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A STUDY TO MINIMIZE THE ENVIRONMENTAL EFFECTS OF THE FMPC STORM WATER RETENTION BASIN OCTOBER 1, 1987

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October 1, 1987

FEED MATERIALS PRODUCTION CENTER

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1.0 INTRODUCTION

This document provides the results of a study which was completed to investigate and minimize the environmental impact to Paddys Run and other portions of the environment caused by any surface water leakage, overflow or bypass of the Storm Water Retention Basin (SWRB) at the Feed Materials Production Center (FMPC). The report was prepared to respond to Orders 5 & 7 of the Ohio Environmental Protection Agency Director's Findings and Orders (DFO's).

On June 26, 1987 the Ohio Environmental Protection Agency (EPA) issued the final DFO's requiring that certain actions be completed at the FMPC on a defined schedule. Order No. 5 of the DFO's states - "By April 30, 1987, DOE and Westinghouse shall submit to Ohio EPA for its review a contingency plan describing actions which will be taken to investigate and minimize the environmental impact to Paddys Run and other portions of the environment caused by any surface water leakage, overflow, or bypass of the stormwater retention basin currently installed at the FMPC".

Order No. 7 states - "As part of the permit to install application required by Order 6 above, DOE and Westinghouse shall submit to Ohio EPA for is review a contingency plan describing actions which will be taken to minimize potential environmental impacts to Paddys Run and other portions of the environment caused by any surface water leakage, overflow, or bypass of the stormwater retention system approved by Ohio EPA pursuant Order 6 above [Submittal of SWRB PTI]. Should Ohio EPA request changes and/or additions to this plan, DOE and Westinghouse shall submit the changes and/or additions to Ohio EPA within thirty days after receiving the requests. This plan shall be implemented by DOE and its contractors at the FMPC."

2.0 BACKGROUND INFORMATION

2.1 GENERAL

The FMPC is located near the unincorporated town of Fernald, Ohio, approximately 32 km (20 mi) northwest of Cincinnati, Ohio (Figure 1). At this site, uranium metal products are produced for use at other Department of Energy (DOE) sites around the country. FMPC production operations cover approximately 136 acres in the center of a 1,050 acre site (Figure 2). Several rural communities and commercial operators lie within a 1-5 km (0.6-3 mi) radius of the plant.

The FMPC is situated on a relatively level plain, about 177 m (580 ft.) above sea level. The land rises to 213 m (698 ft.) at the northern boundary and slopes downward to 168 m (551 ft.) at Paddys Run on the southern boundary. The topographic and geologic features at the site are the result of fluvial and glacial processes associated with Pleistocene glaciation which occurred approximately 100,000 to 400,000 years ago. At the FMPC, nearly 15 m (49 ft.) of clay-rich till, generally characterized as silt loam, overlies sand and gravel deposits

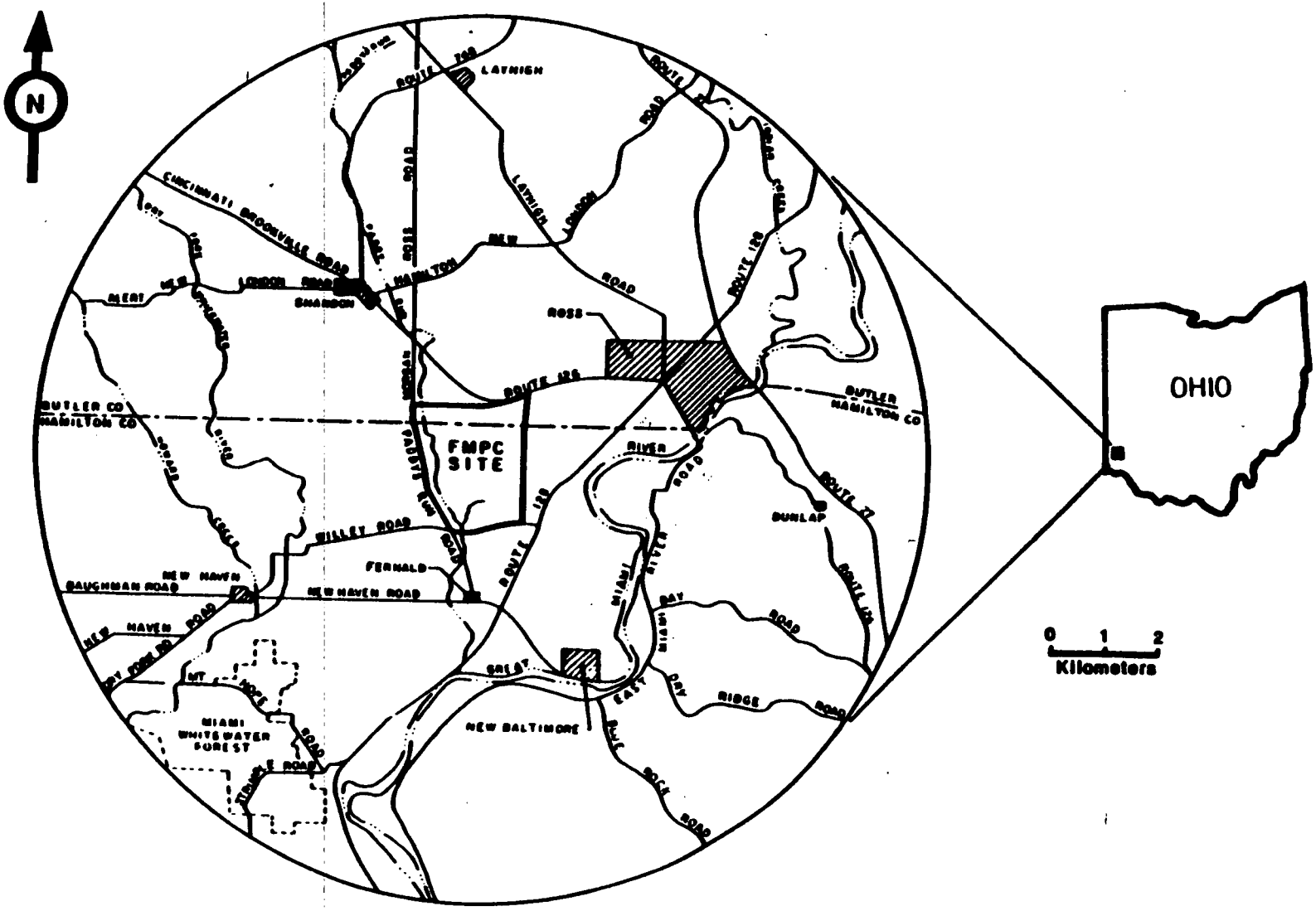


FIGURE 1: *FMPC Area Map*

Water Pollution Control System at FMPC

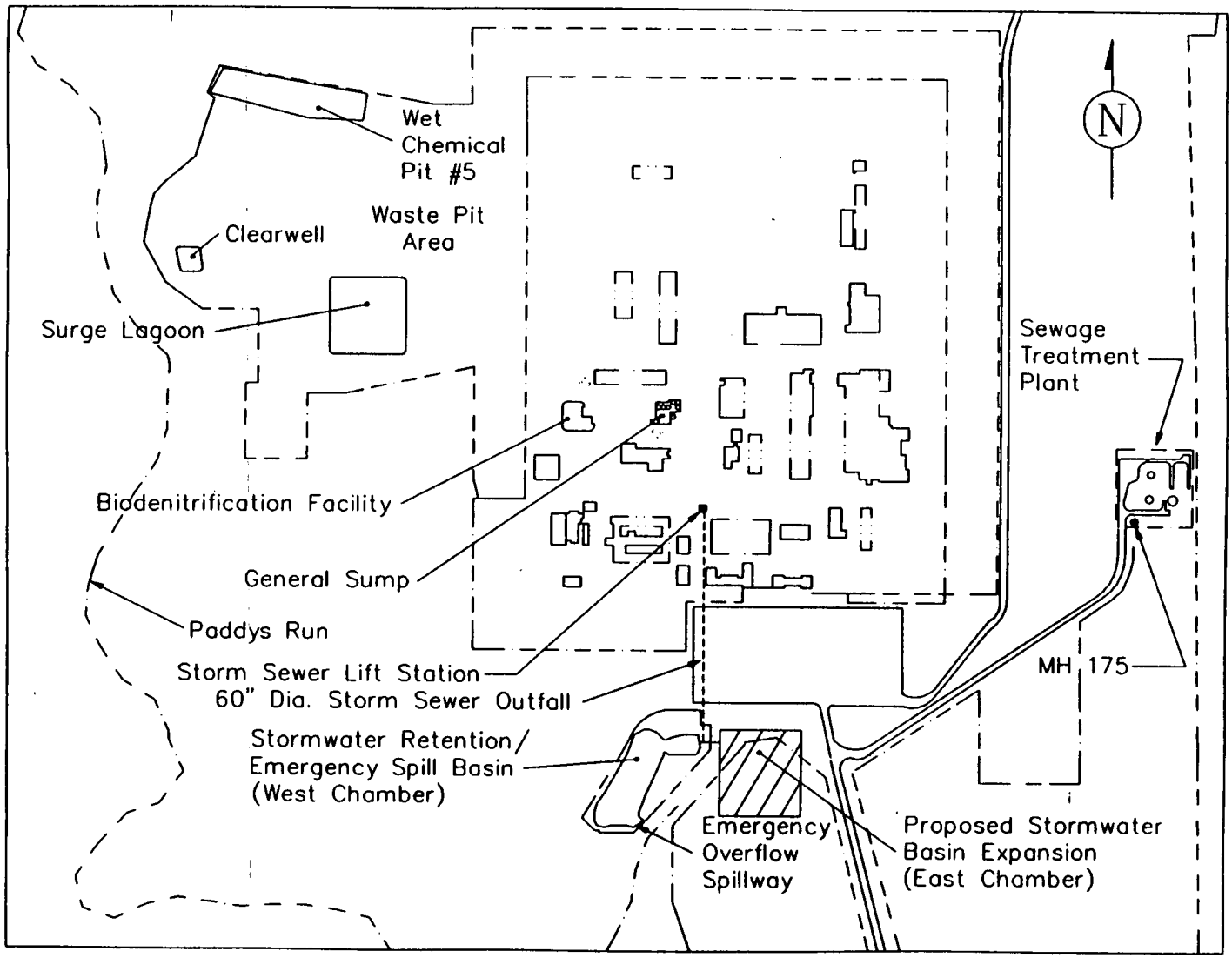


Figure 2. FMPC Site Map

This map is not drawn to scale.

left by a retreating glacier. These sediments were deposited in an ancient river valley that was cut into the bedrock approximately 5 km (3.1 mi) wide and 46 m (151 ft.) deep. These remnant sand and gravel channel deposits, which underlie the FMPC and vicinity are part of a large aquifer system (Figure 3) which extends across southwestern Ohio. The Great Miami River, which runs in a southerly direction about 1 km (0.6 mi) east of the FMPC, presently cuts through these deposits. More than 60 m (200 ft.) below the surface of the FMPC lies bedrock consisting of alternating layers of limestone and shale.

2.2 Storm Sewer System

The FMPC storm sewer system carries a major portion of the stormwater runoff from the 136 acres of plant process area, including support facilities (laboratory and office areas), and 24 acres of drainage from the FMPC parking lot and adjacent areas to the SWRB (See Figure 4). The storm sewer system consists of a network of surface mounted drainage inlets that are connected to underground drainage pipes located throughout the process area, a Storm Sewer Lift Station (SSLS), and the SWRB. Water collected in the process area portion of the storm sewer system flows by gravity to Manhole No. 34 located at the southern boundary of the production area. During dry periods, collected water in the process area sewers flows to the SSLS wet well where float activated pumps transfer it to the Great Miami River via monitoring Manhole No. 175. When a rainfall event causes the collected water quality to be threatened by higher than normal Total Suspended Solids (TSS), the SSLS pumps are shut off after the flow exceeds the capacity of the weir. This facilitates the flow of all collected water to the SWRB.

