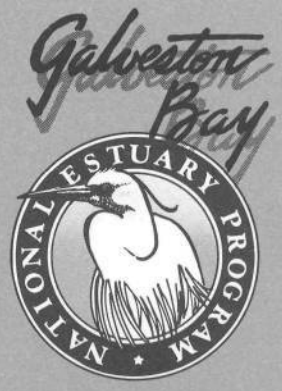
Estimated Loadings Of Partially Treated Domestic Wastewater On Galveston Bay



Galveston Bay
National Estuary Program
GBNEP-41
October 1994

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The Galveston Bay National Estuary Program

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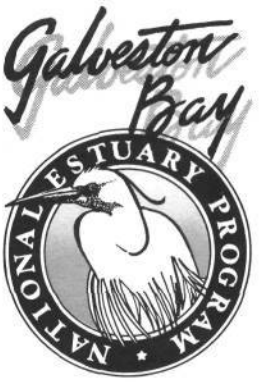

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The Galveston Bay National Estuary Program

Texans increasingly express their expectations for a clean environment in terms of entire ecosystems. Until recently, our tendency was to view environmental problems in isolated pieces we could understand—indeed this view was institutionalized (and seemingly immortalized) in an elaborate mosaic of fragmented jurisdictions. The Galveston Bay National Estuary Program (GBNEP) is a forerunner in elevating hands-on management of coastal environments to the level of the ecosystem; and in doing so, is encouraging an integration of traditionally disparate institutions.

The GBNEP was established under the authority of the Water Quality Act of 1987 to develop a Comprehensive Conservation and Management Plan (CCMP) for Galveston Bay. The purpose of the CCMP is to address threats to the Bay resulting from pollution, development, and overuse. To address these threats, five years of work commenced in 1990, consisting of three phases: (1) Identification of the specific problems facing the Bay; (2) A Bay-wide effort to compile data and information to describe status, trends, and probable causes related to the identified problems; and (3) Creation of the CCMP itself to enhance governance of the Bay at the ecosystem level. The GBNEP is accomplishing this work through a cooperative agreement between the U.S. EPA (Region 6) and the State of Texas (administered by the Texas Natural Resource Conservation Commission.)

The structure of the GBNEP reflects a strong commitment to consensus-building among all Galveston Bay user groups, government agencies, and the public. The GBNEP "Management Conference" consists of six Governor-appointed committees with broad representation, totaling about one hundred individuals. Meetings of these committees are also open to the public, and public participation in policy-setting and in Bay management are considered strengths of the program. When submitted to the Governor of Texas in late 1994, the CCMP will reflect thousands of hours of involvement (much in the form of volunteer time) by individuals who in various ways use, enjoy, or help govern this vital coastal resource.

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Abstract

The potential impacts of partially treated effluent on adjacent waterbodies are numerous. These impacts include reductions in dissolved oxygen, eutrophication, and elevated fecal coliform levels. However, quantification of the quantities and effects of all but the most severe bypasses and overflows has been difficult to determine. Severe bypasses from faulty collection systems have contributed to fish kills in the past. Sources of partially treated effluent include bypasses of partially treated effluent from collection lines and at wastewater treatment plants, and runoff from improperly designed septic tank systems.

The results of this report illustrate the potential magnitude and severity of partially treated effluent loading into the Galveston Bay system. However, due to the lack of good monitoring data it is difficult to ascertain the exact impacts on water quality. Based on the available data it appears that partially treated effluent represents a very small proportion of the overall loading into Galveston Bay. However, loading into specific waterbodies have had severe localized impacts.

The state database on reported bypass and septic tank discharge incidents is poorly organized and difficult to retrieve into a digital format conducive to spatial statistical analysis. Potential solutions to the reported problems include creation of regional databases that would receive bypass and septic tank upset data and dedication of additional staff to septic tank surveillance. In addition, legislation and/or state rules requiring the reporting of minimal information on bypasses and septic tank overflows could be implemented. Additional surveillance staff could be recruited by increases in existing fees and/or implementation of new fees.

Introduction

The potential impacts of partially treated effluent on adjacent waterbodies are numerous. These impacts include reductions in dissolved oxygen, eutrophication, and elevated fecal coliform levels. However, quantification of the quantities and effects of all but the most severe bypasses and overflows is extremely difficult to determine. Severe bypasses from faulty collection systems have contributed to fish kills in the past (Guillen and Luedke, 1990). Sources of partially treated effluent include bypasses of partially treated effluent from collection lines and at wastewater treatment plants, and runoff from improperly designed septic tank systems.

There is currently no well organized centralized system that monitors these illegal discharges at either the municipal, state or federal level. Permitted facilities are required to submit reports of bypasses that occur to the TNRCC. However, only bypasses that occur at the actual wastewater treatment plant site are normally reported to the TNRCC on facility self-reporting forms. This information is then archived on the mainframe computer of the agency database along with other self-reporting data. Access to this data is through the self-reporting unit of the permits section of the TNRCC Watershed Management Division. Many facilities also report collection system bypasses to the TNRCC, but submit this information by letter within five days of the occurrence. These letters are filed, but this information is not logged on any computer database at this time. Unpermitted discharges from septic tank systems are not routinely reported and monitored by either state or local governments. Neither bypass or unpermitted septic tank discharges information is managed or archived in a user friendly centralized database.

Information provided in this report will provide a preliminary estimate of the loading attributable to partially treated effluent. Due to the scarcity of data these estimates are rather crude and are intended to provide a relative estimate of the amount of loading attributable to these sources.

Current Status

Malfunctioning Septic Systems

Overview

Many housing units in rural areas dispose of their wastewater using onsite treatment and disposal systems. Onsite systems can consist of a variety of components and configurations, with the most common being a septic tank followed by a drainfield system.

The responsibility for overseeing the permitting and regulation of onsite systems belonged to the Texas Department of Health until March of 1992, when it was one of the duties absorbed into the Texas Water Commission [1]. This responsibility is typically transferred to local entities, such as counties or incorporated cities, who then become "authorized agents" of the state, and must adhere and enforce rules at least as stringent as the state's.

Septic systems can provide an economical and environmentally sound method of wastewater treatment and disposal providing the soil type, lot size, and other site characteristics are agreeable with the type of system installed. Unfortunately, regulation of the installation of these systems has not been carefully monitored. Local agents are inconsistent in the interpretation and application of state regulations. In addition, state agents have been historically understaffed and unable to efficiently audit the actions of local authorized agents. Additionally, there are many systems that were installed well before the time that they were regulated.

Failures of septic systems can be caused by any of a number of factors. Overloading of a system is one common cause. Septic system capacities are generally determined by the number of bedrooms in the home. Naturally, there is no way to regulate the number of people living in a residence, so problems can occur when, for example, a home changes owners. Another common situation observed along the coastal areas is overloading of weekend house septic systems. Very often beach or bay houses, with two or three bedrooms, are rented out during the weekend to tenants with many more users than the systems were designed for.

Many septic system failures may be directly attributed to the fact that the type of system installed was not compatible with the soil characteristics at the particular location. Since it is through the soil that the wastewater must pass in order to be absorbed and treated, these characteristics are extremely critical. Different types of soil differ greatly in texture, structure, and density, all of which affects the way water will move into and through the soil. Most of the areas in the study area

[1]The Texas Water Commission merged with the Texas Air Control Board on September 1, 1993 to form the Texas Natural Resource Conservation Commission (TNRCC).

have soils that are not acceptable for construction of conventional septic tank/drainfield systems, although this lower cost system is what is most often seen. In addition, the presence of shallow coastal water tables often inhibit the percolation of wastewater from drainfields.

The characteristics of the residential wastewater, septage (the liquid/solid matrix present in septic tanks), and final effluent is depicted in Table 1. There is an approximately 40-50% reduction in BOD and TSS between initial discharge of household waste into the septic tank and the final overflow of effluent onto the drain field. Improperly functioning septic tanks may produce effluent with little reduction in BOD and TSS.

TABLE 1. Characteristics of domestic wastewater, septage, and final effluent from septic tanks - drainfield systems (data source: Schmidt et al., 1980).

Parameter	Source	Mean value (mg/l)
TSS	septage	2,350-21,120
BOD	septage	3,150-5,890
NH_3-N	septage	59-153
Total-P	septage	172-351
Fecal coliform	septage	10^6 - 10^8 (counts/100 ml)
TSS	wastewater	680-1000
BOD	wastewater	200-290
NH_3-N	wastewater	6-18
Total-P	wastewater	18-29
Fecal coliforms	wastewater	10^8 - 10^{10} (counts/100 ml)
TSS	effluent	39-155
BOD	effluent	120-240
NH_3-N	effluent	N/A
Total-P	effluent	N/A
Fecal coliforms	effluent	N/A

Malfunctioning Wastewater Collection Systems

Overview

Discharges of partially treated wastewater can occur at various locations in a municipal wastewater collection and treatment system. During heavy rainfall, discharges of partially treated effluent can occur at the treatment plant, due to hydraulic loading caused by infiltration and inflow. Bypasses of partially treated effluent can also occur in the collection system of many municipalities. Currently the collection system of many older coastal cities and towns adjacent to the Galveston Bay are in need of repair. For example large portions of the older sections of the cities of Houston and Galveston are in advanced stages of

degradation. The City of Houston was placed under an Agreed order with the TNRCC in 1987 (Houston, City of 1987 and 1989). According to the order the City of Houston will have to eliminate all bypasses and renovate their collection system by December 31, 1997. The costs of renovating such systems are extremely high in many instances.

A common problem facing operators of municipal wastewater collection systems is infiltration/inflow, which refers to rainwater that enters what should be a strictly sanitary sewer during storm events. Inflow is defined as water discharged into a sanitary sewer system, including service connections, from such sources as, but not limited to, roof leaders, cellar, yard and area drains, foundation drains, cooling water discharges, drains from springs and swampy areas, manhole covers, cross connections from storm water, surface run-off, street wash waters, or drainage. Inflow does not include, and is distinguished from, infiltration. Infiltration in contrast refers to water entering a sewer system and service connections from the ground, through such means as, but not limited to, defective pipes, pipe joints, connections, or manhole walls.

The effects of inflow and infiltration can be especially profound in areas that have older collection systems where the sewer pipes have lost their integrity. Sudden increases in flow during wet weather events can cause both collection systems and wastewater treatment plants to become surcharged. This in turn can result in bypasses from the system if the flow rates exceed the maximum design capacity of lift stations or other treatment plant components, or reduced quality effluent from the treatment plant. Therefore, inflow should be minimized as much as possible. The water quality of wastewater bypasses can in worst case scenarios approach that of raw untreated sewage. However, due to dilution this is unlikely during large rain storms.

Facilities in the Gulf Coast area face an especially difficult challenge when attempting to address infiltration/inflow. Storm events tend to be very intense yet relatively short in duration, which result in very sharp peaks in the flows through the pipes that recede almost as quickly as they peak.

Previous Studies

EPA Partially Treated Effluent Study

Recent data collected by consultants under contract to EPA Region 6 failed to document the extent of partially treated effluent sources and magnitude in the Galveston Bay watershed (AMS, 1991; Knudsen pers. comm., 1993). Preliminary assessment by this group indicated that little data existed which could be used to document extensive degradation.

Characterization of Non-Point Sources and Loadings to Galveston Bay

Recent data collected by GBNEP funded researchers documents the extent of non-point source loading into the Galveston Bay watershed (Newell et al., 1992).

Estimates generated in that report of non-point source loading in the Galveston Bay watershed are listed in Table 2. Individual components of this non-point source loading are difficult to quantify. However, leaking sanitary sewers, bypasses, and overflows were included as a potentially serious source of non-point source pollution. In particular, these sources may be important contributors to nitrogen, phosphorus, BOD, oil and grease, and fecal coliform loading (Newell et al., 1992). Within the local Galveston Bay watershed the principal contributor to non-point source loading is high density urban land use areas. High density urban land use contribute approximately 87% of the annual oil and grease loading, 59% of the annual fecal coliform loading, and 50% of the annual pesticides loadings to the immediate local watershed (Newell et al., 1992). The contribution of certain pollutants such as nitrogen are primarily controlled by upper watershed loading from the Trinity River. In contrast, loading of fecal coliforms and oil and grease appear to be generated primarily from local sources.

TABLE 2. Estimates of non-point source loading into the Galveston Bay watershed, including discharges from Lake Houston and Lake Livingston during a year with average rainfall (Newell et al., 1992).

Source	Average Quantity	Wet Year Quantity	Individual Storm	Units
Runoff	9,050	13,790	610	ac-ft/yr
Total Suspended Solids	581,000	899,000	92,000	1000X kg/yr
Total Nitrogen	23,128	34,812	1,250	1000X kg/yr
Total Phosphorus	3,711	5,613	208	1000X kg/yr
Biochemical oxygen demand	46,500	71,700	200	1000X kg/yr
Oil and Grease	14,200	20,400	1,800	1000X kg/yr
Fecal Coliforms	355×10^{15}	542×10^{15}	55×10^{15}	cfu/y r
Dissolved copper	34	52	2	1000X kg/yr
Pesticides	1.5	2.2	0.3	1000X kg/yr

cfu: colony forming units, ac-ft: acre-ft.
wet year: 10 year storm
individual storm: 1 year storm

Characterization of Selected Public Health Issues in Galveston Bay

A preliminary estimate of the amount of non-point source loading attributable to sewer plant bypasses and sewer line leaks into the sanitary system within the City of Houston service area was provided by Jensen and Su (1992). Based on data provided by the City of Houston only one bypass of approximately 7 million gallons occurred at the 69th street plant between the period from July 1990 to June 1991. This is based on the total population of 35 wastewater treatment plants managed by the city.

According to a City of Houston September 1991 biannual report to the TWC, approximately 140 overflow points were reported as eliminated (Jensen and Su, 1992). Only three were reported as class A or which release during dry weather. Jensen and Su (1992) tabulated data provided by the City of Houston on dry weather sewer releases. These data are summarized in Table 3.

TABLE 3. Water quality characteristics of dry weather sewer leaks (Jensen and Su, 1992).

PARAMETER	LEVEL
Number	87 incidents
Mean Flow	237.4 gpm
Mean pH	8.1 S.U.
Mean NH_4-N	2.1 mg/l
Mean NO_3-N	1.1 mg/l
Mean TKN	3.1 mg/l
Mean CBOD	13.4 mg/l
fecal coliforms (geometric mean)	16,086/100 ml

Jensen and Su (1992) found that many of the sewer leaks failed to exhibit the combined characteristics of raw sewage including, CBOD >100 mg/l, NH_4-N of approximately 10 mg/l and fecal coliform levels of > 10^6 fecal coliforms/100ml (Table 3). They postulated that the scarcity of leaks fulfilling these criteria are due to dilution with non-wastewater freshwater inflow and/or the natural "treatment" that occurs by laminar flow over storm sewer line surfaces or soil.

TDH Sanitary Public Health Survey

The Texas Department of Health conducted a sanitary survey of Galveston Bay to determine potential sources of fecal contamination that may be impacting the oyster fishery in 1987-1988 (TDH, 1988a and 1988b). The presence and abundance of septic tank systems and straight pipe discharges that may impact shellfish

beds were tabulated during the survey. The results of that survey are listed in Table 4). They estimated that the number of septic tank systems in the immediate watershed that could affect oyster waters is 9,048 connections, based on the data they compiled (Table 4).

TABLE 4. Summary of results of the 1987-1988 sanitary survey of the Galveston Bay watershed by the TDH.

LOCATION	SEGMENT	COUNTY	COMMENTS
Port Bolivar	2439 and 2500	Galveston	pop. 1,200, all homes on septic tanks
Crystal Beach	2439 and 2500	Galveston	pop. 1,600 all homes on septic tanks
Caplen	2423 and 2500	Galveston	pop. 30, all homes on septic tanks
Gilchrist and Rollover Pass	2423 and 2500	Galveston	pop. 750, all on septic tanks
Bolivar Peninsula (includes cities above)	2423, 2439, 2500	Galveston	4,800 water connections, all on septic tanks
Smith Point	2423, 2439	Chambers	142 houses, septic tank or straight pipe
Smith Point	2422	Chambers	30 houses, septic tanks
Ash Point	2421	Chambers	23 houses, septic tank
Bay Harbor	2424	Galveston	36 septic tank
Terramar Beach	2424	Galveston	32 septic tank
Sea Isle	2424	Galveston	<300 houses, septic tanks
Thousand Isles	2424 and 2500	Galveston	trailers, tanks & field
Jamaica Beach	2424	Galveston	Pop. 2700, 99% on septic tanks, frequent problems
Spanish Grant	2424 and 2500	Galveston	Pop. 60, all on septic, inadequate lot size.
Treasure Island	2434	Brazoria	65 houses, septic
Sys Bait Camp	2434	Brazoria	46 houses, common holding tank
Lazy Palms	2435	Brazoria	10 houses, septic.
Various hunting shacks	2434 and 2435	Brazoria	unknown

TNRCC Incidents

In 1991 a dry weather sewer discharge associated with a broken City of Houston main line discharged 0.8 MGD (1.3 CFS) of raw sewage into segment 1007 (Buffalo Bayou) for approximately 3-5 days, and resulted in a massive fish kill (Guillen and Luedke, 1990). This constituted approximately 0.3% of the recorded flow in Buffalo Bayou during the episode. During this particular instance data on the quality of the bypass was recorded. Results of that data are included below (Table 5). An estimated 64,777 fish were killed within a distance of 4.8 miles downstream of the discharge. This incident illustrates the most extreme impacts associated with a major severe bypass.

TABLE 5. Results of monitoring data collected on discharge from broken City of Houston sewer line on July 23, 1991 in Buffalo Bayou.

Parameter	Value
Flow	.864 MGD
Temperature	28.3 C
Fecal Coliforms	>600,000 cfu/100 ml
BOD	210 mg/l
TSS	211 mg/l
pH	6.7 mg/l
Orthophosphate	4.39 mg/l
Total phosphorus	7.42 mg/l
Ammonia nitrogen	12.9 mg/l
Un-ionized ammonia	0.046 mg/l
Nitrates	0.05 mg/l

Study Area

The Galveston Bay Area is the receiving catchment for the San Jacinto River Basin, Trinity-San Jacinto Coastal Basin, and San Jacinto-Brazos Coastal Basin (Figs. 1 and 2). Harris, Galveston, Brazoria and Chambers Counties comprise the perimeter geographic counties of the watershed study area. Included in this description are the freshwater tributaries, bayous and those watershed areas encompassing the vicinity of a tributary draining to Galveston Bay. The TNRCC waterbody segments examined in this study are listed in Table 6. Due to limited resources and the low probability that septic tank violations in the upper watershed affect the water quality of the open bay, only septic tank violations in portions of the San Jacinto and San Jacinto Brazos Coastal watershed located in the southeastern (east of SH 59 North and east of IH 45 South) part of Harris County were included in the total study area (Figs. 1 and 2).

TABLE 6. List of TNRCC waterbody segments surveyed.

BASIN	TNRCC Segments
Trinity River	0801, 0802
Trinity - San Jacinto Coastal	0901, 0902
San Jacinto River	1001, 1005, 1006, 1007, 1013, 1014, 1016, 1017
San Jacinto-Brazos Coastal	1101,1102,1103,1104,1105, 1107,1108,1113
Galveston Bay (Bays and Estuaries)	2421,2422,2423,2424,2425, 2426,2427,2428,2429,2430, 2431,2432,2433,2434,2435, 2436,2437,2438,2439

Harris County is the largest county bordering the Galveston Bay estuary. Ninety-two percent of the San Jacinto River basin resides in Harris County. The City of Houston is the largest city in the basin and is responsible for most of the urban point source pollution loading on the Galveston Bay estuary. The border counties of Galveston, Chambers, and Brazoria counties are minor contributors when compared to the Harris County area. High population density urban land use dominates much of the Harris County area. In contrast, Brazoria and Galveston counties possess a larger proportion of rural land (Guillen et. al., 1988). Chambers county is relatively undeveloped with few metropolitan areas. Large portions are utilized for agriculture. The percentage of high density urban, residential and agriculture/open pasture for each watershed for each of the major watersheds in the study area was estimated by Newell et al.(1992) and is listed in Table 7.

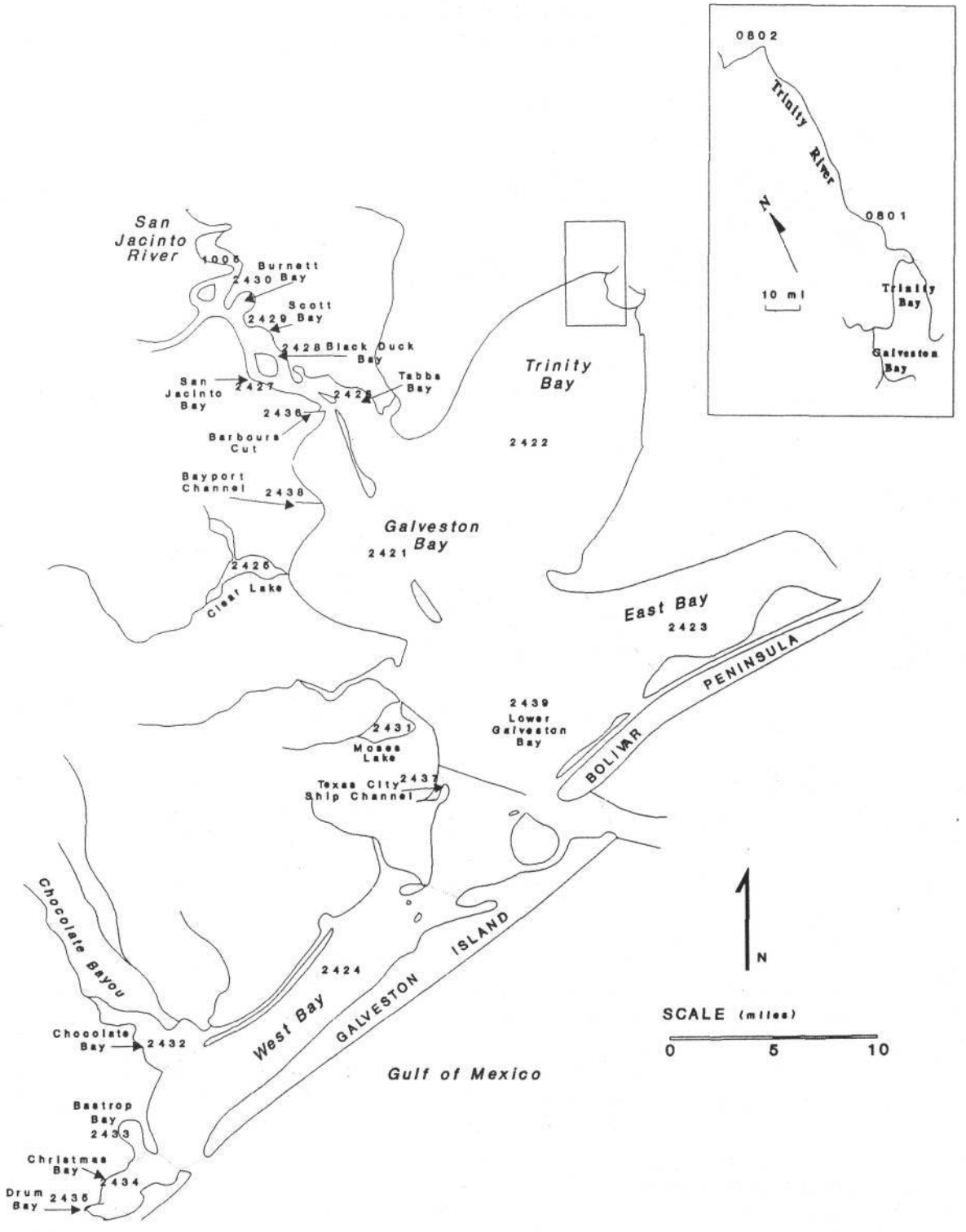

FIGURE 1. Segments included in the study.

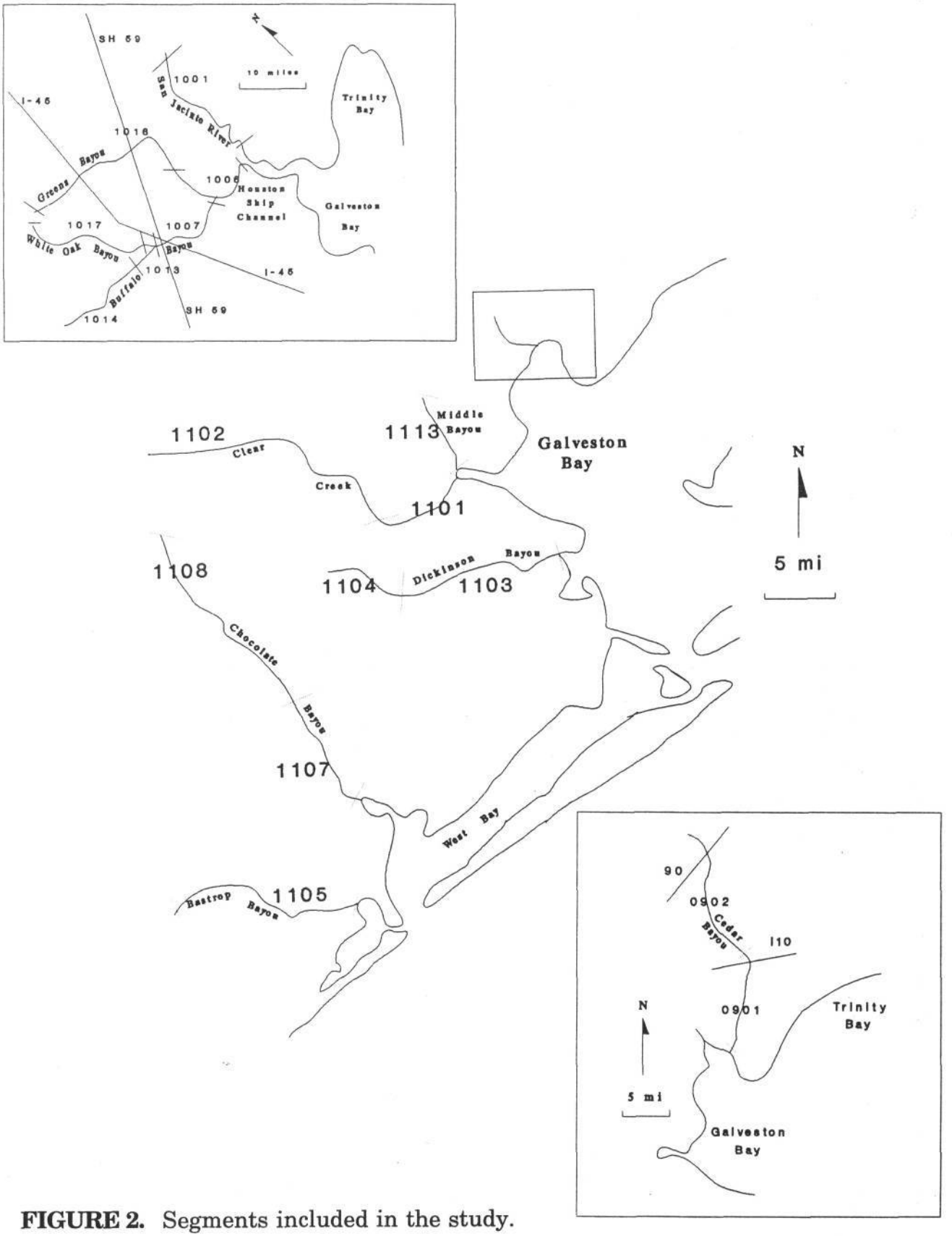

FIGURE 2. Segments included in the study.

TABLE 7. Percent land usage and clay composition of soils by watershed.

Watershed	Segment(s)	Watershed Area (sq. miles)	Clay % of Watershed	High-Density Urban (sq. miles, %)	Residential (sq. miles, %)	Open/Pasture Agriculture (sq. miles, %)	Other (sq. miles, %)
Armand/Taylor	1113	77	98	19.5	13.0	49.4	16.9
Bastrop/Austin	1105	213	99	2.8	6.1	68.5	22.5
Brays Bayou	1007	127	100	41.7	21.3	33.1	3.9
Buffalo Bayou	1007,1013,1014	105	100	37.1	30.5	27.6	4.8
Cedar Bayou	0901,0902	211	100	3.8	8.5	61.6	27.0
Chocolate Bayou	1107,1108	170	100	2.4	3.5	74.7	19.4
Clear Creek	1101,1102,2425,	180	100	11.1	8.3	61.7	19.4
Dickinson Bayou	1103,1104	101	100	5.0	8.9	64.4	20.8
East Bay	2423	288	100	3.5	9.7	50.3	35.8
Green's Bayou	1007	208	95	17.8	25.0	34.6	22.1
North Bay	2438,2421,2436	25	94	24.0	20.0	40.0	12.0
San Jacinto River	1001	68	79	7.4	16.2	36.8	39.7
Ship Channel	1005,1006,1007,2426,2427, 2428,2429,2430	166	92	33.7	18.7	34.3	13.3
Sims Bayou	1007	93	100	24.7	16.1	48.4	9.7
South Bay	2429,2437,2431	78	100	32.1	7.7	37.2	23.1
Trinity Bay	2422,0802	317	100	1.9	6.0	46.7	45.1
Trinity River	0801,0802	1099	46	1.0	3.1	25.5	70.3
West Bay	2424,2434,2435,2432,2433	344	98	8.7	6.4	53.5	31.4
White Oak Bayou	1017	110	99	35.5	29.1	31.8	3.6
Total (Watershed)		3980	—	—	—	—	—
Average (Categories)		—	90	14.9	12.9	41.9	22.0

Source: Newell et al., 1992.

The climate of the study region is characterized by short mild winters, long hot summers, high relative humidity, and prevailing east-southeasterly winds. Very significant rainfall can occur over short periods due to tropical storms and thunderstorms. Runoff varies across the basin and is controlled by land use and land cover. In the urbanized areas runoff is significantly higher than the less urbanized areas.

Soil composition and lowland drainage create unique local problems in the operations and maintenance of septic tank systems and wastewater collection systems. Flooding and storm surge occur as a result of major storms in part due to low-lying topography, presence of shallow aquifers, and proximity to the Gulf of Mexico. Most of the soils in the project area are comprised of silty-clayey loams that are moderately drained with moderate to poor permeability (Newell et al., 1992)(Table 7). These soils have very high runoff potential resulting in non-point pollution problems. Soil conditions are especially important when considering effluent characteristics of failed septic systems. The high expansion capacity of the largely clay soils, poor permeability, and presence of shallow aquifers create stress on collection system drainage pipes. The high percentage of clay also inhibits the proper percolation of wastewater from septic tank systems. Consequently excessive runoff from septic tank drainage fields can occur in coastal areas.

Several communities along the Gulf Coast including Surfside Beach in Brazoria County and certain subdivisions along the western portion of Galveston county have experienced these problems with septic tank systems. Historically high incidence of septic system violations have also occurred in specific 'hot spot' zones in Harris County. These have primarily been in low income areas along the Halls and Greens bayous watersheds in north-northeastern Harris county (Figs. 1 and 2). All of these areas are characterized as having poorly drained soils possessing a very high clay content. These soils are not conducive for the use of traditional septic tank systems. Recent TNRCC statistics indicate that there may be at least 86,616 septic tanks systems in the counties surrounding Galveston Bay (Table 8).

TABLE 8. Estimated total number of septic tanks in the counties surrounding Galveston Bay (Information source: TNRCC 1993, Based on 1990 Census data).

COUNTY	# OF SEPTIC TANKS
Brazoria	25,772
Chambers	3,991
Galveston	12,733
Harris	44,120
Total	86,616

Approximately 553 TNRCC permitted wastewater facilities discharge into stream segments of the study area (Table 9). The highest number of discharges and loading occur in the San Jacinto river watershed (Guillen et al., 1990).

TABLE 9. Number of permitted municipal wastewater discharges in the Galveston Bay watershed.

