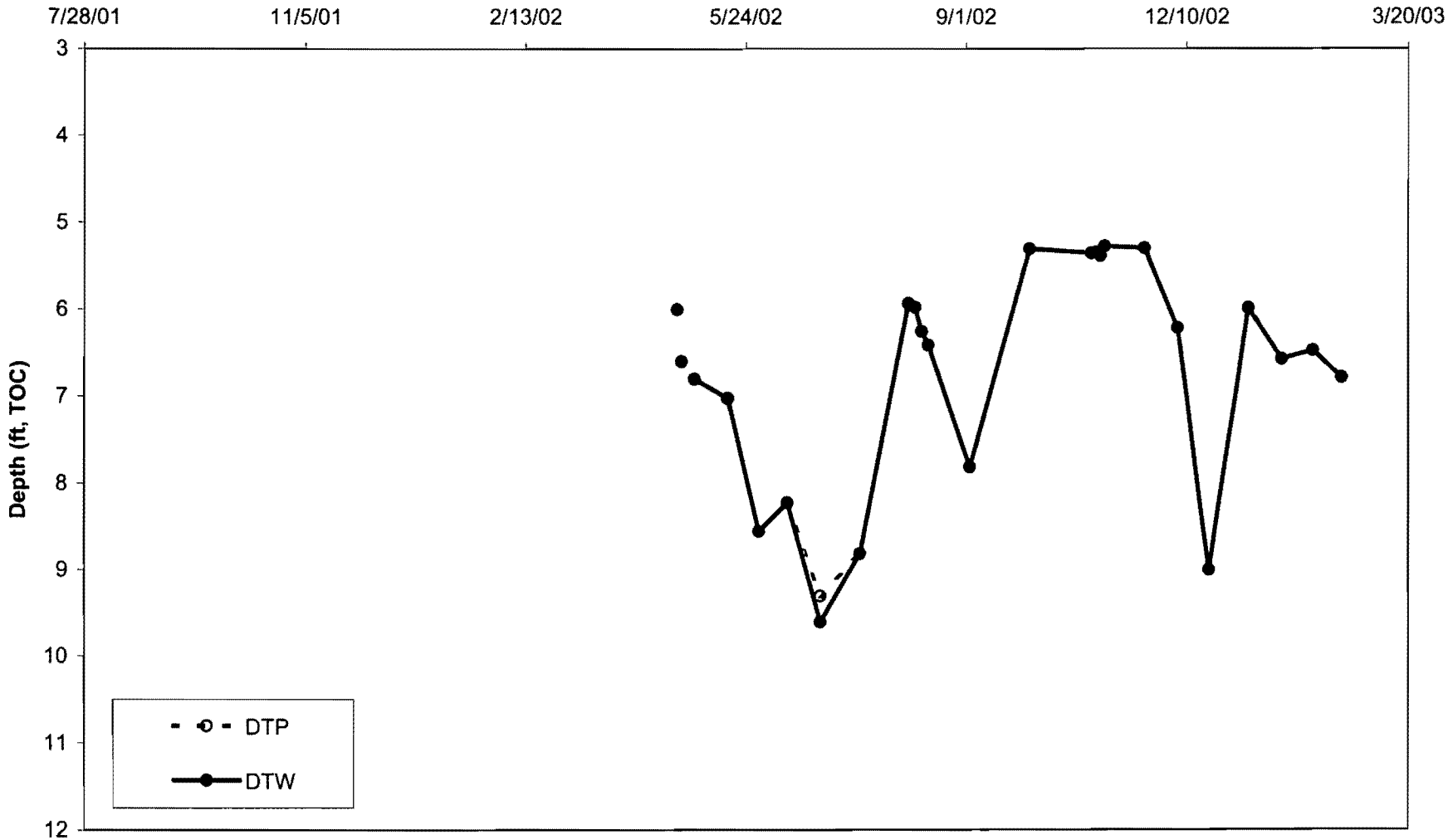

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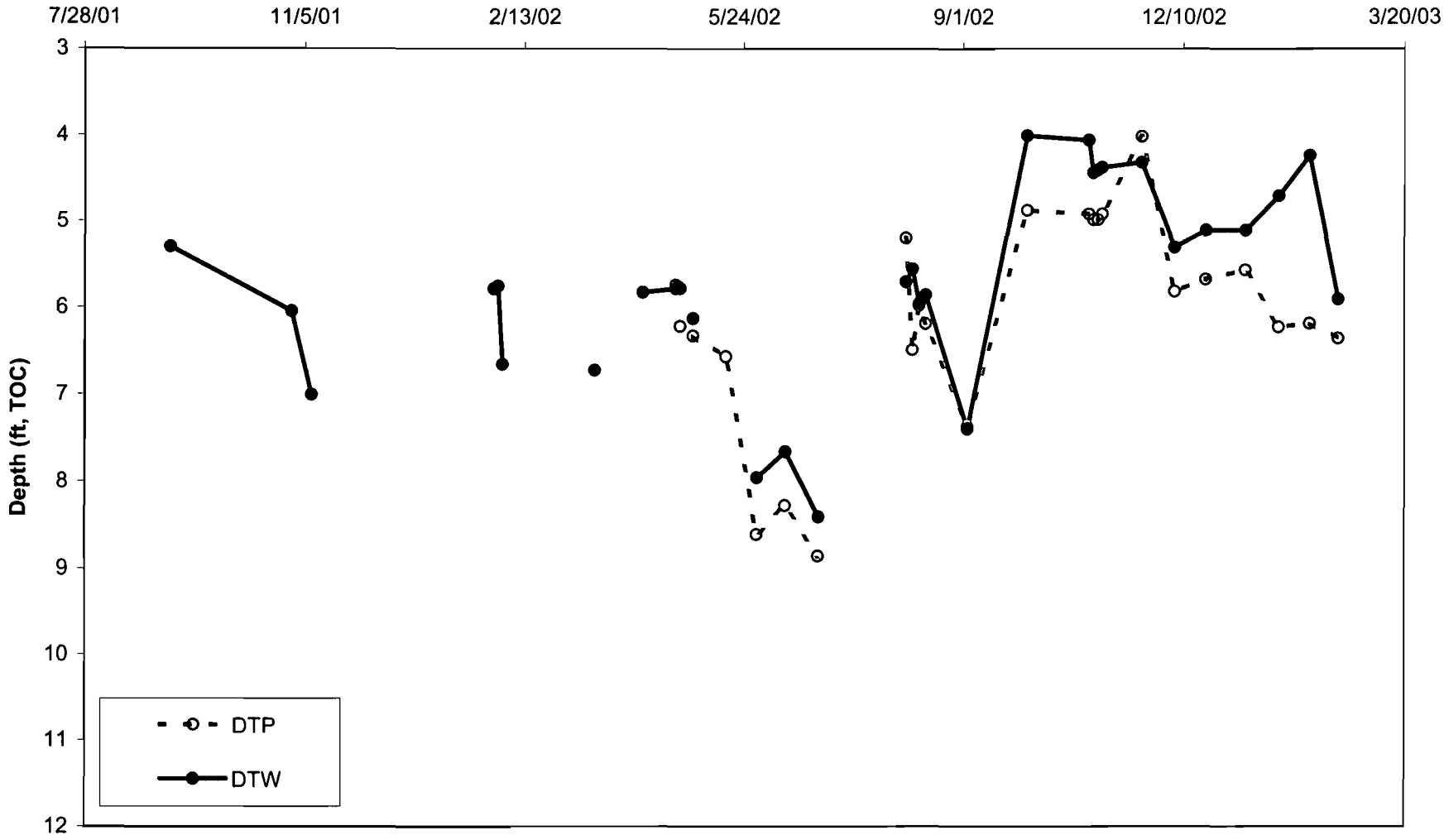