The existing 60 inch storm sewer outlet pipe that presently carries flow from Manhole No. 34 and subsequent downstream areas into the SWRB was a discharge point to a tributary of Paddys Run prior to construction of the basin in the Fall of 1986. This outlet was designated a National Pollution Discharge Elimination System (NPDES) permit discharge point No. 002. A summary of NPDES sampling data, dating back to 1984, for discharge point 002 is presented in Table 1. With the completion of the SWRB construction, the discharge from the SWRB is pumped to the Great Miami River via monitoring Manhole No. 175 (designated as NPDES discharge point No. 001) and the overflow spillway of the SWRB has now been designated as NPDES permit discharge point No. 002. Effluent from Manhole No. 175 is sampled in accordance with NPDES permit requirements.

2.3 Storm Water Retention Basin (SWRB)

The SWRB serves as a collection/retention reservoir for stormwater runoff, and process spills and also as a solids settling basin. Outflow from the basin is accomplished by pumping to the Great Miami River via monitoring Manhole No. 175 in periods of exceptionally high rainfall, the outflow exits the SWRB via NPDES permit discharge point No. 002 (overflow spillway).

2.3.1 Existing SWRB

The existing stormwater retention system (See Figure 5 for plan view) is capable of storing 6.5 million gallons of stormwater runoff. With the addition of a pumpout of 300 gallons/minute, over a 24 hour period, the

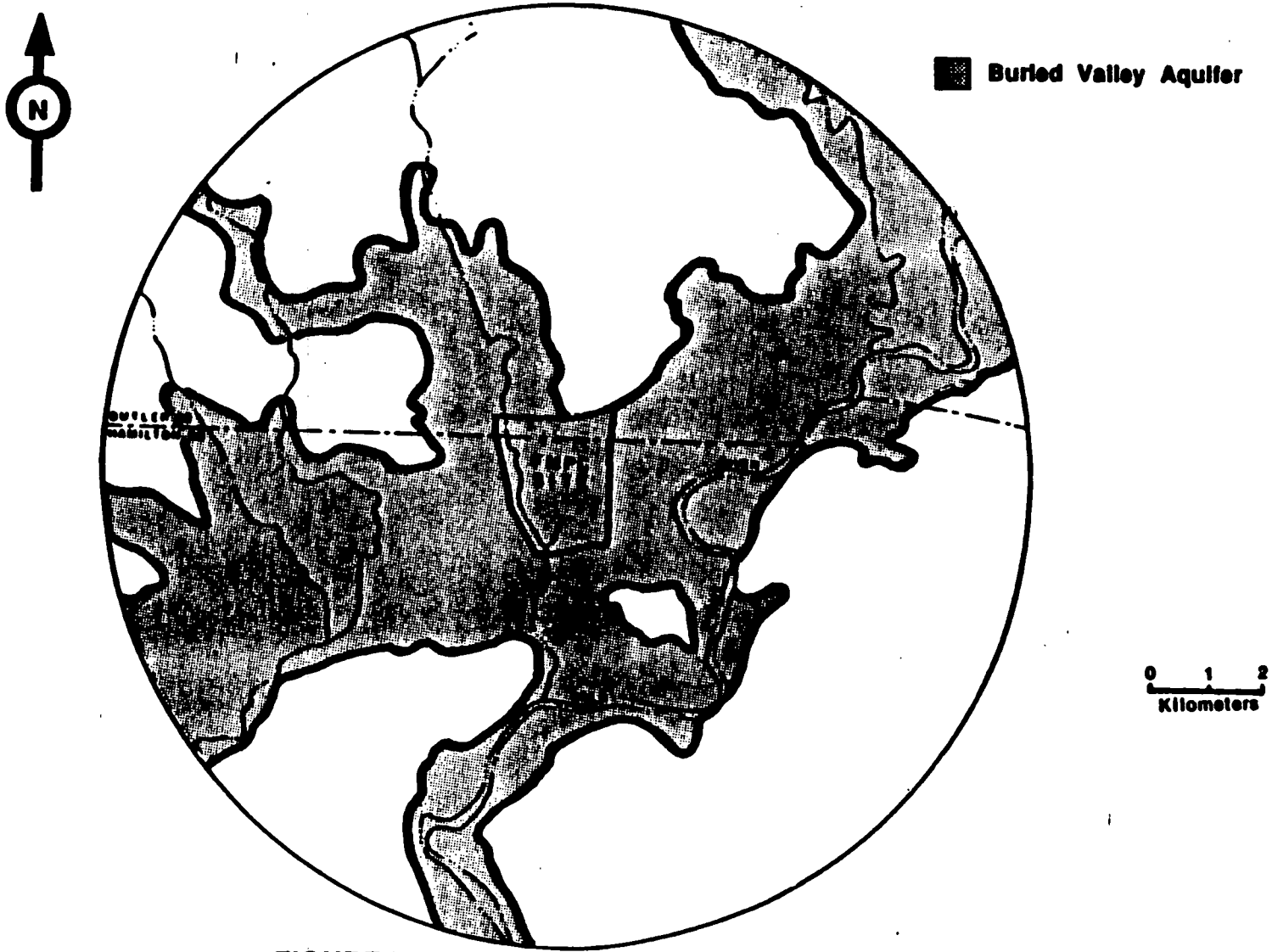


FIGURE 3 : ***Buried Valley Aquifer Underlying the FMPC Site and Vicinity***

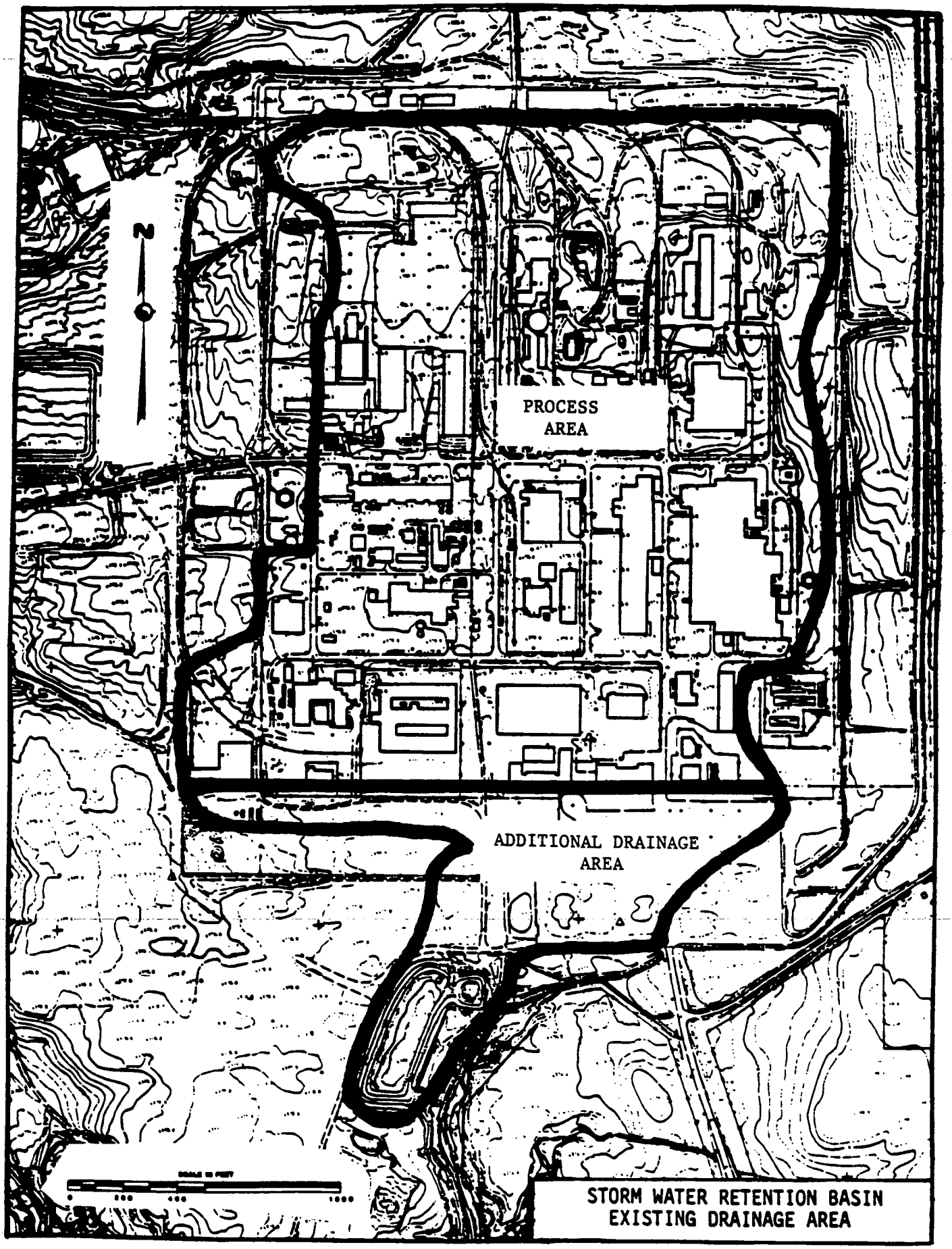

N
PROCESS
AREA
ADDITIONAL DRAINAGE
AREA
STORM WATER RETENTION BASIN
EXISTING DRAINAGE AREA

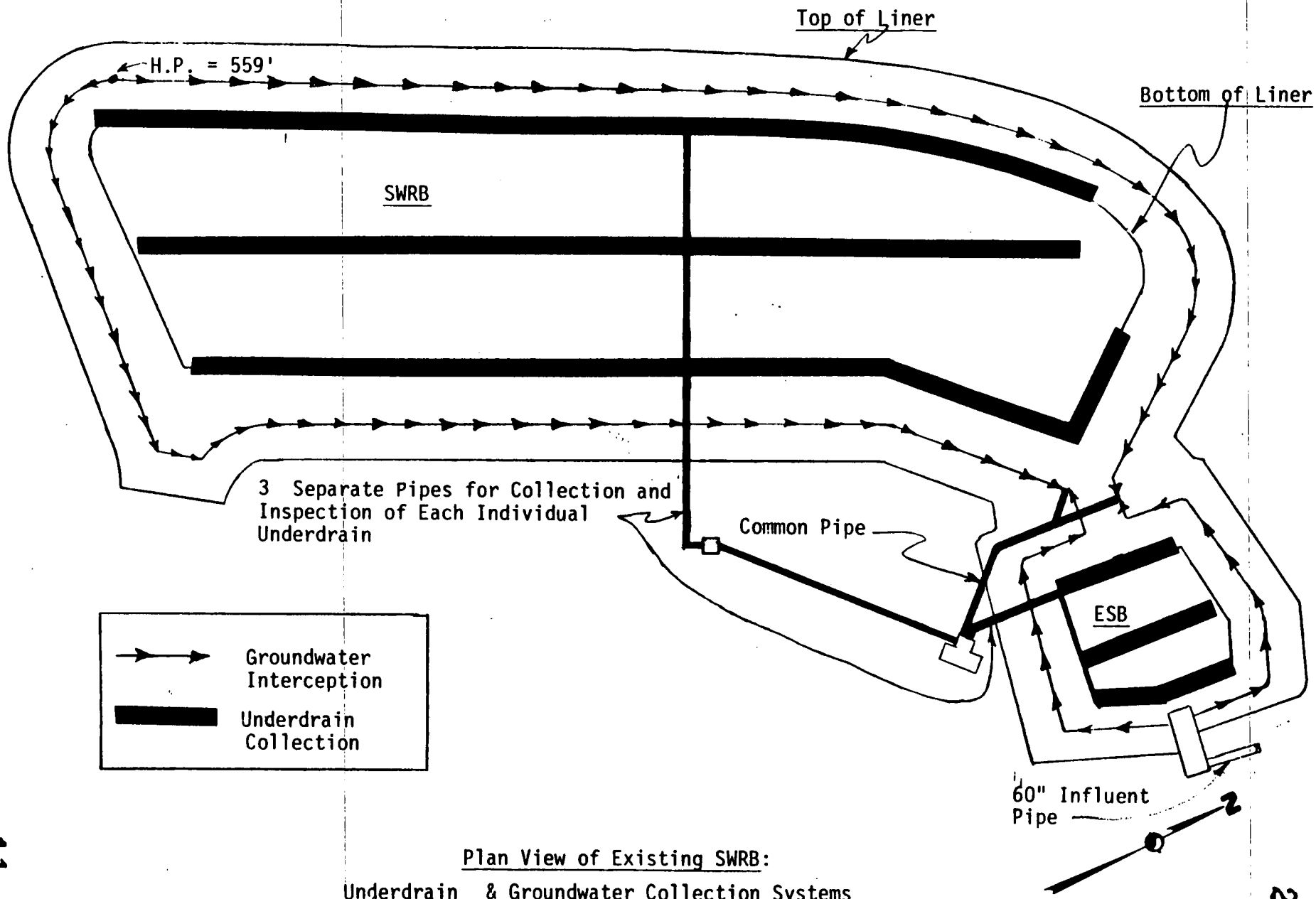
Figure 4

Table 1.