Stream Segment	Number of Discharges	Total Permitted Daily Flow (MGD)
* 801	10	5.82
* 802	16	1.68
901	6	3.1212
902	8	1.07
1001	15	6.297
1005	1	0.01
1006	91	43.5294
1007	52	479.8328
1013	1	0.011
1014	108	91.8258
1016	114	56.58015
1017	54	44.3944
1101	5	7.515
1102	18	17.6045
1103	2	3.75
1105	5	0.1875
1107	2	0.042
*1108	4	0.41
1113	3	11.85
2421	4	11.84
*2422	6	0.89
2423	0	0
2424	6	10.715
2425	3	0.69
2426	3	6.74
2427	2	0
2428	0	0
2429	0	0
2430	0	0
2431	1	8.3
2432	4	5.158
2433	0	0
2434	0	0
2435	0	0
2436	1	0.2
2437	0	0
2438	0	0
2439	8	10.3665
TOTAL	553	830.43025

Sources: (HGAC 1992a, 1992b, 1992c, * TWC 1992).

Methods

Characterization of Septic System Malfunctions

It is very difficult to accurately quantify the volumes or characteristics of wastewater discharged from failing septic systems. The methodology used to estimate the loadings from septic tanks relied on reported malfunctions, which we would expect to greatly underestimate the true incidence of malfunctions, and thus result in underestimates of loadings to the bay. In order to evaluate the scope of the problem, records were reviewed at each of the county offices in the study area to evaluate the extent of documented septic system failures in each county. Data from 1992 was selected for determination of spatial trends. Information from Harris, Galveston, Chambers and Brazoria County was collected from the designated county agents complaint files. Due to limited resources and the low probability that septic tank violations in the upper watershed affect the water quality of the open bay, only septic tank violations in portions of the San Jacinto and San Jacinto Brazos Coastal watershed located in the southeastern (east of SH 59 North and east of IH 45 South) part of Harris County were included in the total study area (Fig. 1). All reported incidents from a watershed were included irregardless of distance from the major tributary. Information on duration, location and estimated volume discharged were tabulated. Little data existed on the volume and chemical quality of the reported septic tank discharges. Therefore an average value of 70 gpd was assigned to most records based on best professional judgement of TNRCC Onsite program staff (Dodd, 1993). A higher value of 90 gpd was used for "severe" cases. Average TSS and BOD levels were estimated based on chemical characterization of local bypasses during wet weather events and from published summary data on the characteristics of untreated residential wastewater (Hammer, 1986). Obviously both of these approaches are very subjective but nonetheless are legitimate methods for calculating initial estimates of documented septic tank effluent loading. All reviewed records are tabulated in Appendix 1.

Characterization of Collection System and Treatment Plant Bypasses

Data on collection system and treatment plant bypasses was collected from various city and county sources within the study area. Due to limited resources, only 426 (77%) of these permitted discharges were examined for their bypass contributions in Harris, Galveston, Brazoria, Chambers, Liberty, and Fort Bend Counties. Bypass/overflow reports were retrieved for the study period for all the WWTP's under review for a two year period (1991 to 1992). The data for 1991 and 1992 from the target watersheds in Harris, Galveston, Brazoria, Chambers, Liberty and Fort Bend counties was utilized as the most complete recent annual data series for spatial comparisons. All reported incidents from a watershed were included irregardless of distance from the major tributary. The following data was recorded from each bypass report:

- Date of Bypass
- Location of Bypass (i.e. at the plant site, manholes, etc.)
- Stream Segment Number
- Duration of Bypass (in hours)
- Rainfall amount (if given)
- Sample data (if given)
- Estimated Volume of Bypass (in gallons)

All reviewed records are listed in Appendix 1. Data were then summarized by water body segment. Summary statistics including estimated gallons, TSS and BOD discharged into the watershed was then calculated. Average and maximum TSS and BOD levels were estimated based on chemical characterization of local bypasses during wet weather events and from published summary data on the characteristics of untreated residential wastewater (Hammer, 1986).

These reported values were adjusted upwards by an expansion factor (551 facilities/426 facilities = 1.2981) to provide an estimate of the total loading into the system. An assumption was made that both the reported and estimated volumes of partially treated effluent reached surface waters within the watershed. This is however, unlikely and the actual amount is unknown but probably much less.

Wastewater Collection System Status and Needs

The response of various wastewater collection systems to inflow during wet weather was evaluated. The water quality of numerous bypasses from several wastewater facilities was used to calculate average concentrations of BOD and TSS. A larger sample of 15 wastewater systems from various counties and watersheds was specifically examined for rainfall discharge relationships. In order to evaluate the extent of inflow among area treatment plants, three facilities were randomly chosen from each of the coastal counties in the study area (Harris, Brazoria, Chambers and Galveston). Each permitted facility is required to self-report effluent data to both the state and the EPA on a monthly basis. This data includes details concerning flows through the plant. Average daily flow and maximum daily flow are reported for each month. The "average daily flow" is the average of all 24-hour flows during the calendar month. The "maximum daily flow" is the highest 24-hour flow recorded during the month. The maximum daily flows almost without exception occur during wet weather events.

The period reviewed was from February 1992 through January 1993, which was the most recent self-reported data available from TNRCC records. The average daily flow and the maximum daily flow for each month were tabulated for each of the subject treatment plants. The percent increase between these two values was then calculated for each data set, which should approximate the flow increase during wet weather events.

In addition, average daily rainfall data from nearby NOAA weather stations were tabulated for each month of the study period. Linear and non-linear least squares regression analysis between monthly average daily rainfall (independent

variable) and average daily discharge (dependent variable) from the facility was conducted. Analysis of variance F tests and R squared values were evaluated to determine the significance and strength of the rainfall discharge relationship. Regression models were considered statistically significant at the alpha = 0.05 level.

Comparison to Other Sources of Loading

Results of the reported volumes from collection system bypasses and septic tank discharges, were compared to previously reported estimates of loading from various published sources (Armstrong, 1993; Jensen and Su, 1992; Newell et al., 1992; Guillen et al., 1989). Estimates of fecal coliform, TSS, total nitrogen and total phosphorus loading were also derived for comparison to other sources. Partially treated wastewater fecal coliform values derived by Jensen and Su (1992) were utilized for calculating loading estimates from bypasses and septic tanks. Average values of partially treated wastewater concentrations of total suspended solids (TSS), total nitrogen, and total phosphorus were obtained from Hammer (1986). These values were used for calculation of total loading of these substances from septic tanks and bypasses within the watershed. The contribution of malfunctioning septic tanks, and overflows and bypasses to the overall loading into the Galveston Bay watershed, was then evaluated.

Results

Characterization of Septic System Malfunctions

A summary of reported septic tank violations and estimated volumes is presented in Table 10. During 1992 an estimated 4.45 million gallons of untreated septic tank wastes were discharged within the study area. A total of 166 septic tank violations were reported and/or discovered within the study area. The highest number of violations occurred within the San Jacinto watershed (TNRCC river basin 10). Approximately 81.3% and 71.6% of the volume discharged and violations reported in the study area occurred in the San Jacinto river basin. Segments 1006 (Houston Ship Channel and tidal tributaries) and 1016 (Greens Bayou above tidal) possessed the highest volume of discharge and number of violations (Table 10).

Characterization of Collection System and Treatment Plant Bypasses

A total of 578 and 788 reported bypass incidents discharged approximately 451 million gallons/yr and 237 million gallons/yr within the study area during 1991 and 1992 respectively (Table 11). The majority of open bay segments did not have any reported incidence of bypasses. The highest incidence and quantities occurred in the San Jacinto River basin segments during both years. The highest quantities discharged within any segment occurred in segments 1007 and 1013 during 1991. These reported values were adjusted upwards by an expansion factor to provide an estimate of the total loading into the system (Table 12). Using this approach an estimated 451 million and 237 million gallons of effluent was discharged into the Galveston Bay watershed during 1992 and 1991 respectively. As previously mentioned both of these projections assume that the entire volume of wastewater actually reached surface waters within the watershed.

Collection System Status and Needs

A review of the facilities in the study area revealed that the only published comprehensive data regarding collection system status and needs is the City of Houston infiltration and inflow study that was conducted as a result of the Agreed Order between the City of Houston and the Texas Water Commission in 1987 (Houston, City of 1987 and 1989). Intensive flow studies were done throughout the thirty-one wastewater treatment plant collection systems outlined in the order, to determine the areas that were experiencing excessive infiltration and/or inflow. These areas were then ranked so that the most critical areas would be addressed first. Physical inspection was the next phase of the evaluation period, and this included any or all of the following wherever appropriate: smoke testing, physical manhole inspection, cleaning, night-time flow isolation, and television inspection.

TABLE 10. List of reported septic tank violations and estimated volume, TSS and BOD Loading

Segment (1992)	Number Reported	Gallons Discharged	Avg. TSS (lb)	Avg. BOD (lb)
UNKNOWN	5	38900	27.7	11.4
801	0	0	0.0	0.0
802	0	0	0.0	0.0
901	5	110950	79.1	32.4
902	12	123980	88.4	36.2
1001	16	377230	269.0	110.1
1005	12	312980	223.2	91.4
1006	50	2169320	1546.9	633.2
1007	2	38990	27.8	11.4
1013	0	0	0.0	0.0
1014	1	2660	1.9	0.8
1016	18	728390	519.4	212.6
1017	3	66430	47.4	19.4
1101	1	2100	1.5	0.6
1102	2	18900	13.5	5.5
1103	5	82810	59.0	24.2
1104	7	117600	83.9	34.3
1105	0	0	0.0	0.0
1107	0	0	0.0	0.0
1108	3	42350	30.2	12.4
1113	2	28840	20.6	8.4
2421	1	16800	12.0	4.9
2422	1	4200	3.0	1.2
2423	5	39810	28.4	11.6
2424	10	69740	49.7	20.4
2425	2	6300	4.5	1.8
2426	0	0	0.0	0.0
2427	0	0	0.0	0.0
2428	0	0	0.0	0.0
2429	0	0	0.0	0.0
2430	0	0	0.0	0.0
2431	0	0	0.0	0.0
2432	0	0	0.0	0.0
2433	0	0	0.0	0.0
2434	0	0	0.0	0.0
2435	0	0	0.0	0.0
2436	0	0	0.0	0.0
2437	0	0	0.0	0.0
2438	0	0	0.0	0.0
2439	3	45750	32.6	13.4
Total	166	4445030	3169.6	1297.5

Avg. TSS = 85.5 mg/l; Avg. BOD = 35.0 mg/l.

TABLE 11. List of reported incidents and volumes of bypasses during 1991 to 1992.

Segment	Number Reported	Gallons Disharged	Max. TSS (lb)	Avg. TSS (lb)	Max. BOD (lb)	Avg. BOD (lb)	Year
0801	0	0	0.0	0.0	0.0	0.0	1992
0802	1	140000	280.2	99.8	233.5	40.9	1992
0901	41	1269540	2541.1	905.3	2117.6	370.6	1992
0902	0	0	0.0	0.0	0.0	0.0	1992
1001	44	46217600	92509.1	32956.4	77091.0	13490.9	1992
1005	0	0	0.0	0.0	0.0	0.0	1992
1006	139	29605830	59259.0	21111.0	49382.5	8641.9	1992
1007	187	32759900	65572.2	23360.1	54643.5	9562.6	1992
1013	39	3485260	6976.1	2485.2	5813.4	1017.3	1992
1014	104	35102510	70261.2	25030.5	58551.0	10246.4	1992
1016	10	1060770	2123.2	756.4	1769.4	309.6	1992
1017	41	54777915	109643.5	39060.5	91369.6	15989.7	1992
1101	28	2990950	5986.7	2132.8	4988.9	873.1	1992
1102	22	1781326	3565.5	1270.2	2971.3	520.0	1992
1103	37	17641900	35312.0	12579.9	29426.7	5149.7	1992
1104	2	200	0.4	0.1	0.3	0.1	1992
1105	0	0	0.0	0.0	0.0	0.0	1992
1107	0	0	0.0	0.0	0.0	0.0	1992
1108	0	0	0.0	0.0	0.0	0.0	1992
1113	3	26000	52.0	18.5	43.4	7.6	1992
2421	46	5645729	11300.5	4025.8	9417.1	1648.0	1992
2422	0	0	0.0	0.0	0.0	0.0	1992
2423	0	0	0.0	0.0	0.0	0.0	1992
2424	6	84400	168.9	60.2	140.8	24.6	1992
2425	4	unknown	0.0	0.0	0.0	0.0	1992
2426	34	4549015	9105.3	3243.8	7587.8	1327.9	1992
2427	0	0	0.0	0.0	0.0	0.0	1992
2428	0	0	0.0	0.0	0.0	0.0	1992
2429	0	0	0.0	0.0	0.0	0.0	1992
2430	0	0	0.0	0.0	0.0	0.0	1992
2431	0	0	0.0	0.0	0.0	0.0	1992
2432	0	0	0.0	0.0	0.0	0.0	1992
2433	0	0	0.0	0.0	0.0	0.0	1992
2434	0	0	0.0	0.0	0.0	0.0	1992
2435	0	0	0.0	0.0	0.0	0.0	1992
2436	0	0	0.0	0.0	0.0	0.0	1992
2437	0	0	0.0	0.0	0.0	0.0	1992
2438	0	0	0.0	0.0	0.0	0.0	1992
2439	0	0	0.0	0.0	0.0	0.0	1992
Total 1992	788	237138845	474657.1	169096.6	395547.6	69220.8	1992
0801	1	7000	14.0	5.0	11.7	2.0	1991
0802	0	0	0.0	0.0	0.0	0.0	1991
0901	7	755200	1511.6	538.5	1259.7	220.4	1991
0902	0	0	0.0	0.0	0.0	0.0	1991
1001	43	45031530	90135.1	32110.6	75112.6	13144.7	1991
1005	0	0	0.0	0.0	0.0	0.0	1991
1006	91	26456080	52954.5	18865.0	44128.7	7722.5	1991
1007	182	165973460	332212.5	118350.7	276843.7	48447.7	1991
1013	47	145267470	290767.4	103585.9	242306.1	42403.6	1991
1014	70	10798405	21614.1	7700.0	18011.7	3152.1	1991
1016	5	390930	782.5	278.8	652.1	114.1	1991
1017	26	26971990	53987.1	19232.9	44989.3	7873.1	1991
1101	17	2792750	5590.0	1991.4	4658.3	815.2	1991
1102	31	6172755	12355.4	4401.6	10296.2	1801.8	1991
1103	1	1000	2.0	0.7	1.7	0.3	1991
1104	3	48000	96.1	34.2	80.1	14.0	1991
1105	2	35225	70.5	25.1	58.8	10.3	1991
1107	1	100	0.2	0.1	0.2	0.0	1991
1108	2	0	0.0	0.0	0.0	0.0	1991
1113	6	866400	1734.2	617.8	1445.2	252.9	1991
2421	13	1592700	3187.9	1135.7	2656.6	464.9	1991
2422	0	0	0.0	0.0	0.0	0.0	1991
2423	0	0	0.0	0.0	0.0	0.0	1991
2424	17	15545000	31114.9	11084.7	25929.1	4537.6	1991
2425	8	2334000	4671.7	1664.3	3893.1	681.3	1991
2426	0	0	0.0	0.0	0.0	0.0	1991
2427	0	0	0.0	0.0	0.0	0.0	1991
2428	0	0	0.0	0.0	0.0	0.0	1991
2429	0	0	0.0	0.0	0.0	0.0	1991
2430	0	0	0.0	0.0	0.0	0.0	1991
2431	0	0	0.0	0.0	0.0	0.0	1991
2431	0	0	0.0	0.0	0.0	0.0	1991
2432	0	0	0.0	0.0	0.0	0.0	1991
2433	0	0	0.0	0.0	0.0	0.0	1991
2434	0	0	0.0	0.0	0.0	0.0	1991
2435	0	0	0.0	0.0	0.0	0.0	1991
2436	0	0	0.0	0.0	0.0	0.0	1991
2437	0	0	0.0	0.0	0.0	0.0	1991
2438	0	0	0.0	0.0	0.0	0.0	1991
Unknown	5	9200	18.4	6.6	15.3	2.7	1991
Total 1991	578	451049195	902820.1	321629.6	752350.1	131661.3	1991

Max. TSS = 240 mg/l; Avg. TSS 85.5 mg/l; Max. BOD 200 mg/l; Avg. BOD 35.0 mg/l.

TABLE 12. Estimated number of incidents and volumes of bypasses during 1991 and 1992.

Segment	Number	Gallons Disharged	Max. TSS (lb)	Avg. TSS (lb)	Max. BOD (lb)	Avg. BOD (lb)	Year
0801	0	0	0	0	0	0	1992
0802	1	181734	364	130	303	53	1992
0901	53	1647990	3299	1175	2749	481	1992
0902	0	0	0	0	0	0	1992
1001	57	59995067	120086	42781	100072	17513	1992
1005	0	0	0	0	0	0	1992
1006	180	38431328	76924	27404	64103	11218	1992
1007	243	42525626	85119	30324	70933	12413	1992
1013	51	4524216	9056	3226	7546	1321	1992
1014	135	45566568	91206	32492	76005	13301	1992
1016	13	1376986	2756	982	2297	402	1992
1017	53	71107211	142328	50704	118607	20756	1992
1101	36	3882552	7771	2769	6476	1133	1992
1102	29	2312339	4628	1649	3857	675	1992
1103	48	22900950	45839	16330	38199	6685	1992
1104	3	260	1	0	0	0	1992
1105	0	0	0	0	0	0	1992
1107	0	0	0	0	0	0	1992
1108	0	0	0	0	0	0	1992
1113	4	33751	68	24	56	10	1992
2421	60	7328721	14669	5226	12224	2139	1992
2422	0	0	0	0	0	0	1992
2423	0	0	0	0	0	0	1992
2424	8	109560	219	78	183	32	1992
2425	5	0	0	0	0	0	1992
2426	44	5905076	11820	4211	9850	1724	1992
2427	0	0	0	0	0	0	1992
2428	0	0	0	0	0	0	1992
2429	0	0	0	0	0	0	1992
2430	0	0	0	0	0	0	1992
2431	0	0	0	0	0	0	1992
2432	0	0	0	0	0	0	1992
2433	0	0	0	0	0	0	1992
2434	0	0	0	0	0	0	1992
2435	0	0	0	0	0	0	1992
2436	0	0	0	0	0	0	1992
2437	0	0	0	0	0	0	1992
2438	0	0	0	0	0	0	1992
2439	0	0	0	0	0	0	1992
Total 1992	1023	307829935	616152	219504	513460	89856	
0801	1	9087	18	6	15	3	1991
0802	0	0	0	0	0	0	1991
0901	9	980325	1962	699	1635	286	1991
0902	0	0	0	0	0	0	1991
1001	56	58455429	117004	41683	97504	17063	1991
1005	0	0	0	0	0	0	1991
1006	118	34342637	68740	24489	57284	10025	1991
1007	236	215450148	431245	153631	359371	62890	1991
1013	61	188571703	377445	134465	314538	55044	1991
1014	91	14017410	28057	9995	23381	4092	1991
1016	6	507466	1016	362	846	148	1991
1017	34	35012340	70081	24966	58401	10220	1991
1101	22	3625269	7256	2585	6047	1058	1991
1102	40	8012853	16039	5714	13365	2339	1991
1103	1	1298	3	1	2	0	1991
1104	4	62309	125	44	104	18	1991
1105	3	45726	92	33	76	13	1991
1107	1	130	0	0	0	0	1991
1108	3	0	0	0	0	0	1991
1113	8	1124674	2251	802	1876	328	1991
2421	17	2067484	4138	1474	3449	603	1991
2422	0	0	0	0	0	0	1991
2423	0	0	0	0	0	0	1991
2424	22	20178965	40390	14389	33659	5890	1991
2425	10	3029765	6064	2160	5054	884	1991
2426	0	0	0	0	0	0	1991
2427	0	0	0	0	0	0	1991
2428	0	0	0	0	0	0	1991
2429	0	0	0	0	0	0	1991
2430	0	0	0	0	0	0	1991
2431	0	0	0	0	0	0	1991
2432	0	0	0	0	0	0	1991
2433	0	0	0	0	0	0	1991
2434	0	0	0	0	0	0	1991
2435	0	0	0	0	0	0	1991
2436	0	0	0	0	0	0	1991
2437	0	0	0	0	0	0	1991
2438	0	0	0	0	0	0	1991
2439	0	0	0	0	0	0	1991
unknown	6	11943	24	9	20	3	1991
Total 1991	750	585506960	1171951	417507	976626	170909	

Note: A correction factor of (553 total facilities/426 evaluated facilities) = 1.2981 was used to calculate estimated values.

Max. TSS = 240 mg/l; Avg. TSS 85.5 mg/l; Max. BOD 200 mg/l; Avg. BOD 35.0 mg/l.

The results of the flow studies and the physical inspections were evaluated to determine the best alternative for addressing the problems in each area. In some of the areas, diversion sewers are being constructed, while in others there may be rehabilitation of existing lines. The overall goal of the program is to eliminate all bypasses within the City of Houston system by the order deadline of December 31, 1997.

Although this was the most comprehensive published study in the area, the City of Houston is by no means the only entity to be faced with the challenge of dealing with infiltration/inflow into the collection system. Nearly every facility in the Gulf

TABLE 13. Inflow data tabulated for representative wastewater facilities.

MONTH	Facility	Outfall (No.)	Permitted Avg. Daily Flow (MGD)	Avg.Daily Flow (MGD)	Max.Daily Flow (MGD)	Increase (%)	Total Precipitation (inches)	Avg. Daily Precipitation (Inches)	Weather Station
Feb-92	Anahuac, City of	001	0.40	0.454	1.037	228.4%	6.27	0.22	ANAHUAC
Mar-92	Anahuac, City of	001	0.40	0.285	0.669	234.7%	3.40	0.11	ANAHUAC
Apr-92	Anahuac, City of	001	0.40	0.276	0.850	308.0%	3.76	0.13	ANAHUAC
May-92	Anahuac, City of	001	0.40				3.84	0.13	ANAHUAC
Jun-92	Anahuac, City of	001	0.40	0.318	1.065	334.9%	6.15	0.21	ANAHUAC
Jul-92	Anahuac, City of	001	0.40				3.22	0.10	ANAHUAC
Aug-92	Anahuac, City of	001	0.40	0.298	0.604	202.7%	2.62	0.08	ANAHUAC
Sep-92	Anahuac, City of	001	0.40	0.284	0.559	196.8%	3.48	0.12	ANAHUAC
Oct-92	Anahuac, City of	001	0.40				1.35	0.04	ANAHUAC
Nov-92	Anahuac, City of	001	0.40	0.350	0.936	267.4%	7.04	0.23	ANAHUAC
Dec-92	Anahuac, City of	001	0.40	0.464	1.659	357.5%	5.63	0.18	ANAHUAC
Jan-93	Anahuac, City of	001	0.40	0.439	0.990	225.5%	8.17	0.26	ANAHUAC
	Total	001	N/A	3.168	8.369	264.2%	54.93	1.81	ANAHUAC
Feb-92	Brazoria, City of	001	0.75	1.451	2.773	191.1%	8.15	0.28	ANGLETON
Mar-92	Brazoria, City of	001	0.75	0.542	1.172	216.3%	1.70	0.05	ANGLETON
Apr-92	Brazoria, City of	001	0.75	0.715	2.909	406.6%	6.25	0.21	ANGLETON
May-92	Brazoria, City of	001	0.75	0.477	0.997	209.1%	5.08	0.17	ANGLETON
Jun-92	Brazoria, City of	001	0.75	0.569	1.114	195.9%	4.72	0.16	ANGLETON
Jul-92	Brazoria, City of	001	0.75	0.312	0.564	180.9%	3.84	0.12	ANGLETON
Aug-92	Brazoria, City of	001	0.75	0.258	0.449	174.0%	1.88	0.06	ANGLETON
Sep-92	Brazoria, City of	001	0.75	0.238	0.368	154.7%	1.46	0.05	ANGLETON
Oct-92	Brazoria, City of	001	0.75	0.219	0.413	188.6%	3.01	0.10	ANGLETON
Nov-92	Brazoria, City of	001	0.75	0.534	2.991	559.7%	7.44	0.25	ANGLETON
Dec-92	Brazoria, City of	001	0.75	0.444	1.175	264.9%	3.26	0.11	ANGLETON
Jan-93	Brazoria, City of	001	0.75	0.960	3.102	323.1%	7.46	0.24	ANGLETON
	Total	001	N/A	6.720	18.028	268.3%	54.25	1.79	ANGLETON
Feb-92	Brazoria Co. M.U.D. 005	001	0.38	0.226	0.799	353.5%	8.15	0.28	ANGLETON
Mar-92	Brazoria Co. M.U.D. 005	001	0.38	0.178	0.363	203.9%	1.70	0.05	ANGLETON
Apr-92	Brazoria Co. M.U.D. 005	001	0.38	0.198	0.346	174.7%	6.25	0.21	ANGLETON
May-92	Brazoria Co. M.U.D. 005	001	0.38	0.235	0.481	204.7%	5.08	0.17	ANGLETON
Jun-92	Brazoria Co. M.U.D. 005	001	0.38	0.253	0.563	222.5%	4.72	0.16	ANGLETON
Jul-92	Brazoria Co. M.U.D. 005	001	0.38	0.217	0.373	171.9%	3.84	0.12	ANGLETON
Aug-92	Brazoria Co. M.U.D. 005	001	0.38	0.195	0.271	139.0%	1.88	0.06	ANGLETON
Sep-92	Brazoria Co. M.U.D. 005	001	0.38	0.200	0.269	134.5%	1.46	0.05	ANGLETON
Oct-92	Brazoria Co. M.U.D. 005	001	0.38	0.165	0.242	146.7%	3.01	0.10	ANGLETON
Nov-92	Brazoria Co. M.U.D. 005	001	0.38	0.176	0.605	343.8%	7.44	0.25	ANGLETON
Dec-92	Brazoria Co. M.U.D. 005	001	0.38	0.182	0.272	149.5%	3.26	0.11	ANGLETON
Jan-93	Brazoria Co. M.U.D. 005	001	0.38	0.204	0.542	265.7%	7.46	0.24	ANGLETON
	Total	001	N/A	2.429	5.126	211.0%	54.25	1.79	ANGLETON
Feb-92	Deer Park, City of	002	4.50	4.690	10.450	222.8%	8.62	0.30	DEER PARK
Mar-92	Deer Park, City of	002	4.50	3.111	8.175	262.8%	3.71	0.12	DEER PARK
Apr-92	Deer Park, City of	002	4.50	3.365	10.450	310.5%	5.28	0.18	DEER PARK
May-92	Deer Park, City of	002	4.50	3.126	9.700	310.3%	4.70	0.16	DEER PARK
Jun-92	Deer Park, City of	002	4.50	4.208	11.275	267.9%	6.35	0.21	DEER PARK
Jul-92	Deer Park, City of	002	4.50				2.31	0.07	DEER PARK
Aug-92	Deer Park, City of	002	4.50	2.734	6.700	245.1%	4.80	0.15	DEER PARK
Sep-92	Deer Park, City of	002	4.50	2.515	5.225	207.8%	3.18	0.11	DEER PARK
Oct-92	Deer Park, City of	002	4.50				0.65	0.02	DEER PARK
Nov-92	Deer Park, City of	002	4.50	2.782	10.700	384.6%	3.25	0.11	DEER PARK
Dec-92	Deer Park, City of	002	4.50	3.328	10.325	310.2%	0.53	0.02	DEER PARK
Jan-93	Deer Park, City of	002	4.50	4.482	12.225	272.8%	6.37	0.21	DEER PARK
	Total	002	N/A	34.341	95.225	277.3%	49.75	1.65	DEER PARK

TABLE 13. Continued

MONTH	Facility	Outfall (No.)	Permitted Avg. Daily Flow (MGD)	Avg.Daily Flow (MGD)	Max.Daily Flow (MGD)	Increase (%)	Total Precipitation (inches)	Avg. Daily Precipitation (Inches)	Weather Station
Feb-92	Freeport, City of	001	2.25	2.589	5.969	230.5%	9.73	0.34	FREEPORT
Mar-92	Freeport, City of	001	2.25	1.620	5.062	312.4%	3.39	0.11	FREEPORT
Apr-92	Freeport, City of	001	2.25	1.775	5.814	327.5%	1.50	0.05	FREEPORT
May-92	Freeport, City of	001	2.25				2.14	0.07	FREEPORT
Jun-92	Freeport, City of	001	2.25	1.550	3.845	248.1%	3.18	0.11	FREEPORT
Jul-92	Freeport, City of	001	2.25	1.298	2.436	187.7%	3.31	0.11	FREEPORT
Aug-92	Freeport, City of	001	2.25	1.320	1.985	150.4%	2.28	0.07	FREEPORT
Sep-92	Freeport, City of	001	2.25	1.084		0.0%	1.29	0.04	FREEPORT
Oct-92	Freeport, City of	001	2.25	1.106	1.935	175.0%	1.34	0.04	FREEPORT
Nov-92	Freeport, City of	001	2.25	1.778	4.523	254.4%	8.71	0.29	FREEPORT
Dec-92	Freeport, City of	001	2.25	2.086	4.866	233.3%	2.38	0.08	FREEPORT
Jan-93	Freeport, City of	001	2.25	2.447	5.337	218.1%	7.21	0.23	FREEPORT
	Total (except 9/92)	001	N/A	17.569	41.772	237.8%	46.46	1.54	FREEPORT
Feb-92	Friendswood, City of	003	0.40	0.395	0.978	247.6%	8.10	0.28	ALVIN
Mar-92	Friendswood, City of	003	0.40	0.293	1.292	441.8%	2.52	0.08	ALVIN
Apr-92	Friendswood, City of	003	0.40	0.319	1.937	606.8%	6.91	0.23	ALVIN
May-92	Friendswood, City of	003	0.40	0.277	0.704	254.3%	9.31	0.31	ALVIN
Jun-92	Friendswood, City of	003	0.40	0.272	0.757	278.1%	6.29	0.21	ALVIN
Jul-92	Friendswood, City of	003	0.40	0.180	0.243	134.8%	3.54	0.11	ALVIN
Aug-92	Friendswood, City of	003	0.40	0.195	0.255	131.0%	1.06	0.03	ALVIN
Sep-92	Friendswood, City of	003	0.40	0.207	0.338	163.7%	4.97	0.17	ALVIN
Oct-92	Friendswood, City of	003	0.40	0.225	0.295	131.1%	0.51	0.02	ALVIN
Nov-92	Friendswood, City of	003	0.40	0.307	0.748	243.8%	7.40	0.25	ALVIN
Dec-92	Friendswood, City of	003	0.40	0.331	0.743	224.3%	3.77	0.12	ALVIN
Jan-93	Friendswood, City of	003	0.40	0.381	0.839	219.8%	6.96	0.22	ALVIN
	Total	003	N/A	3.381	9.128	270.0%	61.34	2.03	ALVIN
Feb-92	Galveston Co. W.C.I.D. 001	001	3.60	6.092	13.821	226.9%	8.34	0.29	GALVESTON
Mar-92	Galveston Co. W.C.I.D. 001	001	3.60	2.707	8.522	314.8%	2.17	0.07	GALVESTON
Apr-92	Galveston Co. W.C.I.D. 001	001	3.60	2.951	11.150	377.8%	5.59	0.19	GALVESTON
May-92	Galveston Co. W.C.I.D. 001	001	3.60	2.811	11.794	419.6%	4.42	0.15	GALVESTON
Jun-92	Galveston Co. W.C.I.D. 001	001	3.60	4.045	12.800	316.5%	2.57	0.09	GALVESTON
Jul-92	Galveston Co. W.C.I.D. 001	001	3.60	2.533	6.352	250.8%	3.43	0.11	GALVESTON
Aug-92	Galveston Co. W.C.I.D. 001	001	3.60	1.881	3.549	188.7%	1.37	0.04	GALVESTON
Sep-92	Galveston Co. W.C.I.D. 001	001	3.60	2.258	7.633	338.1%	4.16	0.14	GALVESTON
Oct-92	Galveston Co. W.C.I.D. 001	001	3.60				1.15	0.04	GALVESTON
Nov-92	Galveston Co. W.C.I.D. 001	001	3.60	3.170	7.598	239.7%	7.17	0.24	GALVESTON
Dec-92	Galveston Co. W.C.I.D. 001	001	3.60				3.80	0.12	GALVESTON
Jan-93	Galveston Co. W.C.I.D. 001	001	3.60				9.26	0.30	GALVESTON
	Total	001	N/A	28.447	83.219	292.5%	53.43	1.77	GALVESTON
Feb-92	Galveston Co. W.C.I.D. 012	001	0.50	0.627	2.183	348.1%	8.34	0.29	GALVESTON
Mar-92	Galveston Co. W.C.I.D. 012	001	0.50	0.288	1.013	351.8%	2.17	0.07	GALVESTON
Apr-92	Galveston Co. W.C.I.D. 012	001	0.50	0.278	1.399	503.2%	5.59	0.19	GALVESTON
May-92	Galveston Co. W.C.I.D. 012	001	0.50	0.386	2.895	750.0%	4.42	0.15	GALVESTON
Jun-92	Galveston Co. W.C.I.D. 012	001	0.50	0.430	2.430	565.1%	2.57	0.09	GALVESTON
Jul-92	Galveston Co. W.C.I.D. 012	001	0.50	0.153	0.464	303.3%	3.43	0.11	GALVESTON
Aug-92	Galveston Co. W.C.I.D. 012	001	0.50	0.221	0.582	263.3%	1.37	0.04	GALVESTON
Sep-92	Galveston Co. W.C.I.D. 012	001	0.50	0.168	0.381	227.2%	4.16	0.14	GALVESTON
Oct-92	Galveston Co. W.C.I.D. 012	001	0.50	0.180	0.489	271.7%	1.15	0.04	GALVESTON
Nov-92	Galveston Co. W.C.I.D. 012	001	0.50	0.333	1.366	410.2%	7.17	0.24	GALVESTON
Dec-92	Galveston Co. W.C.I.D. 012	001	0.50	0.339	1.296	382.3%	3.80	0.12	GALVESTON
Jan-93	Galveston Co. W.C.I.D. 012	001	0.50				9.26	0.30	GALVESTON
	Total	001	N/A	3.403	14.498	426.1%	53.43	1.77	GALVESTON