Oil/Water Data, NCBC Gulfport Site 6
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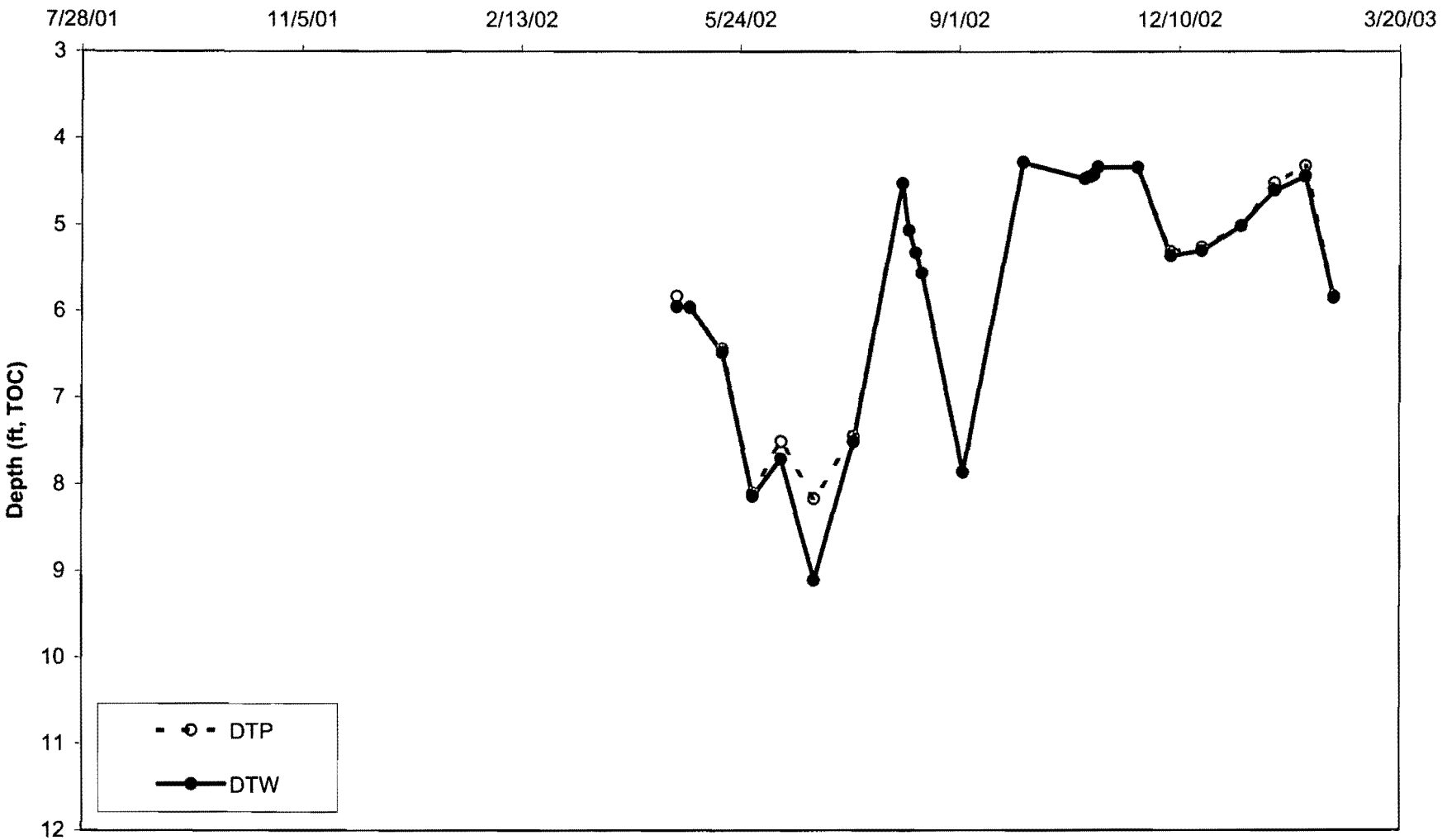
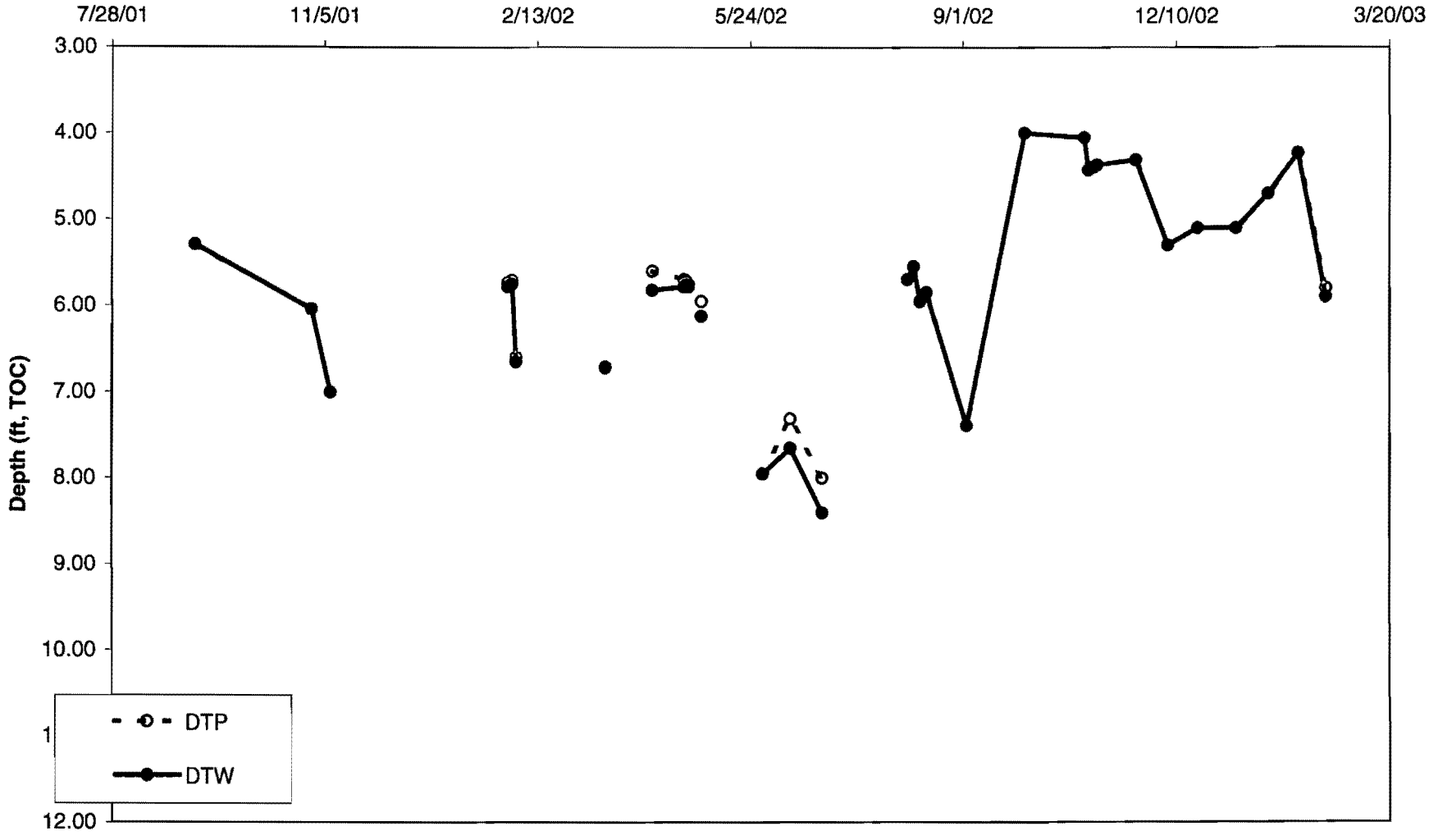


Oil/Water Data, NCBC Gulfport Site 6
EW-17



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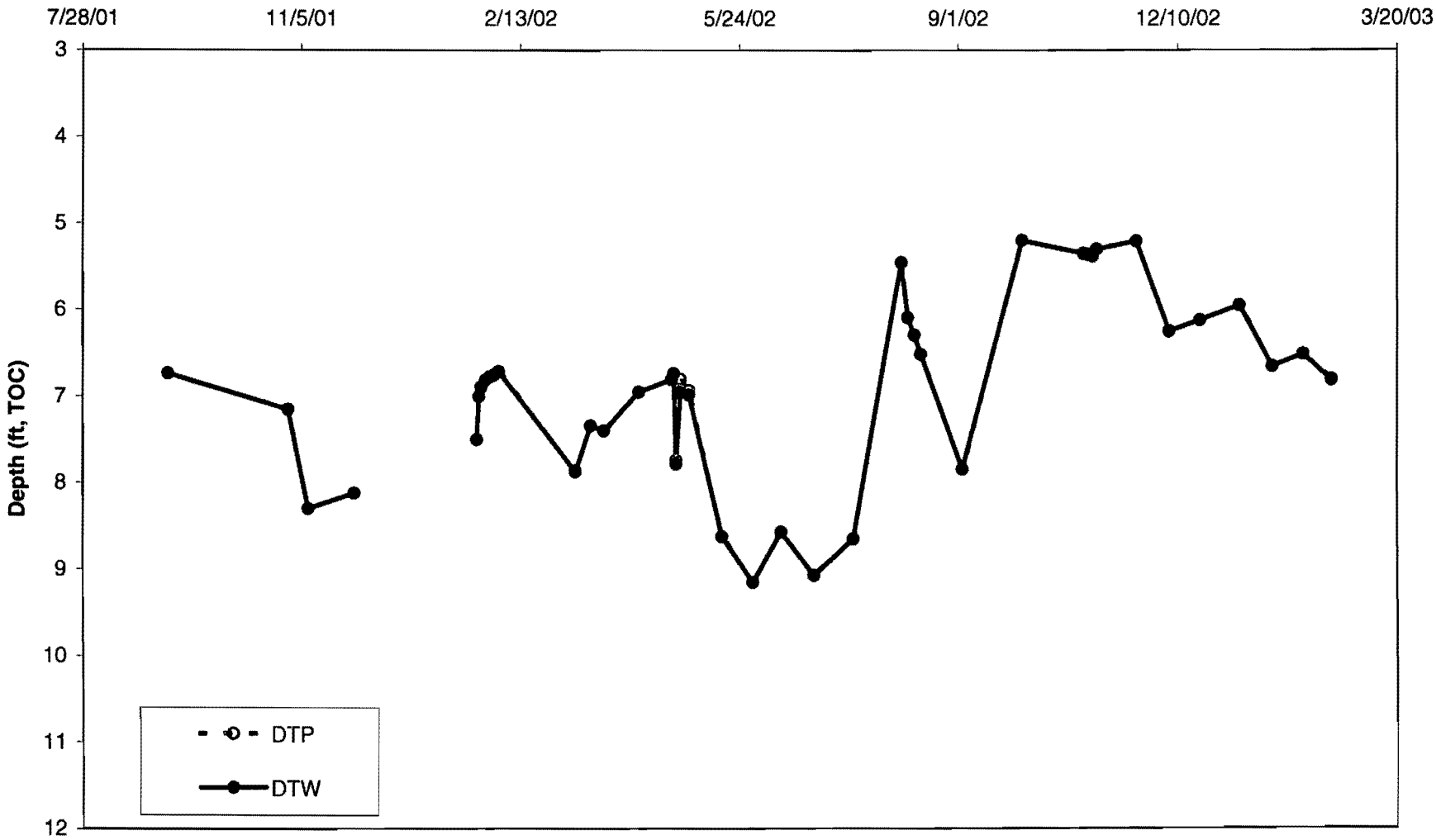