NPDES Sampling Data for Discharge Point 002

Parameter(mg/l)	1984			1985			1986		
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
pH*	7.4	8.5	NA	7.5	8.3	NA	7.4	8.3	NA
TSS	<2	64	8	<2	175	15	<2	223	<21
O&G	<5	17	5	<5	<5	<5	<5	15	<5

*Standard units.



Plan View of Existing SWRB:
Underdrain & Groundwater Collection Systems

Figure 5

system has the capability to control approximately 7 million gallons of stormwater runoff (The volume of a 2-yr./24-hr. stormwater runoff event from the upstream drainage basin).

A perched groundwater table exists in the area where the SWRB is constructed. Because of this, the SWRB was constructed with an underlying collection piping system to intercept the groundwater flow (See Figure 5). An underdrain collection system was also installed to intercept any leakage through the synthetic flexible membrane liner (FML). All collected underdrain water is pumped into the SWRB. This system serves to minimizes the potential for any environmental impact on the groundwater or Paddys Run due to leakage through the liner.

2.3.2 Proposed SWRB Expansion

The stormwater retention system (including the SWRB expansion) will provide the capacity for a 10-year/24-hour storm event. Recent tests (see "Study of Solids Loading and Solids Settling in the FMPC Biodenitrification Surge Lagoon and Stormwater Retention Basin", issued to OEPA June 1, 1987) have indicated that approximately 24 hours of quiescent settling time is required to obtain an effluent level of 30 ppm TSS. In order to achieve maximum removal of TSS from the incoming runoff water, the proposed basin expansion will be constructed to operate in parallel with the existing basin. Sluice gates will be provided to allow for batch sequential filling and 24 hour settling of each basin prior to discharge.

In order to be certain that adequate basin capacity is maintained for the necessary settling and retention, a cleanout schedule of once every 2 years has been established in the PTI for the SWRB expansion. Since the basins will operate in parallel, one basin can be taken off-line during cleanout.

3.0 SWRB PROGRESS SINCE ISSUANCE OF DFO's

In the period between the issuance of the Ohio EPA DFO's and release of this study (response to Orders No. 5 & No. 7), significant progress has been made in several areas concerning the SWRB. Order No. 4 of the Ohio EPA DFO's requested that a study be performed on the solids loading and settling in the SWRB and the Biodenitrification Surge Lagoon (BSL). A final report entitled a "Study of Solids Loading and Solids Settling in the FMPC Biodenitrification Surge Lagoon and Stormwater Retention Basin" which described the work performed in the completion of this study was prepared and submitted to the Ohio EPA on June 1, 1987. Pertinent information in the report concerning the SWRB included: settling test data and results; initial influent sampling; historical effluent pumpout data; solids loading calculations; and maintenance of the SWRB. (For further details concerning this Section (3.0) reference the "Study of Solids Loading and Solids Settling in the FMPC Biodenitrification Surge Lagoon and Stormwater Retention Basin" (Task 4 of OEPA Director Findings & Orders), submitted to the OEPA on June 1, 1987).

3.1 Settling Test Data and Results

A controlled settling test was performed on a composite sample of stormwater runoff that was collected during the April 14, 1987 storm event. The test objective was to characterize the quiescent settling

of influent total suspended solids (TSS). TSS was periodically measured at three different levels in an 8 foot lexan settling column throughout a three day test. The TSS results were plotted against time to establish a curve that depicts the settling rate of TSS in the stormwater runoff from the FMPC process area. Results from the test indicated that approximately 24 hours of quiescent settling was required to produce a water quality of less than 30-40 mg/l of TSS (see Figure 6). A second settling test was performed on a composite sample taken from a rainfall event that occurred on June 3, 1987. Nearly identical results were achieved in this second test (see Figure 7).

3.2 Influent Sampling

Grab samples of stormwater runoff were taken at the entrance to the SWRB. The grab samples were combined in the test column to form a composite sample which was assumed to be characteristic of SWRB content. Initial (time zero) samples for the first settling column test were withdrawn from the column sequentially from top to bottom. This allowed sufficient time differential for significant settling differences. For this reason, the initial (time zero) samples of the settling test showed significant differences in initial TSS levels and were compensated for by averaging to 226 ppm TSS. In conducting the second settling test, this problem was eliminated by withdrawing the initial samples from the column while it was being mixed using an air line at the bottom of the column. For the second settling test the initial TSS samples were much closer in value than in the first test, therefore there was no need for averaging (see Figure 7).

3.3 Historical Effluent Pumpout Data

An analysis of the TSS levels discharged to the Great Miami River from the SWRB was performed in response to Order No. 4. The purpose of this study was to determine the average discharge TSS level that could be expected from the existing SWRB.

The SWRB discharge to the Great Miami River is routinely sampled. Samples are taken at four hour intervals during the operation of the SWRB effluent discharge pumping system. Samples taken during the course of a calendar day are averaged and the composite value is entered into the laboratory log book for that day.

The results of this study showed that the average effluent concentration of TSS from the existing SWRB is 41 ppm.

3.4 Solids Loading.

The estimated net solids loading to the SWRB was based on an average 40 inches of yearly rainfall experienced in Hamilton County, Ohio and on an average influent concentration of 226 mg/L TSS. Based on a composite stormwater runoff coefficient for the FMPC process area of 0.55, the yearly volume of stormwater runoff collected in the SWRB is approximately 96 million gallons (these values will change slightly with the expansion of the SWRB). The calculated solids loading in the SWRB, based on an average influent TSS of 226 ppm and an average effluent TSS of 41 ppm, yields a total solids loading of 147,465 lbs./year (66,890 kg/yr.) for the existing SWRB.

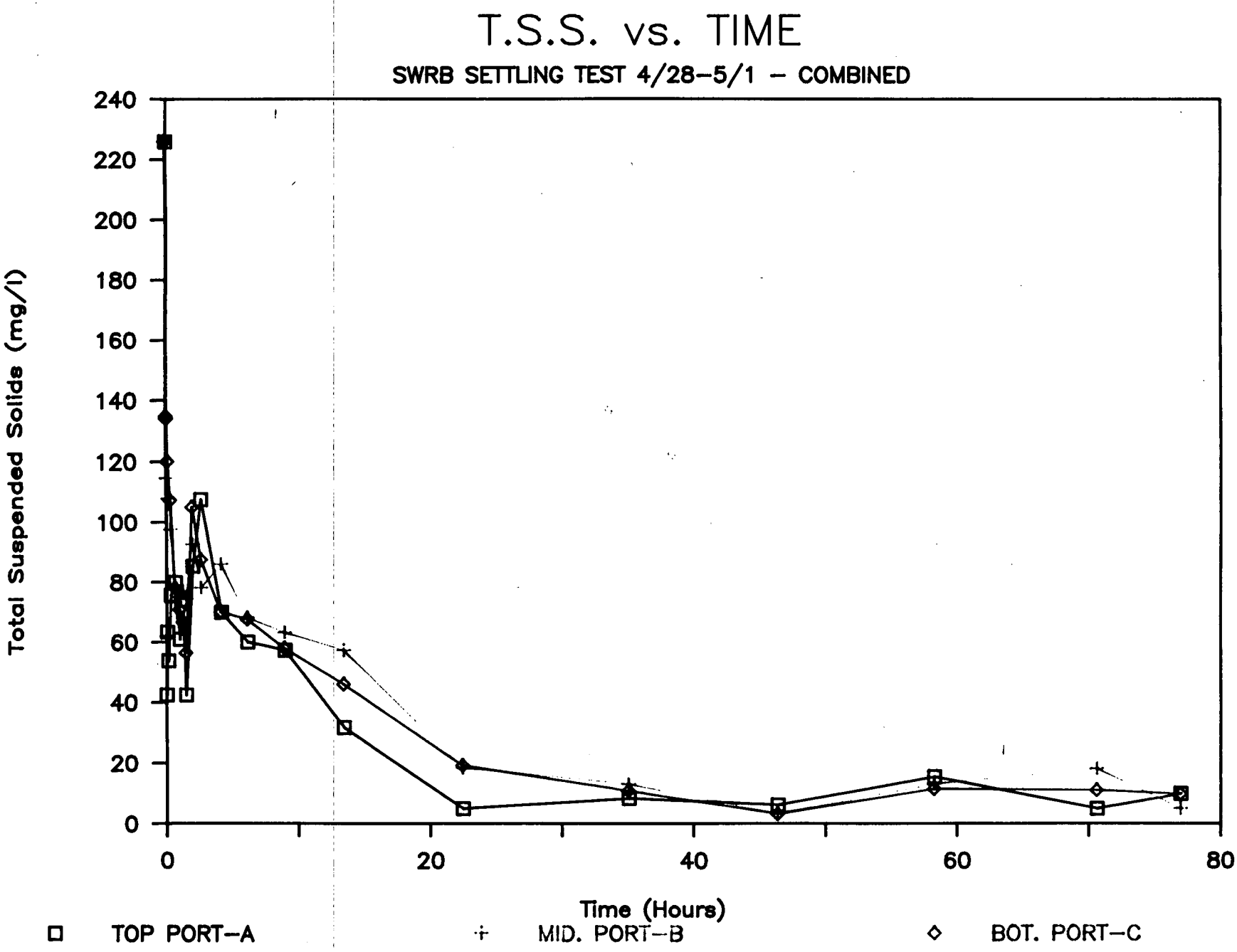

T.S.S. vs. TIME
SWRB SETTLING TEST 4/28-5/1 - COMBINED
Total Suspended Solids (mg/l)
240
220
200
180
160
140
120
100
80
60
40
20
0
0
20
40
60
80
Time (Hours)
TOP PORT-A
MID. PORT-B
BOT. PORT-C