TABLE 13. Continued

MONTH	Facility	Outfall (No.)	Permitted Avg. Daily Flow (MGD)	Avg.Daily Flow (MGD)	Max.Daily Flow (MGD)	Increase (%)	Total Precipitation (inches)	Avg. Daily Precipitation (Inches)	Weather Station
Feb-92	Harris Co. M.U.D. 148	001	0.25	0.144	0.400	278.4%	7.77	0.27	N. HOUSTON
Mar-92	Harris Co. M.U.D. 148	001	0.25	0.139	0.347	249.6%	12.57	0.41	N. HOUSTON
Apr-92	Harris Co. M.U.D. 148	001	0.25	0.120	0.236	196.7%	5.63	0.19	N. HOUSTON
May-92	Harris Co. M.U.D. 148	001	0.25	0.088	0.118	134.1%	7.14	0.24	N. HOUSTON
Jun-92	Harris Co. M.U.D. 148	001	0.25	0.102	0.199	195.1%	5.17	0.17	N. HOUSTON
Jul-92	Harris Co. M.U.D. 148	001	0.25	0.095	0.119	125.3%	9.40	0.30	N. HOUSTON
Aug-92	Harris Co. M.U.D. 148	001	0.25	0.099	0.238	240.4%	1.94	0.06	N. HOUSTON
Sep-92	Harris Co. M.U.D. 148	001	0.25	0.078	0.105	134.6%	4.18	0.14	N. HOUSTON
Oct-92	Harris Co. M.U.D. 148	001	0.25				0.48	0.02	N. HOUSTON
Nov-92	Harris Co. M.U.D. 148	001	0.25	0.192	0.344	179.2%	6.30	0.21	N. HOUSTON
Dec-92	Harris Co. M.U.D. 148	001	0.25				3.23	0.10	N. HOUSTON
Jan-93	Harris Co. M.U.D. 148	001	0.25				5.97	0.19	N. HOUSTON
	Total	001	N/A	1.057	2.106	199.3%	69.78	2.30	N. HOUSTON
Feb-92	Houston, Northeast Plant	077	5.50	6.218	19.030	306.0%	8.14	0.28	SAN JACINTO
Mar-92	Houston, Northeast Plant	077	5.50	4.205	22.270	529.6%	10.68	0.34	SAN JACINTO
Apr-92	Houston, Northeast Plant	077	5.50	3.522	11.520	327.1%	3.24	0.11	SAN JACINTO
May-92	Houston, Northeast Plant	077	5.50	3.540	10.360	292.7%	5.28	0.18	SAN JACINTO
Jun-92	Houston, Northeast Plant	077	5.50	4.429	17.490	394.9%	6.92	0.23	SAN JACINTO
Jul-92	Houston, Northeast Plant	077	5.50	3.162	5.460	172.7%	3.53	0.11	SAN JACINTO
Aug-92	Houston, Northeast Plant	077	5.50	3.566	9.520	267.0%	2.62	0.08	SAN JACINTO
Sep-92	Houston, Northeast Plant	077	5.50	2.674	4.820	180.3%	1.16	0.04	SAN JACINTO
Oct-92	Houston, Northeast Plant	077	5.50	2.291	4.070	177.7%	1.51	0.05	SAN JACINTO
Nov-92	Houston, Northeast Plant	077	5.50	4.044	12.800	316.5%	2.90	0.10	SAN JACINTO
Dec-92	Houston, Northeast Plant	077	5.50	3.906	18.540	474.7%	4.53	0.15	SAN JACINTO
Jan-93	Houston, Northeast Plant	077	5.50					0.00	SAN JACINTO
	Total	077	N/A	41.557	135.880	327.0%		1.67	SAN JACINTO
Feb-92	League City, City of	003	0.66	0.433	1.279	295.4%	8.10	0.28	ALVIN
Mar-92	League City, City of	003	0.66	0.366	0.645	176.2%	2.52	0.08	ALVIN
Apr-92	League City, City of	003	0.66	0.417	1.296	310.8%	6.91	0.23	ALVIN
May-92	League City, City of	003	0.66	0.483	0.985	203.9%	9.31	0.31	ALVIN
Jun-92	League City, City of	003	0.66	0.585	1.482	253.3%	6.29	0.21	ALVIN
Jul-92	League City, City of	003	0.66	0.501	0.659	131.5%	3.54	0.11	ALVIN
Aug-92	League City, City of	003	0.66	0.496	0.630	127.0%	1.06	0.03	ALVIN
Sep-92	League City, City of	003	0.66	0.489	0.696	142.3%	4.97	0.17	ALVIN
Oct-92	League City, City of	003	0.66	0.387	0.663	171.3%	0.51	0.02	ALVIN
Nov-92	League City, City of	003	0.66	0.292	0.616	211.0%	7.40	0.25	ALVIN
Dec-92	League City, City of	003	0.66	0.277	0.481	173.6%	3.77	0.12	ALVIN
Jan-93	League City, City of	003	0.66	0.322	0.914	283.9%	6.96	0.22	ALVIN
	Total	003	N/A	5.048	10.346	205.0%	61.34	2.03	ALVIN
Feb-92	League City, City of	005	4.50	6.188	19.671	317.9%	8.10	0.28	ALVIN
Mar-92	League City, City of	005	4.50	3.125	8.244	263.8%	2.52	0.08	ALVIN
Apr-92	League City, City of	005	4.50	3.557	17.738	498.7%	6.91	0.23	ALVIN
May-92	League City, City of	005	4.50	2.938	11.186	380.8%	9.31	0.31	ALVIN
Jun-92	League City, City of	005	4.50	4.566	17.164	375.9%	6.29	0.21	ALVIN
Jul-92	League City, City of	005	4.50	3.059	13.960	456.4%	3.54	0.11	ALVIN
Aug-92	League City, City of	005	4.50	2.671	5.227	195.7%	1.06	0.03	ALVIN
Sep-92	League City, City of	005	4.50	2.495	4.663	186.9%	4.97	0.17	ALVIN
Oct-92	League City, City of	005	4.50	2.434	4.536	186.4%	0.51	0.02	ALVIN
Nov-92	League City, City of	005	4.50	4.193	12.778	304.7%	7.40	0.25	ALVIN
Dec-92	League City, City of	005	4.50	4.832	13.880	287.3%	3.77	0.12	ALVIN
Jan-93	League City, City of	005	4.50	5.989	16.641	277.9%	6.96	0.22	ALVIN
	Total	005	N/A	46.047	145.688	316.4%	61.34	2.03	ALVIN

TABLE 13. Continued

MONTH	Facility	Outfall (No.)	Permitted Avg. Daily Flow (MGD)	Avg.Daily Flow (MGD)	Max.Daily Flow (MGD)	Increase (%)	Total Precipitation (inches)	Avg. Daily Precipitation (Inches)	Weather Station
Feb-92	League City, City of	007	0.15	0.129	0.427	331.0%	8.10	0.28	ALVIN
Mar-92	League City, City of	007	0.15	0.081	0.199	245.7%	2.52	0.08	ALVIN
Apr-92	League City, City of	007	0.15	0.092	0.306	332.6%	6.91	0.23	ALVIN
May-92	League City, City of	007	0.15	0.090	0.681	752.9%	9.31	0.31	ALVIN
Jun-92	League City, City of	007	0.15	0.106	0.584	550.9%	6.29	0.21	ALVIN
Jul-92	League City, City of	007	0.15	0.053	0.085	160.4%	3.54	0.11	ALVIN
Aug-92	League City, City of	007	0.15	0.070	0.567	810.0%	1.06	0.03	ALVIN
Sep-92	League City, City of	007	0.15	0.050	0.074	148.0%	4.97	0.17	ALVIN
Oct-92	League City, City of	007	0.15	0.069	0.252	365.2%	0.51	0.02	ALVIN
Nov-92	League City, City of	007	0.15	0.085	0.226	265.9%	7.40	0.25	ALVIN
Dec-92	League City, City of	007	0.15	0.098	0.209	213.3%	3.77	0.12	ALVIN
Jan-93	League City, City of	007	0.15	0.117	0.237	202.6%	6.96	0.22	ALVIN
	Total	007	N/A	1.040	3.847	369.7%	61.34	2.03	ALVIN
Feb-92	Mont Belvieu, City of	001	0.50	0.787	1.938	246.3%	9.76	0.34	BAYTOWN
Mar-92	Mont Belvieu, City of	001	0.50	0.434	1.078	248.1%	4.30	0.14	BAYTOWN
Apr-92	Mont Belvieu, City of	001	0.50	0.470	1.397	297.6%	4.69	0.16	BAYTOWN
May-92	Mont Belvieu, City of	001	0.50	0.367	1.047	285.6%	5.33	0.18	BAYTOWN
Jun-92	Mont Belvieu, City of	001	0.50	0.519	1.779	342.9%	9.27	0.31	BAYTOWN
Jul-92	Mont Belvieu, City of	001	0.50	0.455	1.181	259.3%	3.11	0.10	BAYTOWN
Aug-92	Mont Belvieu, City of	001	0.50	0.424	1.251	294.7%	4.04	0.13	BAYTOWN
Sep-92	Mont Belvieu, City of	001	0.50	0.320	0.463	144.7%	2.28	0.08	BAYTOWN
Oct-92	Mont Belvieu, City of	001	0.50	0.282	0.539	191.2%	1.26	0.04	BAYTOWN
Nov-92	Mont Belvieu, City of	001	0.50	0.485	1.576	325.1%	8.14	0.27	BAYTOWN
Dec-92	Mont Belvieu, City of	001	0.50	0.589	1.921	326.4%	5.39	0.17	BAYTOWN
Jan-93	Mont Belvieu, City of	001	0.50	0.840	2.130	253.4%	6.63	0.21	BAYTOWN
	Total	001	N/A	5.971	16.299	273.0%	64.20	2.12	BAYTOWN
Feb-92	Morgan's Point, City of	001	0.20	0.110	0.454	412.7%	9.76	0.34	BAYTOWN
Mar-92	Morgan's Point, City of	001	0.20	0.065	0.156	240.0%	4.30	0.14	BAYTOWN
Apr-92	Morgan's Point, City of	001	0.20	0.071	0.171	240.8%	4.69	0.16	BAYTOWN
May-92	Morgan's Point, City of	001	0.20	0.076	0.252	331.6%	5.33	0.18	BAYTOWN
Jun-92	Morgan's Point, City of	001	0.20	0.110	0.443	402.7%	9.27	0.31	BAYTOWN
Jul-92	Morgan's Point, City of	001	0.20	0.044	0.067	152.3%	3.11	0.10	BAYTOWN
Aug-92	Morgan's Point, City of	001	0.20	0.038	0.075	197.4%	4.04	0.13	BAYTOWN
Sep-92	Morgan's Point, City of	001	0.20	0.038	0.088	231.6%	2.28	0.08	BAYTOWN
Oct-92	Morgan's Point, City of	001	0.20	0.048	0.119	247.9%	1.26	0.04	BAYTOWN
Nov-92	Morgan's Point, City of	001	0.20	0.074	0.338	456.8%	8.14	0.27	BAYTOWN
Dec-92	Morgan's Point, City of	001	0.20	0.073	0.495	678.1%	5.39	0.17	BAYTOWN
Jan-93	Morgan's Point, City of	001	0.20	0.103	0.367	356.3%	6.63	0.21	BAYTOWN
	Total	001	N/A	0.850	3.025	355.9%	64.20	2.12	BAYTOWN

Coast Region experiences this to some degree, although some are much worse than others, particularly those with older collection systems. Collection system status is one of the items that the state inspectors review when conducting facility inspections, and many facilities in the area have been making significant efforts to address the problems in their collection systems including the City of Galveston, the City of LaPorte, the City of Baytown, and Galveston County WCID #1 (Dickinson).

Maximum daily flows were substantially larger than average daily flows measured at the 15 facilities (Table 13). An average of all of the percent increase values for these facilities was calculated to be 274.6%. Therefore, it is believed by the investigators that this would be a reasonable approximation for the amount of inflow expected in a wastewater collection system within the study area.

Results of linear and non-linear regression are presented in Table 14. Based on the observed R^2 values the curvilinear models described the relationship between rainfall and discharge better than the linear model. This suggests that the relationship between average daily rainfall and average daily discharge is

TABLE 14. Results of linear and non-linear regression analysis. * Denotes <u>not</u> significant at .05 alpha level.

Facility	Regression model: where Y = avg. daily discharge (MGD), X = avg. daily rainfall (inches).	R^2 %
City of Anahuac	$Y = 0.201 + 0.885(X)$	51.1
City of Anahuac	$Y = 0.89(X)^{1.02} + 0.204$	49.6
City of Brazoria	$Y = 0.039 + 0.884(X)$	63.1
City of Brazoria	$Y = 643.8(X)^{5.09} + 0.363$	77.5
Brazoria Co. MUD 005	* $Y = 0.188 + 0.0996(X)$	9.4
Brazoria Co. MUD 005	$Y = 16.7(X)^{0.0008} - 16.53$	20.2
City of Deer Park	$Y = 2.30 + 7.31(X)$	52.3
City of Deer Park	$Y = 31.62(X)^{2.215} + 2.766$	67.7
City of Freeport	$Y = 1.22 + 3.60(X)$	54.0
City of Freeport	$Y = 2.875(X)^{0.4185} + 0.5341$	55.8
City of Friendswood	$Y = 0.208 + 4.37(X)$	35.5
City of Friendswood	$Y = 0.3466(X)^{0.7471} + 0.1932$	35.1
Galveston Co. WCID 001	$Y = 1.61 + 10.6(X)$	46.3
Galveston Co. WCID 001	$Y = 1289000(X)^{10.39} + 2.730$	78.1
Galveston Co. WCID 012	$Y = 0.160 + 1.12(X)$	40.0
Galveston Co. WCID 012	$Y = 22180(X)^{8.917} + 0.2700$	59.3
Harris Co. MUD 148	* $Y = 0.0926 + 0.113(X)$	9.7
Harris Co. MUD 148	$Y = 0.1301(X)^{0.2688} + 0.03254$	10.7
Houston NE Plant	$Y = 2.57 + 7.94(X)$	56.4
Houston NE Plant	$Y = 13.36(X)^{0.1135} - 6.802$	61.7
City of League City (003)	* $Y = 0.415 + 0.031(X)$	0.1
City of League City (003)	$Y = 1.04e9(X)^{20.0} + 4.142$	0.4
City of League City (005)	* $Y = 2.62 + 7.18(X)$	27.5
City of League City (005)	$Y = 8.302(X)^{0.1365} - 2.492$	29.7
City of League City (007)	$Y = 0.0602 + 0.146(X)$	33.8
City of League City (007)	$Y = 0.229(X)^{1.433} + 0.06685$	33.6
City of Mont Belvieu	$Y = 0.272 + 1.27(X)$	47.0
City of Mont Belvieu	$Y = 1.117(X)^{0.3521} - 0.09148$	47.7
City of Morgan's Pt.	$Y = 0.0262 + 0.252(X)$	76.9
City of Morgan's Pt.	$Y = 0.2628(X)^{1.063} + 0.02862$	76.4

curvilinear and perhaps exponential in nature. High R^2 values may be due to two phenomenon. First, a strong relationship between rainfall and facility discharge exists suggesting that there may be serious infiltration and inflow problems. Secondly, rainfall recorded at the nearest weather station describes precipitation in the facility collection area fairly well. Conversely, low R^2 values can also be explained by the inverse case of the two previously mentioned causes. Therefore, inter-facility comparisons should be carefully evaluated. Based on the results of linear regression it appears that the average daily discharge increased by approximately 0.33 MGD for each 1 inch increase in average daily rainfall (average slope +3.05 inches) in the service areas of the facilities examined. This however varied according to location and size of facility (Table 13 and Figs. 3-17).

Four facilities showed R^2 values that were considered to be high, since each exceeded .55. These facilities were the City of Brazoria, Brazoria County MUD #5, the City of Houston Northeast Treatment Plant, and the City of Morgan's Point. File reviews of each of these facilities revealed that each had been cited during TNRCC inspections for having significant infiltration and/or inflow into the collection systems. These were not the only facilities of the randomly chosen fifteen, however, that had been designated as having I/I problems. All three of the City of League City facilities used in this study have been known to have I/I problems. In fact, the City of League City is currently in the inspection stage of a system-wide sanitary sewer evaluation that is being done to reduce the I/I into the collection systems. The City of League City Countywide Plant (003) had a R^2 value of <0.01, which was exceptionally low. Rainfall data utilized for the calculations for the League City facilities was collected in Alvin, which is far enough away from the League City plants to have impacted the correlation. Harris County MUD #148 also had a very low R^2 value. A review of this file did show that the facility has historically not shown signs of experiencing significant I/I. The collection system is fairly small, and problems can be easily found when they do appear.

Limited data compiled during this report document the chemical nature of bypasses (Table 15). The potential variability of these sources should not however, be underestimated. For example all the chemical constituents measured by Guillen and Luedke (1991) greatly exceed the amounts compiled by the facilities.

TABLE 15. Water quality of selected bypasses from several facilities within the study area.

Facility	Number of entries	Total BOD (mg/l)	Total TSS (mg/l)
Crosby MUD	28	787	1257.2
Bay City	6	161	317
Harris County WCID 21	5	418.7	1759
Totals	39	1366.7	3333.2
Average		35.0	85.5

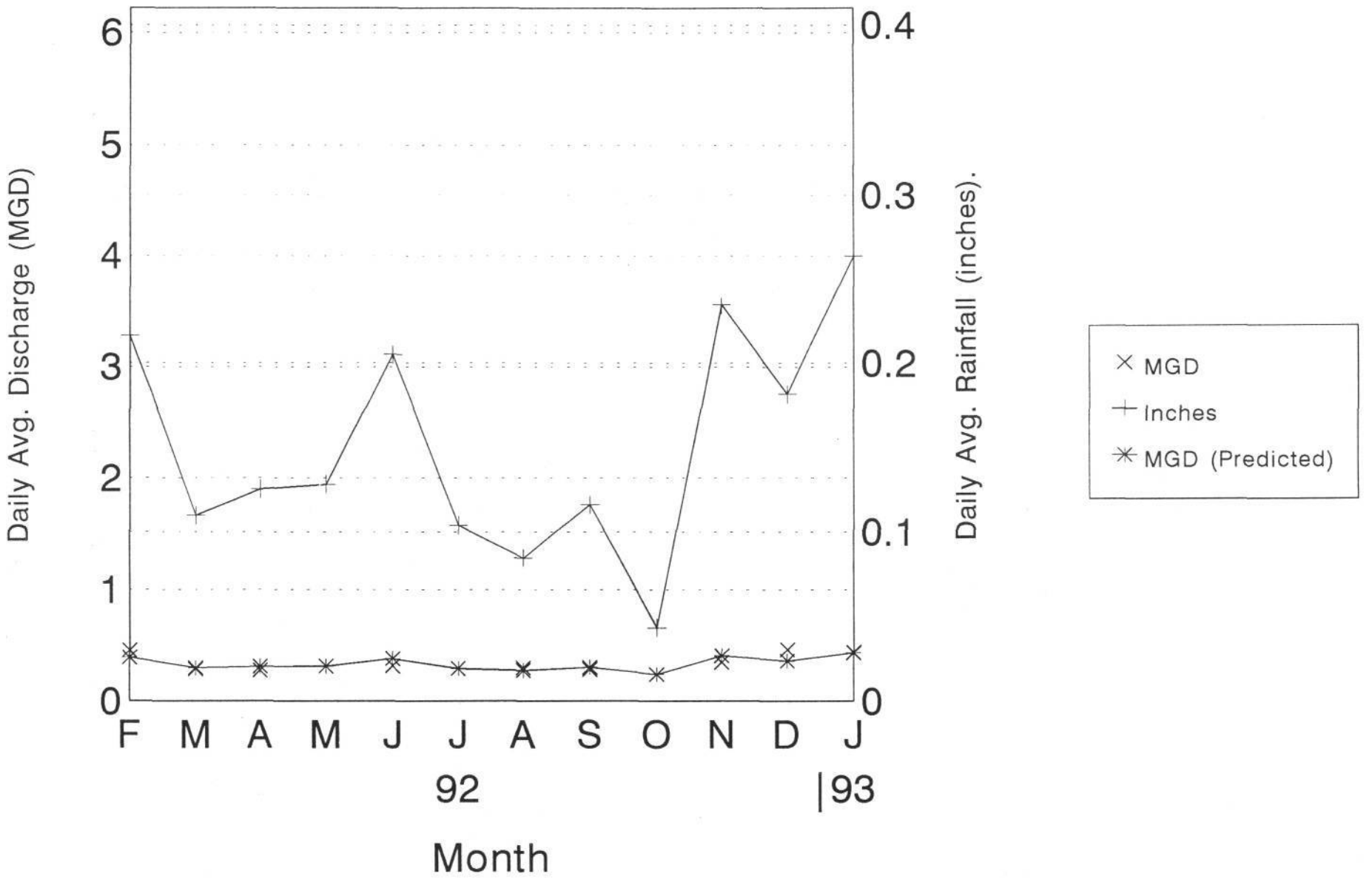

FIGURE 3. Discharge and rainfall data for the City of Anahuac wastewater collection system.
Prediction equation: MGD = 0.200 + 0.884 inches, R squared = 0.51.
Rainfall data from NOAA Anahuac weather station.

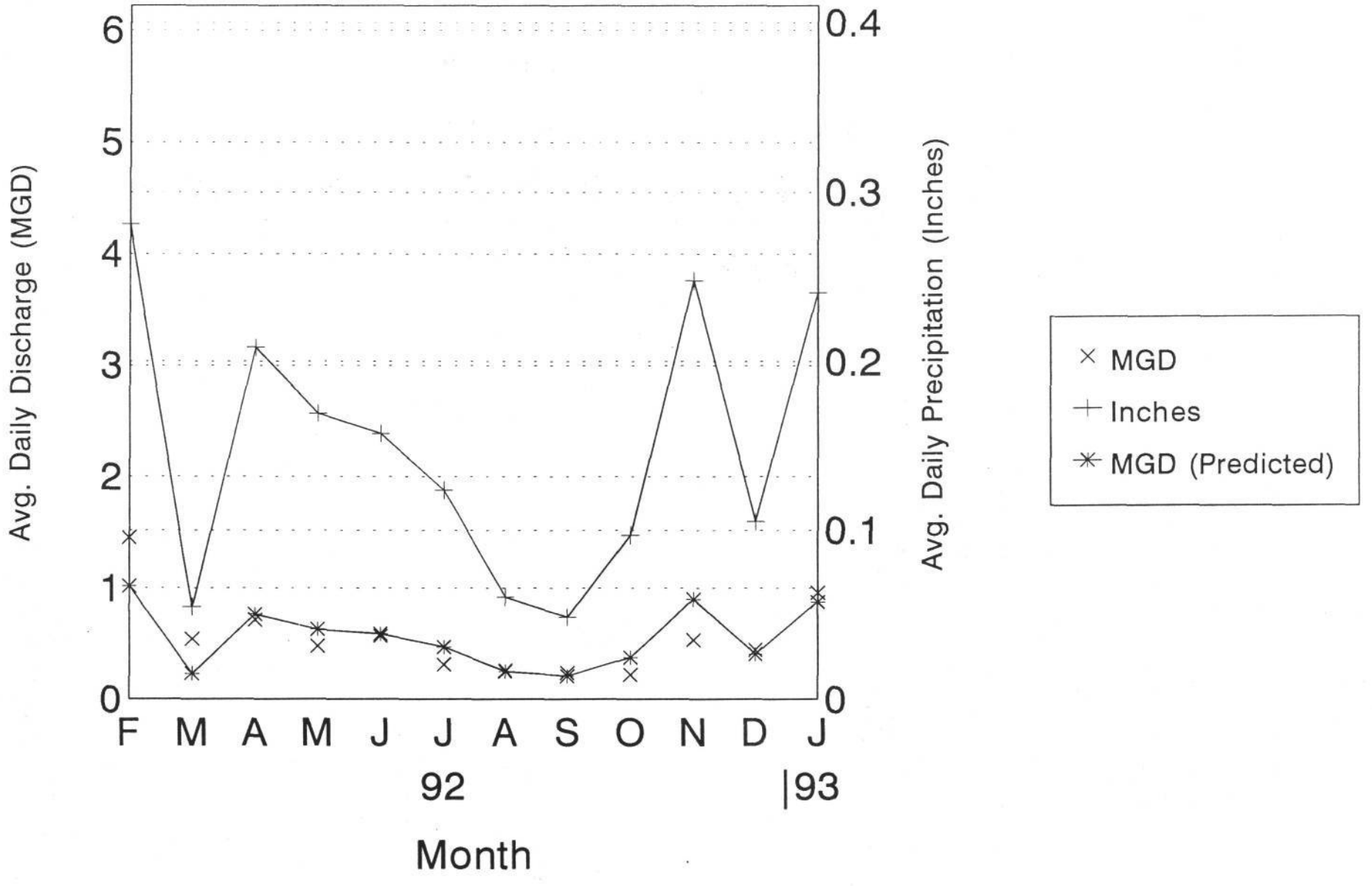

FIGURE 4. Discharge and rainfall data for the City of Brazoria wastewater collection system.
Predicted equation: MGD = 0.039 + 3.47 inches, R squared = 0.63
Rainfall data from NOAA Angleton weather station.

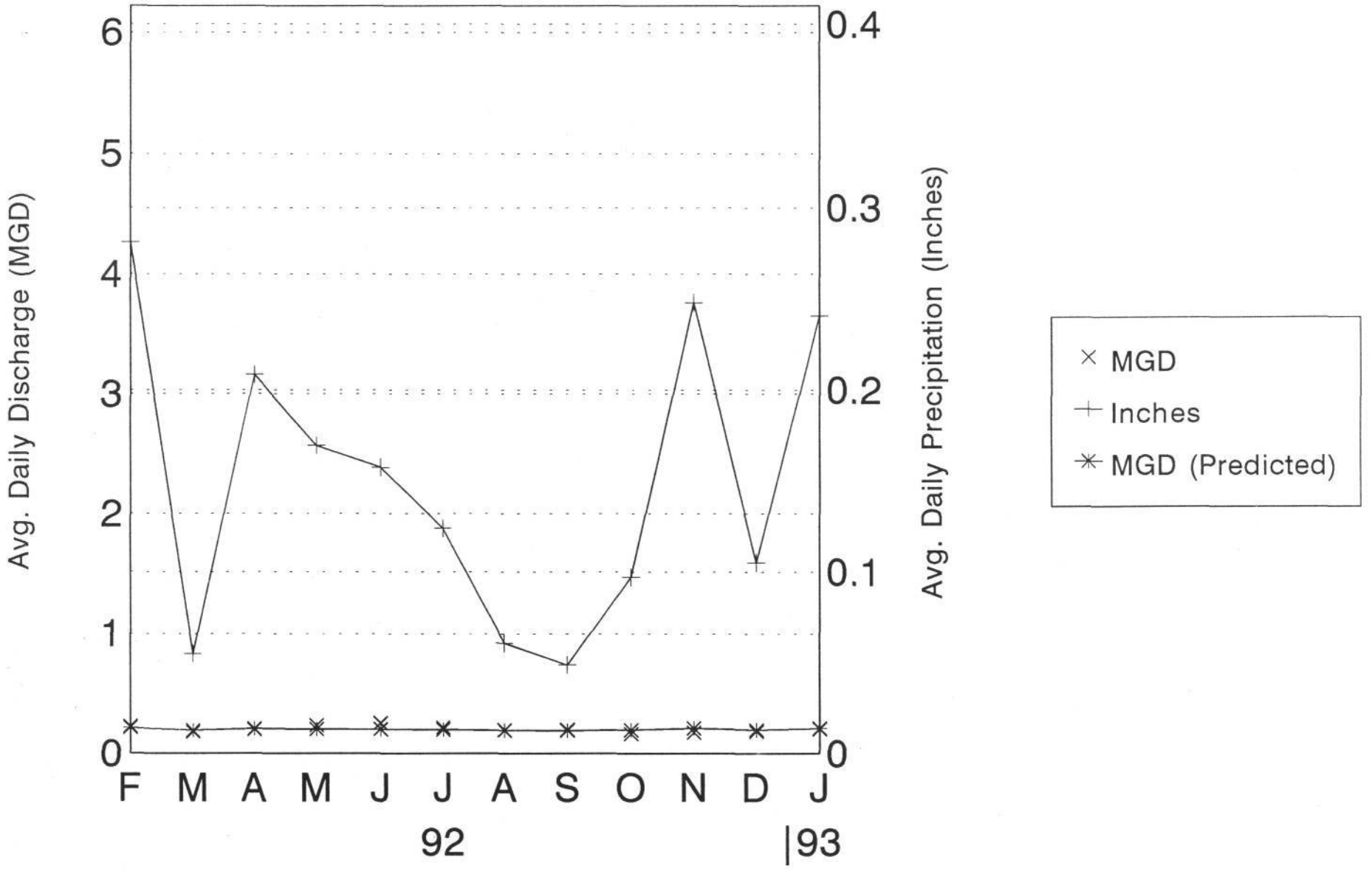

FIGURE 5. Discharge and rainfall data for the Brazoria County MUD 005 wastewater collection system.
Predicted equation: MGD = 0.039 + 3.47 inches, R squared = 0.63
Rainfall data from NOAA Angleton weather station.