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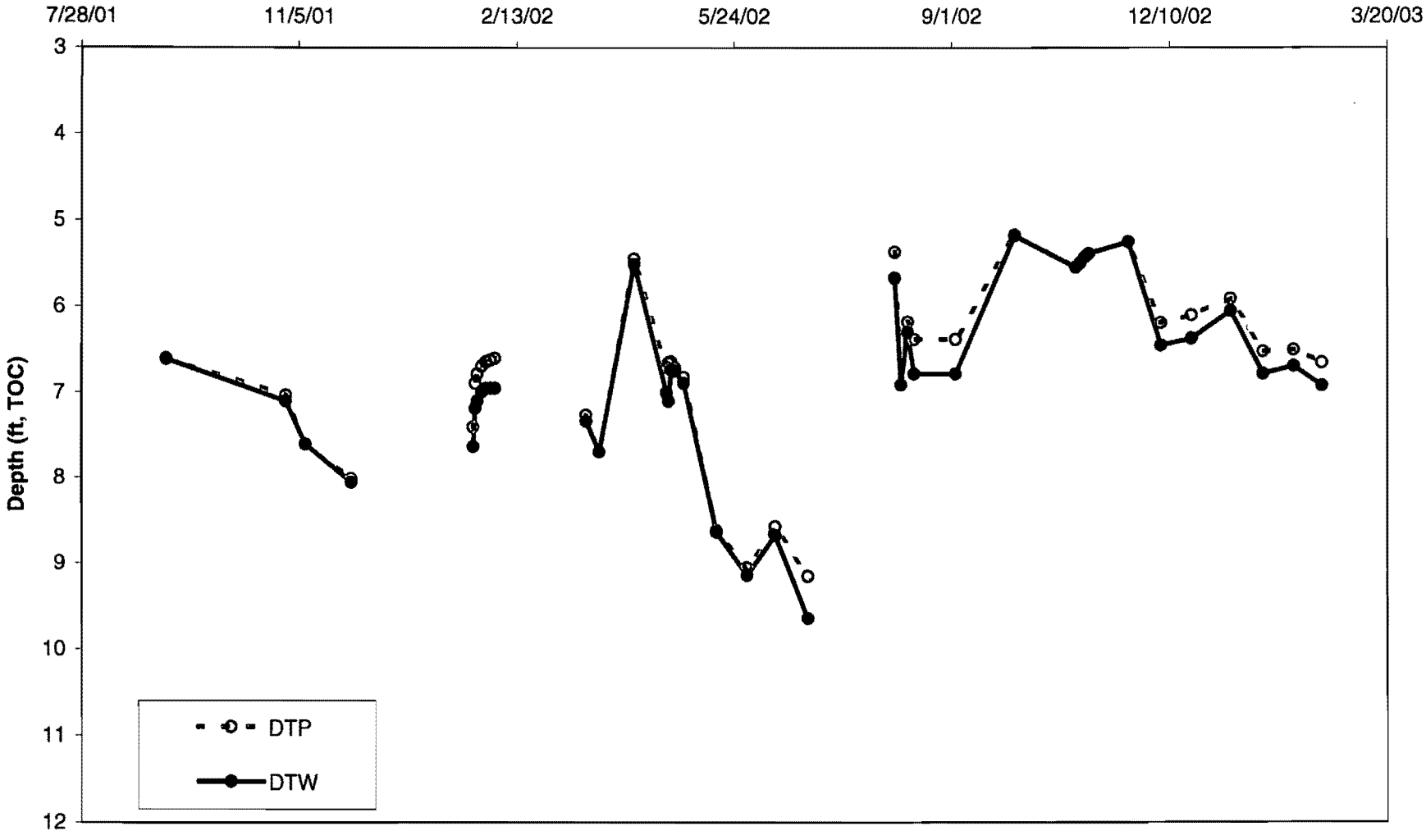
EW-15



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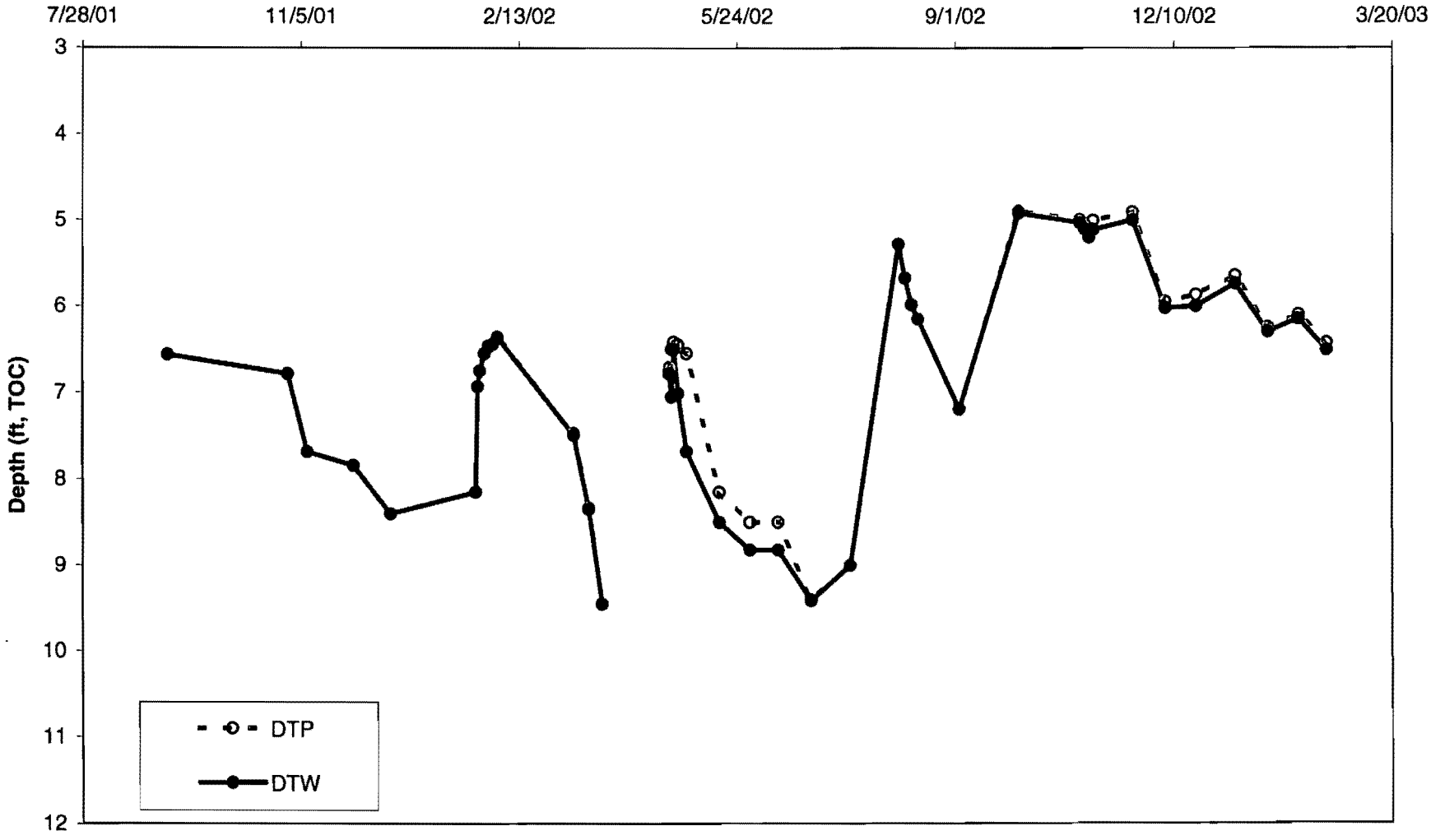
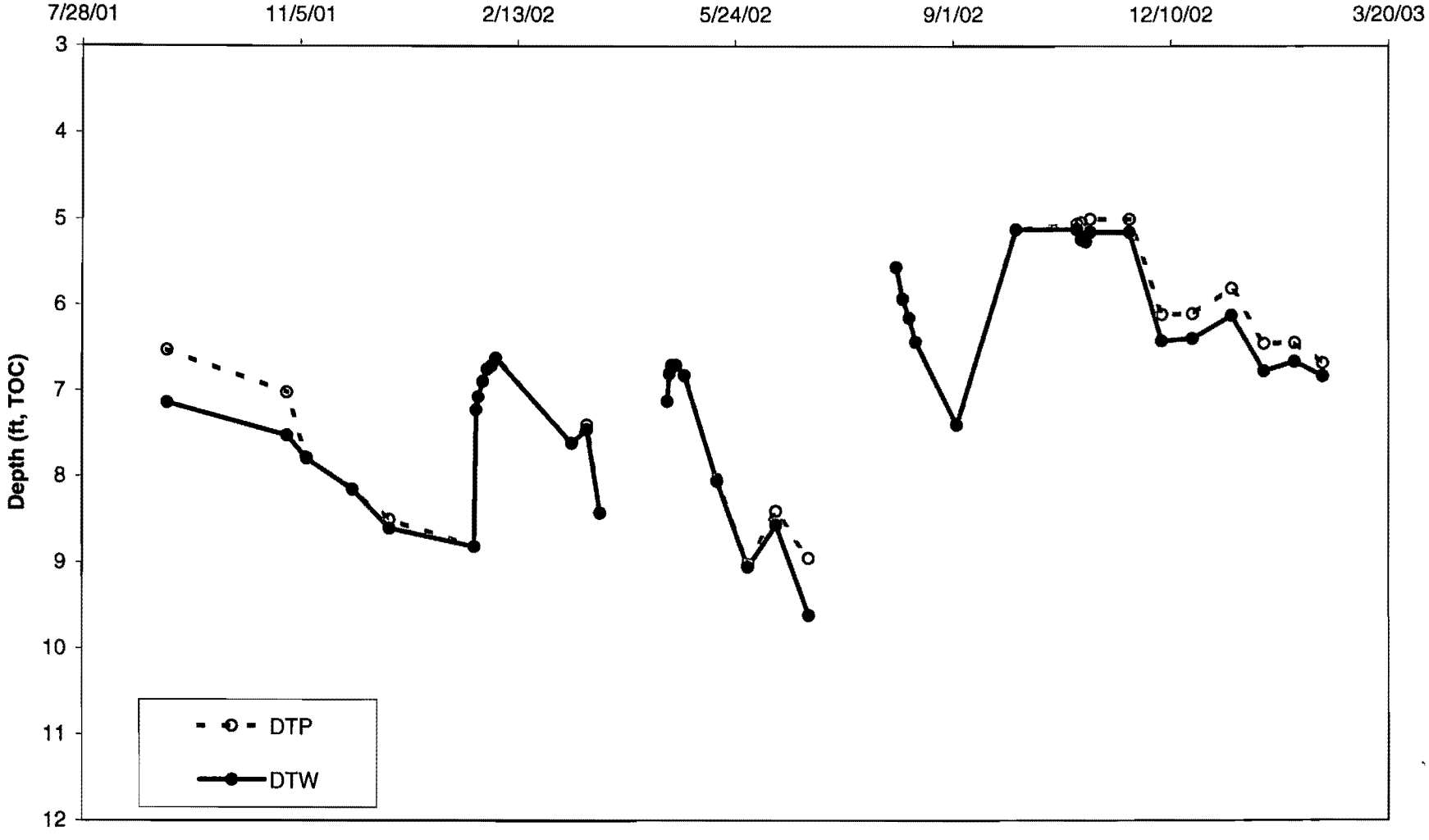
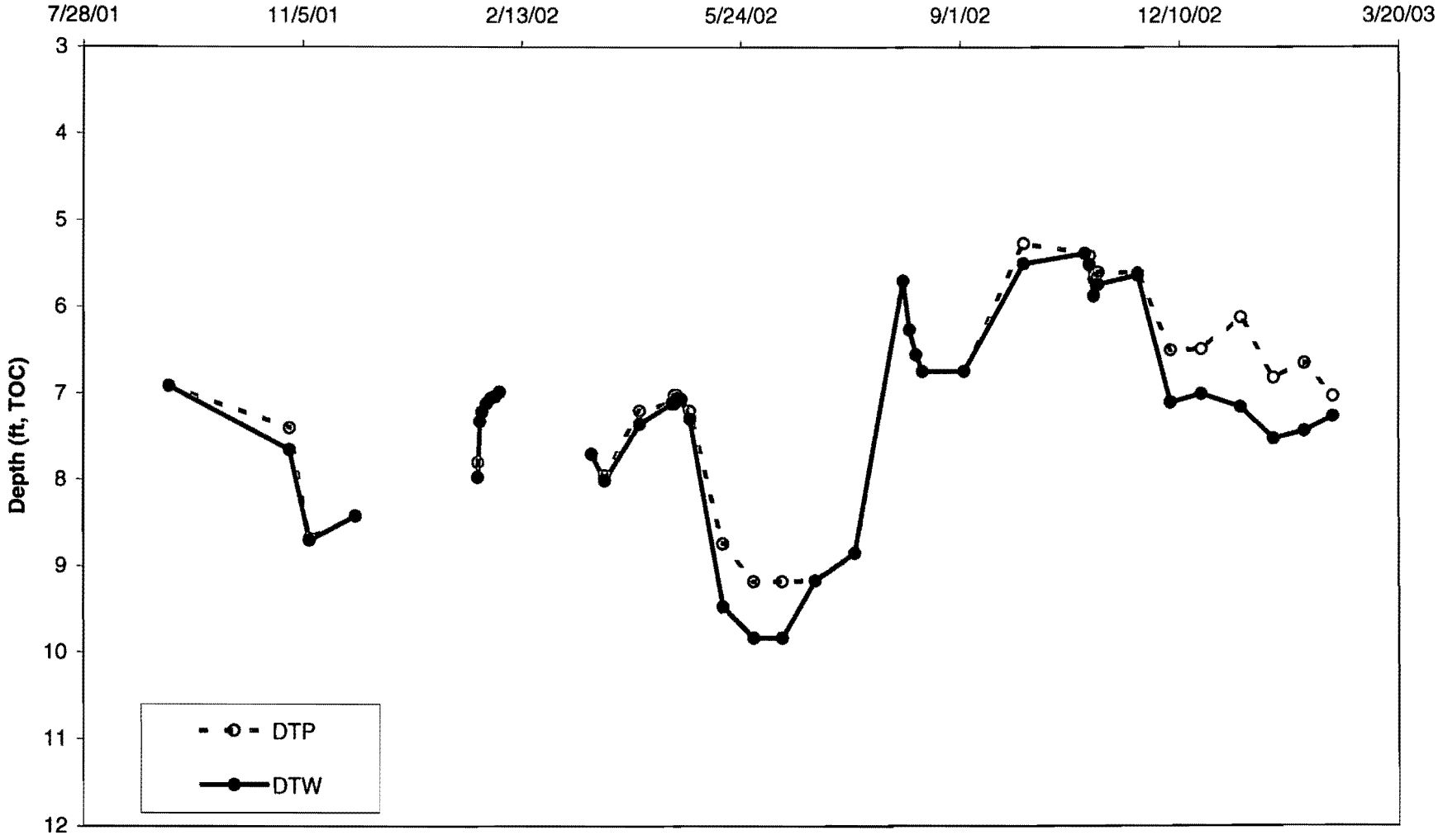