Figure 6

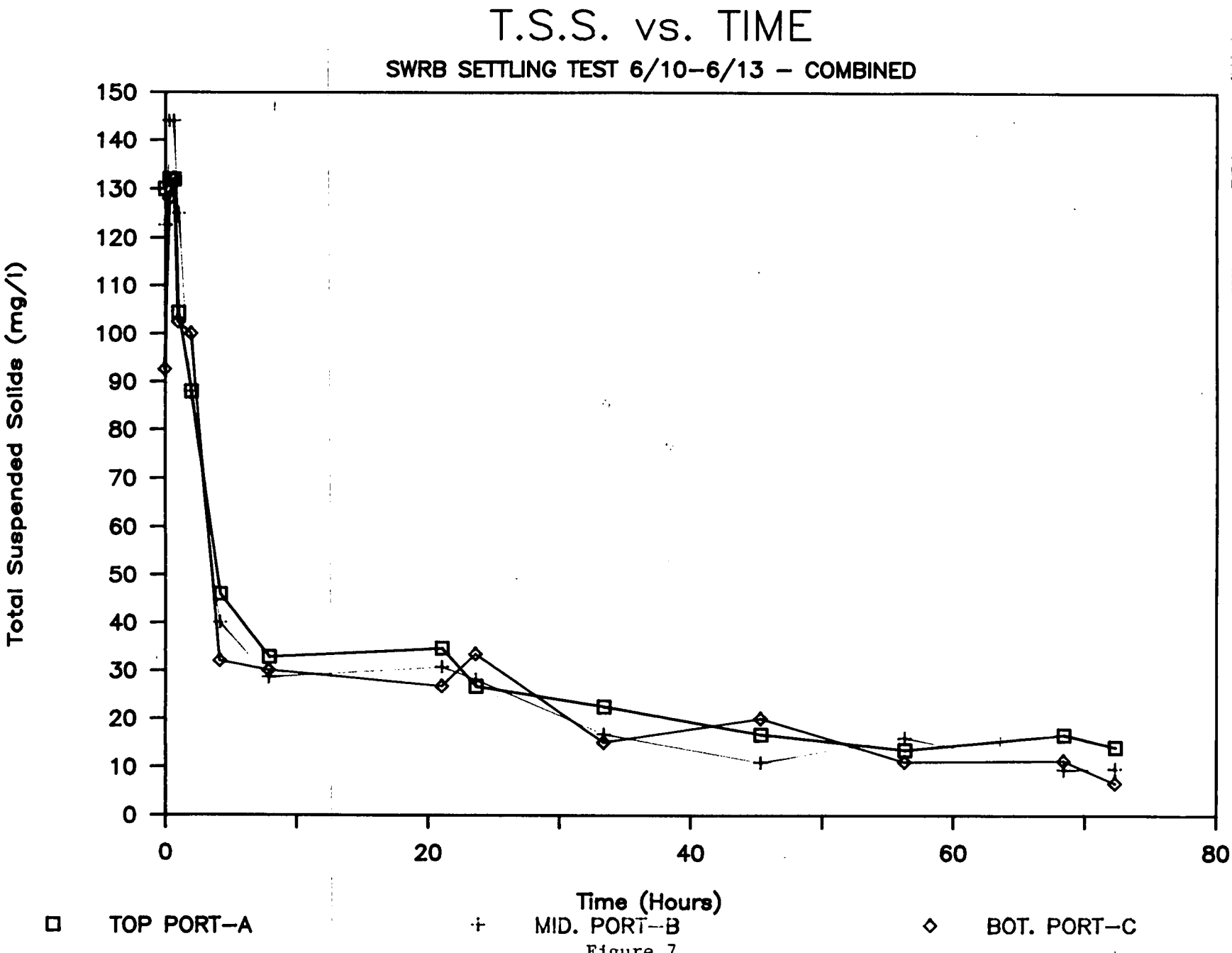

T.S.S. vs. TIME
SWRB SETTLING TEST 6/10-6/13 - COMBINED
Total Suspended Solids (mg/l)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
Time (Hours)
TOP PORT-A
MID. PORT-B
BOT. PORT-C

Figure 7

3.5 Maintenance

The cleanout of the existing SWRB is based on when the accumulated sediments reach an average depth of approximately six (6) inches. This represents a volume of approximately 150,000 gallons of sediment. The dry solids content of the sediment has been estimated to be about 15%. With this factor in mind, the amount of sediment that will accumulate in a given year will be approximately 118,000 gallons. With the existing 6.5 million gallon basin, this accumulation rate requires a cleanout frequency of approximately every 1.3 years. However, a conservative cleanout schedule of once per year will be followed for the existing basin. An updated maintenance schedule will be provided in the PTI for the expanded SWRB.

4.0 DISCUSSION OF STUDY TASKS FOR EXISTING SWRB (Order No. 5)

On April 29, 1987 the FMPC issued the "Workplan for the Study of the Existing FMPC Stormwater Retention Basin" to the Ohio EPA in response to Order No. 5 of the DFO's. On May 27, 1987 the Ohio EPA issued comments on the workplan to the FMPC. A response to these comments was prepared and issued to the Ohio EPA on June 26, 1987. The response included some modification to the original workplan. The following describes the revised actions taken and conclusions drawn from investigations to minimize the environmental impact to Paddys Run and other portions of the environment caused by any surface water leakage, overflow, or bypass of the currently installed SWRB at the FMPC.

4.1 Surface Water Leak Detection

Objective: The objective of this section was to minimize future environmental impacts due to surface water leaks in the synthetic liner of the SWRB.

4.1.1 Scope of Work

The existing SWRB has an underdrain collection system that is used to collect any water that may pass through the synthetic membrane inner liner. A ground water interception system has also been installed beneath the clay, outer liner. Both of these drainage systems discharge to a common sump and are pumped into the SWRB on a regular basis. Because of the need to pump the underdrain sump on a regular basis, it is obvious that there exists a relatively steady flow from the overall underdrain systems. However, it is necessary to differentiate the source of this flow. In an effort to accomplish this, the tasks detailed below were performed.

4.1.2 Description and Resolution of Tasks

4.1.2.1 Task 1

Description: Perform a review of available flow information for the underdrain system to determine if a correlation can be identified between the volume of collected water and other factors which may have an influence.

Resolution: A review of the available flow information for the SWRB underdrain pumping system has been completed. The flow data that exists for the underdrain sump system consists of recorded measures of pumping times that were logged during the regular pumpout of the SWRB underdrain sump.

The vast majority of this data is based on pumping out of the sump using both of the existing 100 gallon/minute pumps. Therefore, the volume of collected water was calculated by multiplying the pump time by 200 gallons/minute. An approximate arithmetic average of this information for the time period between January 15, 1987 and August 31, 1987 was 1450 gallons/day (for detailed daily volumes see Appendix A).

The flows into the SWRB underdrain sump were observed on several occasions and were individually measured once. The visual inspections of the sump flows revealed some fluctuations in flow from the groundwater interception drains but only various degrees of dripping from the underdrain collection piping.

4.1.2.2 Task 2

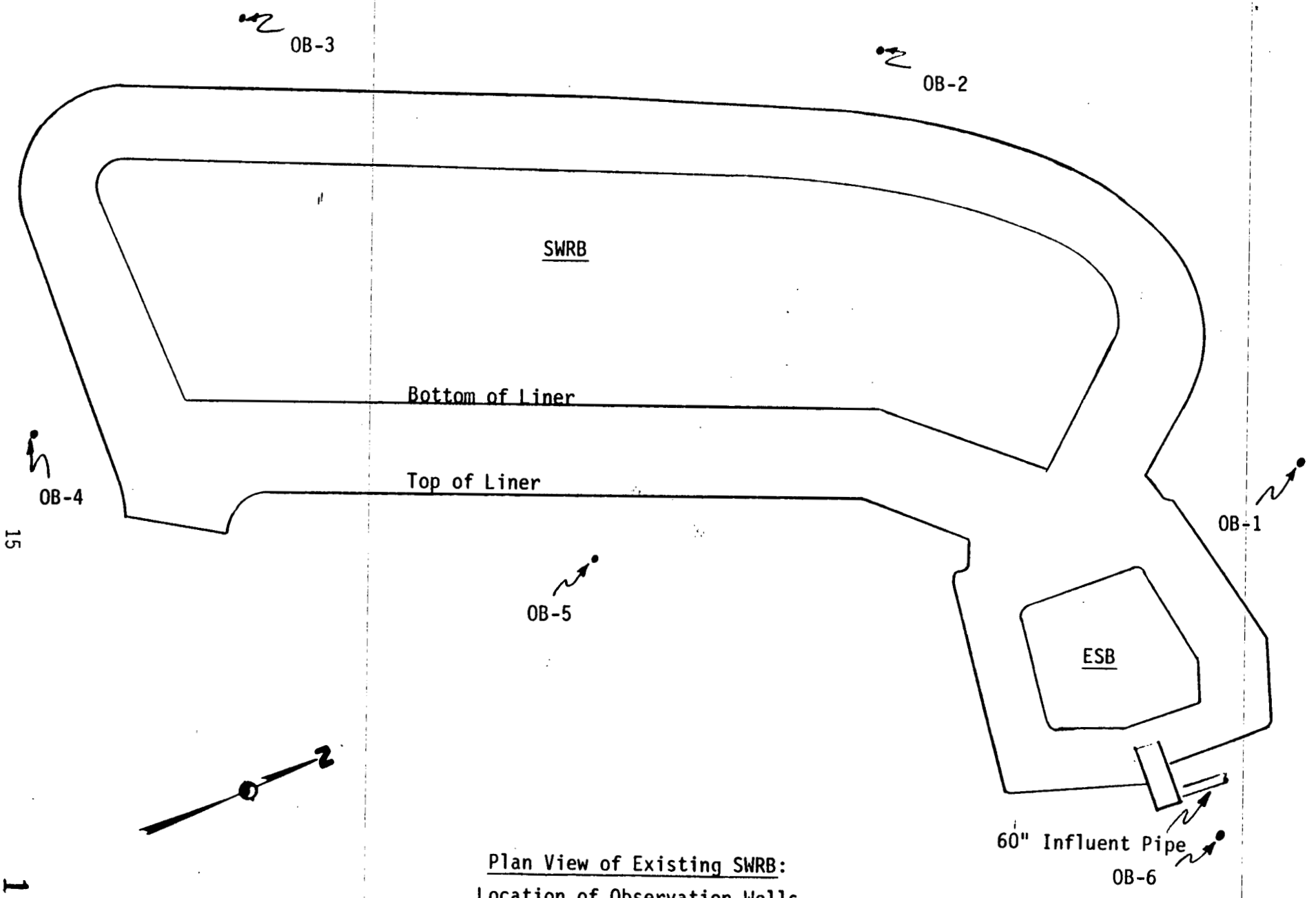
Description: Collect additional data such as water from the underdrains, groundwater interception drain, and the basin, as required to determine the source of water collected in the underdrain system. Data collected may include a dye test in the SWRB.

Resolution: Information collected to date that could aid in the determination of the source of water collected in the underdrain system includes observation well water levels; measurement of the groundwater interception drain flow; and observations of the underdrain flows.

Observation well data has been collected for the past several months and is presented below.

Well	6/5/87	6/25/87	7/2/87	7/16/87	7/23/87	8/26/87
OB-1	546.63′	546.63′	546.46′	546.70′	546.79′	546.88′
OB-2	563.81′	562.23′	561.98′	563.56′	562.65′	560.40′
OB-3	DRY	DRY	DRY	DRY	DRY	DRY
OB-4	DRY	DRY	DRY	DRY	DRY	DRY
OB-5	DRY	DRY	DRY	DRY	DRY	DRY
OB-6	DRY	DRY	DRY	DRY	DRY	DRY

The data presented in this table lists the elevations of water in the six observation wells (for locations see Figure 8). It can be seen that the water level in Well OB-2 is consistently higher in elevation than the high point of the groundwater drains (see Figure 5). It was observed that the water level fluctuations in OB-2 roughly correspond to fluctuations in the SWRB underdrain sump pumpout volumes presented in Appendix A.



Plan View of Existing SWRB:
Location of Observation Wells

Figure 8

A measurement of the groundwater interception drain flow was performed on June 26, 1987. This measurement was taken using a container of known volume and timed for five minutes. This indicated a flow of 0.625 gallons/minute, which, when extrapolated, is a volume of approximately 900 gallons/day. When compared to flow data of late June (Appendix A) this seems consistent. Any difference between this measured flow and the pumpout underdrain flows should not be construed as leakage from the basin. 2989

All attempts to measure the flow from the underdrain collection system proved unsuccessful. All observations of these drains showed either no flow or only slient dripping. It is therefore estimated that the flow from the groundwater underdrain can vary significantly. It has been observed that the SWRB underdrain collection piping makes only a very minor contribution to the total flow into the sump as the flows contributed by the underdrain system were observed to be only dripping flows or no flow at all. Because of these observations the dye test was not considered necessary.

4.1.2.3 Task 3

Description: Determine the Best Available Demonstrated Technology (BADT) leakage rate for the synthetic liner.

Resolution: A BADT leakage rate value for a synthetic FML, 40 gallons per day per acre of surface area of liner was presented at the July Technical Information Exchange meeting (see minutes from July Technical Information Exchange). This information was obtained from a presentation at the Thirteenth Annual U. S. EPA Research Symposium in Cincinnati, Ohio, May 6-9, 1987. No flows near this quantity have been observed from the underdrains of the SWRB.