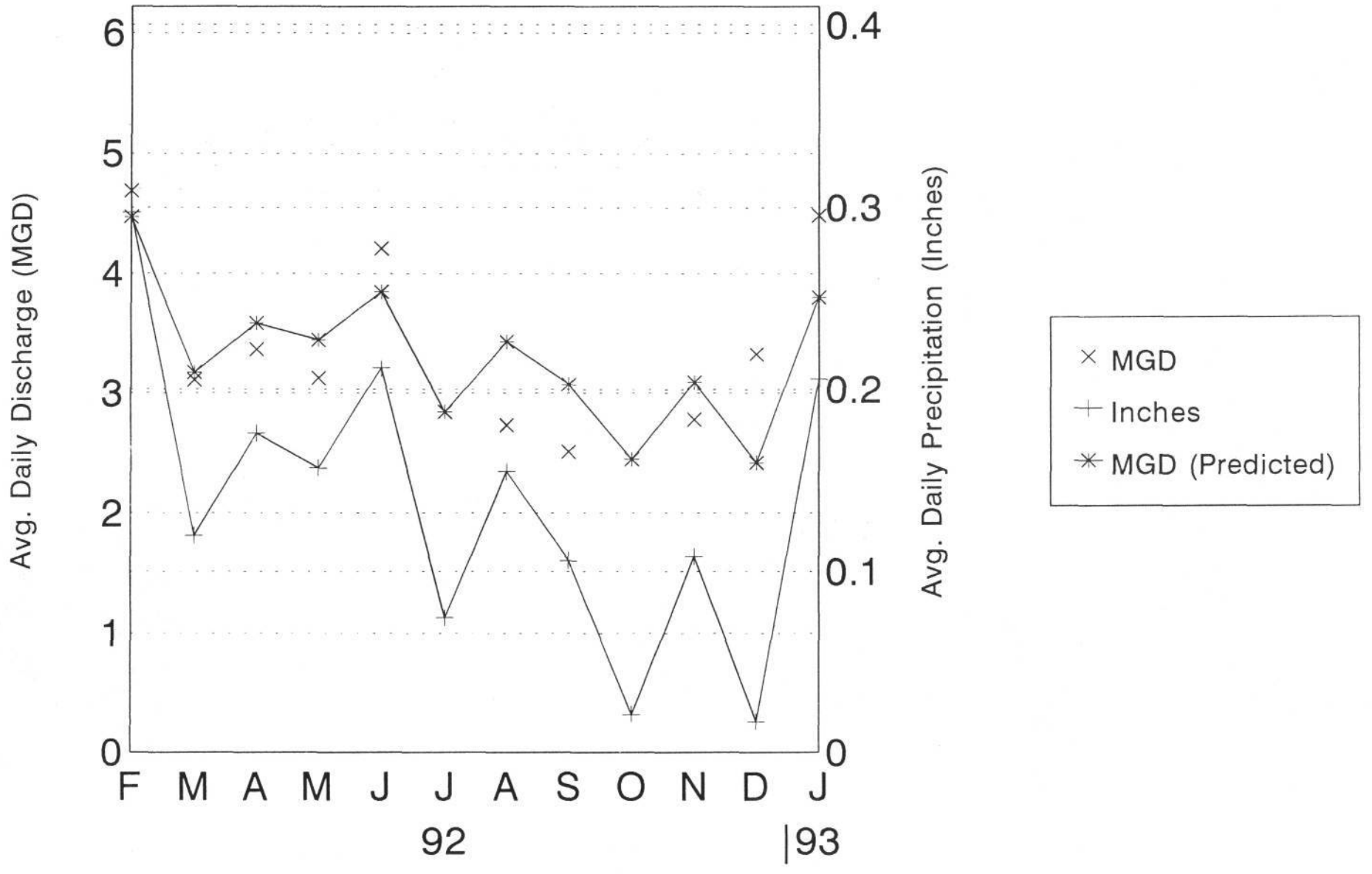

FIGURE 6. Discharge and rainfall data for the City of Deer Park wastewater collection system.
Predicted equation: MGD = 2.29 + 7.31 inches, R squared = 0.52
Rainfall data from NOAA Deer Park weather station.

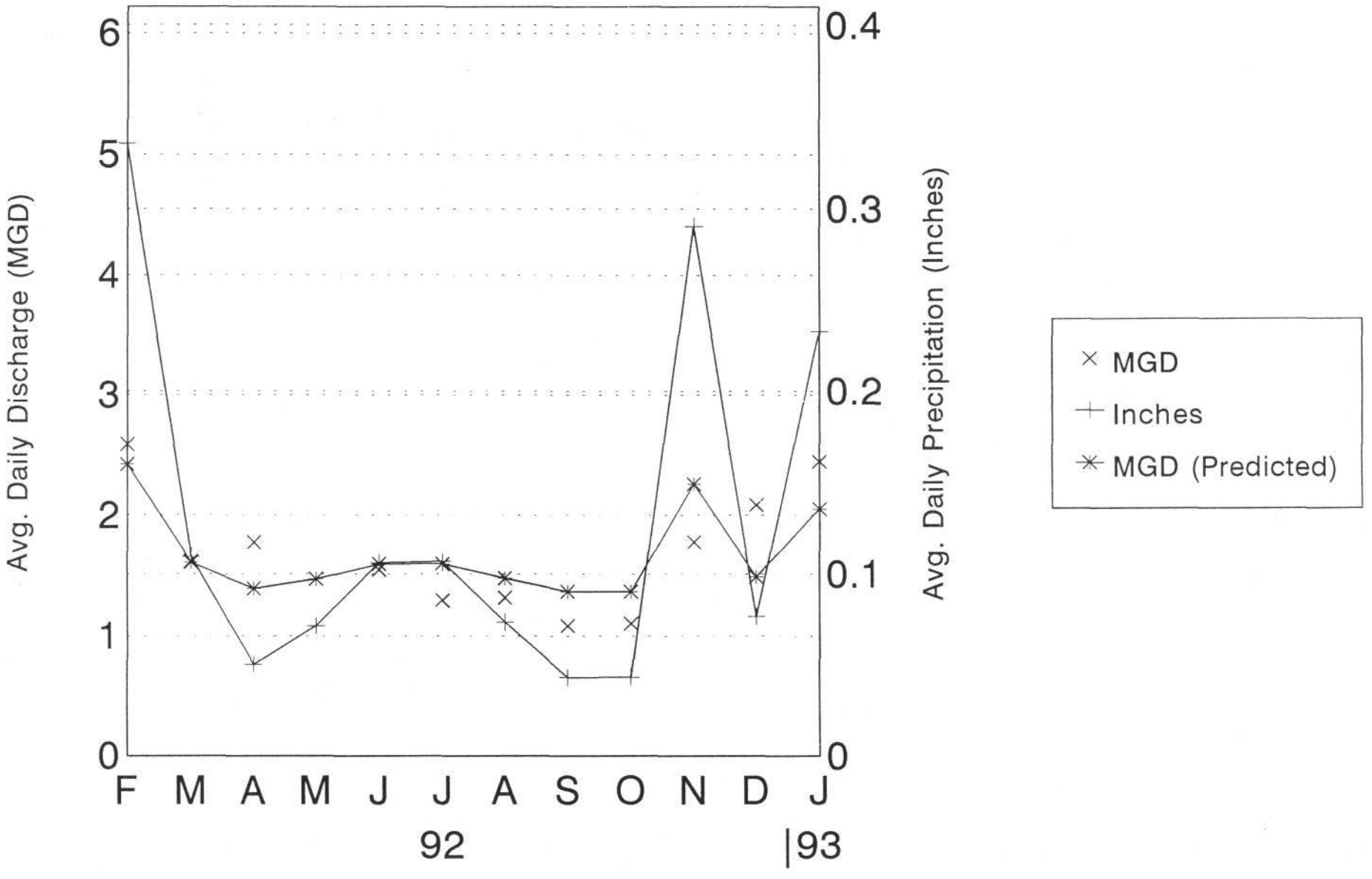

FIGURE 7. Discharge and rainfall data for the City of Freeport wastewater collection system.
Predicted equation: MGD = 1.21 + 3.60 inches, R squared = 0.54
Rainfall data from NOAA Freeport weather station.

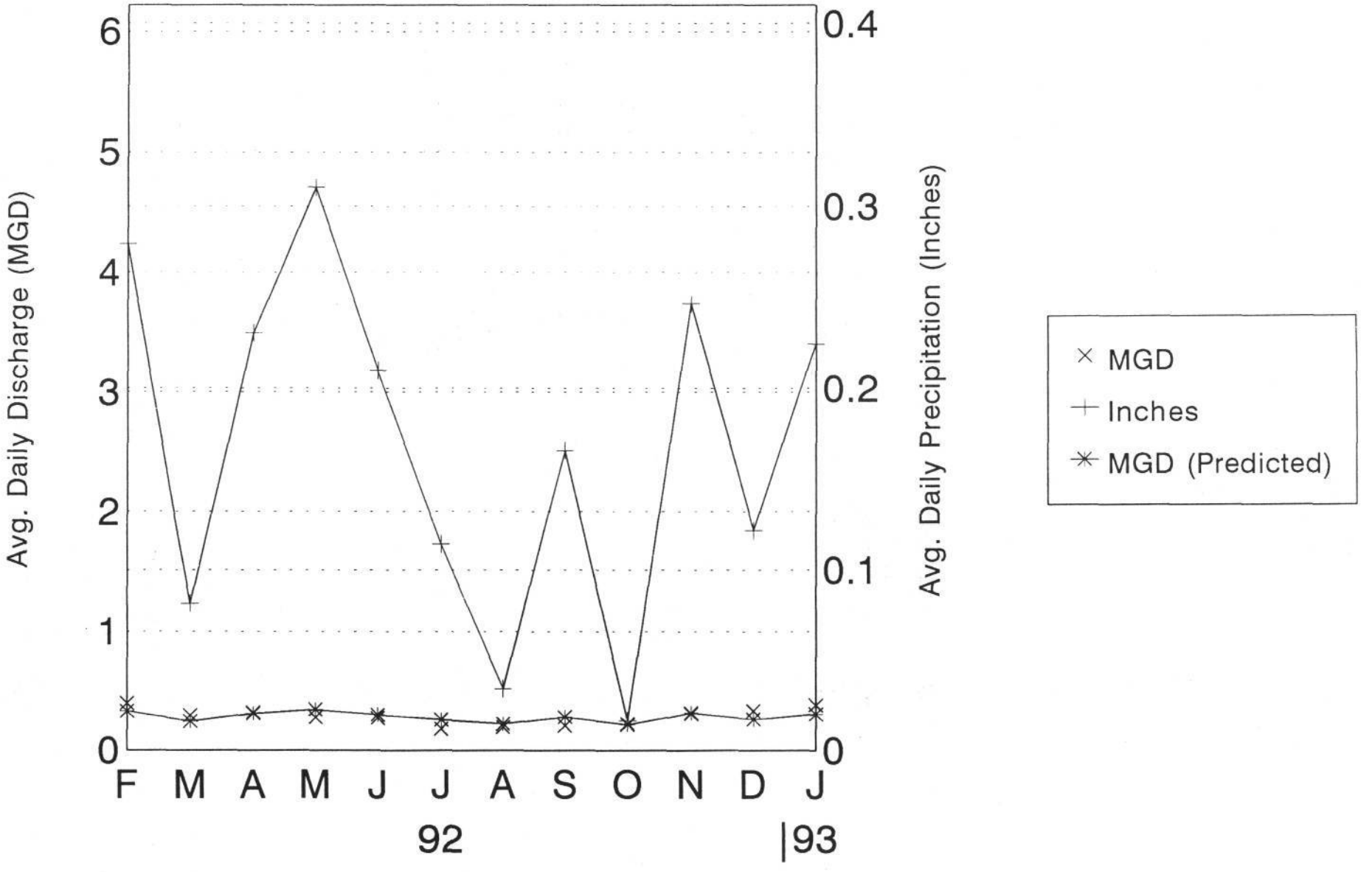

FIGURE 8. Discharge and rainfall data for the City of Friendswood wastewater collection system.
Predicted equation: MGD = 0.20 + 0.43 inches, R squared = 0.355
Rainfall data from NOAA Alvin weather station

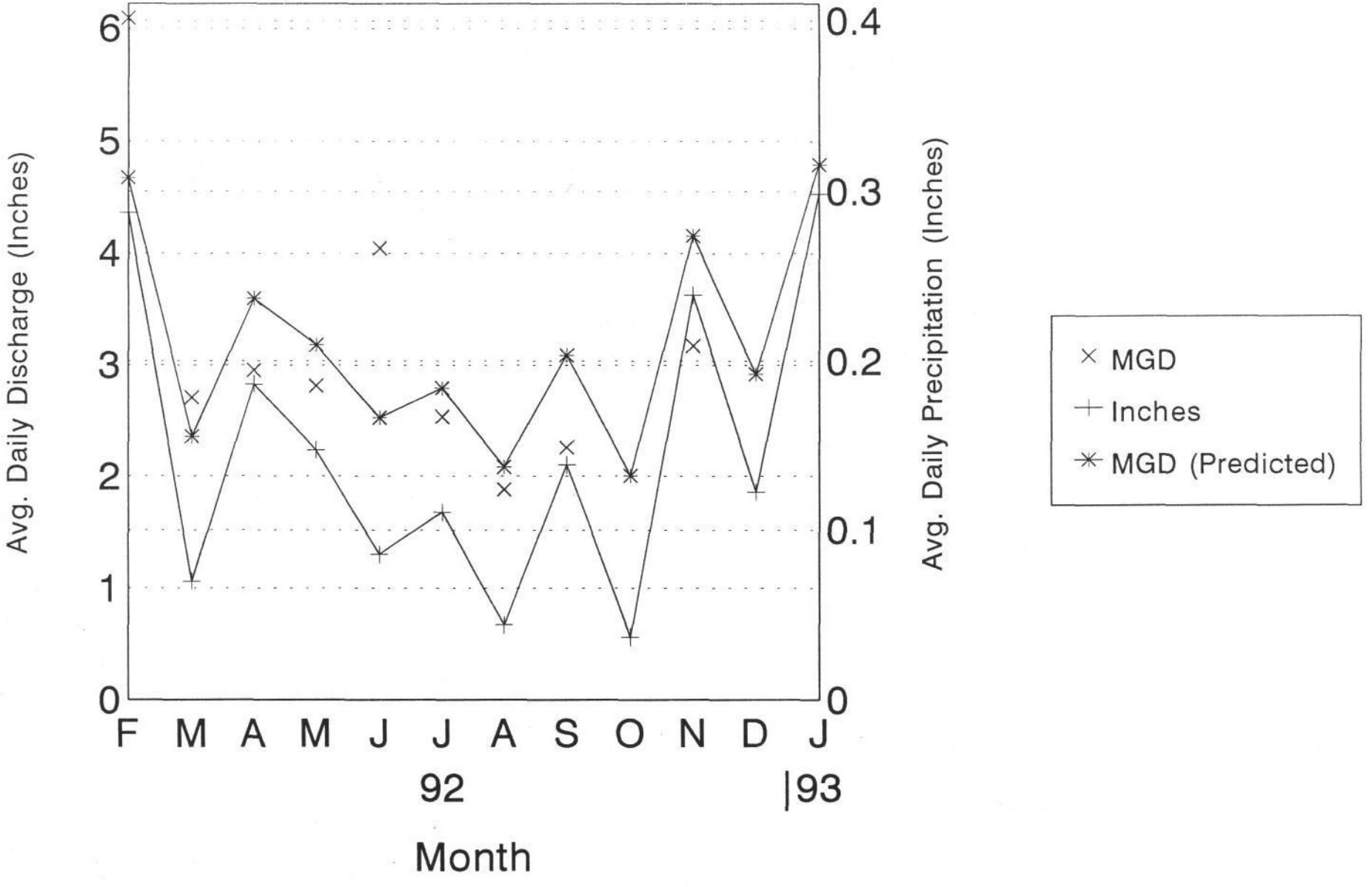

FIGURE 9. Discharge and rainfall data for the Galveston Co. WCID 001 wastewater collection system.
Predicted equation: MGD = 1.61 + 10.64 inches, R squared = 0.46
Rainfall data from NOAA Galveston weather station.

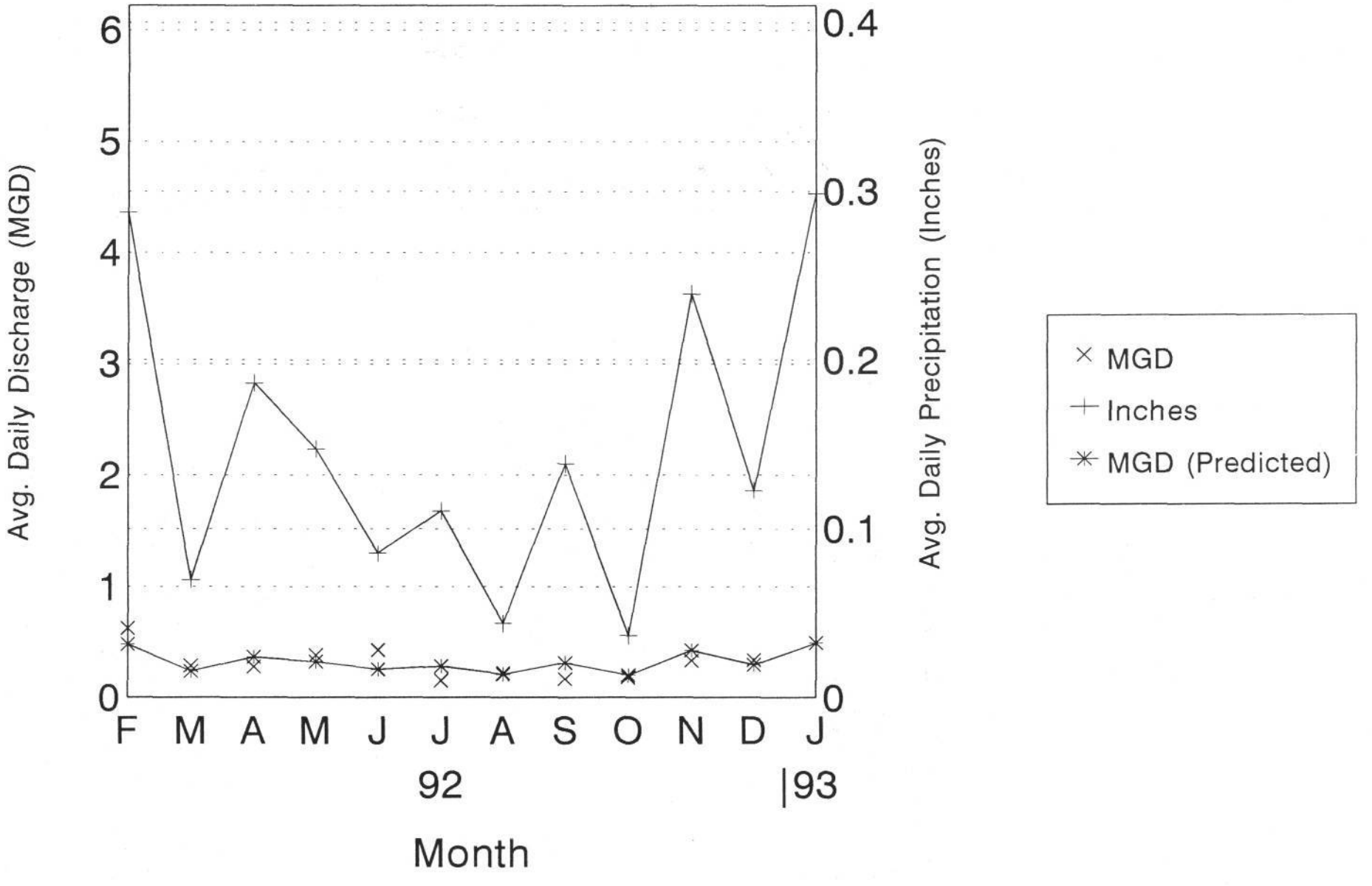

FIGURE 10. Discharge and rainfall data for the Galveston Co. WCID 012 wastewater collection system.
Predicted equation: MGD = 0.16 + 1.11 inches, R squared = 0.40.
Rainfall data from NOAA Galveston weather station.

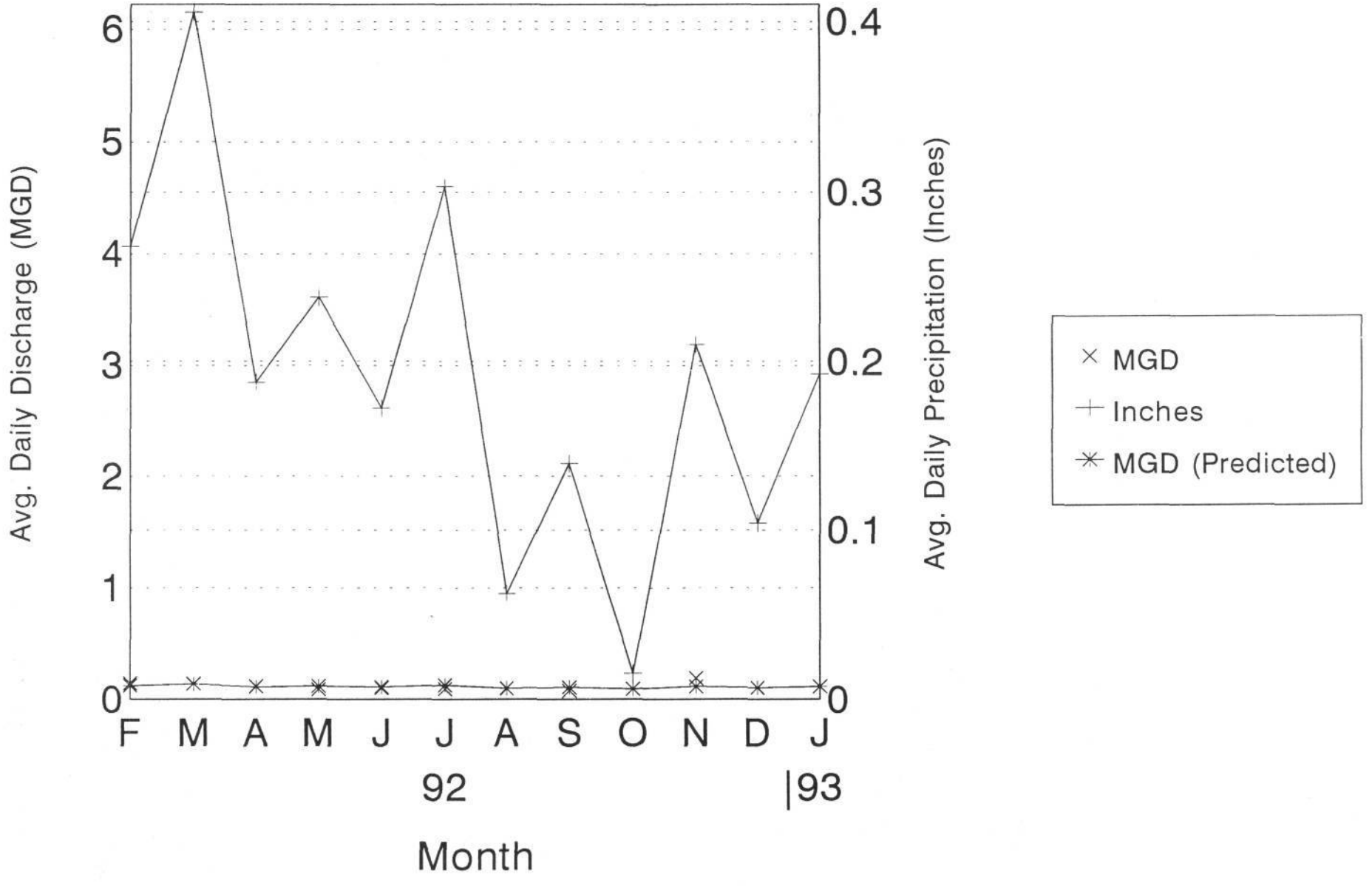

FIGURE 11. Discharge and rainfall data for the Harris County MUD 148 wastewater collection system.
Predicted equation: MGD = 0.09 + 0.11 inches, R squared = 0.09
Rainfall data from NOAA North Houston weather station.

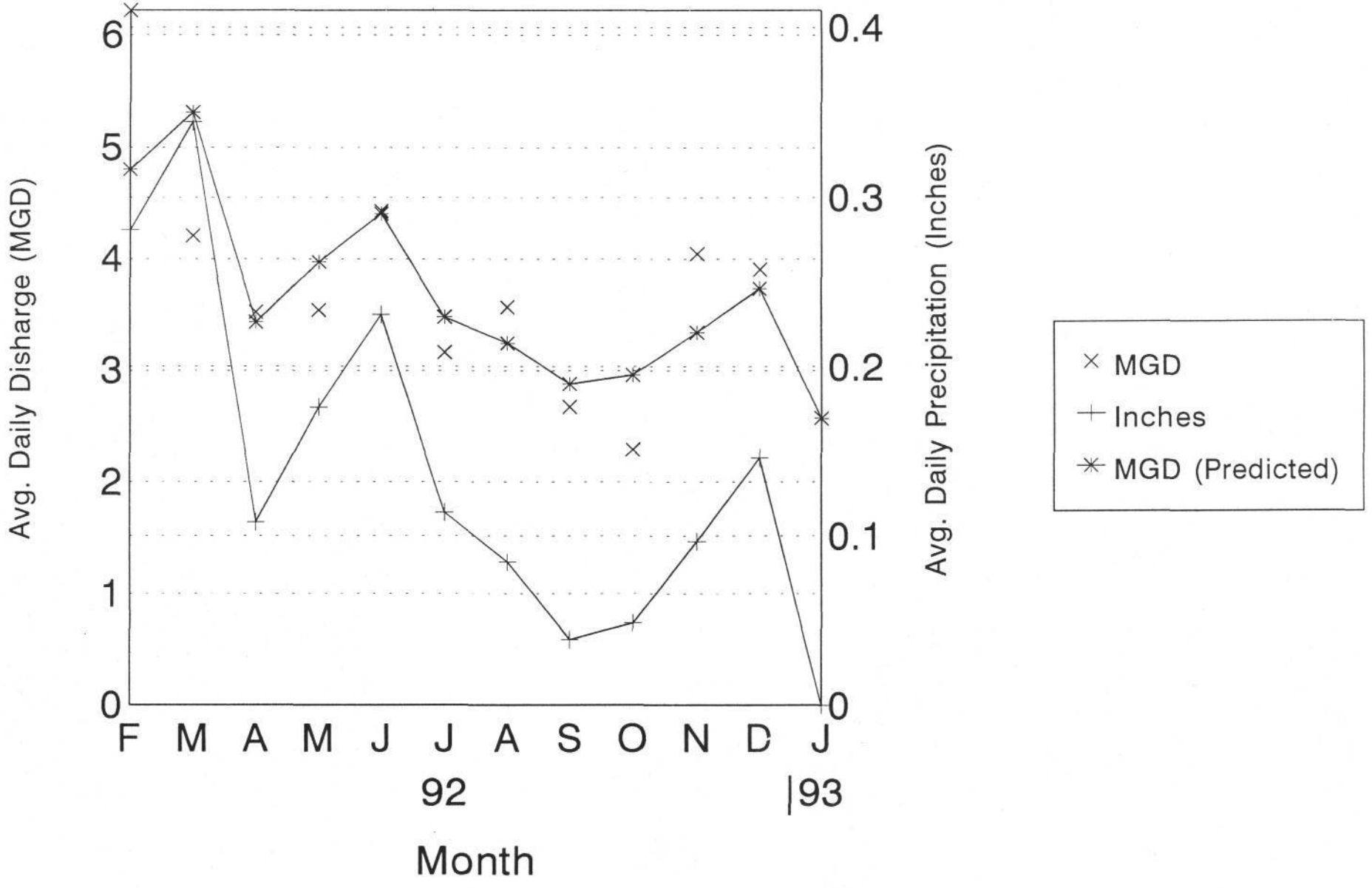

FIGURE 12. Discharge and rainfall data for the Houston NE plant wastewater collection system.
Predicted equation: MGD = 2.57 + 7.94 inches, R squared = 0.56
Rainfall data from NOAA San Jacinto weather station.

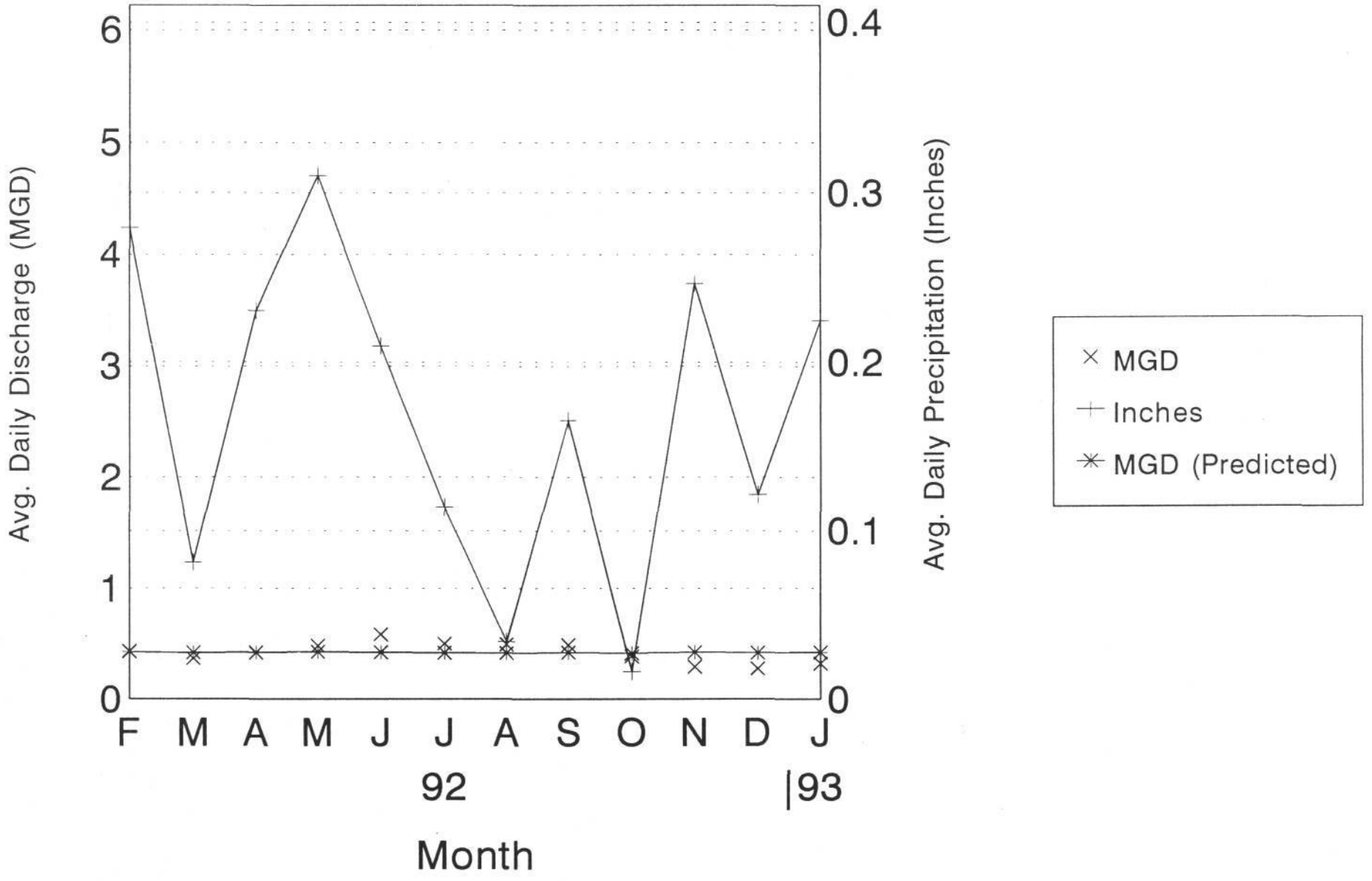

FIGURE 13. Discharge and rainfall data for the League City plant (003) wastewater collection system.
Predicted equation: MGD = 0.41 + 0.03 inches, R squared = < 0.01
Rainfall data from NOAA Alvin weather station

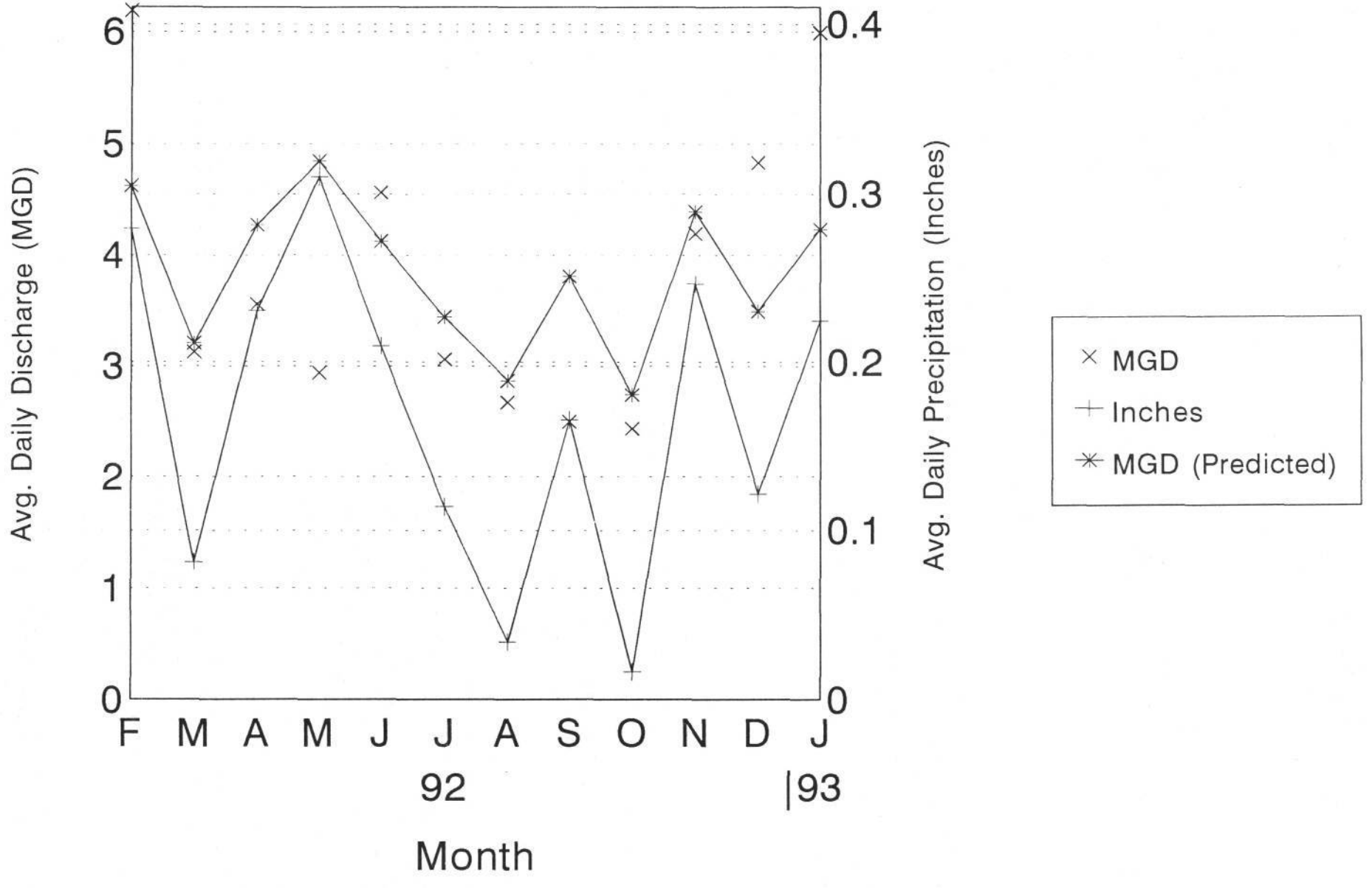

FIGURE 14. Discharge and rainfall data for the League City plant (005) wastewater collection system.
Predicted equation: MGD = 2.62 + 7.17 inches, R squared = 0.27
Rainfall data from NOAA Alvin weather station.