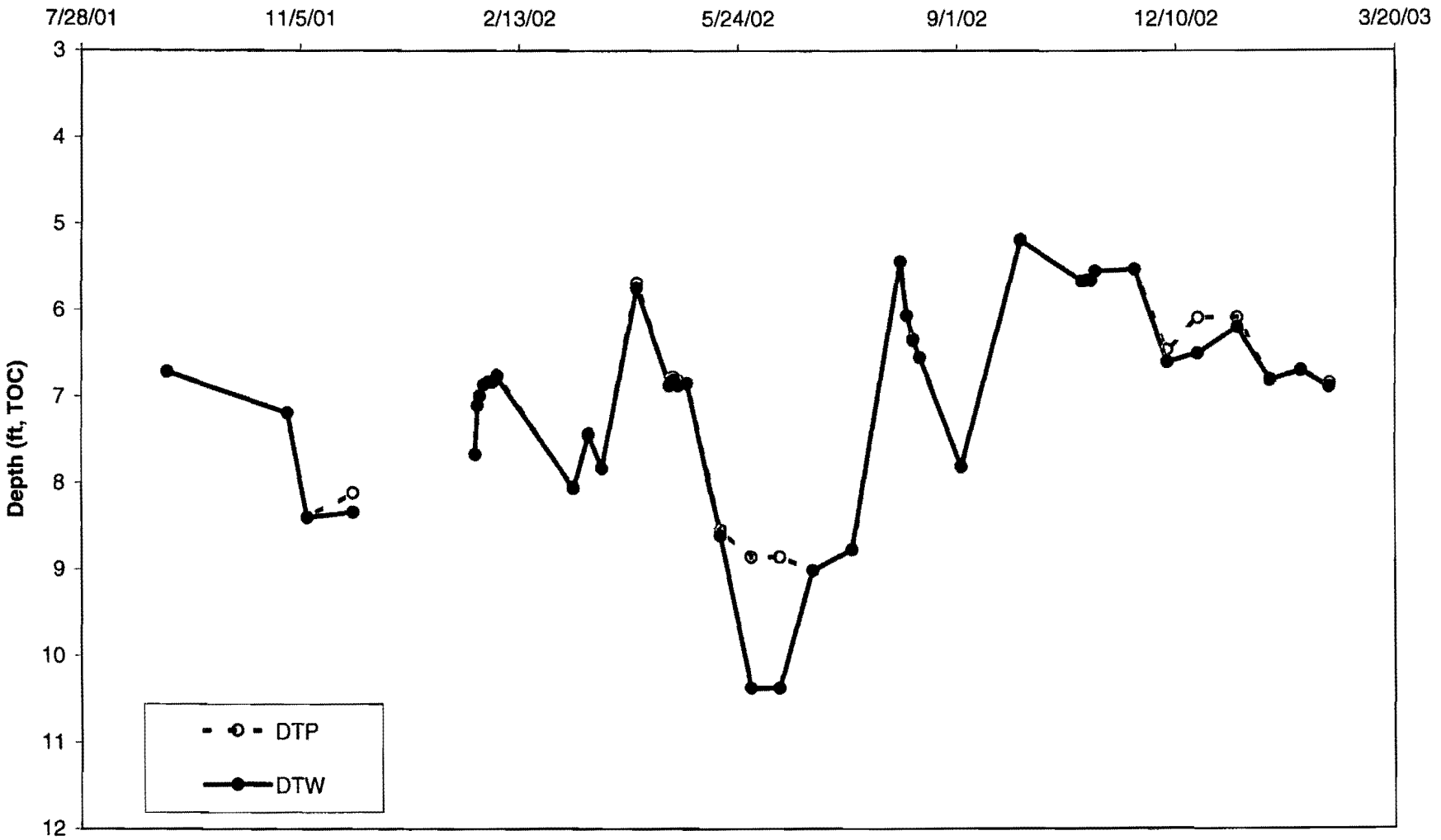
Oil/Water Data, NCBC Gulfport Site 6
EW-13