4.1.2.4 Task 4

Description: Perform a visual inspection of the SWRB for tears or holes.

Resolution: A visual inspection of the SWRB was performed on June 5 and 25, 1987 in order to locate and identify any tears or holes that may exist in the basin liner. There were no observable holes or tears in the liner. This is verified by the low flow in the underdrains.

4.1.2.5 Task 5

Description: If leakage is documented in the findings of tasks 1-4 and is greater than the BADT limit determined in the task 3, the FMPC will prepare a corrective action plan which comments on the feasibility of making liner repairs. If leakage is detected and the liner can easily be repaired - the repair will be made. If leakage greater than BADT is detected and repairs are difficult, Ohio EPA and the FMPC will jointly evaluate the options available and their overall feasibility.

Resolution: Based on several visual observations of flows to the underdrain sump, the underdrain flows appear to be well below the BADT limits. Therefore, no corrective action is anticipated at this time. The groundwater interception and underdrain flows will be separated as documented below as part of the proposed basin expansion scope of work. The separated drains can then be monitored on a regular basis as each is pumped out.

4.1.2.6 Task 6

Description: Separate the underdrains from the groundwater drains, if feasible.

Resolution: An inspection of the SWRB underdrain sump was conducted in order to investigate the feasibility of separating the underdrain flow from the groundwater interception flow. The result of this inspection showed that it would be possible to separate the flows. These could be accomplished by installing a partition into the sump. In addition to this it would also be necessary to extend the six inch groundwater interception line over this partition and to install a small submersible pump in the underdrain portion of the divided sump. By doing this, the volume of flow into each of the sumps can be individually measured. The conceptual design for this separation is presented in Figure 9.

4.1.2.7 Task 7

Description: Collect data from the separated underdrains and groundwater drains.

Resolution: Since the separation of the SWRB underdrain sump has not been completed at this time, no data has been collected to this date. As soon as the separation is completed, the gathering of this data will commence.

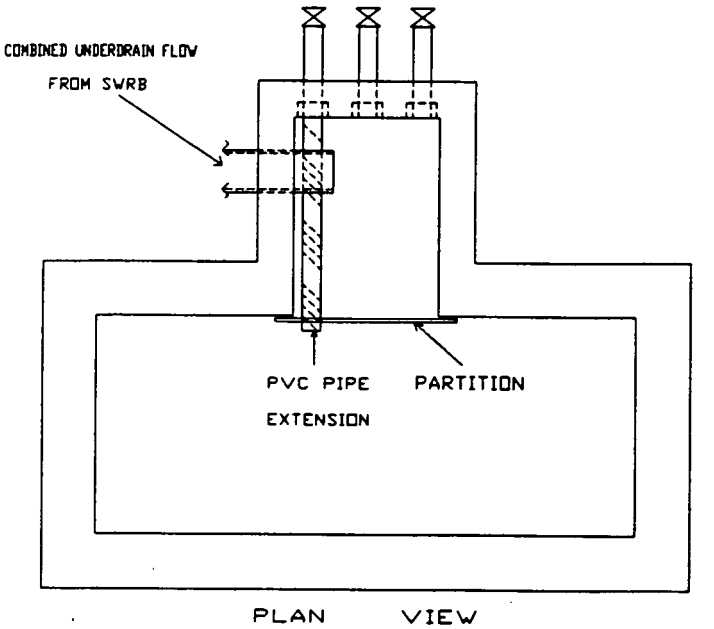
4.2 Overflow of the SWRB

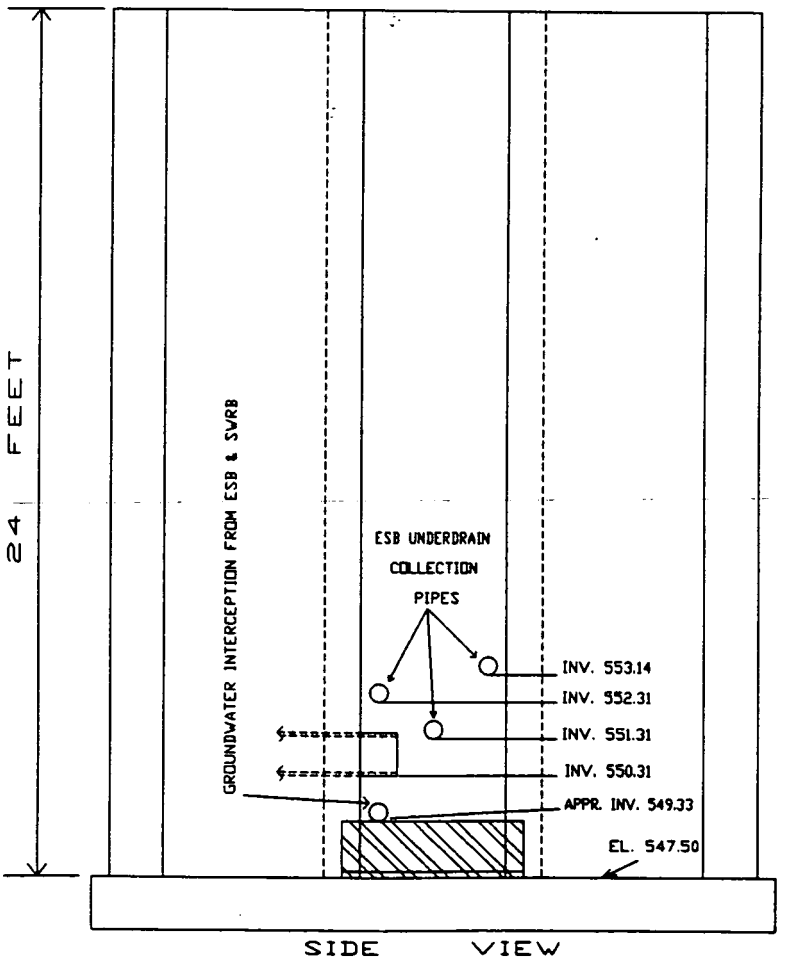
Objective: The objective of this program is to minimize the quantity of Total Suspended Solids (TSS) released into the environment during SWRB overflow events.

4.2.1 Scope of Work

The existing SWRB has a total volume of approximately 6.5 million gallons and can contain (with pumpout) approximately a 2-year, 24-hour frequency, storm event. In the event that a storm of greater total volume, or a series of smaller storms with a greater total volume, is encountered, the SWRB will overflow its emergency spillway and discharge into Paddys run. In order to minimize the quantity of TSS that is released into the environment, the tasks detailed below were performed.

FIGURE 9. PROPOSED SWRB UNDERDRAIN SUMP SEPARATION





4.2.2 Description and Resolution of Tasks

4.2.2.1 Task 1

Description: Review existing TSS and flow data for inflows to the SWRB during past overflow events.

Resolution: A review of existing TSS and flow data from past overflow events was completed. The overflows that occurred on November 26, 1986, December 1, 2, & 3, 1986, and on July 13, 1987 are summarized in Appendix B. This information was taken from SWRB overflow reports that were forwarded to the OEPA after each of the events. In these reports, the general occurrence of higher effluent suspended solids than the influent suspended solids was attributed to sampling location and technique. Sampling location was felt to be a contributing factor since the relative velocity of the water was higher at the emergency overflow when compared to the entrance to the SWRB.

4.2.2.2 Task 2

Description Based on the data obtained from the settling test performed as part of the response to Order #4, determine if resuspension of sediment in the SWRB is occurring during an overflow event.

Resolution: In order to characterize if resuspension is occurring within the SWRB, very precise flow and suspended solids monitoring are needed. However, at this time only relatively crude monitoring of this intricate system has been achieved. Therefore, only data that was obtained during the sampling for the settling tests and the effluent information obtained during the overflow events can be used to determine if overall resuspension is occurring within the SWRB. For the purposes of this task, overall resuspension will be defined as a net increase in effluent TSS measurements with respect to the inflow TSS measurements.

It should be noted that the SWRB operates in a manner slightly different than a conventional settling basin. The most notable difference is the fact that the SWRB is pumped out between storm events.

It is generally judged that the most concentrated influent TSS enters the SWRB during the "first flush" of a storm event. Analysis of the samples taken from the storm event of June 3, 1987 showed an average TSS of 226 mg/l. It is felt that this range of TSS is typical for major storm events during the early hours. When this date is compared to overflow TSS data from each of the overflow events (presented below and detailed in Appendix B), a net decrease of TSS is seemingly achieved in the SWRB.

Event (date)	Average Overflow TSS (ppm)
1 (11/26/86)	78
2 (12/2-3/86)	23
3 (07/13/87)	49

This overflow data shows that a net decrease of TSS is seemingly achieved in the SWRB when compared to the amounts of TSS in the previously listed influent samples.

The above information leads to two other scenarios which can assist in explaining the noted increase in TSS levels documented in the previously investigated overflow events.

Scenario 1: It is possible that this first flush of runoff containing relatively high TSS levels moves through the SWRB as a plug flow. Hours later, when the overflow occurs, and the first flush has passed, the influent TSS level has dropped significantly. However, this inflow volume displaces an equal volume of the first flush inflow which is now positioned adjacent to the spillway. This plug flow overflows the emergency spillway to Paddys Run. The water which overflows could, therefore, while appearing to have an increase in TSS, actually have had a TSS level much higher than the current inflow and could be a substantially reduced TSS value from that which existed during its inflow.

Scenario 2: When the basin overflows, the 60 inch influent pipe is surcharged essentially to the crown of the pipe. It is estimated that approximately 200,000 gallons of water is backed up in the storm sewer piping system at that time. Therefore, settling of the influent could be occurring in the pipe. This indicates that the TSS measured for influent is not truly representative of the original runoff TSS level. This rapid settling of the bulk of the material was also observed during the first settling test when the initial samples were withdrawn from the column.

Closer monitoring of storm events of large magnitude would need to be incorporated into the monitoring of the overflow events. These events can not be accurately modeled if the data collected is only that which occurs after the overflow commences. Much of this data can now be obtained with the aid of new, in line, flow monitoring equipment that has recently been purchased at the FMPC.

In reviewing the influent and effluent data during overflow events it can be concluded that the SWRB is effective in achieving a net decrease in TSS relative to the influent and effluent flows. Therefore it is believed that resuspension of solids in the SWRB is not occurring in a manner that would significantly affect the quality of water that would be released during an overflow event.

Additional investigations into the resuspension of sediment were performed. Calculations based on Stoke's law of sedimentation and settling velocities in the settling column test were performed in order to determine what size particles could be theorized to settle within the time constraints of the test (See Appendix C). Other calculations were performed to determine a Scouring Velocity for an average cross section of the SWRB, and then back-calculated to determine the maximum particle size that would be disturbed (resuspended) at this velocity (See Appendix C). In summary these calculations show that the maximum particle to be resuspended by horizontal flows in the SWRB has a diameter of 0.88 microns (0.000088 cm). The particles that would have settled in a reasonable amount of time are much larger than this and therefore particles this small should be considered too small to effectively settle in the first place. Although several assumptions were made in performing these calculations the results support the above findings that significant resuspension does not occur in the SWRB.

4.2.2.3 Task 3

Description: If resuspension is occurring in the SWRB during an overflow event, evaluate techniques for reducing hydraulic turbulence within the basin.

Resolution: In the Resolution of Task 2 it was determined that significant resuspension of particles was not occurring during an overflow event.

4.2.2.4 Task 4

Description: Based on the results of Tasks 1,2, and 3, evaluate alternatives and recommend actions to be taken to minimize TSS released during an overflow event.

Resolution: No practical actions were found which could minimize TSS released during an overflow event, However, since resuspension of sediment is not thought to be a major problem and a parallel expansion to the existing basin is to be constructed by December 1988, no actions were felt to be necessary.

4.3 Bypass of the Storm Sewer System

Objective: The objective of this program is to determine if all stormwater runoff from the FMPC process area is being collected and directed to the SWRB.