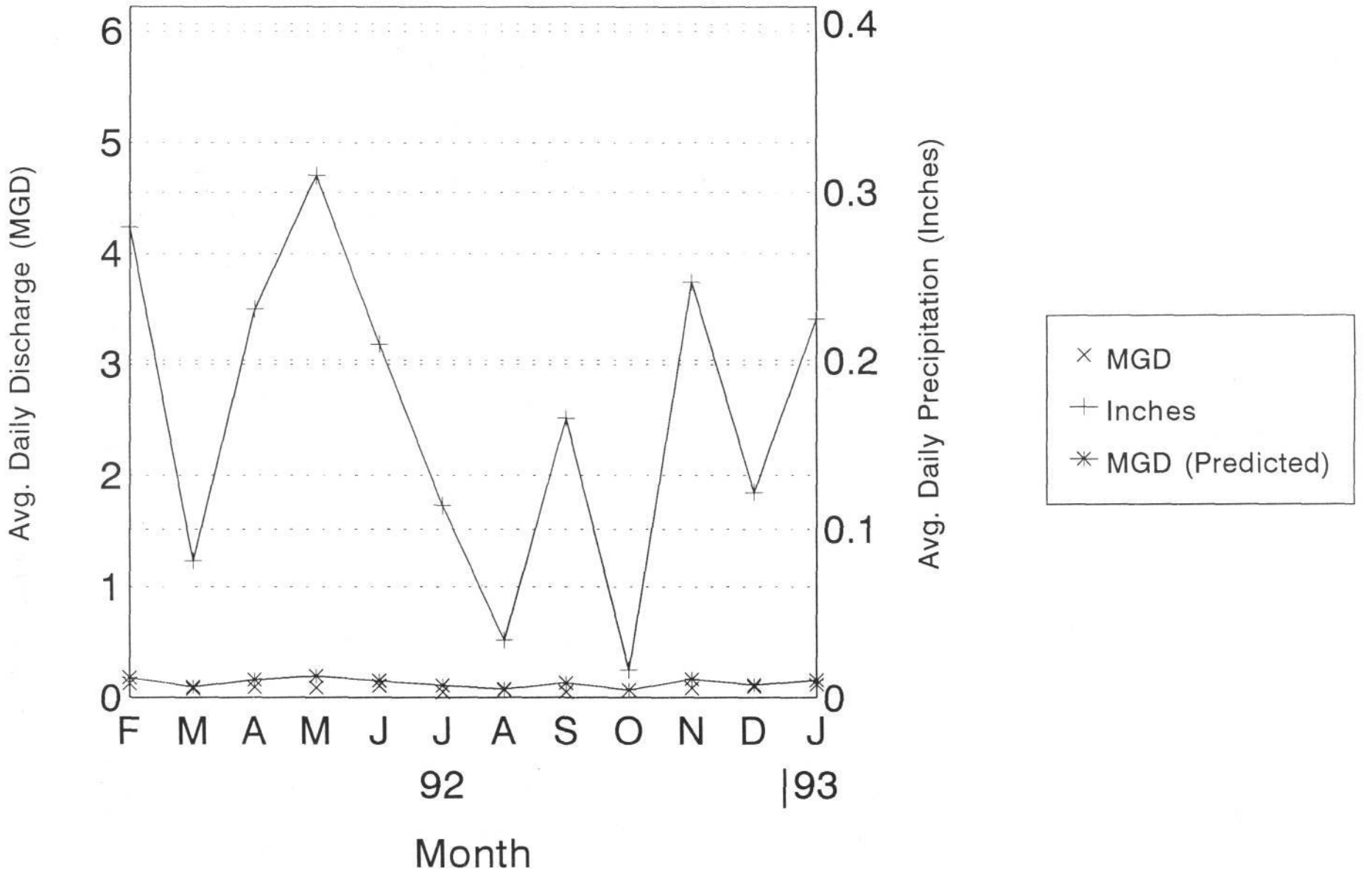

FIGURE 15. Discharge and rainfall data for the League City plant (007) wastewater collection system.
Predicted equation: MGD = 0.06 + 0.14 inches, R squared = 0.33
Rainfall data from NOAA Alvin weather station.

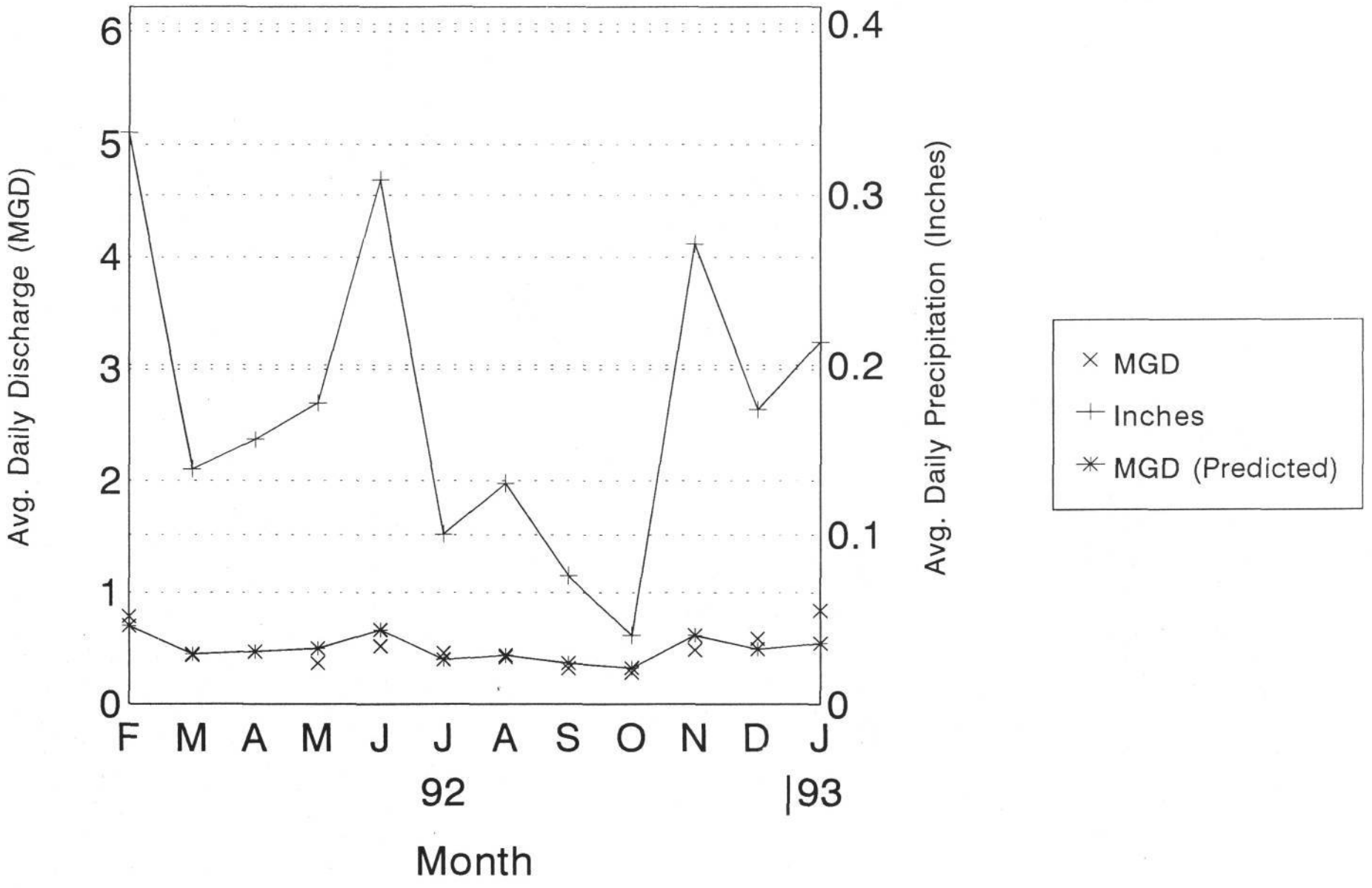

FIGURE 16. Discharge and rainfall data for the Mont Belvieu plant wastewater collection system.
Predicted equation: MGD = 0.27 + 1.27 inches, R squared = 0.46
Rainfall Data from NOAA Baytown weather station.

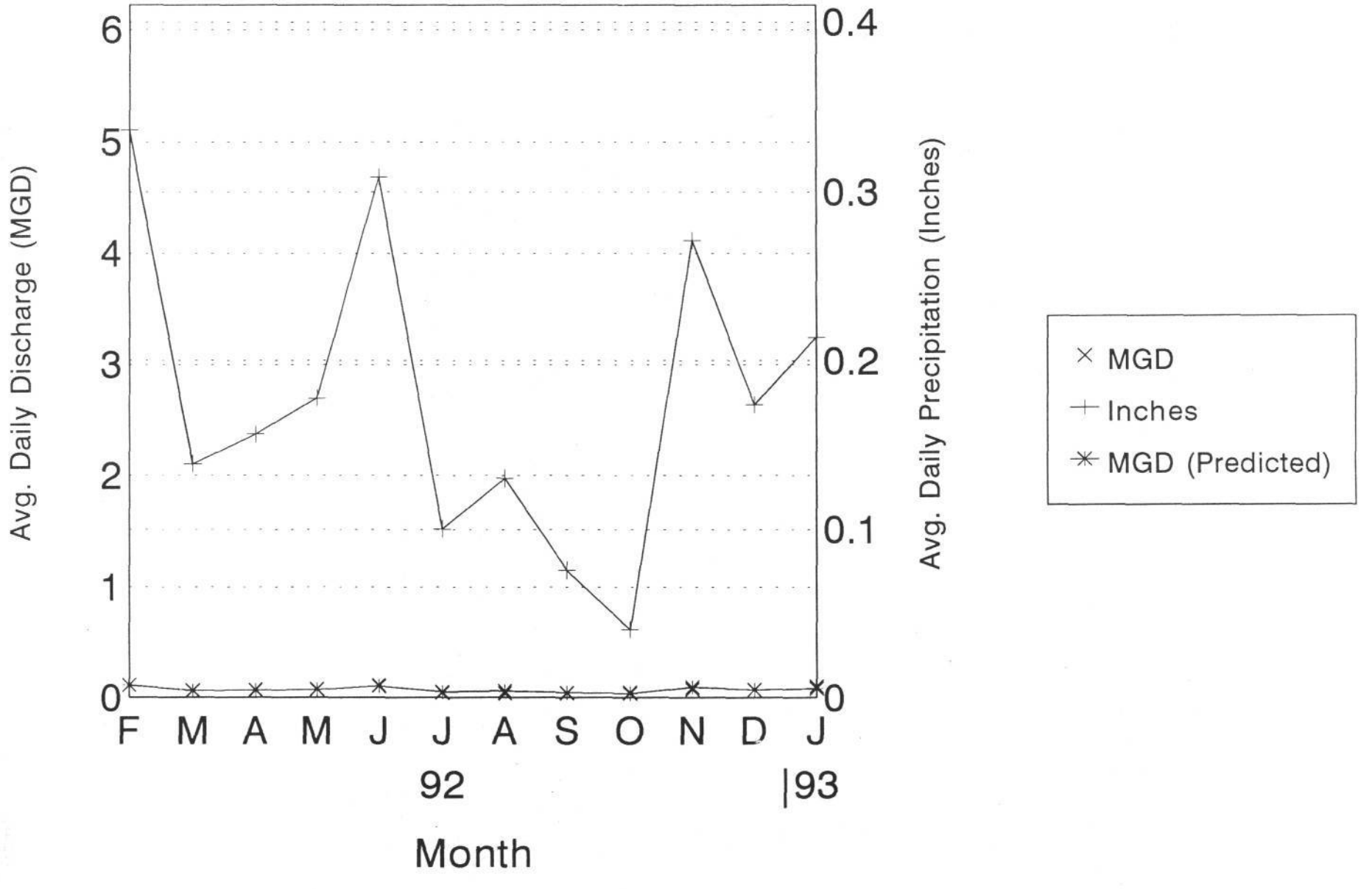

FIGURE 17. Discharge and rainfall data for the City of Morgan's Point wastewater collection system.
Predicted equation: MGD = 0.02 + 0.25 inches, R squared = 0.76
Rainfall data from NOAA Baytown weather station

Comparison to Other Sources of Loading

Results of the reported volume of collection system bypasses and septic tank discharges were compared to previously reported estimates of loading from various sources (Fig. 18). Both of these sources produced a combined discharge over 282 million gallons of effluent into the system during 1992, making them significant sources of wastewater loading. Based on best available published estimates both of these sources appear to contribute only a small percentage (0.01%) of the overall volume of effluent loading in the system (Figs. 18 and 19)(Armstrong, 1993; Newell et al., 1992; Guillen et al., 1989). Similar patterns were observed when comparing the various effluent parameters (Figs. 20,21,22,23, and 24). Discharge levels of fecal coliforms, BOD, TSS, total nitrogen and total phosphorus from reported malfunctioning septic tanks and/or overflows and bypasses represented less than 0.01% of the total loading for any specific constituent (Armstrong, 1993; Jensen and Su, 1992; Newell et al., 1992). However, other chemical constituents were not compared and this ratio may not hold true for these parameters. In addition, due to the unknown factors (e.g. poor monitoring and reporting) the potential loading from bypasses and septic tanks may actually exceed the estimated amounts in this report by a substantial amount. Using information on the ratio of maximum to average daily flows, the best estimate of the amount of additional wastewater discharge generated during wet weather inflow is approximately 174% of the reported municipal wastewater loading (Table 13). Applying this percentage and data tabulated by Armstrong (1993) (daily estimated flow = 3,222.684 MGD) for municipal wastewater, this could translate into an additional 5,626.807 MGD of loading into the Galveston Bay system from wastewater generated by inflow into the collection system on "wet weather" days. Certain areas of Galveston Bay do however, appear to have heavily localized areas of septic tank usage (Table 4). These areas included West and East Bay where a large number of septic tanks are used and where reported violations have occurred. Some of these areas, such as East Bay, possess few permitted wastewater treatment plants. Consequently, the predominant loading of wastewater into these segments would come from improperly functioning septic tank systems. The potential health risks could be fairly high, especially in areas frequented by wade-fisherman (e.g. East and West Bays).

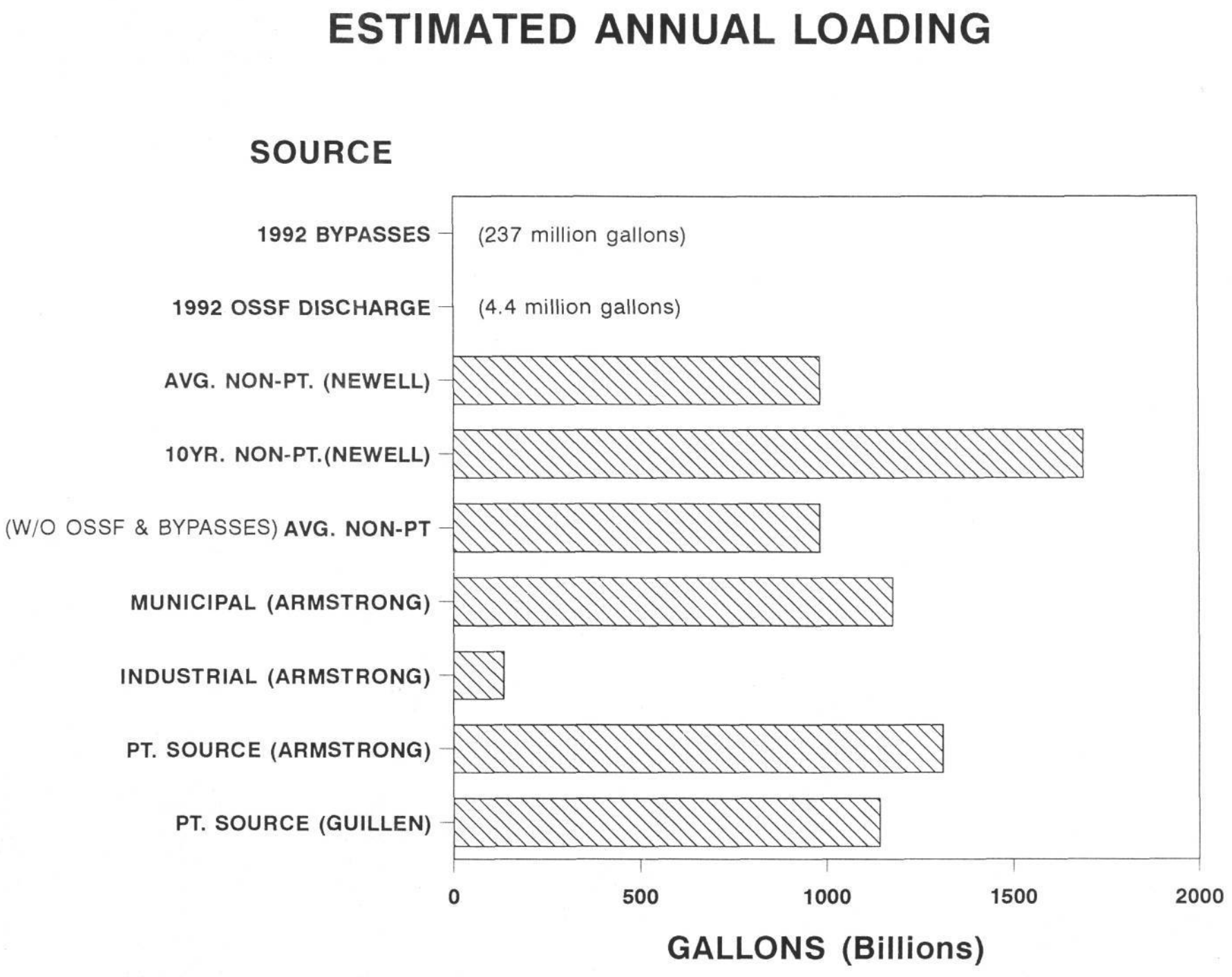

FIGURE 18. Estimated loading by source. (Armstrong, 1993; Newell et al., 1992; Guillen et al., 1989).

Percent Annual Volume Disharged into the Galveston Bay Watershed

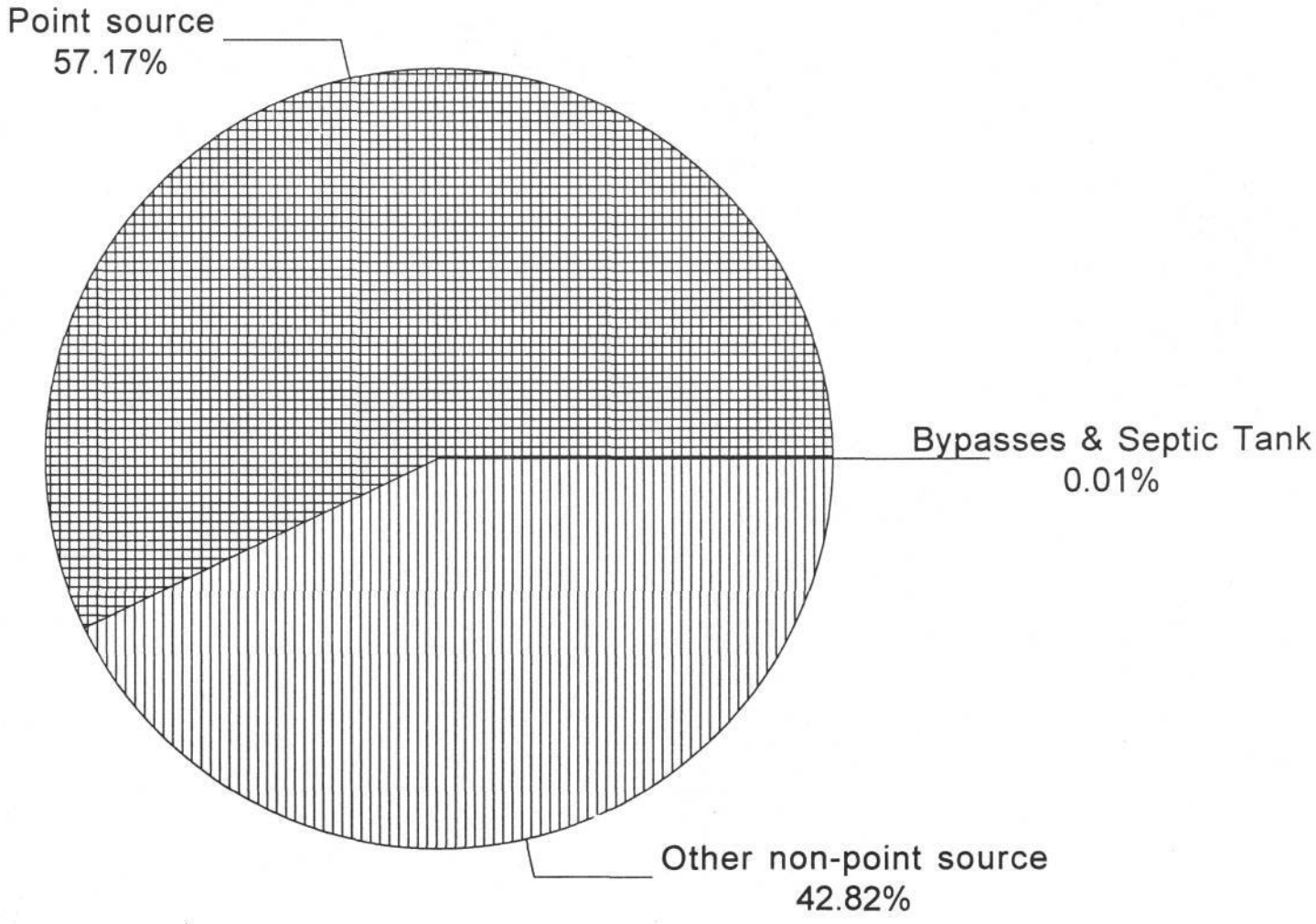

FIGURE 19. Estimated percent loading of various sources of effluent by volume discharged. Other nonpoint source data from Newell et al., 1992; Point source data from Armstrong, 1993.

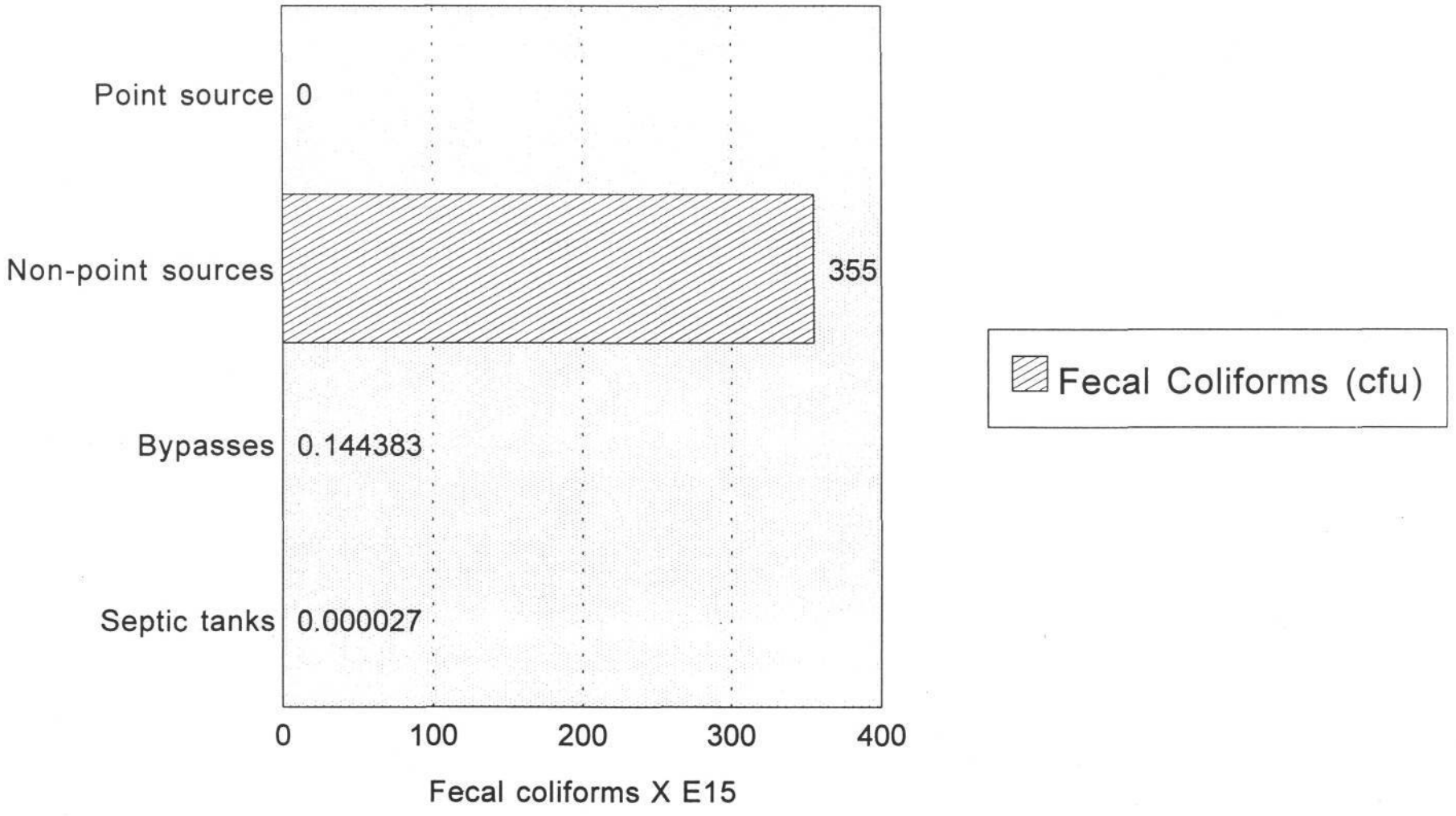

FIGURE 20. Estimated annual loading of fecal coliforms from various sources. Total estimated nonpoint source data from Newell et al., 1992; Point source data from Armstrong, 1993. Fecal coliform effluent levels derived from Jensen and Su (1992).

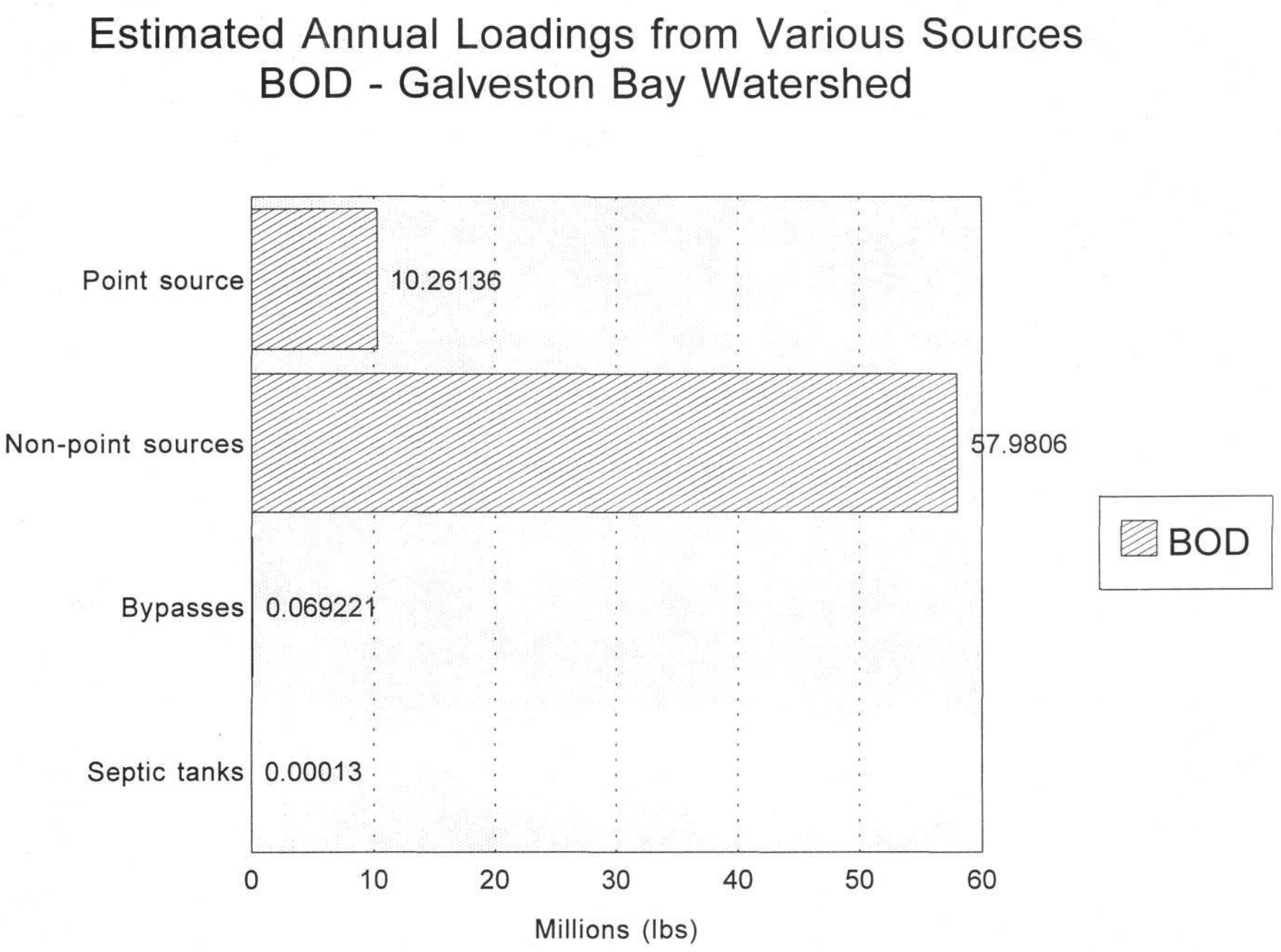

FIGURE 21. Estimated annual loading of BOD from various sources. Total estimated nonpoint source data from Newell et al., 1992; Point source data from Armstrong, 1993.