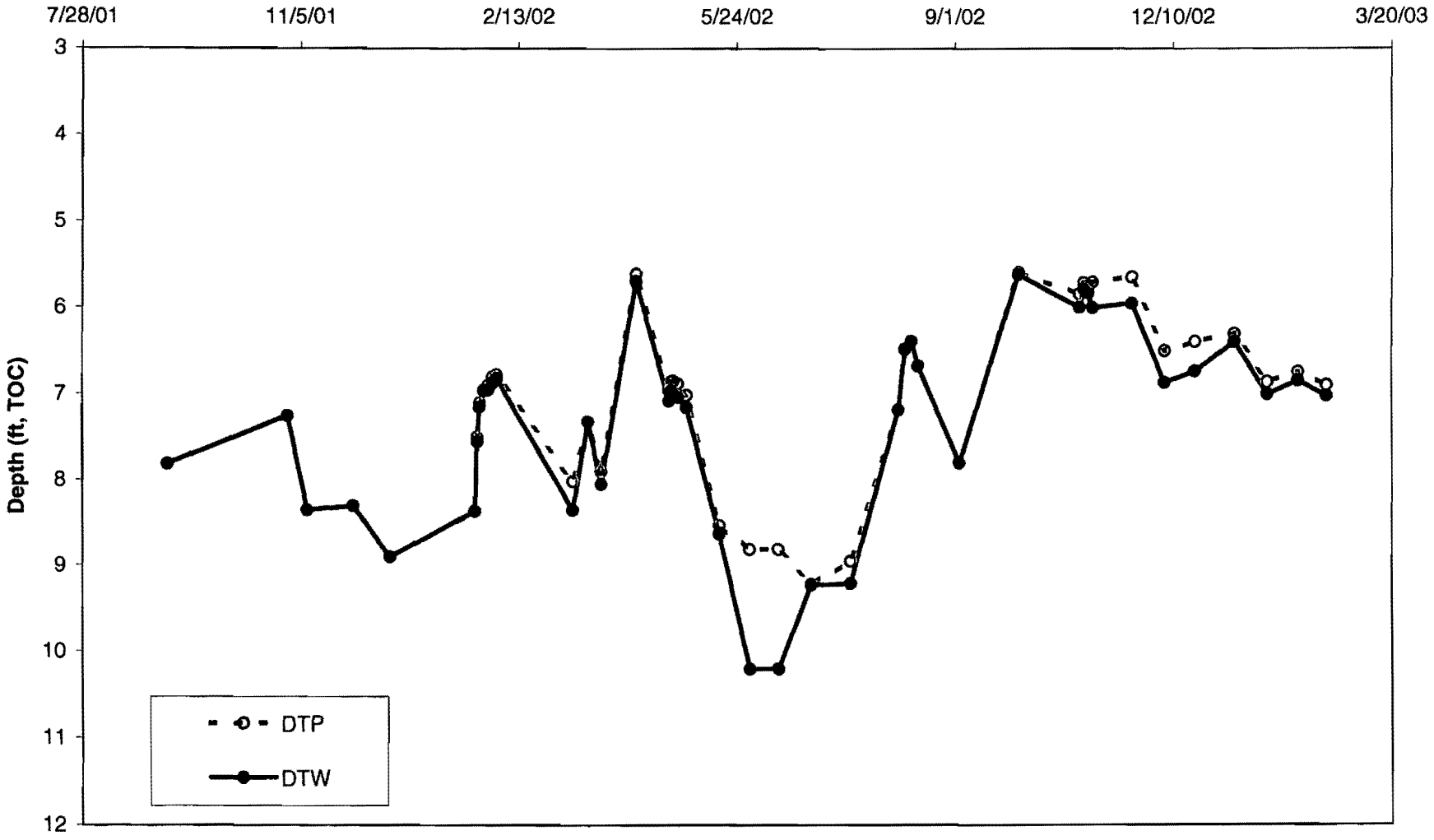
Oil/Water Data, NCBC Gulfport Site 6
EW-12



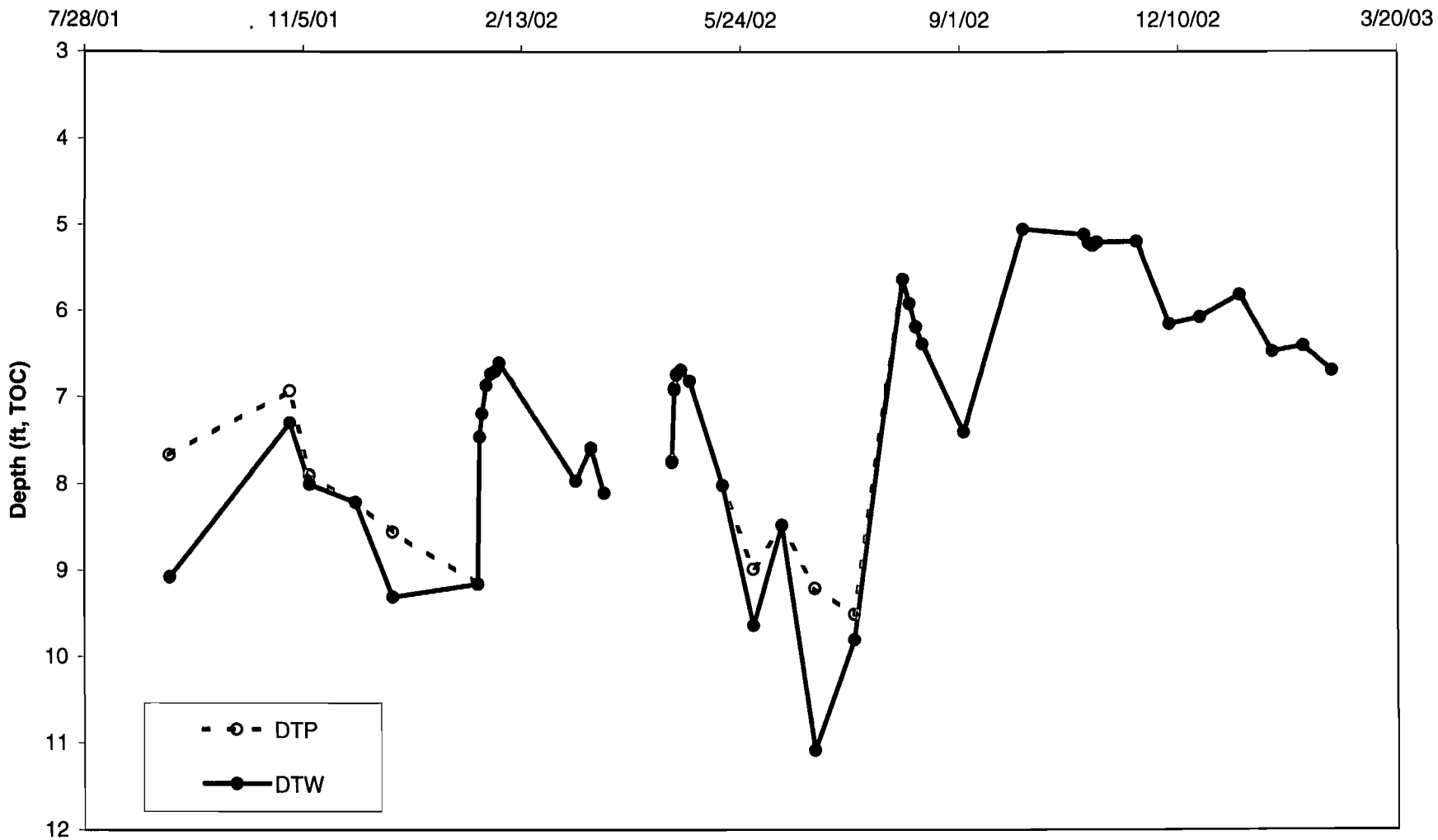
Oil/Water Data, NCBC Gulfport Site 6
EW-11



Oil/Water Data, NCBC Gulfport Site 6
EW-10



Oil/Water Data, NCBC Gulfport Site 6
EW-09



Oil/Water Data, NCBC Gulfport Site 6
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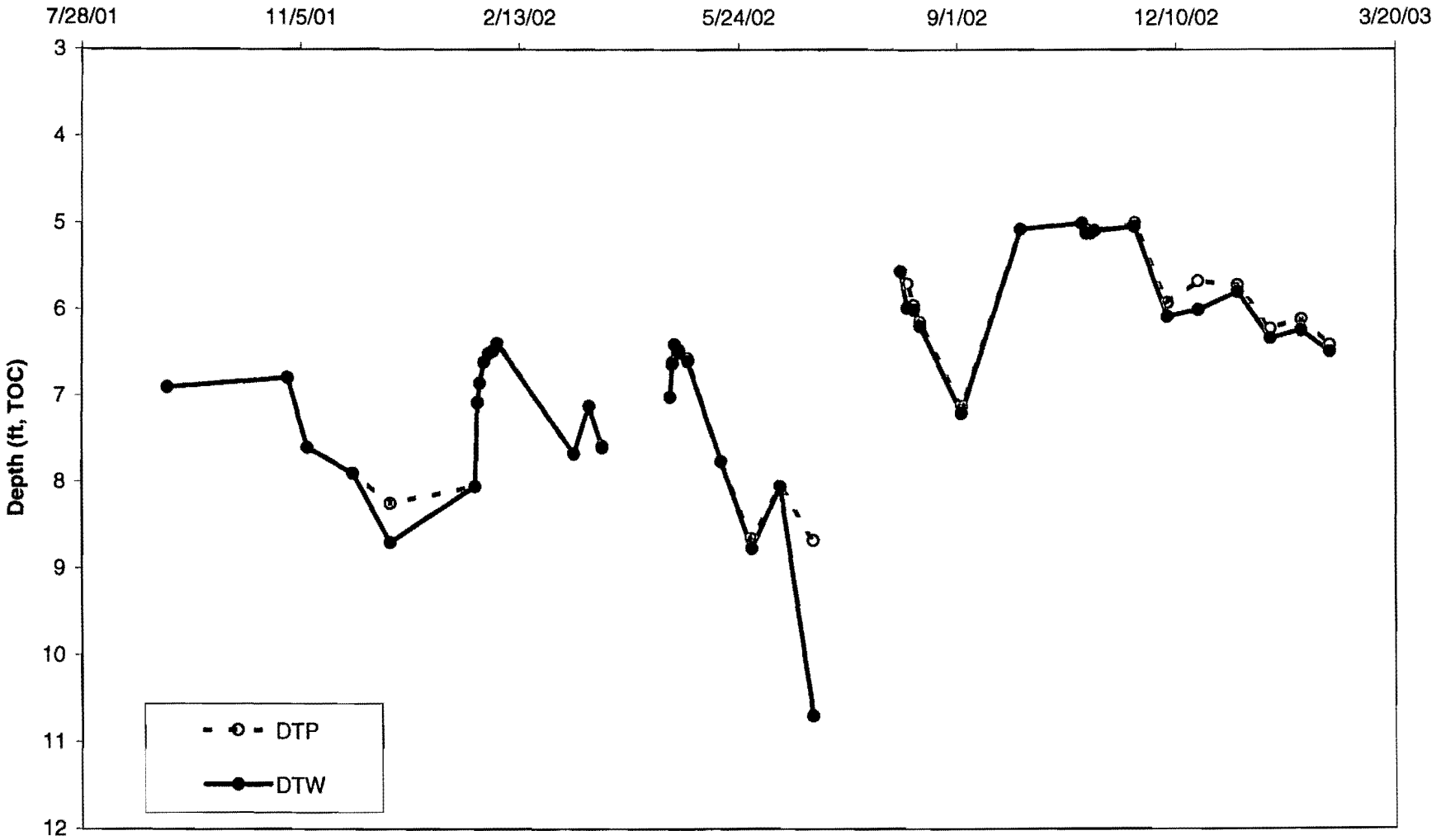