4.3.1 Scope of Work

In general the areas contributing to the SWRB are the FMPC process area and the parking lots to the south of the process area. In order to more precisely determine the boundaries of these contributing areas, the tasks detailed below were performed.

4.3.2 Description and Resolution of Tasks

4.3.2.1 Task 1

Description: Inspect the FMPC process area boundaries during storm events to verify that runoff is being channeled to the SWRB.

Resolution: In May, 1986 a photogrammetric topography study was conducted. Using information generated by this study, drainage areas around the perimeter of the production area fenceline were located on topographic maps. Then those areas were observed in the field during and after storm events in order to verify the topographic maps.

This study indicates that while the production area fenceline was appropriate enough to define the SWRB drainage area for purposes of calculating the quantity of stormwater runoff to SWRB, it does not precisely define the actual drainage area. The existing drainage area contributing to the SWRB is more precisely described by Figure 4 and Appendix D. As can be seen from these drawings, areas not presently being collected include the north, northwest, and southeast perimeter areas of the process area and the southeast corner of the parking lot.

4.3.2.2 Task 2

Description: If process areas are found where stormwater is not flowing to the SWRB, identify those actions necessary to redirect the runoff to the basin.

Resolution: Field inspection of the process area boundaries along with the aid of the topographic study indicates several "process" areas that do not contribute to the drainage area that empties into the SWRB.

A new building was recently constructed on the east perimeter of the plant in the uncollected area. The roof drainage from the building has been tied into the FMPC storm sewer system (see Appendix D). Drainage on the northwest edge of the plant which drains toward the waste pit area was found to contain a low level of contamination. A project (PA #40-86602) has been developed to redirect the drainage of the north west area (near Plant 1 Storage Pad) into the storm sewer system. Other areas lot collected are not actively used for production operations and no redirection of flows is presently considered necessary. Seventeen perimeter drainage sub-basins have been defined and sampled during rainfall events. Two rounds of sampling have been taken on April 23 and July 28, 1987. The runoff was found to be substantially below levels acceptable for discharge to uncontrolled areas in accordance with DOE guidelines. Additionally, sampling is planned for those areas to confirm the initial results.

5.0 DISCUSSION OF SWRB EXPANSION (Order No. 7)

The following sections are intended to address the future expansion of the SWRB. Below are the three areas of concern which were discussed in the previous section for the existing SWRB to fulfill the response to DFO No. 7.

5.1 Surface Water Leak Detection

The proposed basin expansion will also have a double-liner system. The inner liner (the liner in direct contact with the water) will be a flexible membrane liner. The outer liner will be 18 inches of Bentonite and soil mixture. Between the two liners will be an underdrain collection system. The collection system will detect and collect any leak in the synthetic liner. The underdrain collection system will flow by gravity to a new sump where it can be monitored before being pumped back into the new chamber. The liner will be an ultraviolet light and oil solvent resistant, synthetic liner. The liner system will not leak more than 40 gallons/acre/day into the underdrain collection system. If leakage exceeds this quantity, leak detection measures will be initiated and the source(s) repaired. Water collected will be removed from the new chamber via a floating outlet structure. Discharged water will flow by gravity to the existing pump sump located to the north of the existing east chamber.

A perched groundwater table exists in the area where the proposed SWRB expansion is to be located. Therefore, the new chamber will be provided with a groundwater interception system. All collected groundwater will be pumped into the new chamber. Gas vents will be installed at 50 feet centers around the basin perimeter.

5.2 Overflow of the SWRB

Sluice gates will be installed at the entrances to each of the two large chambers. The height of the gates will be set to allow automatic overflow of the full 60 inch incoming pipe flow to either chamber upon filling of the first chamber to the height of the shutoff gate. After one chamber is filled to a level which results in overflow to the other chamber, the first chamber's gate will be closed and the second chamber's gate opened. The first chamber will then be allowed to remain quiescent for 24 hours before pumpout begins. During large storm events, once the second chamber's water level reaches that of the first chamber, the chambers will begin to continue filling simultaneously. At this point, discharge pumping will begin simultaneously from both chambers at a combined outflow rate of 300 gpm. This simultaneous pumping is done in an effort to minimize the possibility of an overflow occurring. Since water will be pumped from each chamber at the same time, the surface overflow rate will be reduced to the existing chamber. Reducing the surface overflow rate combined with allowing some quiescent settling of the first flush of runoff accumulated in the initial chamber should decrease the level of TSS in the water that is being pumped.

The estimated capacity of the sixty (60) inch storm sewer line (the discharge pipe into the SWRB) is 135 cubic feet per second. The design height of the shutoff gates will be based on the clearance required to flow 135 cubic feet per second over the top of an individual gate. The

height of the wake caused by this rate of water flowing over the top of the gate is estimated to be 2.7 feet. Therefore, the top of the half gates will be approximately 2.7 feet below the crown of the 60 inch main. The volume of water that will be contained in both basins at the height of the top of the half gates will be a minimum of 7.6 million gallons.

If both chambers fill beyond their design capacity, an overflow will occur at the existing west chamber's emergency overflow spillway.

The Storm Basin Transfer Pump Station has the ability to withdraw from any, all, or a combination of the three basins by the use of the shutoff gates that cover the inlet pipes to the sump. When a basin is to be emptied, the gate to the appropriate inlet pipe to the sump will be opened. Water will flow by gravity from the respective chamber's 'floating inlet structure' to the Storm Basin Transfer Pump Sump. The sump's pump will discharge this water at a rate of approximately 300 gpm to Manhole No. 175 where it will flow by gravity to the Great Miami River.

5.3 Bypass of the Storm Sewer System

See section 4.3 Bypass of the Storm Sewer System for a description of measures to be taken to address bypass of the SWRB.

APPENDIX A

SWRB UNDERDRAIN SUMP PUMPOUT VOLUMES

DATE	PUMP TIME (MIN	VOLUME (GALLONS)
01 /15 /87	20	4000
01 /16 /87	11	2200
01 /17 /87	15	3000
01 /18 /87	14	2800
01 /19 /87	15	3000
01 /20 /87	12	2400
01 /21 /87	11	2200
01 /22 /87	12	2400
01 /23 /87	11	2200
01 /24 /87	0	0
01 /25 /87	16	3200
01 /26 /87	22	4400
01 /27 /87	12	2400
01 /28 /87	13	2600
01 /29 /87	9	1800
01 /30 /87	10	2000
01 /31 /87	15	3000
02 / 1 /87	18	3600
02 / 2 /87	10	2000
02 / 3 /87	12	2400
02 / 4 /87	9	1800
02 / 5 /87	7.5	1500
02 / 6 /87	8	1600
02 / 7 /87	8	1600
02 / 8 /87	7.5	1500
02 / 9 /87	13	1300
02 /10 /87	7	1400
02 /11 /87	7	1400
02 /12 /87	8	1600
02 /13 /87	6	1200
02 /14 /87	7	1400
02 /15 /87	8	1600
02 /16 /87	6	1200
02 /17 /87	6	1200
02 /18 /87	9	1800
02 /19 /87	14	2800
02 /20 /87	16	3200
02 /21 /87	8	1600
02 /22 /87	6	1200
02 /23 /87	6	1200
02 /24 /87	6	1200
02 /25 /87	8	1600
02 /26 /87	10	2000
02 /27 /87	15	3000
02 /28 /87	0	0
03 / 1 /87	0	0
03 / 2 /87	17	3400
03 / 3 /87	15	3000

SWRB UNDERDRAIN SUMP PUMPOUT VOLUMES

DATE	PUMP TIME (MIN	VOLUME (GALLONS)
03 / 4 /87	0	0
03 / 5 /87	0	0
03 / 6 /87	21	4200
03 / 7 /87	0	0
03 / 8 /87	12	2400
03 / 9 /87	11	2200
03 /10 /87	12	2400
03 /11 /87	16	3200
03 /12 /87	8	1600
03 /13 /87	0	0
03 /14 /87	15	3000
03 /15 /87	8.5	1700
03 /16 /87	13	2600
03 /17 /87	13	2600
03 /18 /87	10.5	2100
03 /19 /87	0	0
03 /20 /87	0	0
03 /21 /87	0	0
03 /22 /87	0	0
03 /23 /87	0	0
03 /24 /87	0	0
03 /25 /87	18.5	3700
03 /26 /87	13	2600
03 /27 /87	9	1800
03 /28 /87	0	0
03 /29 /87	20	4000
03 /30 /87	0	0
03 /31 /87	26	5200
04 / 1 /87	25	5000
04 / 2 /87	26	5200
04 / 3 /87	20	4000
04 / 4 /87	17	3400
04 / 5 /87	0	0
04 / 6 /87	17	3400
04 / 7 /87	22	4400
04 / 8 /87	15	3000
04 / 9 /87	17	3400
04 /10 /87	14	2800
04 /11 /87	15	3000
04 /12 /87	13	2600
04 /13 /87	14	2800
04 /14 /87	0	0
04 /15 /87	0	0
04 /16 /87	26	5200
04 /17 /87	0	0
04 /18 /87	0	0
04 /19 /87	0	0
04 /20 /87	0	0

SWRB UNDERDRAIN SUMP PUMPOUT VOLUMES

DATE	PUMP TIME (MIN	VOLUME (GALLONS)
04 /21 /87	0	0
04 /22 /87	0	0
04 /23 /87	0	0
04 /24 /87	0	0
04 /25 /87	0	0
04 /26 /87	0	0
04 /27 /87	0	0
04 /28 /87	0	0
04 /29 /87	0	0
04 /30 /87	0	0
05 / 1 /87	0	0
05 / 2 /87	18	3600
05 / 3 /87	18	3600
05 / 4 /87	0	0
05 / 5 /87	0	0
05 / 6 /87	19	3800
05 / 7 /87	0	0
05 / 8 /87	13	2600
05 / 9 /87	0	0
05 /10 /87	0	0
05 /11 /87	23	4600
05 /12 /87	0	0
05 /13 /87	0	0
05 /14 /87	0	0
05 /15 /87	13	2600
05 /16 /87	9	1800
05 /17 /87	0	0
05 /18 /87	0	0
05 /19 /87	10	2000
05 /20 /87	0	0
05 /21 /87	6	1200
05 /22 /87	7	1400
05 /23 /87	7	1400
05 /24 /87	6	1200
05 /25 /87	5	1000
05 /26 /87	13	2600
05 /27 /87	6	1200
05 /28 /87	7	1400
05 /29 /87	8	1600
05 /30 /87	0	0
05 /31 /87	0	0
06 / 1 /87	0	0
06 / 2 /87	0	0
06 / 3 /87	0	0
06 / 4 /87	0	0
06 / 5 /87	20	4000
06 / 6 /87	13	2600
06 / 7 /87	10	2000

SWRB UNDERDRAIN SUMP PUMPOUT VOLUMES

DATE	PUMP TIME (MIN	VOLUME (GALLONS)
06 / 8 /87	7	1400
06 / 9 /87	7	1400
06 /10 /87	6	1200
06 /11 /87	7	1400
06 /12 /87	8	1600
06 /13 /87	0	0
06 /14 /87	8	1600
06 /15 /87	0	0
06 /16 /87	10	2000
06 /17 /87	0	0
06 /18 /87	6	1200
06 /19 /87	0	0
06 /20 /87	0	0
06 /21 /87	13	2600
06 /22 /87	8	1600
06 /23 /87	0	0
06 /24 /87	12	2400
06 /25 /87	5	1000
06 /26 /87	6	1200
06 /27 /87	5	1000
06 /28 /87	5	1000
06 /29 /87	0	0
06 /30 /87	8	1600
07 / 1 /87	0	0
07 / 2 /87	0	0
07 / 3 /87	0	0
07 / 4 /87	5.5	1100
07 / 5 /87	5	1000
07 / 6 /87	0	0
07 / 7 /87	15	3000
07 / 8 /87	0	0
07 / 9 /87	0	0
07 /10 /87	6	1200
07 /11 /87	0	0
07 /12 /87	0	0
07 /13 /87	13	2600
07 /14 /87	20	4000
07 /15 /87	20	4000
07 /16 /87	15	3000
07 /17 /87	17	3400
07 /18 /87	15	3000
07 /19 /87	0	0
07 /20 /87	12	2400
07 /21 /87	10	2000
07 /22 /87	0	0
07 /23 /87	8	1600
07 /24 /87	9	1800
07 /25 /87	9	1800