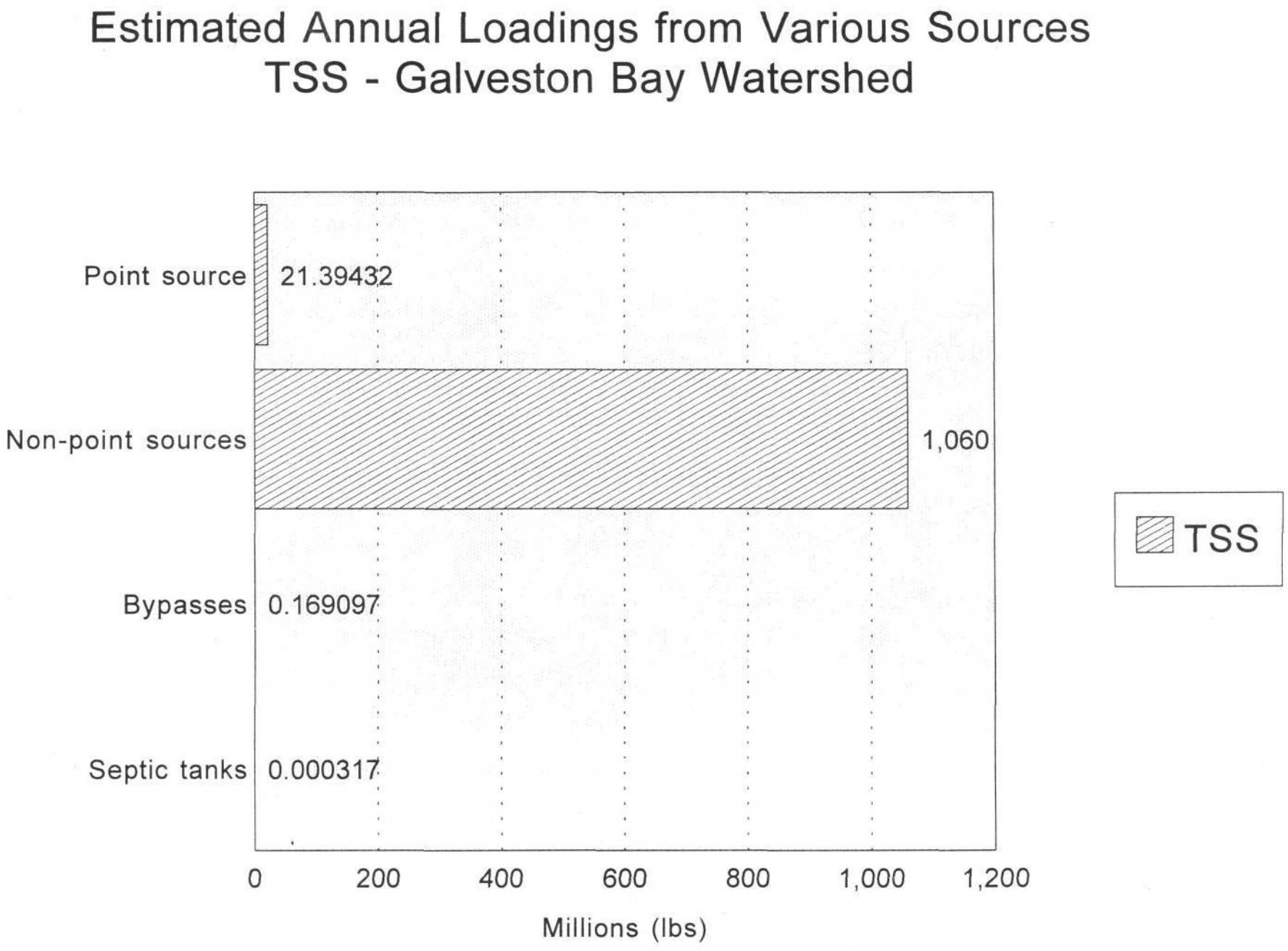

FIGURE 22. Estimated annual loading of TSS from various sources. Total estimated nonpoint source data from Newell et al., 1992; Point source data from Armstrong, 1993.

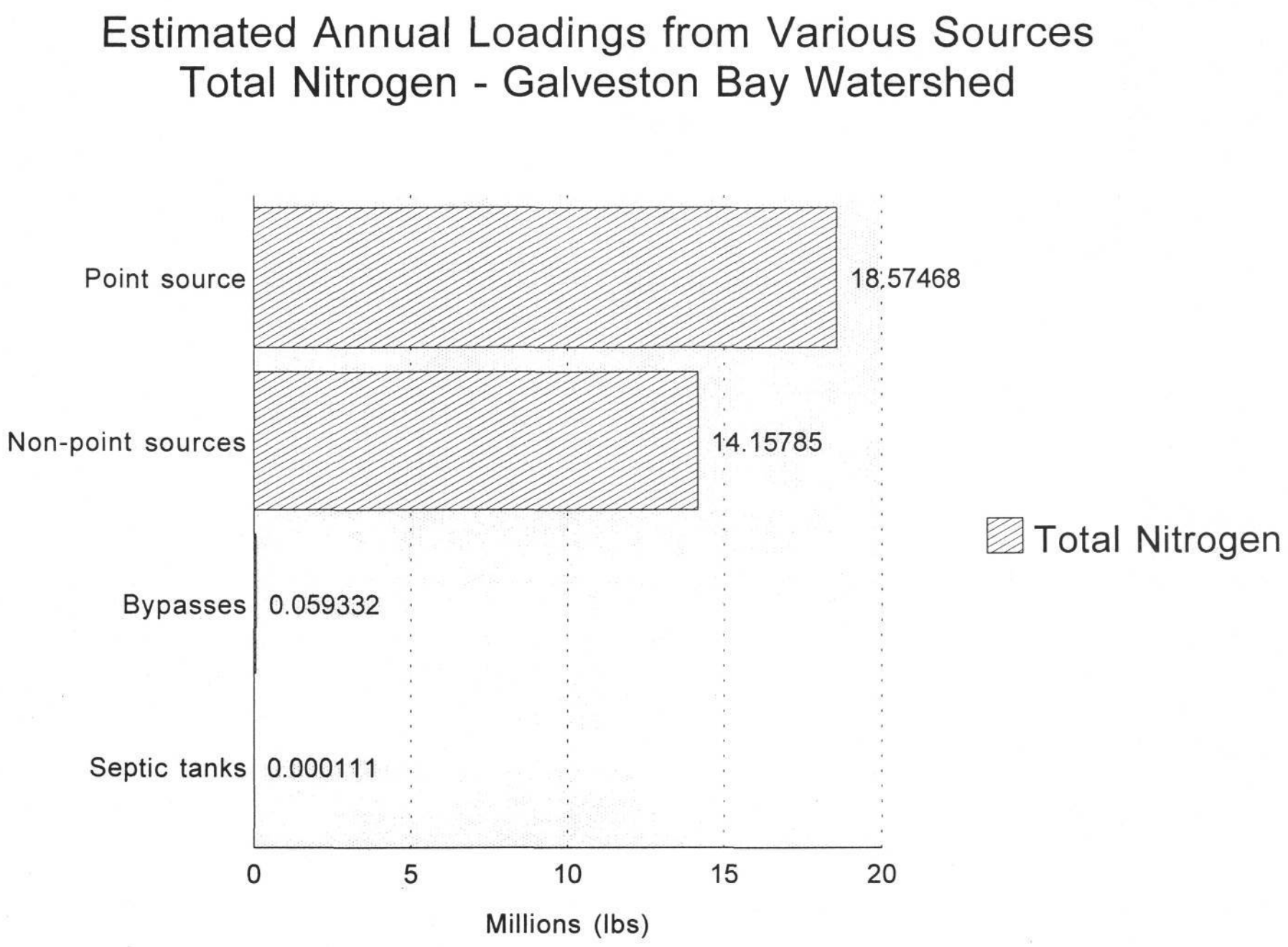

FIGURE 23. Estimated annual loading of total nitrogen from various sources. Total estimated nonpoint source data from Newell et al., 1992; Point source data from Armstrong, 1993.

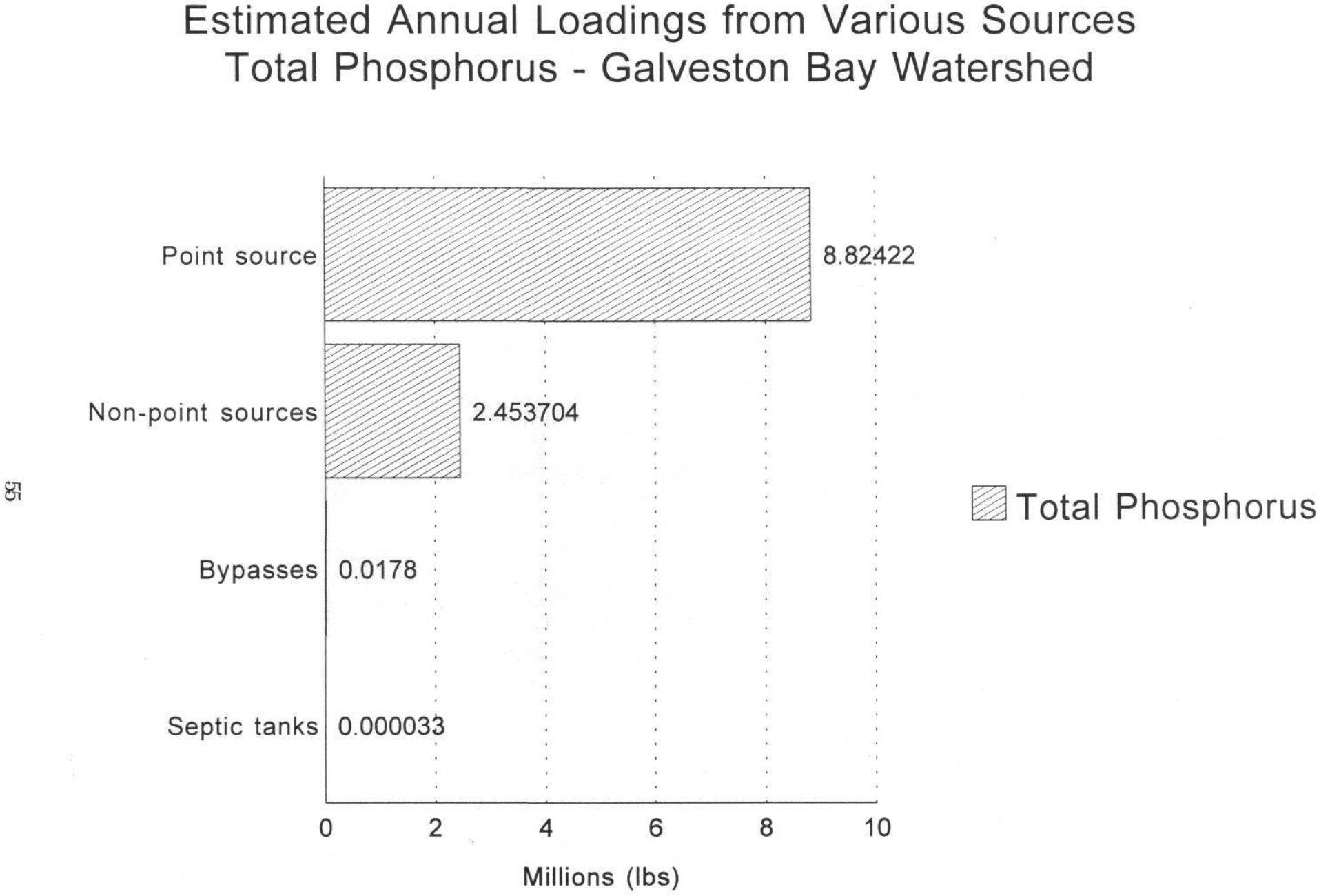

FIGURE 24. Estimated annual loading of total phosphorus from various sources. Total estimated nonpoint source data from Newell et al., 1992; Point source data from Armstrong, 1993.

Discussion

The results of this report illustrate the potential magnitude and severity of partially treated effluent loading into the Galveston Bay system. However, due to lack of good monitoring data it is difficult to ascertain the exact impacts on water quality. Limited data exist on the chemical quality and final effects of bypasses and septic tank overflows. In some circumstances they can be severely acute causing immediate impacts on aquatic communities, including fish kills. Based on the available data it appears that partially treated effluent represents a very small proportion of the overall loading into Galveston Bay. However, loading into specific waterbodies have had severe localized impacts.

The state database on reported bypass incidents is poorly organized and difficult to retrieve into a digital format conducive to spatial statistical analysis. The same problem exists in regards to the management of septic tank overflow/complaints. Standardized information regarding the quantity and volume of the discharge is not included in routine complaint reports. In addition, county and/or city agencies often do not have automated systems to track septic tank upset incidents.

Routine surveillance of septic tank systems by government agencies is virtually non-existent. Currently the TNRCC has (2) dedicated staff patrolling an area consisting of 14 counties which includes the Galveston Bay system. This level of effort is primarily targeted at complaint type investigations. Routine compliance monitoring does not exist. Those counties and/or cities that possess an authorized agent do little else than inspect the installation of new systems. Typically each local government entity only has 1-2 dedicated staff persons responsible for septic tank permitting, surveillance and inspection. There is concern that many of the agents do not do an adequate job of this either. This may be partially due to poor training and potential apathy on the part of the local regulatory agency. There is also difficulty in enforcing septic tank rules, since those that violate them often live in lower income areas and are financially unable to afford repairs. Septic system repairs and/or replacements are very expensive, and currently there is little, if any, financial assistance available for those who need to upgrade their systems and simply cannot afford it. Enforcement in these instances may be even more difficult when the regulators are local people who are friends with the violators and sympathetic of their financial hardship.

Recommendations

Potential solutions to the reported problems include creation of regional databases that would receive all bypass and septic tank upset data, allocation of additional staff and resources to septic tank surveillance, and some system of financial aid to disadvantage owners of malfunctioning septic tank systems. The first might be accomplished through the creation and management of regional databases such as those proposed by GBNEP and/or the Texas Clean Rivers Program. In addition, legislation and/or state rules requiring the reporting of minimal information on bypasses and septic tank overflows could be implemented. Additional surveillance staff could be recruited by increases in existing fees and/or implementation of new fees.

Monitoring of bypass and septic tank discharge effluent quality is needed to quantify the loading and effects of these discharges. Regulated entities who discover a bypass should be required by existing programs to characterize the quantity and quality of the discharge. Wet weather sampling of known bypass locations should be conducted by the TNRCC to evaluate the impacts of these discharges.

Finally, minimal required routine surveillance of septic tanks should be implemented. A system similar to that currently used to monitor the operations of permitted wastewater facilities should be used. The inspections should include engineering and performance audits. Implementation of this could be accomplished by the state or through state approved local programs. Fees generated by septic tank owners could finance wholly or partially the proposed system.

Additional sources of funds, such as fees, are needed to finance low interest loans and/or grants to financially disadvantages owner of septic systems in need of repair. Low cost alternatives to traditional wastewater treatment systems in low income rural areas will continue to be problematic. Unless a funding source is identified to address this problem, continued deterioration of these systems will occur. One potential source, the state revolving fund, could be used to set up a low interest loan fund.

In addition, increased compliance monitoring, enforcement and educational programs are needed to address this problem. Educational programs are needed to inform the public of the need and potential benefits of correctly designed septic systems. Many citizens in rural areas are unaware of the potential health risks of overflowing septic systems. Unless addressed the public health threat of these malfunctioning systems will continue to grow.

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Appendix 1. Records reviewed for septic tank violations or raw files.

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
23-May-91	270	1113	2	Harris	18900
21-May-91	750	1113	2	Harris	52500
25-Jun-93	15	1113	2	Harris	1050
06-Mar-85	1020	1113	2	Harris	71400
27-May-93	30	1102	2	Harris	2100
14-Jan-93	30	1102	2	Harris	2100
09-May-93	30	1102	2	Harris	2100
30-Jun-92	30	1102	2	Harris	2100
17-Mar-92	240	1102	2	Harris	16800
24-Sep-91	15	1101	2	Harris	1050
18-Aug-92	30	1101	2	Harris	2100
25-Jun-92	210	1017	2	Harris	14700
22-Jun-92	30	1017	2	Harris	2100
15-May-91	780	1017	2	Harris	54600
16-May-91	780	1017	2	Harris	54600
20-Feb-91	870	1016	2	Harris	60900
04-Jun-91	720	1016	2	Harris	50400
25-Apr-91	810	1016	2	Harris	56700
03-Jul-91	180	1016	2	Harris	12600
29-Mar-93	90	1016	3	Harris	8100
12-May-93	30	1016	2	Harris	2100
24-Sep-91	60	1016	3	Harris	5400
02-Nov-92	15	1016	2	Harris	1050
06-Oct-92	15	1016	2	Harris	1050
19-Mar-91	840	1016	2	Harris	58800
14-Apr-93	30	1016	2	Harris	2100
18-Feb-93	30	1016	2	Harris	2100
11-Jun-92	90	1016	2	Harris	6300
28-Jan-91	900	1016	2	Harris	63000
08-Jul-92	15	1016	2	Harris	1050
11-Apr-91	90	1016	2	Harris	6300
26-Mar-91	840	1016	2	Harris	58800
11-Oct-91	90	1016	2	Harris	6300
18-May-92	15	1016	2	Harris	1050
24-Jun-91	360	1016	2	Harris	25200
21-Apr-92	120	1016	1	Harris	6000
05-Oct-92	60	1016	2	Harris	4200
09-Apr-90	810	1016	2	Harris	56700
11-Apr-91	30	1016	2	Harris	2100
24-Apr-91	810	1016	2	Harris	56700
14-Feb-91	870	1016	2	Harris	60900
19-Mar-91	840	1016	2	Harris	58800
06-Feb-91	870	1016	2	Harris	60900
10-Apr-91	810	1016	2	Harris	56700
07-Apr-92	15	1016	2	Harris	1050
09-Nov-90	960	1016	2	Harris	67200
08-Oct-92	60	1016	2	Harris	4200
30-Dec-92	60	1016	2	Harris	4200

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
11-Aug-92	30	1006	2	Harris	2100
25-Jun-91	720	1006	2	Harris	50400
25-Sep-89	1020	1006	2	Harris	71400
17-Mar-93	30	1006	2	Harris	2100
14-Feb-91	840	1006	2	Harris	58800
06-Jan-92	570	1006	2	Harris	39900
14-Jan-93	15	1006	2	Harris	1050
20-Mar-91	810	1006	2	Harris	56700
01-Apr-93	30	1006	2	Harris	2100
27-Nov-90	990	1006	2	Harris	69300
12-Apr-93	30	1006	2	Harris	2100
08-Apr-91	810	1006	2	Harris	56700
14-Jul-92	30	1006	2	Harris	2100
21-Feb-92	30	1006	2	Harris	2100
03-Mar-93	15	1006	2	Harris	1050
21-Jan-92	180	1006	2	Harris	12600
24-Apr-92	420	1006	2	Harris	29400
01-May-92	15	1006	2	Harris	1050
21-Jan-92	210	1006	2	Harris	14700
17-Sep-91	15	1006	2	Harris	1050
05-Feb-93	15	1006	2	Harris	1050
20-Mar-91	810	1006	2	Harris	56700
03-Jan-92	90	1006	2	Harris	6300
29-Oct-91	30	1006	2	Harris	2100
24-Apr-91	810	1006	2	Harris	56700
26-Sep-91	30	1006	2	Harris	2100
04-Dec-91	60	1006	2	Harris	4200
26-Sep-91	300	1006	2	Harris	21000
05-Feb-91	810	1006	2	Harris	56700
14-Apr-92	120	1006	2	Harris	8400
22-Feb-93	30	1006	2	Harris	2100
23-Dec-92	180	1006	2	Harris	12600
17-Nov-92	60	1006	2	Harris	4200
12-May-93	30	1006	2	Harris	2100
22-May-91	750	1006	2	Harris	52500
05-Jun-91	720	1006	2	Harris	50400
01-Apr-93	30	1006	2	Harris	2100
23-Jan-92	300	1006	2	Harris	21000
22-May-92	60	1006	2	Harris	4200
31-Jan-92	60	1006	3	Harris	5400
14-Mar-91	840	1006	2	Harris	58800
27-Sep-91	90	1006	2	Harris	6300
13-Nov-92	30	1006	2	Harris	2100
11-Jun-92	60	1006	2	Harris	4200
25-Apr-91	90	1006	2	Harris	6300
30-Mar-93	30	1006	2	Harris	2100
09-Apr-91	90	1006	2	Harris	6300
01-Jun-92	30	1006	2	Harris	2100
02-Apr-91	810	1006	2	Harris	56700
18-May-93	30	1006	2	Harris	2100

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
07-Sep-90	15	1006	2	Harris	1050
20-Feb-91	870	1006	2	Harris	60900
31-Dec-91	30	1006	2	Harris	2100
11-Feb-93	60	1006	2	Harris	4200
21-May-92	150	1006	2	Harris	10500
16-Feb-93	90	1006	2	Harris	6300
30-Jan-91	30	1006	2	Harris	2100
28-May-92	90	1006	2	Harris	6300
13-Aug-91	150	1006	2	Harris	10500
28-May-92	30	1006	2	Harris	2100
08-Feb-91	30	1006	2	Harris	2100
08-Jun-92	30	1006	2	Harris	2100
08-May-91	750	1006	2	Harris	52500
28-May-92	30	1006	2	Harris	2100
04-Jun-92	15	1006	2	Harris	1050
05-Jun-92	30	1006	2	Harris	2100
12-Jan-93	60	1006	2	Harris	4200
08-Apr-91	810	1006	2	Harris	56700
02-Apr-92	150	1006	2	Harris	10500
27-May-92	420	1006	2	Harris	29400
13-Jul-91	240	1006	2	Harris	16800
08-Apr-91	810	1006	2	Harris	56700
30-Mar-92	150	1006	2	Harris	10500
11-Feb-93	60	1006	2	Harris	4200
08-Apr-91	810	1006	2	Harris	56700
30-Mar-93	30	1006	2	Harris	2100
30-Mar-93	60	1006	2	Harris	4200
16-Apr-92	15	1006	2	Harris	1050
17-Jun-91	30	1006	2	Harris	2100
12-Apr-93	30	1006	2	Harris	2100
08-Apr-91	810	1006	2	Harris	56700
17-Oct-90	990	1006	2	Harris	69300
23-Mar-93	90	1006	2	Harris	6300
08-Oct-92	270	1006	2	Harris	18900
18-Aug-92	300	1006	2	Harris	21000
21-Nov-90	960	1006	2	Harris	67200
23-Jan-92	30	1006	2	Harris	2100
18-Nov-92	150	1006	2	Harris	10500
20-Feb-92	300	1006	2	Harris	21000
11-May-93	30	1006	2	Harris	2100
29-Sep-92	240	1006	2	Harris	16800
30-Apr-93	60	1006	2	Harris	4200
06-Oct-92	60	1006	2	Harris	4200
07-Apr-92	420	1006	2	Harris	29400
11-Jan-91	900	1006	2	Harris	63000
18-Mar-91	810	1006	2	Harris	56700
31-Jan-92	120	1006	2	Harris	8400
27-May-93	30	1006	2	Harris	2100
03-Apr-90	1020	1006	2	Harris	71400
21-Jun-93	15	1006	2	Harris	1050

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
21-Feb-92	60	1006	2	Harris	4200
02-May-91	750	1006	2	Harris	52500
17-Dec-91	480	1006	2	Harris	33600
27-Jun-91	720	1006	2	Harris	50400
16-Feb-93	30	1006	2	Harris	2100
15-Oct-92	60	1006	2	Harris	4200
05-Jan-93	30	1006	2	Harris	2100
25-Feb-93	60	1006	2	Harris	4200
30-Mar-93	30	1006	2	Harris	2100
18-Dec-90	300	1006	2	Harris	21000
24-Nov-92	180	1006	2	Harris	12600
21-Jun-91	180	1006	2	Harris	12600
12-Feb-91	840	1006	2	Harris	58800
05-Dec-91	15	1006	2	Harris	1050
06-Aug-92	15	1006	2	Harris	1050
10-Dec-91	60	1006	2	Harris	4200
30-May-91	750	1006	2	Harris	52500
28-May-92	180	1006	3	Harris	16200
13-Jul-92	270	1006	2	Harris	18900
13-Jan-92	60	1006	3	Harris	5400
25-Feb-93	30	1006	2	Harris	2100
29-Nov-90	960	1006	2	Harris	67200
26-Feb-93	30	1006	2	Harris	2100
24-Jun-91	30	1006	3	Harris	2700
05-Jan-93	15	1006	2	Harris	1050
12-Jan-93	90	1006	2	Harris	6300
13-May-92	15	1006	2	Harris	1050
27-Sep-91	30	1006	2	Harris	2100
20-Feb-92	30	1006	2	Harris	2100
23-Apr-92	420	1006	2	Harris	29400
05-Apr-93	15	1006	2	Harris	1050
11-Jun-92	360	1006	2	Harris	25200
06-Aug-92	60	1006	2	Harris	4200
05-Apr-93	90	1006	2	Harris	6300
03-Apr-90	660	1006	2	Harris	46200
06-Jun-91	720	1006	2	Harris	50400
29-Mar-93	30	1006	2	Harris	2100
23-Jan-92	540	1006	2	Harris	37800
30-Jul-92	30	1006	2	Harris	2100
13-Apr-93	30	1006	2	Harris	2100
09-Apr-91	780	1006	2	Harris	54600
15-Apr-93	30	1006	3	Harris	2700
28-Nov-90	180	1006	2	Harris	12600
13-Mar-90	1020	1006	2	Harris	71400
02-Oct-92	15	1006	2	Harris	1050
17-Sep-92	30	1006	2	Harris	2100
13-Mar-92	60	1006	2	Harris	4200
12-Oct-90	990	1006	2	Harris	69300
27-Mar-91	840	1006	2	Harris	58800
25-Jun-93	15	1006	2	Harris	1050

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
07-Nov-90	30	1006	2	Harris	2100
23-Sep-92	30	1006	2	Harris	2100
30-Jun-92	180	1006	2	Harris	12600
11-Apr-91	810	1006	2	Harris	56700
29-Oct-92	60	1006	2	Harris	4200
02-Jun-93	15	1006	2	Harris	1050
26-Mar-92	480	1006	2	Harris	33600
26-Feb-93	90	1006	2	Harris	6300
12-Apr-93	60	1006	2	Harris	4200
10-Feb-92	15	1006	2	Harris	1050
22-May-92	30	1006	2	Harris	2100
12-Jan-93	60	1006	2	Harris	4200
08-Apr-91	840	1006	2	Harris	58800
27-Aug-92	30	1006	2	Harris	2100
08-Jan-92	270	1006	2	Harris	18900
23-Dec-92	60	1006	2	Harris	4200
11-May-93	30	1006	2	Harris	2100
07-Oct-91	15	1006	2	Harris	1050
09-Jan-91	900	1006	2	Harris	63000
26-Mar-91	840	1006	2	Harris	58800
20-Mar-92	15	1006	2	Harris	1050
14-Jan-93	120	1006	2	Harris	8400
11-Aug-92	120	1006	2	Harris	8400
03-Feb-92	180	1006	2	Harris	12600
23-May-91	750	1006	2	Harris	52500
11-Jun-93	15	1006	2	Harris	1050
15-Dec-92	30	1006	2	Harris	2100
27-Mar-91	810	1006	2	Harris	56700
30-Mar-92	30	1006	2	Harris	2100
25-Sep-91	60	1006	2	Harris	4200
01-Apr-93	15	1006	2	Harris	1050
28-Apr-93	60	1006	2	Harris	4200
17-Apr-91	810	1006	2	Harris	56700
13-Jul-92	15	1006	2	Harris	1050
23-Aug-91	150	1006	2	Harris	10500
22-Jul-91	300	1006	2	Harris	21000
19-Apr-91	420	1006	2	Harris	29400
23-Dec-92	210	1006	2	Harris	14700
21-Aug-92	60	1006	2	Harris	4200
18-Sep-92	15	1006	2	Harris	1050
19-Apr-91	810	1006	2	Harris	56700
14-Apr-93	60	1006	2	Harris	4200
28-Mar-91	840	1006	2	Harris	58800
10-Jun-91	720	1006	2	Harris	50400
05-Feb-92	210	1006	2	Harris	14700
18-Dec-91	150	1006	3	Harris	13500
02-Dec-92	60	1006	2	Harris	4200
05-May-93	30	1006	2	Harris	2100
17-Jun-93	15	1006	2	Harris	1050
10-Sep-92	15	1006	2	Harris	1050

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
21-Sep-90	1020	1006	2	Harris	71400
18-Dec-91	150	1006	3	Harris	13500
22-May-91	780	1006	2	Harris	54600
16-Jun-91	300	1005	2	Harris	21000
31-May-91	360	1005	2	Harris	25200
05-May-93	30	1005	2	Harris	2100
25-Feb-93	120	1005	2	Harris	8400
14-Apr-92	270	1005	3	Harris	24300
28-May-93	15	1005	2	Harris	1050
29-May-91	60	1005	2	Harris	4200
27-Nov-90	990	1005	2	Harris	69300
10-Dec-92	210	1005	2	Harris	14700
22-May-91	750	1005	2	Harris	52500
28-Nov-90	15	1005	1	Harris	750
16-Apr-91	810	1005	2	Harris	56700
11-Oct-90	990	1005	2	Harris	69300
13-Aug-92	30	1005	2	Harris	2100
05-Dec-91	120	1005	3	Harris	10800
28-Oct-91	90	1005	2	Harris	6300
30-May-91	780	1005	2	Harris	54600
13-Mar-91	810	1005	2	Harris	56700
11-Oct-90	15	1005	2	Harris	1050
28-Jan-91	180	1005	3	Harris	16200
17-Jun-91	720	1005	2	Harris	50400
22-Jan-92	510	1005	2	Harris	35700
20-May-91	330	1005	2	Harris	23100
24-Feb-92	540	1005	2	Harris	37800
11-Dec-91	540	1005	2	Harris	37800
10-Dec-92	15	1005	2	Harris	1050
28-Oct-92	240	1003	2	Harris	16800
02-Feb-93	15	1003	2	Harris	1050
11-Feb-93	30	1003	2	Harris	2100
11-Nov-92	150	1003	2	Harris	10500
07-Dec-92	210	1003	2	Harris	14700
28-Feb-91	840	1003	2	Harris	58800
04-Sep-91	30	1002	2	Harris	2100
13-Jul-92	330	1002	2	Harris	23100
27-Dec-91	330	1002	3	Harris	29700
26-Sep-91	660	1002	2	Harris	46200
19-Sep-91	150	1002	2	Harris	10500
15-Oct-91	15	1002	2	Harris	1050
04-Dec-93	30	1002	2	Harris	2100
10-Oct-91	30	1002	2	Harris	2100
26-Feb-91	840	1002	2	Harris	58800
29-Oct-92	30	1002	2	Harris	2100
29-Oct-92	30	1002	2	Harris	2100
15-May-91	750	1002	2	Harris	52500
14-Apr-92	450	1002	2	Harris	31500
03-Mar-93	15	1002	2	Harris	1050
07-Aug-92	150	1002	3	Harris	13500