Oil/Water Data, NCBC Gulfport Site 6
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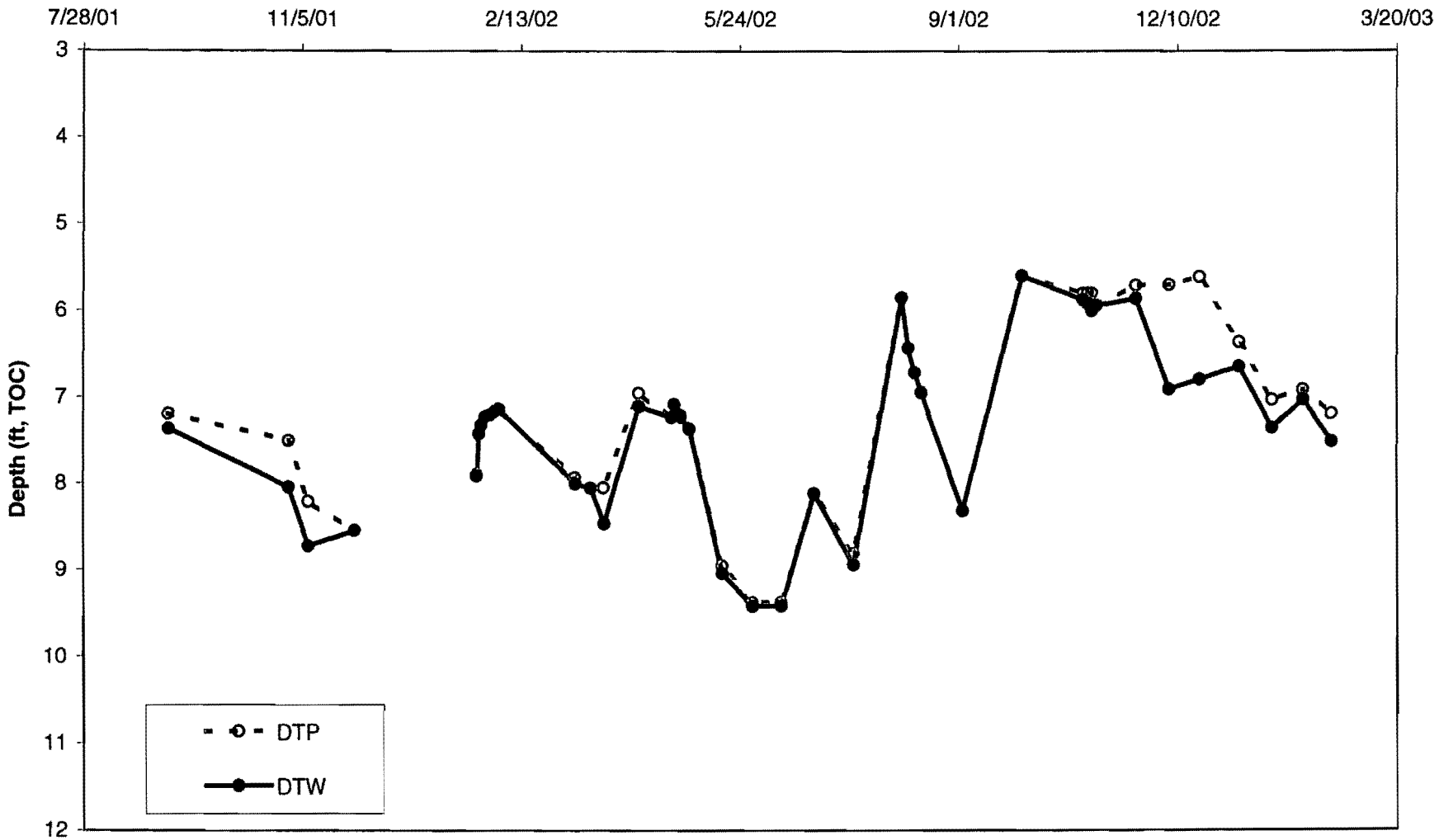

Oil/Water Data, NCBC Gulfport Site 6
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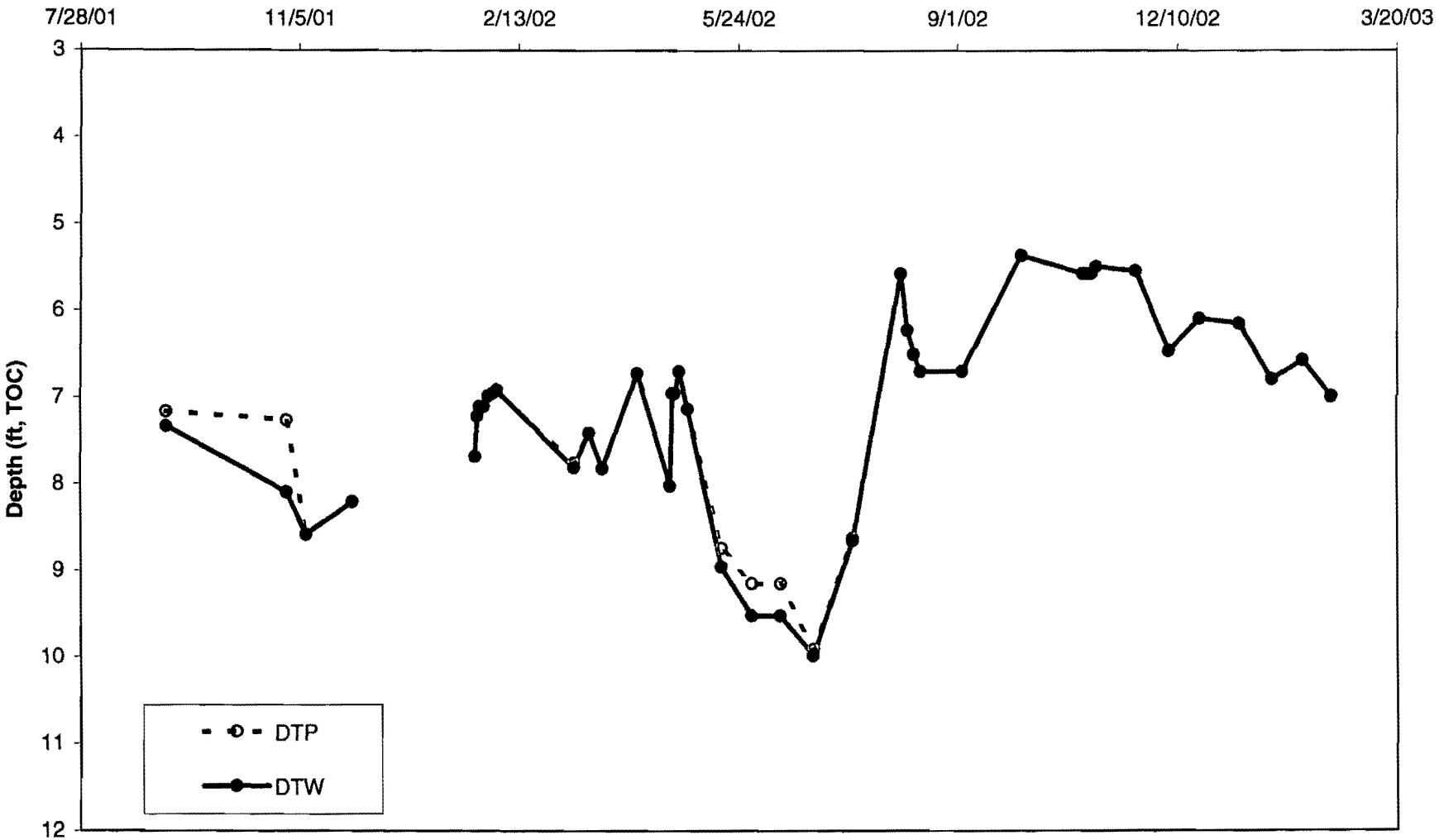