SWRB UNDERDRAIN SUMP PUMPOUT VOLUMES

DATE	PUMP TIME (MIN	VOLUME (GALLONS)
07 /26 /87	7	1400
07 /27 /87	13	2600
07 /28 /87	7	1400
07 /29 /87	7	1400
07 /30 /87	12	2400
07 /31 /87	6	1200
08 / 1 /87	6	1200
08 / 2 /87	6	1200
08 / 3 /87	6	1200
08 / 4 /87	5	1000
08 / 5 /87	5	1000
08 / 6 /87	0	0
08 / 7 /87	0	0
08 / 8 /87	12	2400
08 / 9 /87	0	0
08 /10 /87	10	2000
08 /11 /87	0	0
08 /12 /87	9	1800
08 /13 /87	4	800
08 /14 /87	0	0
08 /15 /87	0	0
08 /16 /87	0	0
08 /17 /87	12	2400
08 /18 /87	4	800
08 /19 /87	4	800
08 /20 /87	4	800
08 /21 /87	0	0
08 /22 /87	0	0
08 /23 /87	6	1200
08 /24 /87	3	600
08 /25 /87	3.5	700
08 /26 /87	4	800
08 /27 /87	3	600
08 /28 /87	6	1200
08 /29 /87	0	0
08 /30 /87	3	600
08 /31 /87	3	600
AVERAGE	7.272925	1448.908

APPENDIX B

SWRB OVERFLOW DATA 11/26/86

OVERFLOW DATE	TIME (HOURS)	OVERFLOW TSS (ppm)
11/26/86	09:30	97
11/26/86	11:00	88
11/26/86	12:15	88
11/26/86	13:15	97
11/26/86	14:30	80
11/26/86	15:30	105
11/26/86	16:30	79
11/26/86	17:30	102
11/26/86	18:30	87
11/26/86	19:30	66
11/26/86	20:30	50
11/26/86	21:30	80
11/26/86	22:30	67
11/26/86	23:30	41
11/26/86	00:30	47

Average = 78

SWRB OVERFLOW DATA 12/1-3/86

OVERFLOW DATE	TIME (HOURS)	OVERFLOW TSS (ppm)
12/01/86	22:30	39
12/01/86	23:30	43
12/02/86	00:30	42
12/02/86	01:30	27
12/02/86	02:30	22
12/02/86	03:30	31
12/02/86	04:30	22
12/02/86	05:30	29
12/02/86	06:30	27
12/02/86	07:30	17
12/02/86	08:30	25
12/02/86	09:30	3
12/02/86	10:30	22
12/02/86	11:30	26
12/02/86	12:30	16
12/02/86	13:30	10
12/02/86	14:30	17
12/02/86	15:30	3
12/02/86	16:30	32
12/02/86	17:30	3
12/02/86	18:30	36
12/02/86	19:30	11
12/02/86	20:30	10
12/02/86	21:30	10
12/02/86	22:30	22
12/02/86	23:30	44
12/03/86	00:30	33
12/03/86	01:30	18
12/03/86	02:30	11
12/03/86	03:30	26
12/03/86	04:30	3
12/03/86	05:30	59
12/03/86	06:30	23
12/03/86	07:30	26
12/03/86	08:30	21
12/03/86	09:30	32
12/03/86	10:30	24
12/03/86	11:30	13

Average = 23

SWRB OVERFLOW DATA 7/13/87

OVERFLOW DATE	TIME (HOURS)	OVERFLOW TSS (ppm)
07/13/87	01:00	58
07/13/87	02:00	64
07/13/87	03:00	55
07/13/87	04:00	51
07/13/87	05:00	52
07/13/87	07:00	46
07/13/87	09:00	38
07/13/87	11:00	44
07/13/87	13:00	45
07/13/87	14:00	41

Average = 49

APPENDIX C

From known settling velocities - calculate the particle diameters settled by back calculating using Stokes Law.

STOKES LAW: $$V_c = \frac{g\,(\rho_s - \rho)\,d^2}{18\,\mu}$$

g = Acceleration of gravity - 981 cm/sec^2

ρ_s = density of particle - (s.g. = 2.65) $\therefore \rho_s$ = 2.65 (.9982) = 2.645 g/cm^3

ρ = density of water @ 20°C = 0.9982 g/cm^3

d = diameter of particle (cm)

μ = viscosity of water @ 20°C = .01002 g/cm-sec

Solve above equation for d: $$d = \sqrt{\frac{V_c\,(18)\,\mu}{g\,(\rho_s - \rho)}}$$

Note: V_c (ft/min) x 0.508 = V_c (cm/sec)

Substitute and Simplify:

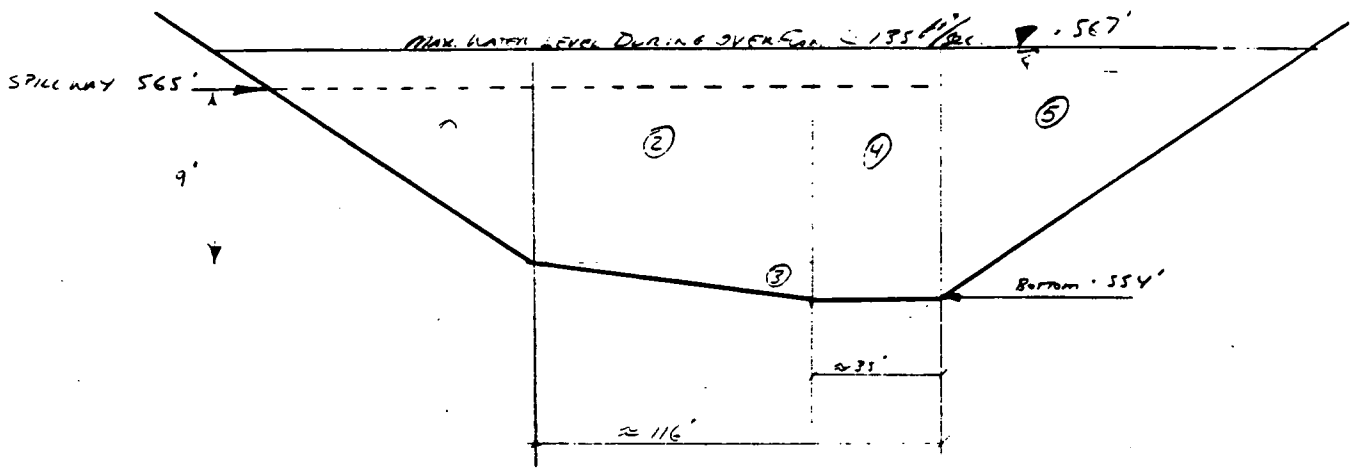
$$d = \sqrt{\frac{(V_c \times .508)\,(18)\,(.01002)}{(981)\,(2.645 - .9882)}} \overset{\text{units}}{=} \sqrt{\frac{(\text{cm/sec})\,(18)\,(\text{g/cm-sec})}{(\text{cm/sec}^2)\,(\text{g/cm}^3)}} = (\text{cm})$$

$$d(\text{cm}) = \sqrt{V_c\ (\text{ft/min}) \times (5.637 \times 10^{-5})}$$

Determine Horizontal in Stormwater Retention Basin @ Overflow:

Flow @ Overflow = 135 ft^3/sec. = Q max

Cross Sectional Area @ Overflow: Given 3:1 Side Slope



TYPICAL X - SECTION THROUGH RECTANGULAR PORTION OF STORMWATER RETENTION BASIN

Area 1:	(1/2) (11' x (3)(11))	=	181.5 ft^2
Area 2:	11'(116' - 35')	=	891.0 ft^2
Area 3:	(1/2) (2' x (3)(2'))	=	6.0 ft^2
Area 4:	13' x 35'	=	455.0 ft^2
Area 5:	(1/2) (13' x 3(13'))	=	253.5 ft^2
	Total Area	=	1787.0 ft^2

$$Q\ max = V_H\ A$$

$$V_H = \frac{Q\ max}{A} = \frac{135\ ft3/sec\left(\frac{60\ sec}{min}\right)}{1787\ ft^2} = 4.53\ feet/min = V_{Horizontal}$$

$$4.53\ ft/min\left(\frac{1\ min}{60\ sec}\right)\cdot\left(\frac{30.48\ cm}{ft}\right) = 2.30\ cm/sec = V_{Horizontal}$$

Scour Velocity:

$$V_H = \left(\frac{8K\ (S-1)gd}{f}\right)^{1/2}$$

V_H = Critical Horizontal Scour Velocity (Set @ $V_{Horizontal}$ for SWRB)

S = Specific Gravity of Particles (2.65)

d = Diameter of Particles Scoured

K = Constant - Depends on Properities of Particles (0.5)

f = Darcy Weisbach Constant (.025)

Substitute Above Values:

$$V_H = \frac{8(.05)(2.65-1)(981\ cm/sec2)\ d}{(.025)}^{1/2}$$

$$V_H = (25{,}898.4\ d)^{1/2}$$

Solve For Particle Diameter: **(Note: V_H must be in cm/sec for d to be in cm)**

$$d = \frac{(VH)^2}{25{,}898.4}$$

Particles Scoured $\longrightarrow$ $d = \frac{(2.30\ cm/sec)^2}{25{,}898.4\ cm/sec^2} = .000088\ cm$

SETTLING COLUMN TEST (4/28 - 5/1) TRIAL A - TOP

ELAPSED TIME (MIN)	SAMPLE DEPTH (IN)	SETTLING VEL. (ft/min)	PARTICLE DIA. (cm)
0	33.50		
2	33.25	1.38542	0.00884
4	33.00	0.68750	0.00623
10	32.50	0.27083	0.00391
20	32.25	0.13438	0.00275
40	32.00	0.06667	0.00194
60	31.75	0.04410	0.00158
75	31.25	0.03472	0.00140
90	30.75	0.02847	0.00127
120	30.50	0.02118	0.00109
159	30.00	0.01572	0.00094
249	29.50	0.00987	0.00075
369	29.00	0.00655	0.00061
539	28.75	0.00444	0.00050
809	27.88	0.00287	0.00040
1349	27.31	0.00169	0.00031
2107	26.50	0.00105	0.00024
2784	25.69	0.00077	0.00021
3499	24.75	0.00059	0.00018
4239	24.00	0.00047	0.00016
4619	23.00	0.00041	0.00015

SETTLING COLUMN TEST (4/28 - 5/1) TRIAL B - MIDDLE

ELAPSED TIME (MIN)	SAMPLE DEPTH (IN)	SETTLING VEL. (ft/min)	PARTICLE DIA. (cm)
0	57.50		
2	57.25	2.38542	0.01160
4	57.00	1.18750	0.00818
10	56.50	0.47083	0.00515
20	56.25	0.23438	0.00363
40	56.00	0.11667	0.00256
60	55.75	0.07743	0.00209
75	55.25	0.06139	0.00186
90	54.75	0.05069	0.00169
120	54.50	0.03785	0.00146
159	54.00	0.02830	0.00126
249	53.50	0.01790	0.00100
369	53.00	0.01197	0.00082
539	52.75	0.00816	0.00068
809	51.88	0.00534	0.00055
1349	51.31	0.00317	0.00042
2107	50.50	0.00200	0.00034
2784	49.69	0.00149	0.00029
3499	48.75	0.00116	0.00026
4239	48.00	0.00094	0.00023
4619	23.00	0.00041	0.00015