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
25-Nov-92	90	1002	2	Harris	6300
20-Aug-92	330	1002	2	Harris	23100
30-Mar-92	150	1002	2	Harris	10500
28-May-92	90	1002	2	Harris	6300
10-Apr-91	300	1002	2	Harris	21000
14-May-93	30	1002	2	Harris	2100
13-Mar-91	510	1002	2	Harris	35700
08-Jul-91	270	1002	2	Harris	18900
25-Jun-93	15	1002	2	Harris	1050
15-May-91	15	1001	2	Harris	1050
02-Jun-93	15	1001	2	Harris	1050
08-Jan-92	240	1001	2	Harris	16800
10-Feb-92	240	1001	2	Harris	16800
21-May-90	150	1001	2	Harris	10500
06-Aug-90	90	1001	2	Harris	6300
05-May-93	15	1001	2	Harris	1050
28-Oct-92	270	1001	2	Harris	18900
06-May-91	15	1001	2	Harris	1050
10-Apr-92	240	1001	2	Harris	16800
19-Apr-93	60	1001	2	Harris	4200
20-Jul-92	330	1001	2	Harris	23100
06-May-91	750	1001	2	Harris	52500
05-Aug-92	15	1001	2	Harris	1050
06-May-91	750	1001	2	Harris	52500
03-Oct-90	15	1001	2	Harris	1050
19-Mar-91	60	1001	3	Harris	5400
27-Mar-91	810	1001	2	Harris	56700
30-Jan-91	30	1001	2	Harris	2100
03-Oct-88	1020	1001	2	Harris	71400
13-Oct-92	30	1001	2	Harris	2100
26-Nov-90	90	1001	2	Harris	6300
16-Mar-93	90	1001	2	Harris	6300
24-Oct-90	15	1001	1	Harris	750
16-Jun-93	15	1001	2	Harris	1050
04-Nov-92	240	1001	2	Harris	16800
01-Apr-93	60	1001	2	Harris	4200
09-Jul-90	1020	1001	2	Harris	71400
04-Dec-93	90	1001	2	Harris	6300
13-Apr-93	90	1001	2	Harris	6300
10-Dec-92	210	1001	2	Harris	14700
09-May-91	690	1001	2	Harris	48300
12-Aug-91	90	1001	2	Harris	6300
22-Apr-92	210	1001	2	Harris	14700
21-Aug-91	690	1001	2	Harris	48300
29-Oct-92	60	1001	2	Harris	4200
17-Sep-92	150	1001	2	Harris	10500
15-Apr-92	15	1001	2	Harris	1050
30-Mar-93	90	1001	2	Harris	6300
23-Dec-92	120	1001	2	Harris	8400
11-Sep-91	270	1001	2	Harris	18900

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
05-Feb-93	60	1001	3	Harris	5400
13-Mar-91	810	1001	2	Harris	56700
11-Apr-91	90	1001	2	Harris	6300
07-Apr-92	150	1001	2	Harris	10500
26-May-92	120	1001	2	Harris	8400
11-Apr-91	780	1001	2	Harris	54600
30-Jan-91	90	1001	2	Harris	6300
01-May-92	150	1001	2	Harris	10500
30-Nov-88	1020	1001	2	Harris	71400
28-Feb-92	30	1001	2	Harris	2100
19-Mar-91	810	1001	2	Harris	56700
29-Jan-91	90	1001	2	Harris	6300
12-Mar-92	480	902	2	Harris	33600
17-Feb-92	120	902	2	Harris	8400
30-Jul-92	60	902	3	Harris	5400
25-Jun-92	15	902	2	Harris	1050
29-Sep-89	1020	902	2	Harris	71400
27-Mar-92	30	902	2	Harris	2100
02-May-91	750	902	2	Harris	52500
11-May-92	150	902	2	Harris	10500
03-Nov-92	210	902	2	Harris	14700
18-Nov-92	210	902	2	Harris	14700
21-Feb-92	510	902	2	Harris	35700
21-Nov-91	150	902	2	Harris	10500
09-Jan-91	870	901	2	Harris	60900
08-Jan-91	870	901	2	Harris	60900
06-Aug-90	15	901	2	Harris	1050
15-Jan-91	870	901	2	Harris	60900
03-Oct-90	990	901	2	Harris	69300
09-Jun-92	30	901	2	Harris	2100
14-Oct-92	150	901	2	Harris	10500
27-Oct-92	30	unknown	2	Harris	2100
17-Jun-91	150	unknown	2	Harris	10500
18-May-93	15	unknown	2	Harris	1050
16-Apr-91	810	unknown	2	Harris	56700
11-Feb-91	90	unknown	3	Harris	8100
03-May-93	15	unknown	2	Harris	1050
26-Mar-92	30	1006	2	Harris	2100
08-Jan-92	291	1104	2	Brazos	20370
18-Jan-92	291	1104	2	Brazos	20370
03-Feb-92	291	1108	2	Brazos	20370
18-Feb-92	291	1104	2	Brazos	20370
12-Mar-92	291	1104	2	Brazos	20370
17-Apr-92	291	1104	2	Brazos	20370
20-Apr-92	291	1108	2	Brazos	20370
04-May-92	291	1104	2	Brazos	20370
10-Jun-92	291	1104	2	Brazos	20370
11-Jun-92	291	1104	2	Brazos	20370
27-Jul-92	291	1108	2	Brazos	20370
07-Aug-92	291	1104	2	Brazos	20370

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
06-Oct-92	291	1108	2	Brazos	20370
09-Oct-92	291	1104	2	Brazos	20370
23-Oct-92	291	1108	2	Brazos	20370
13-Nov-92	291	1104	2	Brazos	20370
16-Nov-92	291	1104	2	Brazos	20370
08-Dec-92	291	1104	2	Brazos	20370
04-Jan-93	291	1104	2	Brazos	20370
06-Jan-93	291	1102	2	Brazos	20370
07-Jan-93	291	1108	2	Brazos	20370
02-Feb-93	291	1108	2	Brazos	20370
16-Feb-93	291	1108	2	Brazos	20370
23-Feb-93	291	1108	2	Brazos	20370
11-Mar-93	291	1104	2	Brazos	20370
26-Mar-93	291	1104	2	Brazos	20370
30-Mar-93	291	1104	2	Brazos	20370
30-Mar-93	291	1104	2	Brazos	20370
23-Apr-93	291	1104	2	Brazos	20370
26-Apr-93	291	1104	2	Brazos	20370
27-Apr-93	291	1108	2	Brazos	20370
02-May-93	291	1104	2	Brazos	20370
01-Jun-93	291	1108	2	Brazos	20370
15-Jun-93	291	1108	2	Brazos	20370
28-Jun-93	291	1104	2	Brazos	20370
06-Jul-93	291	1108	2	Brazos	20370
14-Jul-93	291	1104	2	Brazos	20370
27-Jul-93	291	1104	2	Brazos	20370
28-Jul-93	291	1104	2	Brazos	20370
28-Jul-93	291	1104	2	Brazos	20370
24-Feb-93	60	801	2	Chambers	4200
30-Mar-93	90	2422	2	Chambers	6300
12-Feb-93	120	2423	2	Chambers	8400
29-Dec-92	210	901	2	Chambers	14700
22-Feb-93	120	2422	2	Chambers	8400
18-Dec-92	15	2423	2	Chambers	1050
22-Oct-92	60	unknown	3	Chambers	5400
17-Jul-92	60	2422	2	Chambers	4200
04-Jun-92	15	901	2	Chambers	1050
unknown	0	unknown	2	Chambers	0
30-May-92	60	2421	2	Chambers	4200
06-Apr-92	60	2421	2	Chambers	4200
12-Jun-92	60	2421	2	Chambers	4200
12-Jun-92	60	2421	2	Chambers	4200
20-Apr-93	15	2424	2	Galveston	1050
23-Apr-93	30	2424	2	Galveston	2100
08-Jun-93	15	2424	1	Galveston	750
08-Jan-93	15	2424	1	Galveston	750
14-Dec-92	195	2424	2	Galveston	13650
08-Jun-93	15	2424	1	Galveston	750
23-Apr-92	15	2424	1	Galveston	750
15-Jul-92	180	1103	3	Galveston	16200

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
18-May-92	300	2424	2	Galveston	21000
10-Dec-92	60	2424	3	Galveston	5400
25-Feb-92	15	1103	2	Galveston	1050
15-Sep-92	15	2424	3	Galveston	1350
07-Aug-92	15	2424	3	Galveston	1350
18-Nov-92	15	2424	2	Galveston	1050
01-Jul-92	15	unknown	2	Galveston	1050
20-Feb-92	15	unknown	2	Galveston	1050
17-Mar-92	15	2424	3	Galveston	1350
15-Apr-92	15	1103	1	Galveston	750
22-Jan-93	15	1103	2	Galveston	1050
03-Mar-93	15	2424	2	Galveston	1050
13-Feb-93	30	2424	2	Galveston	2100
20-Apr-93	105	1104	2	Galveston	7350
24-Mar-93	30	1103	2	Galveston	2100
23-Apr-93	15	2424	2	Galveston	1050
12-May-93	15	2424	3	Galveston	1350
22-Apr-93	15	2424	3	Galveston	1350
06-Aug-92	15	2424	2	Galveston	1050
01-Jul-92	75	2425	2	Galveston	5250
04-Jun-92	390	1103	2	Galveston	27300
21-Oct-92	15	unknown	2	Galveston	1050
14-Sep-92	45	2424	2	Galveston	3150
06-Dec-92	15	2425	2	Galveston	1050
04-Dec-92	15	unknown	3	Galveston	1350
26-Nov-91	15	2421	2	Galveston	1050
22-Apr-92	15	2424	2	Galveston	1050
08-Feb-92	135	1104	2	Galveston	9450
21-Oct-91	15	2424	2	Galveston	1050
21-Oct-91	15	2424	2	Galveston	1050
16-Dec-91	15	2424	2	Galveston	1050
05-Nov-91	0	2424	2	Galveston	0
13-Aug-91	15	2424	2	Galveston	1050
11-Sep-91	15	1104	2	Galveston	1050
16-Sep-91	45	2424	2	Galveston	3150
25-Sep-91	15	2421	2	Galveston	1050
29-Oct-91	15	2421	2	Galveston	1050
02-Jul-91	15	1103	2	Galveston	1050
27-Jun-91	30	1104	2	Galveston	2100
30-Jul-91	15	1103	2	Galveston	1050
25-Jun-91	15	1104	1	Galveston	750
17-May-91	15	2424	2	Galveston	1050
19-Mar-90	75	2424	2	Galveston	5250
11-Jun-91	15	2424	2	Galveston	1050
13-Jun-91	15	2424	1	Galveston	1050
16-May-91	45	1104	2	Galveston	3150
09-Jul-91	15	2424	2	Galveston	1050
04-Jun-91	165	1103	3	Galveston	14850
06-Jun-91	15	unknown	1	Galveston	1050
09-Apr-91	15	2424	2	Galveston	1050

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
30-Mar-92	150	1016	2	Harris	10500
29-Oct-92	90	1016	2	Harris	6300
29-Jan-91	900	1016	2	Harris	63000
18-Mar-91	840	1016	2	Harris	58800
24-Sep-90	1020	1016	2	Harris	71400
01-Feb-93	150	1016	2	Harris	10500
28-Aug-92	60	1016	2	Harris	4200
19-Mar-91	840	1016	2	Harris	58800
25-Jun-91	720	1016	2	Harris	50400
04-Jan-93	30	1016	2	Harris	2100
11-Nov-91	60	1016	2	Harris	4200
14-Feb-91	870	1016	2	Harris	60900
31-Oct-90	990	1016	2	Harris	69300
21-Aug-92	60	1016	2	Harris	4200
21-Aug-91	330	1016	2	Harris	23100
28-Aug-92	30	1016	2	Harris	2100
25-Sep-91	300	1016	2	Harris	21000
28-Aug-92	150	1016	2	Harris	10500
21-Mar-91	840	1016	2	Harris	58800
16-Mar-92	15	1016	2	Harris	1050
10-Feb-92	150	1016	3	Harris	13500
24-Apr-91	810	1016	2	Harris	56700
28-Jan-93	90	1016	2	Harris	6300
08-Apr-91	780	1016	2	Harris	54600
20-Mar-92	180	1016	2	Harris	12600
19-Jul-91	720	1016	2	Harris	50400
23-Sep-91	60	1014	2	Harris	4200
23-Nov-92	210	1014	2	Harris	14700
21-May-93	30	1014	2	Harris	2100
12-Jan-93	180	1014	4	Harris	18000
11-Mar-92	30	1009	2	Harris	2100
17-Nov-92	60	1009	2	Harris	4200
05-Aug-92	30	1009	2	Harris	2100
25-Jan-91	900	1009	2	Harris	63000
17-Nov-92	60	1009	2	Harris	4200
16-Jun-93	15	1009	2	Harris	1050
21-Jan-92	390	1009	2	Harris	27300
21-May-91	750	1009	2	Harris	52500
07-Apr-93	90	1008	2	Harris	6300
22-Jan-93	30	1008	2	Harris	2100
08-Sep-92	15	1008	2	Harris	1050
14-Feb-91	840	1008	2	Harris	58800
09-Jan-92	270	1008	2	Harris	18900
25-Jan-93	150	1008	2	Harris	10500
20-Apr-92	90	1008	2	Harris	6300
15-Apr-91	810	1007	2	Harris	56700
25-Sep-89	1020	1007	2	Harris	71400
04-Jun-91	210	1007	1	Harris	10500
05-Mar-93	15	1006	2	Harris	1050
07-May-91	60	1006	2	Harris	4200

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
02-May-88	1020	1006	2	Harris	71400
27-May-93	30	1006	2	Harris	2100
10-Jul-91	240	1006	1	Harris	12000
21-Oct-92	120	1006	2	Harris	8400
18-Mar-93	30	1006	2	Harris	2100
09-Oct-92	270	1006	2	Harris	18900
31-Jan-91	870	1006	2	Harris	60900
16-Sep-91	30	1006	2	Harris	2100
23-Jan-92	210	1006	2	Harris	14700
25-Jun-93	15	1006	2	Harris	1050
11-Feb-93	150	1006	2	Harris	10500
26-May-92	420	1006	2	Harris	29400
26-Apr-93	30	1006	2	Harris	2100
16-Mar-93	90	1006	2	Harris	6300
28-May-92	90	1006	2	Harris	6300
01-Jul-91	690	1006	2	Harris	48300
06-Nov-90	30	1006	1	Harris	1500
16-Feb-93	120	1006	2	Harris	8400
27-May-92	90	1006	2	Harris	6300
23-Dec-92	210	1006	2	Harris	14700
18-Sep-92	30	1006	1	Harris	1500
01-Jun-92	150	1006	2	Harris	10500
06-Feb-91	840	1006	2	Harris	58800
04-Nov-92	60	1006	2	Harris	4200
19-Apr-91	810	1006	2	Harris	56700
20-Jan-93	150	1006	2	Harris	10500
11-Feb-93	60	1006	2	Harris	4200
25-Nov-92	240	1006	2	Harris	16800
20-May-93	30	1006	1	Harris	1500
28-Apr-93	60	1006	2	Harris	4200
11-Aug-92	90	1006	2	Harris	6300
06-May-93	30	1006	2	Harris	2100
19-Mar-91	15	1006	1	Harris	750
14-Apr-92	420	1006	2	Harris	29400
22-Feb-93	120	1006	2	Harris	8400
06-May-91	750	1006	2	Harris	52500
18-May-92	15	1006	2	Harris	1050
10-May-93	30	1006	2	Harris	2100
01-Jul-91	690	1006	2	Harris	48300
08-May-91	750	1006	2	Harris	52500
04-Aug-92	15	1006	2	Harris	1050
18-Mar-93	90	1006	2	Harris	6300
13-Apr-92	240	1006	2	Harris	16800
25-Feb-93	120	1006	2	Harris	8400
17-Mar-92	15	1006	2	Harris	1050
15-Oct-92	30	1006	2	Harris	2100
02-Apr-91	810	1006	2	Harris	56700
25-Sep-90	1020	1006	2	Harris	71400
12-Feb-92	15	1006	2	Harris	1050
06-Mar-91	810	1006	2	Harris	56700

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
10-Apr-91	15	1103	2	Galveston	1050
24-Apr-91	15	2424	1	Galveston	1050
27-Mar-91	45	1104	2	Galveston	3150
09-Apr-91	15	1103	1	Galveston	1050
31-Jan-91	105	2421	2	Galveston	7350
08-May-91	15	2424	1	Galveston	1050
07-May-91	15	1103	2	Galveston	1050
09-May-91	45	1104	2	Galveston	3150
09-Apr-91	75	1103	2	Galveston	5250
19-Mar-90	15	2424	3	Galveston	1350
01-Apr-91	15	1103	2	Galveston	1050
09-Mar-91	45	unknown	2	Galveston	3150
12-Mar-91	15	2424	1	Galveston	1050
12-Mar-91	15	2424	2	Galveston	1050
04-Mar-91	15	2424	2	Galveston	1050
26-Feb-91	15	unknown	3	Galveston	1350
14-Dec-90	15	1103	2	Galveston	1050
27-Dec-90	15	2421	2	Galveston	1050
11-Feb-91	15	2424	2	Galveston	1050
18-Feb-91	15	2424	2	Galveston	1050
15-Nov-90	105	2424	2	Galveston	7350
07-Feb-91	15	2424	2	Galveston	1050
08-Mar-91	840	1103	2	Galveston	58800
07-Mar-91	15	2424	2	Galveston	1050
20-Nov-90	75	2424	2	Galveston	5250
16-Mar-90	225	2424	3	Galveston	20250
26-Oct-90	60	2424	2	Galveston	4200
31-Oct-90	15	2424	2	Galveston	1050
31-Oct-90	15	2424	2	Galveston	1050
31-Oct-90	15	2424	2	Galveston	1050
13-Dec-90	1080	1103	2	Galveston	75600
13-Mar-90	270	1104	2	Galveston	18900
17-Sep-90	15	2421	2	Galveston	1050
17-Sep-90	60	1103	2	Galveston	4200
14-Sep-90	1080	2424	2	Galveston	75600
24-Jun-93	60	2424	3	Galveston	5400
16-Jun-93	15	2424	2	Galveston	1050
04-May-93	30	2423	2	Galveston	2100
27-Mar-93	15	2423	4	Galveston	1500
12-Feb-93	15	2423	1	Galveston	750
28-Jan-93	180	2423	2	Galveston	12600
06-Aug-92	15	2423	1	Galveston	750
13-Jul-92	150	2423	2	Galveston	10500
20-May-92	15	2424	1	Galveston	750
15-May-92	15	2439	3	Galveston	1350
08-Apr-92	15	2439	3	Galveston	1350
20-Mar-92	15	2423	2	Galveston	1050
20-Mar-92	15	2439	3	Galveston	1350
19-Mar-92	15	2423	2	Galveston	1050
10-Dec-91	120	2424	3	Galveston	10800

Appendix 1. Information on septic tank complaints within study area.

Date	Total Days	Segment	Severity Index	County	Estimated Volume (Gallons)
08-Nov-91	15	2439	2	Galveston	1050
05-Nov-91	15	2439	2	Galveston	1050
09-Oct-91	45	2423	2	Galveston	3150
21-Aug-91	60	2439	3	Galveston	5400
06-Aug-91	15	2439	2	Galveston	1050
12-Jul-91	750	2439	1	Galveston	52500
22-Apr-91	30	2423	3	Galveston	2700
30-Oct-91	15	2421	3	Galveston	1350
01-Oct-91	30	2439	3	Galveston	2700
14-Aug-91	30	2424	2	Galveston	2100
25-Jun-91	15	unknown	3	Galveston	1350
14-Jun-91	780	2423	2	Galveston	54600
14-Jun-91	60	2423	2	Galveston	4200
01-Apr-91	180	unknown	3	Galveston	16200
05-Mar-91	75	unknown	3	Galveston	6750
23-Apr-91	120	2423	3	Galveston	10800
08-Mar-93	90	2423	3	Galveston	8100
27-Oct-92	90	2424	2	Galveston	6300
31-Jan-92	570	2439	2	Galveston	39900
28-Apr-92	15	unknown	3	Galveston	1350
22-Jul-91	15	2439	2	Galveston	1050

* Information on duration and severity was lacking in Brazoria County files.
* A value of 291 days and a severity index of 2 was used as a default for Brazoria County.
* Severity index 1 = 50 GPD, 2 = 70 GPD, 3 = 90 GPD, 4 = 100 GPD
* Only areas southeast of SH 59 N and I-45 S were evaluated in Harris County.

Appendix 2. Records reviewed for bypass violations or raw files

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	14-May-93	Harris	1007	0.3	100
City of Houston	14-May-93	Harris	1007		
City of Houston	11-May-93	Harris	1007		
City of Houston	11-May-93	Harris	1007		
City of Houston	11-May-93	Harris	1007		
City of Houston	09-May-93	Harris	1007	24	17000
City of Houston	07-May-93	Harris	1007	96	29000
City of Houston	06-May-93	Harris	1014	2	6000
City of Houston	06-May-93	Harris	1007	2	6000
City of Houston	04-May-93	Harris	1007		
City of Houston	30-Apr-93	Harris	1007	8	9600
City of Houston	29-Apr-93	Harris	1007	5.1	2440
City of Houston	28-Apr-93	Harris	1017	2.6	3820
City of Houston	27-Apr-93	Harris	1017	3	3600
City of Houston	27-Apr-93	Harris	1013		
City of Houston	27-Apr-93	Harris	1013	49	5880
City of Houston	22-Apr-93	Harris	1007		
City of Houston	20-Apr-93	Harris	1017	0.6	180
City of Houston	19-Apr-93	Harris	1017	1.8	1660
City of Houston	19-Apr-93	Harris	1017	17.2	4130
City of Houston	14-Apr-93	Harris	1017		
City of Houston	14-Apr-93	Harris	1013	144	85000
City of Houston	08-Apr-93	Harris	1017		
City of Houston	08-Apr-93	Harris	1006	5.5	173000
City of Houston	07-Apr-93	Harris	1102	5	150000
City of Houston	07-Apr-93	Harris	1007	0.5	2500
City of Houston	07-Apr-93	Harris	1007	5	30000
City of Houston	07-Apr-93	Harris	1007	9	90000
City of Houston	07-Apr-93	Harris	1007	3.5	221900
City of Houston	07-Apr-93	Harris	1006	5	163000
City of Houston	05-Apr-93	Harris	1017	1.3	78
City of Houston	04-Apr-93	Harris	1017	6	3600
City of Houston	04-Apr-93	Harris	1007		
City of Houston	04-Apr-93	Harris	1006	3	112000
City of Houston	03-Apr-93	Harris	1102	14	80000
City of Houston	03-Apr-93	Harris	1017	23	276000
City of Houston	03-Apr-93	Harris	1007	15	70000
City of Houston	03-Apr-93	Harris	1007	21	170000
City of Houston	02-Apr-93	Harris	1013	92	750000
City of Houston	31-Mar-93	Harris	1017	4.4	130
City of Houston	25-Mar-93	Harris	1007	0.7	2150
City of Houston	22-Mar-93	Harris	1017	16	597440
City of Houston	22-Mar-93	Harris	1017	29	25000000
City of Houston	22-Mar-93	Harris	1014	5	407620
City of Houston	22-Mar-93	Harris	1014	5.5	55000
City of Houston	22-Mar-93	Harris	1013	10	256350
City of Houston	22-Mar-93	Harris	1007	3	13930
City of Houston	22-Mar-93	Harris	1007	4.5	40500

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	22-Mar-93	Harris	1007	5	30000
City of Houston	22-Mar-93	Harris	1007	2	408000
City of Houston	22-Mar-93	Harris	1006	9	293000
City of Houston	22-Mar-93	Harris	1002	6	10000
City of Houston	18-Mar-93	Harris	1007		
City of Houston	13-Mar-93	Harris	1013	0.6	3800
City of Houston	06-Mar-93	Harris	1014	0.3	2000
City of Houston	06-Mar-93	Harris	1013	3	20000
City of Houston	03-Mar-93	Harris	1007	49	220000
City of Houston	01-Mar-93	Harris	1102	6	45000
City of Houston	01-Mar-93	Harris	1017	7	524000
City of Houston	01-Mar-93	Harris	1017	13	726000
City of Houston	01-Mar-93	Harris	1017	7	285000
City of Houston	01-Mar-93	Harris	1014	4	40000
City of Houston	01-Mar-93	Harris	1013	18	461000
City of Houston	01-Mar-93	Harris	1007	12	120000
City of Houston	01-Mar-93	Harris	1007	2	80000
City of Houston	01-Mar-93	Harris	1007	13	130000
City of Houston	01-Mar-93	Harris	1007	6	50000
City of Houston	01-Mar-93	Harris	1006	14	227000
City of Houston	01-Mar-93	Harris	1006	10	187000
City of Houston	01-Mar-93	Harris	1006	22	717000
City of Houston	25-Feb-93	Harris	1014	4	40000
City of Houston	25-Feb-93	Harris	1007	1	5000
City of Houston	25-Feb-93	Harris	1007	5	40000
City of Houston	25-Feb-93	Harris	1007	5	50000
City of Houston	23-Feb-93	Harris	1102	4	60
City of Houston	16-Feb-93	Harris	1007	2	150000
City of Houston	15-Feb-93	Harris	1007	4	40000
City of Houston	21-Jan-93	Harris	1014	32	5000
City of Houston	21-Jan-93	Harris	1007	27	140000
City of Houston	20-Jan-93	Harris	1102	4	30000
City of Houston	20-Jan-93	Harris	1006	3	176000
City of Houston	20-Jan-93	Harris	1006	17	316900
City of Houston	13-Jan-93	Harris	1007	24	22000
City of Houston	07-Jan-93	Harris	1102	13	90000
City of Houston	07-Jan-93	Harris	1013	24	40000
City of Houston	07-Jan-93	Harris	1007	3	18570
City of Houston	07-Jan-93	Harris	1007	10	80000
City of Houston	07-Jan-93	Harris	1006	19	327240
City of Houston	15-Dec-92	Harris	1014	2	40000
City of Houston	15-Dec-92	Harris	1007	5.5	40000
City of Houston	14-Dec-92	Harris	1007	10	80000
City of Houston	14-Dec-92	Harris	1006	29	550000
City of Houston	09-Dec-92	Harris	1007	1	10000
City of Houston	09-Dec-92	Harris	1007	3	30000
City of Houston	09-Dec-92	Harris	1007	93.5	11220
City of Houston	09-Dec-92	Harris	1007	3	55930
City of Houston	09-Dec-92	Harris	1007	7	70000
City of Houston	07-Dec-92	Harris	1007	1	1500

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	24-Nov-92	Harris	1014	32	20000
City of Houston	22-Nov-92	Harris	1007	5	11130
City of Houston	21-Nov-92	Harris	1014	10	100000
City of Houston	21-Nov-92	Harris	1007	18	90000
City of Houston	21-Nov-92	Harris	1007	7	30000
City of Houston	21-Nov-92	Harris	1007	1	10000
City of Houston	21-Nov-92	Harris	1007	8	80000
City of Houston	21-Nov-92	Harris	1006	8	150000
City of Houston	20-Nov-92	Harris	1007	0.5	10000
City of Houston	20-Nov-92	Harris	1007	3	35000
City of Houston	19-Nov-92	Harris	1007	6	78000
City of Houston	18-Nov-92	Harris	1017	29	3500
City of Houston	02-Nov-92	Harris	1016	12.5	140000
City of Houston	01-Nov-92	Harris	1007	2	15000
City of Houston	20-Oct-92	Harris	1014	212.5	130000
City of Houston	20-Oct-92	Harris	1007	27	250000
City of Houston	19-Oct-92	Harris	1014	48	15000
City of Houston	13-Oct-92	Harris	1007	24	1000
City of Houston	13-Oct-92	Harris	1007	48	2000
City of Houston	13-Oct-92	Harris	1007	24	1000
City of Houston	10-Oct-92	Harris	1017	14	10000
City of Houston	07-Oct-92	Harris	1007	0.75	900
City of Houston	01-Oct-92	Harris	1014	8	5000
City of Houston	29-Sep-92	Harris	1007	5.3	11200
City of Houston	26-Sep-92	Harris	1007	76	40000
City of Houston	26-Sep-92	Harris	1007	240	72000
City of Houston	24-Sep-92	Harris	1014	31.5	189000
City of Houston	22-Sep-92	Harris	1014	2.5	4500
City of Houston	22-Sep-92	Harris	1007	1	1900
City of Houston	17-Sep-92	Harris	1007	3	
City of Houston	14-Sep-92	Harris	1007	3	9000
City of Houston	14-Sep-92	Harris	1007	21	5000
City of Houston	14-Sep-92	Harris	1007	2	2400
City of Houston	12-Sep-92	Harris	1017	22.4	13500
City of Houston	11-Sep-92	Harris	1017	22.4	13440
City of Houston	10-Sep-92	Harris	1006	4	36160
City of Houston	31-Aug-92	Harris	1016	7	114000
City of Houston	31-Aug-92	Harris	1013	26	3200
City of Houston	26-Aug-92	Harris	1014	9.5	90000
City of Houston	03-Aug-92	Harris	1016	7.5	122000
City of Houston	03-Aug-92	Harris	1007	2.5	25000
City of Houston	02-Aug-92	Harris	1017	9	3000000
City of Houston	02-Aug-92	Harris	1014	3	225000
City of Houston	02-Aug-92	Harris	1007	1	10000
City of Houston	02-Aug-92	Harris	1007	3	30000
City of Houston	02-Aug-92	Harris	1007	5	149000
City of Houston	02-Aug-92	Harris	1006	5	100000
City of Houston	02-Aug-92	Harris	1006	6.5	242000
City of Houston	02-Aug-92	Harris	1006	3.75	749000
City of Houston	24-Jul-92	Harris	1007	2	3600