Oil/Water Data, NCBC Gulfport Site 6
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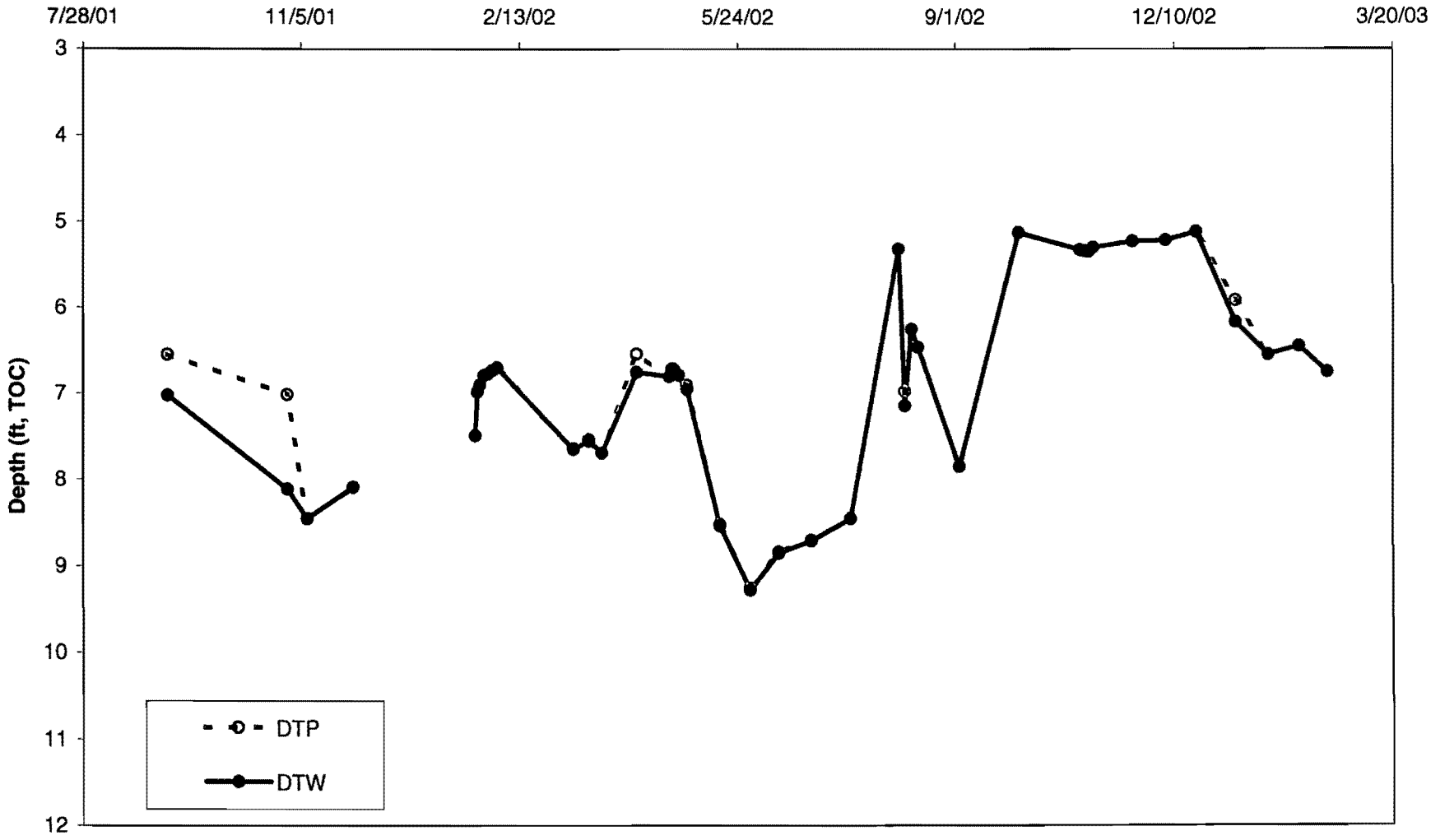

Oil/Water Data, NCBC Gulfport Site 6
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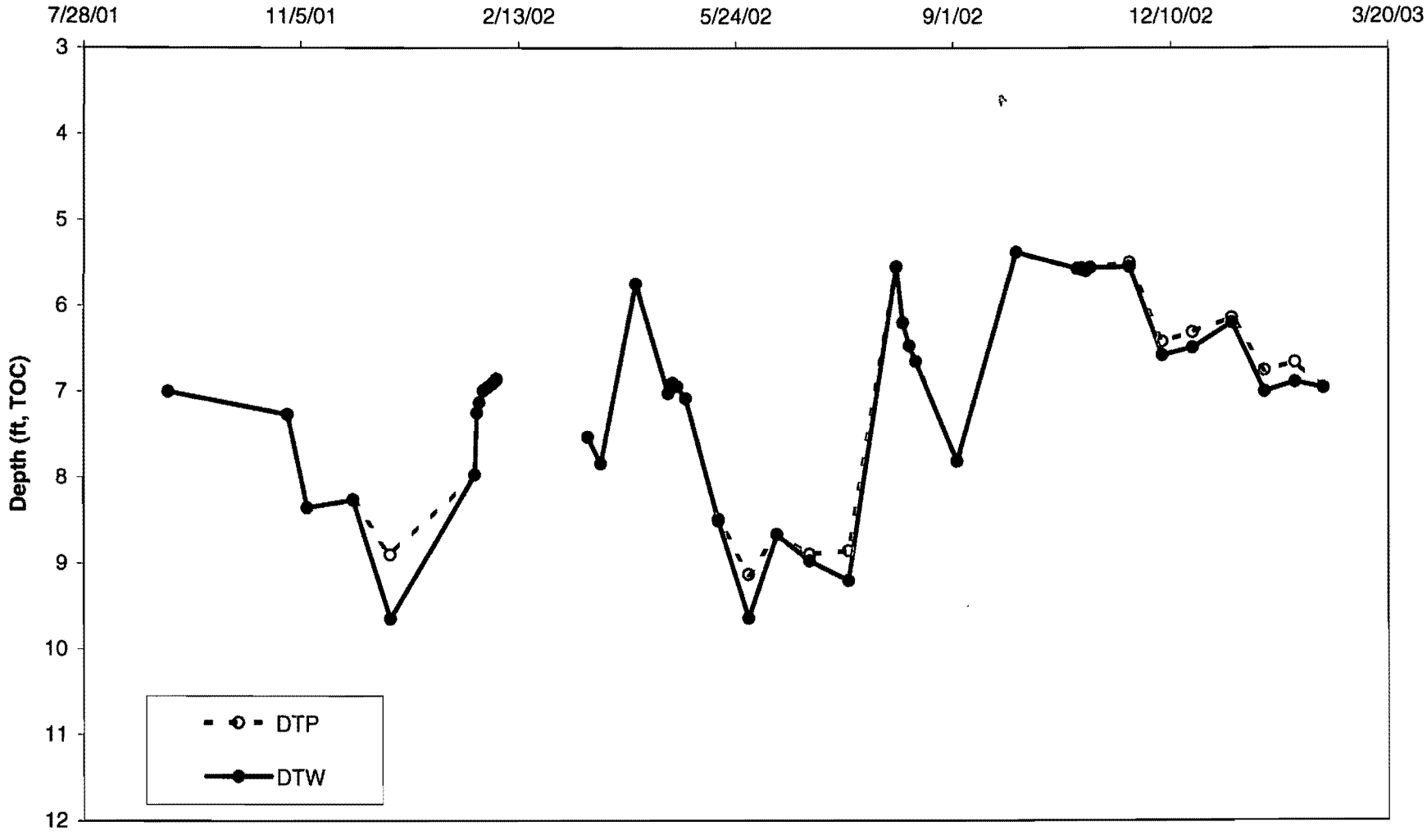