SETTLING COLUMN TEST (4/28 - 5/1) TRIAL C - BOTTOM

ELAPSED TIME (MIN)	SAMPLE DEPTH (IN)	SETTLING VEL. (ft/min)	PARTICLE DIA. (cm)
0	81.50		
2	81.25	3.38542	0.01381
4	81.00	1.68750	0.00975
10	80.50	0.67083	0.00615
20	80.25	0.33438	0.00434
40	80.00	0.16667	0.00307
60	79.75	0.11076	0.00250
75	79.25	0.08806	0.00223
90	78.75	0.07292	0.00203
120	78.50	0.05451	0.00175
159	78.00	0.04088	0.00152
249	77.50	0.02594	0.00121
369	77.00	0.01739	0.00099
539	76.75	0.01187	0.00082
809	75.88	0.00782	0.00066
1349	75.31	0.00465	0.00051
2107	74.50	0.00295	0.00041
2784	73.69	0.00221	0.00035
3499	72.34	0.00172	0.00031
4239	72.00	0.00142	0.00028
4619	71.00	0.00128	0.00027

SETTLING COLUMN TEST 6/10 - 6/13 TOP PORT "A"

ELAPSED TIME (MIN)	SAMPLE DEPTH (IN)	SETTLING VEL. (ft/min)	PARTICLE DIA. (cm)
0	18.750		
20	17.250	0.07260	0.00202
40	16.875	0.03498	0.00140
60	15.875	0.02205	0.00111
120	14.875	0.01033	0.00076
250	13.125	0.00437	0.00050
475	12.250	0.00215	0.00035
1265	11.625	0.00077	0.00021
1420	10.750	0.00063	0.00019
2005	9.875	0.00041	0.00015
2720	7.000	0.00021	0.00011
3380	5.750	0.00014	0.00009
4105	4.500	0.00009	0.00007
4340	2.250	0.00004	0.00005

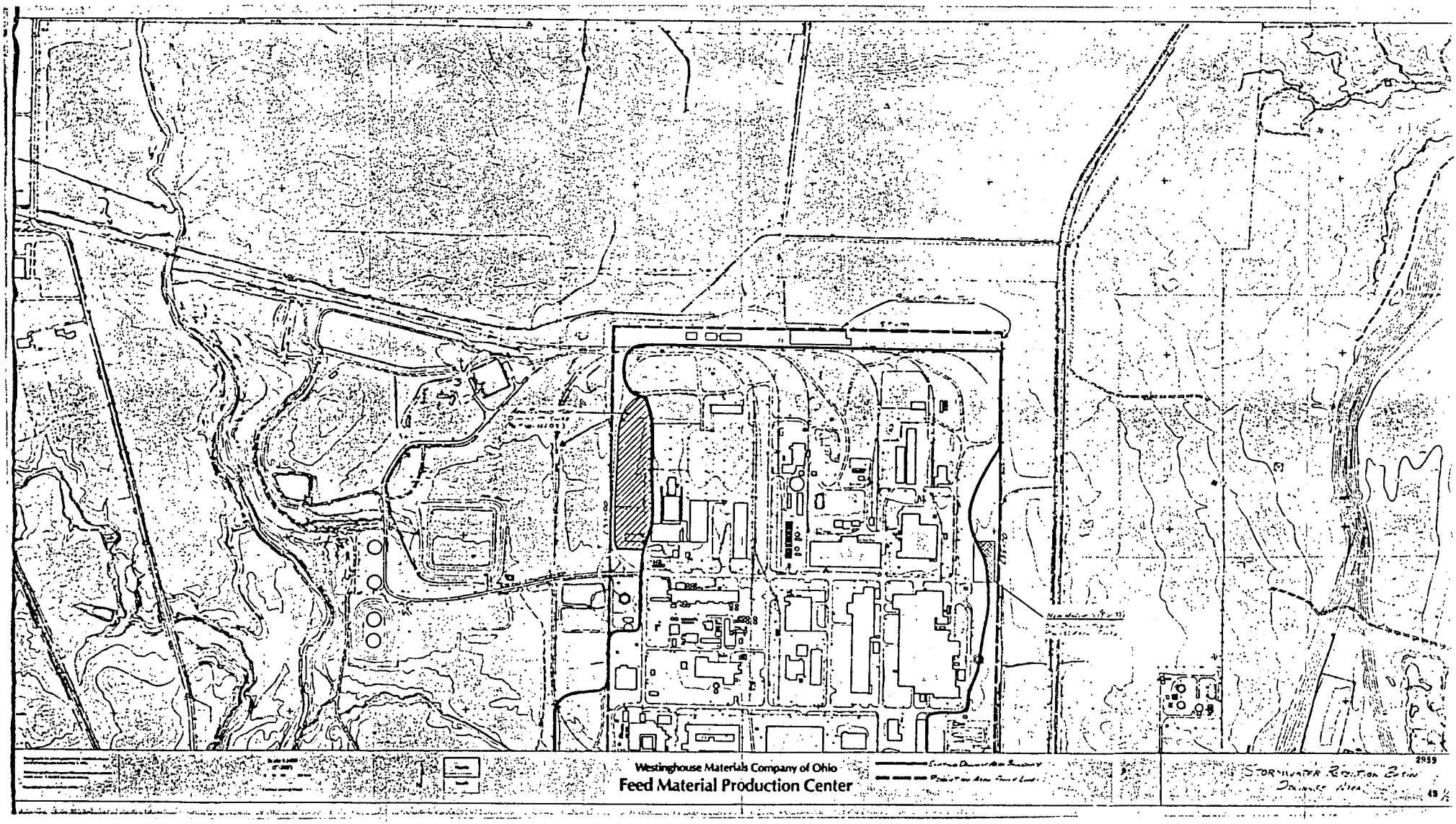
SETTLING COLUMN TEST 6/10 - 6/13 MIDDLE PORT "B"

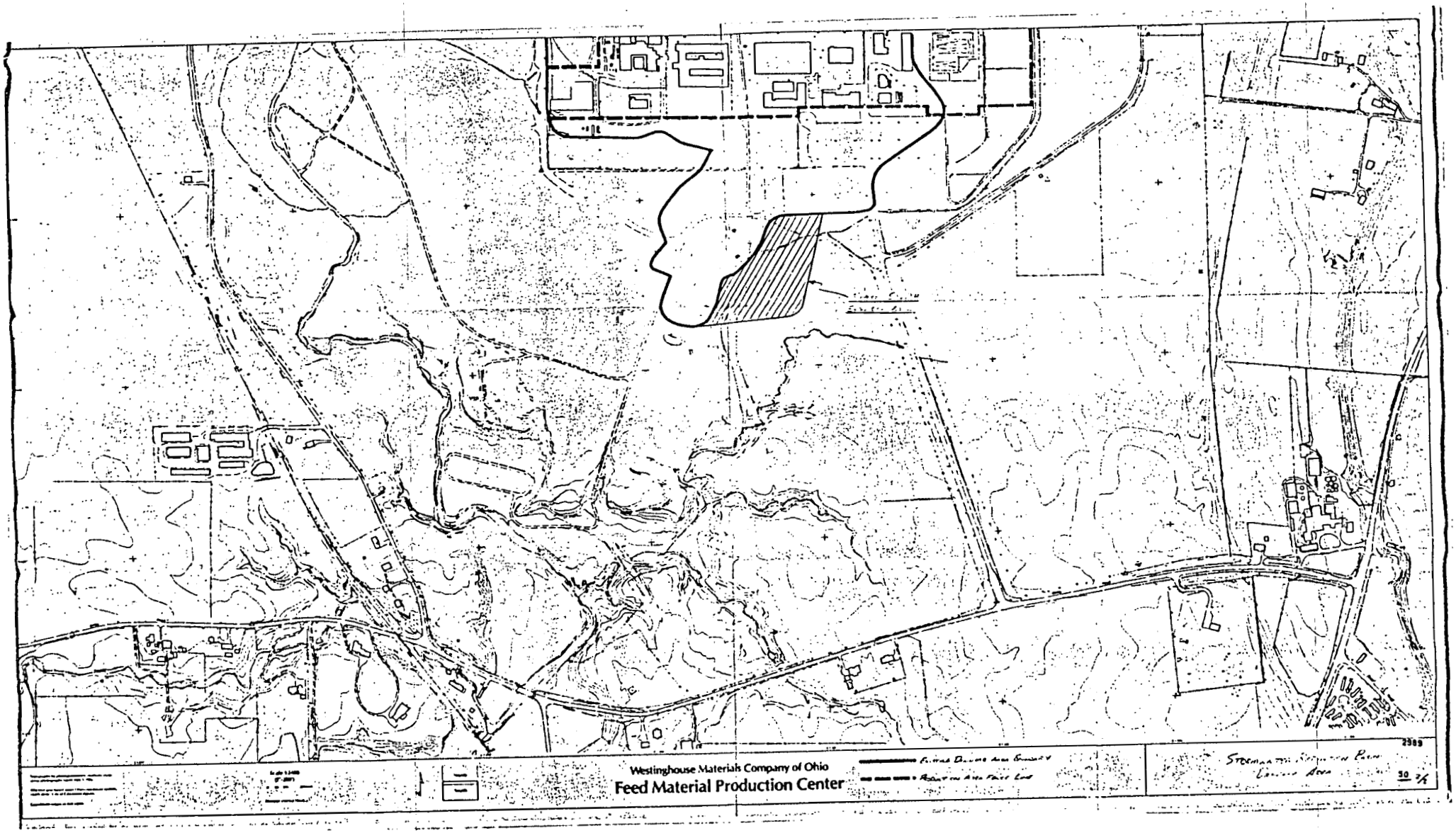
ELAPSED TIME (MIN)	SAMPLE DEPTH (IN)	SETTLING VEL. (ft/min)	PARTICLE DIA. (cm)
0	42.750		
20	41.250	0.17361	0.00313
40	40.875	0.08473	0.00219
60	39.875	0.05538	0.00177
120	38.875	0.02700	0.00123
250	37.125	0.01237	0.00083
475	36.250	0.00636	0.00060
1265	35.625	0.00235	0.00036
1420	34.750	0.00204	0.00034
2005	33.875	0.00141	0.00028
2720	31.000	0.00095	0.00023
3380	29.750	0.00073	0.00020
4105	28.500	0.00058	0.00018
4340	26.250	0.00050	0.00017

SETTLING COLUMN TEST 6/10 - 6/13 BOTTOM PORT "C"

ELAPSED TIME (MIN)	SAMPLE DEPTH (IN)	SETTLING VEL. (ft/min)	PARTICLE DIA. (cm)
0	78.765		
20	77.250	0.32513	0.00428
40	76.875	0.15936	0.00300
60	75.875	0.10538	0.00244
120	74.875	0.05200	0.00171
250	73.125	0.02436	0.00117
475	72.250	0.01267	0.00085
1265	71.625	0.00472	0.00052
1420	70.750	0.00415	0.00048
2005	69.875	0.00290	0.00040
2720	67.000	0.00205	0.00034
3380	65.750	0.00162	0.00030
4105	64.500	0.00131	0.00027
4340	62.250	0.00120	0.00026

APPENDIX D


Westinghouse Materials Company of Ohio
Feed Material Production Center
Storm Water Retention Basin
Drainage Area


Westinghouse Materials Company of Ohio
Feed Material Production Center

Topography by photogrammetric methods from aerial photographs taken May 3, 1986.

1000 foot grid based upon Ohio coordinate system, south zone. City of Cincinnati datum.

Coordinate values in feet x1000.

Scale 1:2400
(1"=200')
0 50 100 200 feet

Contour interval 1 foot.

N

North
South

Westinghouse Materials Company of Ohio
Feed Material Production Center

Existing Drainage Area Boundary
Production Area Fence Line

2989

Stormwater Retention Basin
Drainage Area

49 1/2

Topography by photogrammetric methods from aerial photographs taken May 3, 1986.

1000 foot grid based upon Ohio coordinate system, south zone. City of Cincinnati datum.

Coordinate values in feet x1000.

Scale 1:2400
(1"=200')
0 50 100 200 feet

Contour interval 1 foot.

N

North
South

Westinghouse Materials Company of Ohio
Feed Material Production Center

EXISTING DRAINAGE AREA BOUNDARY
PRODUCTION AREA FENCE LINE

2989

STORMWATER RETENTION BASIN
DRAINAGE AREA

50 2/2