Oil/Water Data, NCBC Gulfport Site 6
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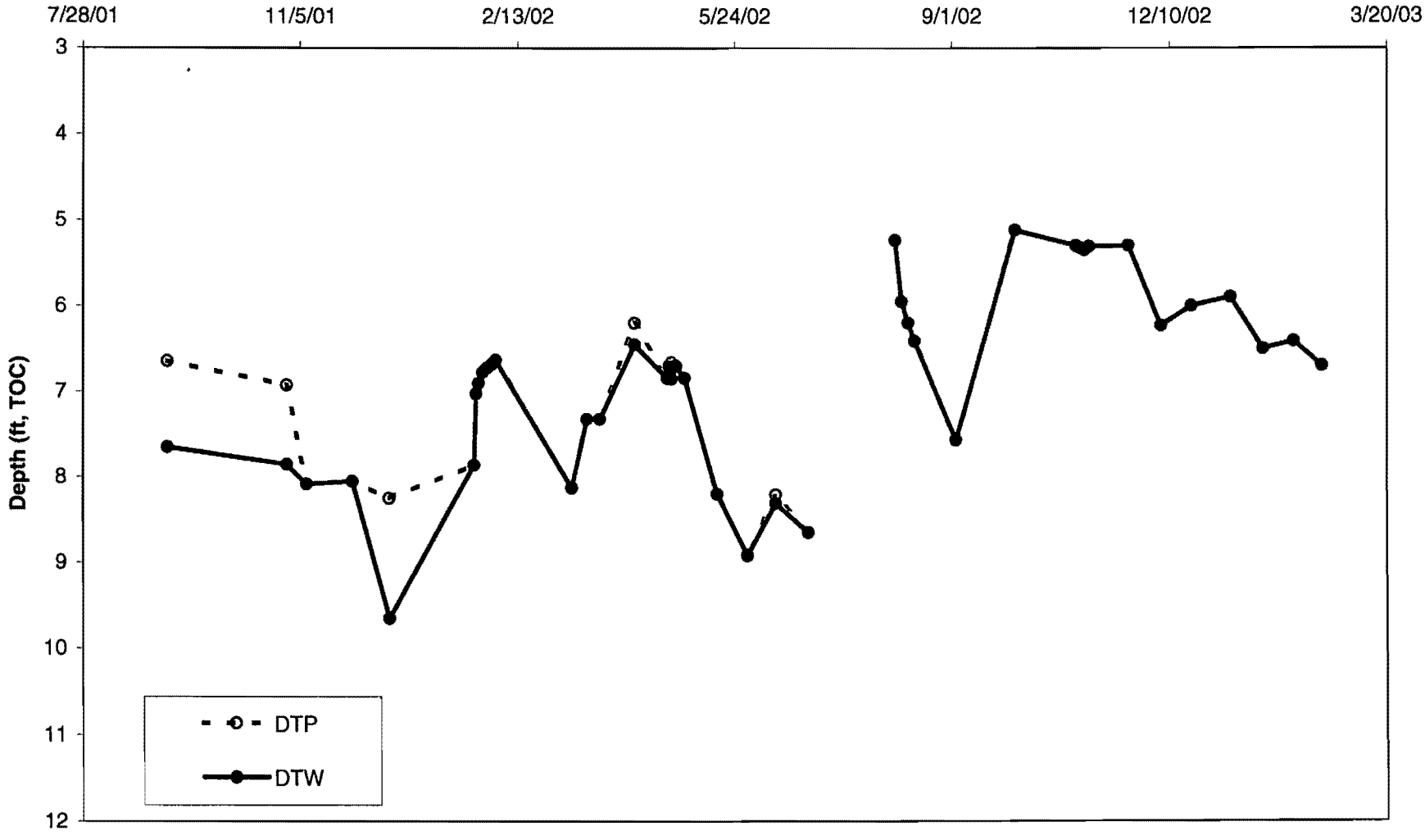
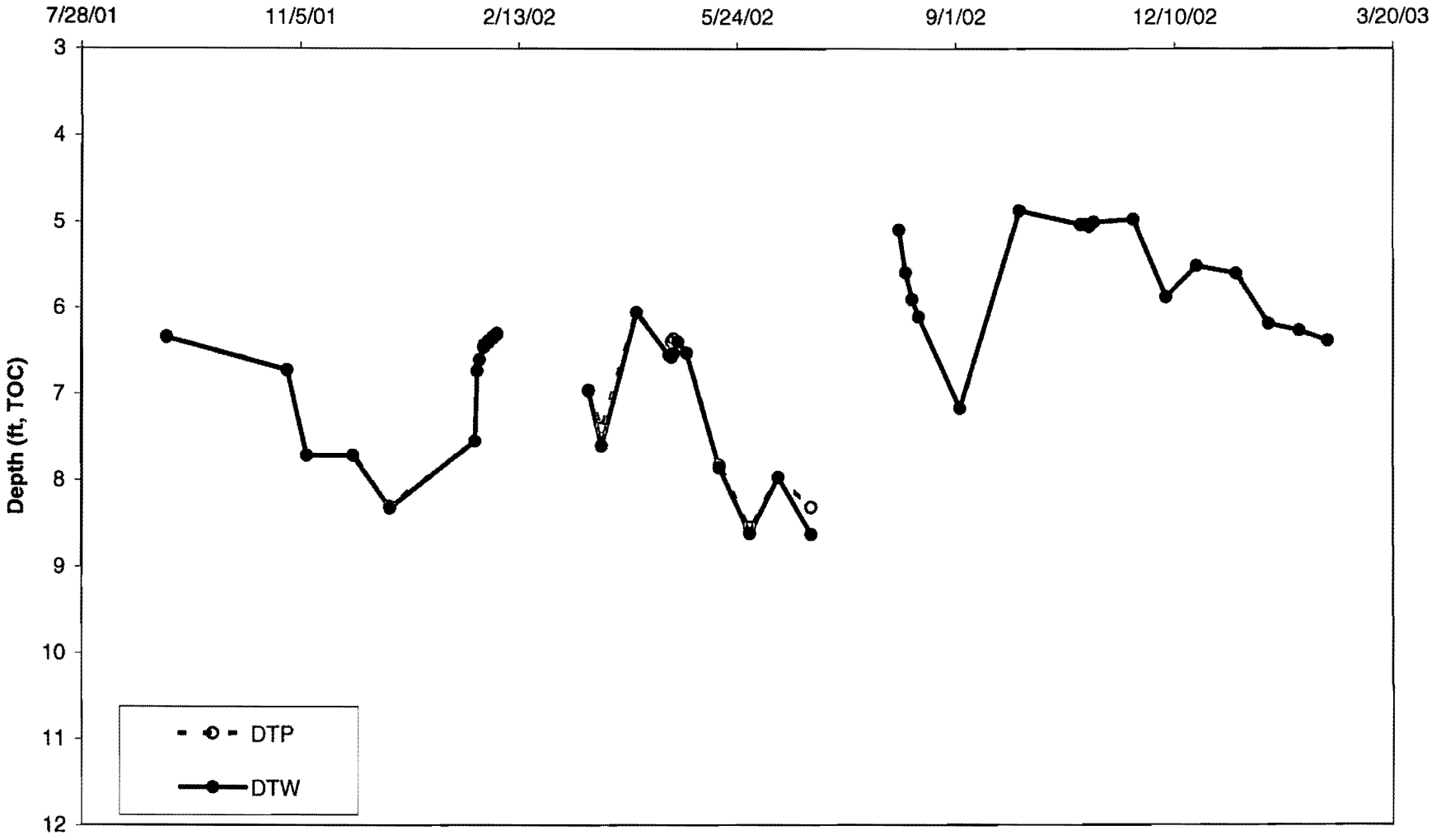
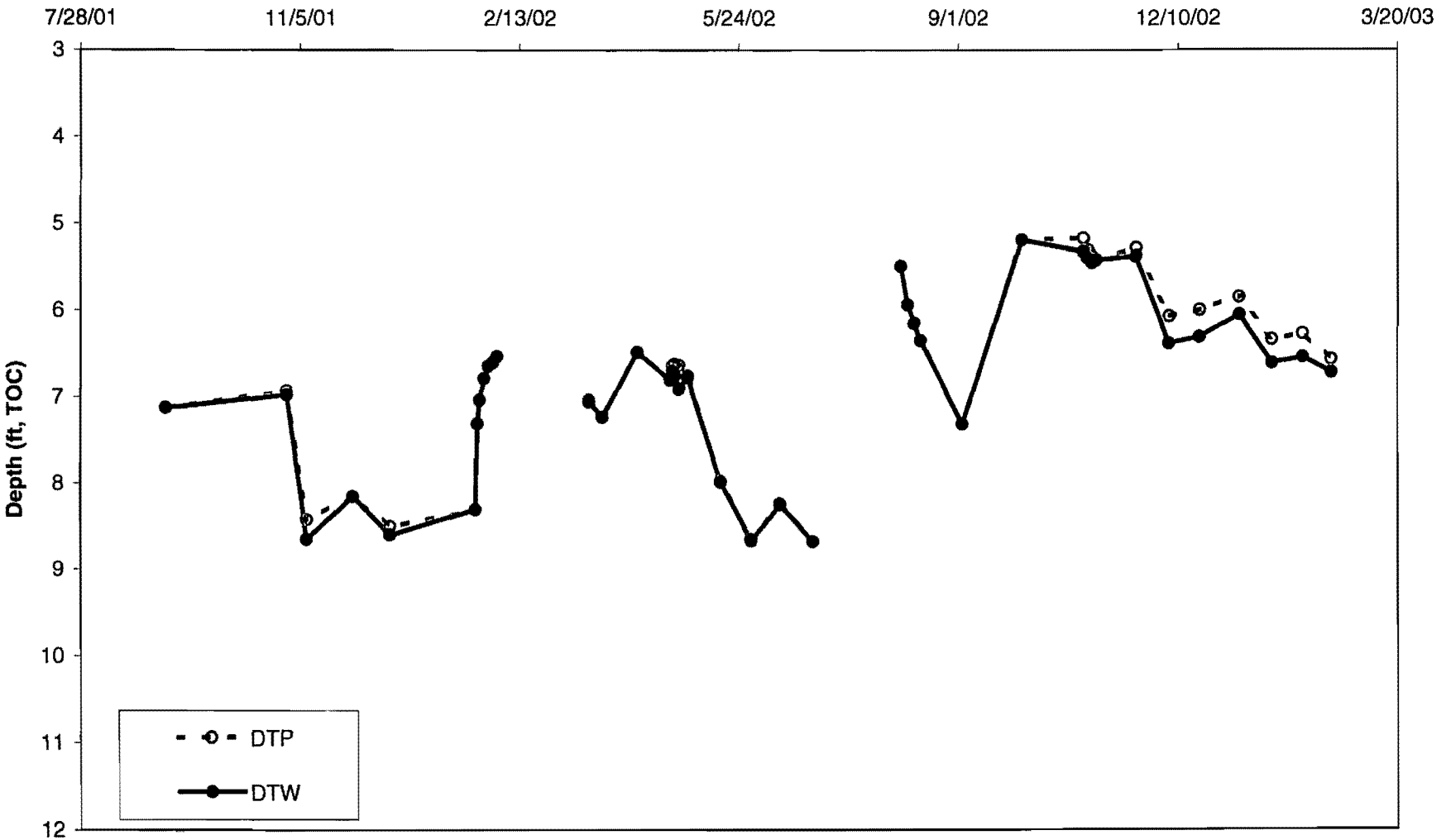


Oil/Water Data, NCBC Gulfport Site 6
EW-02



Oil/Water Data, NCBC Gulfport Site 6
EW-01



ATTACHMENT 3
SOIL-GAS MEASUREMENTS

Soil Gas Measurements
02-18-03

Monitoring Point	Depth (ft bgs)	Oxygen	Carbon Dioxide	TPH
MP-1	2.5	4.5	8.5	200
	5.0	0	16.5	300
MP-2	2.5	2.0	13	720
	5.0	0	15	900
MP-3	2.5	NA	NA	NA
	5.0	0	16	1,600
MP-4	2.5	2.0	11	340
	5.0	1.0	11	240
MP-5	2.5	NA	NA	NA
	5.0	NA	NA	NA
MP-6	2.5	0	15	200
	5.0	0.5	15	240

NA – Not available. Monitoring point was inundated with water