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	22-Jul-92	Harris	1017	6	334900
City of Houston	22-Jul-92	Harris	1007	3	111860
City of Houston	21-Jul-92	Harris	1017	8	2600000
City of Houston	21-Jul-92	Harris	1006	2	75000
City of Houston	20-Jul-92	Harris	1016	8	130000
City of Houston	19-Jul-92	Harris	1016	4.5	2000
City of Houston	17-Jul-92	Harris	1013	142	852000
City of Houston	16-Jul-92	Harris	1007	6	3600
City of Houston	22-Jun-92	Harris	1014	240	360000
City of Houston	16-Jun-92	Harris	1013	17.8	26620
City of Houston	15-Jun-92	Harris	1017	45.7	137100
City of Houston	14-Jun-92	Harris	1007	18.1	51580
City of Houston	11-Jun-92	Harris	1006	50	250000
City of Houston	10-Jun-92	Harris	1007	4	51200
City of Houston	08-Jun-92	Harris	1014	2	37000
City of Houston	06-Jun-92	Harris	1102	4.5	35000
City of Houston	06-Jun-92	Harris	1017	2	662000
City of Houston	06-Jun-92	Harris	1014	1.5	10000
City of Houston	05-Jun-92	Harris	1014	1	5000
City of Houston	05-Jun-92	Harris	1007	6	1800
City of Houston	03-Jun-92	Harris	1006		
City of Houston	02-Jun-92	Harris	1102	6	46000
City of Houston	02-Jun-92	Harris	1017	12	4000000
City of Houston	02-Jun-92	Harris	1016	6.25	167000
City of Houston	02-Jun-92	Harris	1013	5.25	135000
City of Houston	02-Jun-92	Harris	1007	9	90000
City of Houston	02-Jun-92	Harris	1007	2	34000
City of Houston	02-Jun-92	Harris	1007	4	51200
City of Houston	02-Jun-92	Harris	1007		
City of Houston	02-Jun-92	Harris	1006	10.5	429000
City of Houston	01-Jun-92	Harris	1102	5	36000
City of Houston	01-Jun-92	Harris	1017	28	1260000
City of Houston	01-Jun-92	Harris	1017	9.25	3100000
City of Houston	01-Jun-92	Harris	1017	1.25	102000
City of Houston	01-Jun-92	Harris	1017	4.75	861000
City of Houston	01-Jun-92	Harris	1007		
City of Houston	01-Jun-92	Harris	1007	4	51200
City of Houston	01-Jun-92	Harris	1007	6	70000
City of Houston	01-Jun-92	Harris	1007	2	100000
City of Houston	01-Jun-92	Harris	1007	4	300000
City of Houston	01-Jun-92	Harris	1006	5.75	214000
City of Houston	29-May-92	Harris	1013	1.75	4200
City of Houston	28-May-92	Harris	1017	5	1248650
City of Houston	28-May-92	Harris	1017	10	750000
City of Houston	28-May-92	Harris	1007	4	
City of Houston	28-May-92	Harris	1007	4	125000
City of Houston	28-May-92	Harris	1007	19.5	35100
City of Houston	28-May-92	Harris	1007	2	25600
City of Houston	28-May-92	Harris	1007	4.5	540
City of Houston	28-May-92	Harris	1007	5	250000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	28-May-92	Harris	1007	3	15000
City of Houston	28-May-92	Harris	1006	4	91500
City of Houston	27-May-92	Harris	1102	13	180000
City of Houston	21-May-92	Harris	1007	24.5	88200
City of Houston	21-May-92	Harris	1007	1	35000
City of Houston	19-May-92	Harris	1007	22	10000
City of Houston	19-May-92	Harris	1007	3	3000
City of Houston	18-May-92	Harris	1014	13.4	12060
City of Houston	18-May-92	Harris	1007	13.9	336000
City of Houston	18-May-92	Harris	1007	4	300000
City of Houston	18-May-92	Harris	1007	7	80000
City of Houston	18-May-92	Harris	1006	14.2	34080
City of Houston	17-May-92	Harris	1014	5	424000
City of Houston	17-May-92	Harris	1007	17.5	50000
City of Houston	17-May-92	Harris	1007	5	372000
City of Houston	16-May-92	Harris	1017	7.3	10950
City of Houston	16-May-92	Harris	1017	11	1821000
City of Houston	16-May-92	Harris	1017	7	1063250
City of Houston	16-May-92	Harris	1017	3	122290
City of Houston	16-May-92	Harris	1017	7.1	31950
City of Houston	16-May-92	Harris	1016	8	129950
City of Houston	16-May-92	Harris	1014	9	2979860
City of Houston	16-May-92	Harris	1014	1	12820
City of Houston	16-May-92	Harris	1014	6	449190
City of Houston	16-May-92	Harris	1013	8	218580
City of Houston	16-May-92	Harris	1007	6.2	18600
City of Houston	16-May-92	Harris	1007	9	631000
City of Houston	16-May-92	Harris	1006	14	2317630
City of Houston	15-May-92	Harris	1007	3.1	2320
City of Houston	14-May-92	Harris	1007	13.3	3990
City of Houston	13-May-92	Harris	1014	4.2	10080
City of Houston	13-May-92	Harris	1014	3	10800
City of Houston	13-May-92	Harris	1007	135	6080
City of Houston	06-May-92	Harris	1017	0.75	180
City of Houston	01-May-92	Harris	1014	43	64500
City of Houston	19-Apr-92	Harris	1014	3	310000
City of Houston	19-Apr-92	Harris	1007	5.5	70500
City of Houston	17-Apr-92	Harris	1017	13	4304170
City of Houston	17-Apr-92	Harris	1014	1	149730
City of Houston	17-Apr-92	Harris	1014	1	55000
City of Houston	17-Apr-92	Harris	1014	6.25	940000
City of Houston	17-Apr-92	Harris	1014	6	1986000
City of Houston	17-Apr-92	Harris	1007	18	20000
City of Houston	17-Apr-92	Harris	1007	0.25	50000
City of Houston	17-Apr-92	Harris	1007	3.5	39000
City of Houston	17-Apr-92	Harris	1007	6	26000
City of Houston	17-Apr-92	Harris	1006	14	5219990
City of Houston	15-Apr-92	Harris	1017	0.4	25
City of Houston	15-Apr-92	Harris	1013	0.8	240
City of Houston	11-Apr-92	Harris	1007	0.75	10000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	11-Apr-92	Harris	1006	2.5	1500
City of Houston	05-Apr-92	Harris	1102	8	120000
City of Houston	05-Apr-92	Harris	1014	3	310000
City of Houston	05-Apr-92	Harris	1007	4.5	25000
City of Houston	05-Apr-92	Harris	1007	6	10000
City of Houston	05-Apr-92	Harris	1007	6	77000
City of Houston	05-Apr-92	Harris	1007	6	78000
City of Houston	05-Apr-92	Harris	1006	4	85780
City of Houston	04-Apr-92	Harris	1014	28.6	17160
City of Houston	03-Apr-92	Harris	1013	6	360000
City of Houston	02-Apr-92	Harris	1007	17	4100
City of Houston	29-Mar-92	Harris	1014	2	149700
City of Houston	28-Mar-92	Harris	1007	9	98000
City of Houston	27-Mar-92	Harris	1013	26	30000
City of Houston	25-Mar-92	Harris	1007	12.5	8000
City of Houston	20-Mar-92	Harris	1007	4.9	3000
City of Houston	18-Mar-92	Harris	1014	6.2	28000
City of Houston	18-Mar-92	Harris	1014	3.75	177000
City of Houston	18-Mar-92	Harris	1007	4.5	150
City of Houston	17-Mar-92	Harris	1017	146	750000
City of Houston	17-Mar-92	Harris	1007	11.75	3500
City of Houston	15-Mar-92	Harris	1007	24	15000
City of Houston	14-Mar-92	Harris	1014	1	3300
City of Houston	10-Mar-92	Harris	1007	17	92000
City of Houston	05-Mar-92	Harris	1013	264	158400
City of Houston	05-Mar-92	Harris	1013	44	334000
City of Houston	04-Mar-92	Harris	1017	21	7284000
City of Houston	04-Mar-92	Harris	1017	6	245000
City of Houston	04-Mar-92	Harris	1017	11.8	1722000
City of Houston	04-Mar-92	Harris	1017	15	1304000
City of Houston	04-Mar-92	Harris	1016	9	126000
City of Houston	04-Mar-92	Harris	1016	7.3	117000
City of Houston	04-Mar-92	Harris	1014	15	73000
City of Houston	04-Mar-92	Harris	1014	26	8608000
City of Houston	04-Mar-92	Harris	1014	14	2096000
City of Houston	04-Mar-92	Harris	1014	4	103000
City of Houston	04-Mar-92	Harris	1014	26	969000
City of Houston	04-Mar-92	Harris	1014	27	692000
City of Houston	04-Mar-92	Harris	1014	24	7200
City of Houston	04-Mar-92	Harris	1014	18	2500000
City of Houston	04-Mar-92	Harris	1014	7	1481000
City of Houston	04-Mar-92	Harris	1013	6	489000
City of Houston	04-Mar-92	Harris	1007	12	154000
City of Houston	04-Mar-92	Harris	1007	8	598000
City of Houston	04-Mar-92	Harris	1007	3	30000
City of Houston	04-Mar-92	Harris	1007	11	110000
City of Houston	04-Mar-92	Harris	1007	5	243000
City of Houston	04-Mar-92	Harris	1007	9	422000
City of Houston	04-Mar-92	Harris	1007	7.5	70000
City of Houston	04-Mar-92	Harris	1006	28	5742000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	04-Mar-92	Harris	1006	30	1018000
City of Houston	04-Mar-92	Harris	1006	25	406000
City of Houston	28-Feb-92	Harris	1017	96	44000
City of Houston	28-Feb-92	Harris	1014	4.4	7000
City of Houston	25-Feb-92	Harris	1017	1	900
City of Houston	24-Feb-92	Harris	1102	3.5	51000
City of Houston	24-Feb-92	Harris	1017	21	6953000
City of Houston	24-Feb-92	Harris	1017	4.25	449390
City of Houston	24-Feb-92	Harris	1014	6	900000
City of Houston	24-Feb-92	Harris	1007	3	15000
City of Houston	24-Feb-92	Harris	1007	4.5	3600
City of Houston	24-Feb-92	Harris	1007	5.5	
City of Houston	24-Feb-92	Harris	1007	6	60000
City of Houston	24-Feb-92	Harris	1007	8	384000
City of Houston	24-Feb-92	Harris	1007	6.75	86520
City of Houston	24-Feb-92	Harris	1006	15.75	587000
City of Houston	22-Feb-92	Harris	1017	2	397000
City of Houston	22-Feb-92	Harris	1017	11.25	4055850
City of Houston	22-Feb-92	Harris	1016	0.5	12820
City of Houston	22-Feb-92	Harris	1014	8.5	1272700
City of Houston	22-Feb-92	Harris	1014	5	2083000
City of Houston	22-Feb-92	Harris	1013	2	51220
City of Houston	22-Feb-92	Harris	1007	3	30000
City of Houston	22-Feb-92	Harris	1007	2.5	204000
City of Houston	22-Feb-92	Harris	1007	4	636000
City of Houston	22-Feb-92	Harris	1007	1	70000
City of Houston	22-Feb-92	Harris	1007	11	60000
City of Houston	22-Feb-92	Harris	1007	10	
City of Houston	22-Feb-92	Harris	1007	5.5	372000
City of Houston	22-Feb-92	Harris	1007	12	580000
City of Houston	22-Feb-92	Harris	1007	7.5	217900
City of Houston	22-Feb-92	Harris	1007	1	149000
City of Houston	22-Feb-92	Harris	1007	4	120000
City of Houston	22-Feb-92	Harris	1006	15.75	577920
City of Houston	22-Feb-92	Harris	1006	7	409820
City of Houston	22-Feb-92	Harris	1002	5	156420
City of Houston	21-Feb-92	Harris	1007	8	14400
City of Houston	18-Feb-92	Harris	1007	16.5	20000
City of Houston	13-Feb-92	Harris	1007	46.8	70250
City of Houston	12-Feb-92	Harris	1014	2	290000
City of Houston	12-Feb-92	Harris	1007	0.5	5000
City of Houston	11-Feb-92	Harris	1017		
City of Houston	11-Feb-92	Harris	1014	6	898000
City of Houston	11-Feb-92	Harris	1007	6.5	84000
City of Houston	11-Feb-92	Harris	1007	3	38460
City of Houston	11-Feb-92	Harris	1006	10.8	252000
City of Houston	11-Feb-92	Harris	1006	144	432000
City of Houston	05-Feb-92	Harris	1017	24	100000
City of Houston	05-Feb-92	Harris	1006	1	12820
City of Houston	04-Feb-92	Harris	1013	42	190000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	04-Feb-92	Harris	1013	42	252000
City of Houston	04-Feb-92	Harris	1007	1	148000
City of Houston	04-Feb-92	Harris	1007	6	70000
City of Houston	04-Feb-92	Harris	1007	1	13000
City of Houston	04-Feb-92	Harris	1007	1	600
City of Houston	04-Feb-92	Harris	1007	6	200000
City of Houston	04-Feb-92	Harris	1006	32.5	764000
City of Houston	03-Feb-92	Harris	1102	12	100000
City of Houston	03-Feb-92	Harris	1014	3.5	130000
City of Houston	03-Feb-92	Harris	1014	12	1800000
City of Houston	03-Feb-92	Harris	1013	7.25	186000
City of Houston	03-Feb-92	Harris	1007	1	16000
City of Houston	03-Feb-92	Harris	1007	2	296000
City of Houston	03-Feb-92	Harris	1007	8	300000
City of Houston	03-Feb-92	Harris	1007	3.5	44000
City of Houston	03-Feb-92	Harris	1007	5	45000
City of Houston	03-Feb-92	Harris	1007	17	220000
City of Houston	27-Jan-92	Harris	1102	4	24000
City of Houston	27-Jan-92	Harris	1017	15.5	4810000
City of Houston	27-Jan-92	Harris	1007	6.75	160220
City of Houston	27-Jan-92	Harris	1007	12	148000
City of Houston	27-Jan-92	Harris	1007	11.25	202500
City of Houston	27-Jan-92	Harris	1007	18.5	165000
City of Houston	27-Jan-92	Harris	1006	8.5	317000
City of Houston	26-Jan-92	Harris	1007	46.5	91000
City of Houston	26-Jan-92	Harris	1006	0.5	5000
City of Houston	24-Jan-92	Harris	1007	6.6	1600
City of Houston	24-Jan-92	Harris	1007	2.6	450
City of Houston	23-Jan-92	Harris	1007	20	500
City of Houston	22-Jan-92	Harris	1017	120	28800
City of Houston	22-Jan-92	Harris	1006	1	37000
City of Houston	22-Jan-92	Harris	1006	1	37000
City of Houston	21-Jan-92	Harris	1006	9	335000
City of Houston	20-Jan-92	Harris	1014	4.5	63000
City of Houston	20-Jan-92	Harris	1006	0.25	10000
City of Houston	18-Jan-92	Harris	1102	4	216000
City of Houston	18-Jan-92	Harris	1017	6.5	349710
City of Houston	18-Jan-92	Harris	1014	8	598900
City of Houston	18-Jan-92	Harris	1007	0.5	400000
City of Houston	18-Jan-92	Harris	1007	4	36000
City of Houston	18-Jan-92	Harris	1007	0.4	
City of Houston	18-Jan-92	Harris	1006	17	1120000
City of Houston	17-Jan-92	Harris	1017	30	834360
City of Houston	17-Jan-92	Harris	1007	19	829000
City of Houston	17-Jan-92	Harris	1007	2.25	539780
City of Houston	17-Jan-92	Harris	1007	15.5	5397340
City of Houston	17-Jan-92	Harris	1006	26.25	540000
City of Houston	16-Jan-92	Harris	1007	3	10000
City of Houston	16-Jan-92	Harris	1007	4.7	1410
City of Houston	16-Jan-92	Harris	1007	4	10000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	14-Jan-92	Harris	1007	9.2	11000
City of Houston	14-Jan-92	Harris	1007	25.2	37720
City of Houston	13-Jan-92	Harris	1102	10.5	3150
City of Houston	12-Jan-92	Harris	1007	12.5	111720
City of Houston	11-Jan-92	Harris	1102	3	20000
City of Houston	08-Jan-92	Harris	1102	3	20000
City of Houston	08-Jan-92	Harris	1014	6	898200
City of Houston	08-Jan-92	Harris	1013	96	170000
City of Houston	08-Jan-92	Harris	1007	3	48600
City of Houston	08-Jan-92	Harris	1006	2	39980
City of Houston	07-Jan-92	Harris	1013	0.5	150
City of Houston	07-Jan-92	Harris	1007	8	9600
City of Houston	01-Jan-92	Harris	1007	10	815000
City of Houston	26-Dec-91	Harris	1014	10	1497800
City of Houston	26-Dec-91	Harris	1014	34.5	2657710
City of Houston	26-Dec-91	Harris	1013	42	126000
City of Houston	26-Dec-91	Harris	1007	4	36000
City of Houston	26-Dec-91	Harris	1007	1	16240
City of Houston	23-Dec-91	Harris	1014	4	748650
City of Houston	23-Dec-91	Harris	1007	0.3	45
City of Houston	22-Dec-91	Harris	1014	5	898380
City of Houston	22-Dec-91	Harris	1007	1	16240
City of Houston	22-Dec-91	Harris	1007	1	25640
City of Houston	22-Dec-91	Harris	1007	7.5	279640
City of Houston	21-Dec-91	Harris	1102	11	1647000
City of Houston	21-Dec-91	Harris	1017	32	4791360
City of Houston	21-Dec-91	Harris	1017	31	2527280
City of Houston	21-Dec-91	Harris	1017	33	10925970
City of Houston	21-Dec-91	Harris	1014	24	3593520
City of Houston	21-Dec-91	Harris	1013	21.5	269170
City of Houston	21-Dec-91	Harris	1007	16.5	435800
City of Houston	21-Dec-91	Harris	1007	1	16240
City of Houston	21-Dec-91	Harris	1006	42	13904780
City of Houston	08-Dec-91	Harris	1016	18	129950
City of Houston	30-Nov-91	Harris	1007	13	259900
City of Houston	25-Nov-91	Harris	N/A	5	600
City of Houston	17-Nov-91	Harris	1017	15	417180
City of Houston	17-Nov-91	Harris	1014	12	97450
City of Houston	17-Nov-91	Harris	1014	0.6	11980
City of Houston	17-Nov-91	Harris	1007	3.5	25000
City of Houston	17-Nov-91	Harris	1007	4.25	20890
City of Houston	17-Nov-91	Harris	1006	14	279890
City of Houston	17-Nov-91	Harris	1006	16	1054000
City of Houston	15-Nov-91	Harris	1007	26	7800
City of Houston	11-Nov-91	Harris	1007	48	3000
City of Houston	07-Nov-91	Harris	1013	2	6000
City of Houston	04-Nov-91	Harris	1007	52.4	62880
City of Houston	30-Oct-91	Harris	1014	0.25	10000
City of Houston	30-Oct-91	Harris	1006	2	10000
City of Houston	29-Oct-91	Harris	1017	0.75	580000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	29-Oct-91	Harris	1014	0.5	8000
City of Houston	29-Oct-91	Harris	1006	4	100000
City of Houston	21-Oct-91	Harris	1007	0.5	50
City of Houston	11-Oct-91	Harris	N/A	1	600
City of Houston	30-Sep-91	Harris	1007	30	18000
City of Houston	29-Sep-91	Harris	N/A	0.5	8000
City of Houston	20-Sep-91	Harris	1007	8	36000
City of Houston	19-Sep-91	Harris	1013	23.4	3000
City of Houston	17-Sep-91	Harris	1017	1	27810
City of Houston	17-Sep-91	Harris	1007	3	4550
City of Houston	17-Sep-91	Harris	1007	1.5	1350
City of Houston	16-Sep-91	Harris	1007	52	15600
City of Houston	13-Sep-91	Harris	1007	6	30000
City of Houston	12-Sep-91	Harris	1013	36	64800
City of Houston	12-Sep-91	Harris	1007	21	189000
City of Houston	09-Sep-91	Harris	1007	48.2	7000
City of Houston	09-Sep-91	Harris	1007	2.5	20000
City of Houston	07-Sep-91	Harris	1007	2.5	36000
City of Houston	06-Sep-91	Harris	1102	6	40000
City of Houston	06-Sep-91	Harris	1007	1	15000
City of Houston	06-Sep-91	Harris	1007	7	35000
City of Houston	06-Sep-91	Harris	1007	52.8	158450
City of Houston	05-Sep-91	Harris	1007	1	25640
City of Houston	02-Sep-91	Harris	1007	4	20000
City of Houston	02-Sep-91	Harris	1006	1	55620
City of Houston	01-Sep-91	Harris	1007	1	15000
City of Houston	01-Sep-91	Harris	1007	3.5	16000
City of Houston	30-Aug-91	Harris	1006	0.7	800
City of Houston	28-Aug-91	Harris	1014	5.5	8250
City of Houston	27-Aug-91	Harris	1007	3	30000
City of Houston	26-Aug-91	Harris	1006	2.9	520
City of Houston	19-Aug-91	Harris	1006	29.8	5400
City of Houston	16-Aug-91	Harris	1007	4	56960
City of Houston	16-Aug-91	Harris	1007	1	15000
City of Houston	13-Aug-91	Harris	1006	5.4	4700
City of Houston	09-Aug-91	Harris	1007	69.5	41700
City of Houston	29-Jul-91	Harris	1007	0.25	6410
City of Houston	23-Jul-91	Harris	1013	9.25	333000
City of Houston	22-Jul-91	Harris	1013	17.75	639000
City of Houston	21-Jul-91	Harris	1013	21.5	774000
City of Houston	20-Jul-91	Harris	1013	21.5	774000
City of Houston	20-Jul-91	Harris	1007	408	1224000
City of Houston	08-Jul-91	Harris	1007	24	7200
City of Houston	28-Jun-91	Harris	1013	73	87600
City of Houston	25-Jun-91	Harris	1102	6	103000
City of Houston	25-Jun-91	Harris	1017	7	261000
City of Houston	25-Jun-91	Harris	1017	4	12000
City of Houston	25-Jun-91	Harris	1013	6	213000
City of Houston	25-Jun-91	Harris	1006	3	60000
City of Houston	24-Jun-91	Harris	1017	12	544000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	24-Jun-91	Harris	1007	4	18000
City of Houston	23-Jun-91	Harris	1006	12	544000
City of Houston	22-Jun-91	Harris	1014	0.5	23000
City of Houston	21-Jun-91	Harris	1102	76	45600
City of Houston	20-Jun-91	Harris	1014	3	49000
City of Houston	20-Jun-91	Harris	1014	2.75	38000
City of Houston	20-Jun-91	Harris	1014	5.45	88000
City of Houston	20-Jun-91	Harris	1006	3	136000
City of Houston	19-Jun-91	Harris	1007	2	51000
City of Houston	16-Jun-91	Harris	1102	4	68960
City of Houston	16-Jun-91	Harris	1017	9	1214170
City of Houston	16-Jun-91	Harris	1013	5	10090000
City of Houston	16-Jun-91	Harris	1007	2	1120
City of Houston	16-Jun-91	Harris	1006	10	1349080
City of Houston	15-Jun-91	Harris	1017	7	944000
City of Houston	15-Jun-91	Harris	1016	6.75	108280
City of Houston	15-Jun-91	Harris	1016	6	97460
City of Houston	15-Jun-91	Harris	1013	2	4030000
City of Houston	15-Jun-91	Harris	1013	55	7650000
City of Houston	15-Jun-91	Harris	1007	4.5	1690
City of Houston	15-Jun-91	Harris	1007	0.5	8000
City of Houston	15-Jun-91	Harris	1007	4	1620
City of Houston	15-Jun-91	Harris	1007	2	142680
City of Houston	15-Jun-91	Harris	1007	6	3250
City of Houston	15-Jun-91	Harris	1007	1	1000
City of Houston	15-Jun-91	Harris	1006	10	1349080
City of Houston	07-Jun-91	Harris	1007	1.5	5940
City of Houston	07-Jun-91	Harris	1007	1.3	7023000
City of Houston	07-Jun-91	Harris	1007	2.5	40610
City of Houston	07-Jun-91	Harris	1007	7.5	35980
City of Houston	05-Jun-91	Harris	1007	45	135000
City of Houston	05-Jun-91	Harris	1007	19	
City of Houston	03-Jun-91	Harris	1007	71.2	21340
City of Houston	17-May-91	Harris	1007		
City of Houston	17-May-91	Harris	1007	69	103500
City of Houston	16-May-91	Harris	1016	1	16240
City of Houston	15-May-91	Harris	1007	2.5	89720
City of Houston	15-May-91	Harris	1007	1	8120
City of Houston	15-May-91	Harris	1007	11.5	12180
City of Houston	15-May-91	Harris	1006	5.5	139990
City of Houston	15-May-91	Harris	1006	8.6	408180
City of Houston	13-May-91	Harris	1007	63	189000
City of Houston	09-May-91	Harris	1014	0.5	74570
City of Houston	09-May-91	Harris	1014	0.25	270
City of Houston	08-May-91	Harris	1102	5.5	2440
City of Houston	08-May-91	Harris	1017	7.1	317470
City of Houston	08-May-91	Harris	1007	0.25	560
City of Houston	08-May-91	Harris	1007	2	32850
City of Houston	08-May-91	Harris	1007	3.25	83310
City of Houston	08-May-91	Harris	1007	4.4	65200

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	08-May-91	Harris	1006	0.75	12810
City of Houston	07-May-91	Harris	1102	5.25	11700
City of Houston	05-May-91	Harris	1007	70.5	
City of Houston	30-Apr-91	Harris	1014	3.5	1050
City of Houston	30-Apr-91	Harris	1007	7.9	9480
City of Houston	25-Apr-91	Harris	1007	122.5	73500
City of Houston	25-Apr-91	Harris	1006	8.75	
City of Houston	24-Apr-91	Harris	N/A	22.25	
City of Houston	24-Apr-91	Harris	N/A	22.25	
City of Houston	23-Apr-91	Harris	1007	22.3	2680
City of Houston	18-Apr-91	Harris	1014	1.5	900
City of Houston	18-Apr-91	Harris	1013	17	3200000
City of Houston	18-Apr-91	Harris	1007	15	73110
City of Houston	17-Apr-91	Harris	1014	1	8800
City of Houston	17-Apr-91	Harris	1007	0.25	1820
City of Houston	17-Apr-91	Harris	1007	0.5	7900
City of Houston	17-Apr-91	Harris	1007	1.5	40000
City of Houston	15-Apr-91	Harris	1007	25	225000
City of Houston	14-Apr-91	Harris	1102	2.5	18560
City of Houston	14-Apr-91	Harris	1017	2	16240
City of Houston	14-Apr-91	Harris	1017	5	292720
City of Houston	14-Apr-91	Harris	1017	16	725650
City of Houston	14-Apr-91	Harris	1014	0.75	3880
City of Houston	14-Apr-91	Harris	1014	0.5	535
City of Houston	14-Apr-91	Harris	1014	3	48730
City of Houston	14-Apr-91	Harris	1013	27	4900000
City of Houston	14-Apr-91	Harris	1013	14	7200000
City of Houston	14-Apr-91	Harris	1013	12	2900000
City of Houston	14-Apr-91	Harris	1007	1	16240
City of Houston	14-Apr-91	Harris	1007	0.75	2970
City of Houston	14-Apr-91	Harris	1007	2.5	22340
City of Houston	14-Apr-91	Harris	1007	3	76950
City of Houston	14-Apr-91	Harris	1007	2	25640
City of Houston	14-Apr-91	Harris	1007	10	48850
City of Houston	14-Apr-91	Harris	1006	3	24370
City of Houston	14-Apr-91	Harris	1006	15	210760
City of Houston	14-Apr-91	Harris	1006	8	260880
City of Houston	11-Apr-91	Harris	1017	7	194690
City of Houston	11-Apr-91	Harris	1013	17	1600000
City of Houston	11-Apr-91	Harris	1007	5	22420
City of Houston	05-Apr-91	Harris	1102	9.5	149520
City of Houston	05-Apr-91	Harris	1017	10.5	538000
City of Houston	05-Apr-91	Harris	1017	17	958870
City of Houston	05-Apr-91	Harris	1016	3	39000
City of Houston	05-Apr-91	Harris	1014	11	261430
City of Houston	05-Apr-91	Harris	1013	36	8400000
City of Houston	05-Apr-91	Harris	1013	10	9200000
City of Houston	05-Apr-91	Harris	1013	12	9800000
City of Houston	05-Apr-91	Harris	1007	3	162000
City of Houston	05-Apr-91	Harris	1007	11	157000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	05-Apr-91	Harris	1007	4	64980
City of Houston	05-Apr-91	Harris	1007	10	257000
City of Houston	05-Apr-91	Harris	1007	5	81220
City of Houston	05-Apr-91	Harris	1007	9	246450
City of Houston	05-Apr-91	Harris	1007	10.5	149520
City of Houston	05-Apr-91	Harris	1007	0.25	15000
City of Houston	05-Apr-91	Harris	1006	19	1276400
City of Houston	04-Apr-91	Harris	1014	6	174000
City of Houston	04-Apr-91	Harris	1007	2.7	61520
City of Houston	04-Apr-91	Harris	1007	2	76900
City of Houston	04-Apr-91	Harris	1007	5.5	183690
City of Houston	04-Apr-91	Harris	1007	12	87340
City of Houston	04-Apr-91	Harris	1007	3	48730
City of Houston	04-Apr-91	Harris	1007	7	179690
City of Houston	09-Mar-91	Harris	1013	2	600
City of Houston	01-Mar-91	Harris	1017	3.5	62000
City of Houston	01-Mar-91	Harris	1006	1	26000
City of Houston	28-Feb-91	Harris	1014	4.75	121000
City of Houston	28-Feb-91	Harris	1007	72	1300000
City of Houston	21-Feb-91	Harris	1102	6.7	134810
City of Houston	21-Feb-91	Harris	1007	7	136810
City of Houston	21-Feb-91	Harris	1007	1.5	48930
City of Houston	21-Feb-91	Harris	1007	9	42890
City of Houston	21-Feb-91	Harris	1007	6.1	179000
City of Houston	21-Feb-91	Harris	1007	12	10000
City of Houston	21-Feb-91	Harris	1006	4.5	60750
City of Houston	21-Feb-91	Harris	1006	4.8	121120
City of Houston	13-Feb-91	Harris	1007	134.9	6100
City of Houston	13-Feb-91	Harris	1007	94.5	250000
City of Houston	12-Feb-91	Harris	1007	2.5	22500
City of Houston	06-Feb-91	Harris	1017	2.75	1650
City of Houston	04-Feb-91	Harris	1102	4.5	31640
City of Houston	04-Feb-91	Harris	1017	13	725610
City of Houston	04-Feb-91	Harris	1013	9	7100000
City of Houston	04-Feb-91	Harris	1013	18	7500000
City of Houston	04-Feb-91	Harris	1013	36	29800000
City of Houston	04-Feb-91	Harris	1007	7	428050
City of Houston	04-Feb-91	Harris	1007	1.25	65250
City of Houston	04-Feb-91	Harris	1007		
City of Houston	04-Feb-91	Harris	1007	1	16240
City of Houston	04-Feb-91	Harris	1007	7	32490
City of Houston	04-Feb-91	Harris	1007	117	861670
City of Houston	04-Feb-91	Harris	1007	2	32490
City of Houston	04-Feb-91	Harris	1007	3	34820
City of Houston	04-Feb-91	Harris	1007	3	76900
City of Houston	04-Feb-91	Harris	1007	3	49270
City of Houston	04-Feb-91	Harris	1007	2.5	93210
City of Houston	04-Feb-91	Harris	1007	1	50000
City of Houston	04-Feb-91	Harris	1006	11.5	412310
City of Houston	04-Feb-91	Harris	1006		

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	24-Jan-91	Harris	1013	2	400000
City of Houston	18-Jan-91	Harris	1102	7	136810
City of Houston	18-Jan-91	Harris	1017	11	150980
City of Houston	18-Jan-91	Harris	1013	1	
City of Houston	18-Jan-91	Harris	1013	126.5	26600000
City of Houston	18-Jan-91	Harris	1013		
City of Houston	18-Jan-91	Harris	1007	29	34800
City of Houston	18-Jan-91	Harris	1007	4	2240
City of Houston	18-Jan-91	Harris	1007	6.5	166630
City of Houston	18-Jan-91	Harris	1007	29	17400
City of Houston	18-Jan-91	Harris	1007	2	14570
City of Houston	18-Jan-91	Harris	1007	2	331090
City of Houston	18-Jan-91	Harris	1007	4.5	20890
City of Houston	18-Jan-91	Harris	1007	7.5	6750
City of Houston	18-Jan-91	Harris	1006	14	383380
City of Houston	18-Jan-91	Harris	1006	14.5	371710
City of Houston	16-Jan-91	Harris	1007	22	39600
City of Houston	15-Jan-91	Harris	1007	3	245000
City of Houston	15-Jan-91	Harris	1007	9	133000
City of Houston	14-Jan-91	Harris	1102	5.2	37000
City of Houston	14-Jan-91	Harris	1017	9.5	243000
City of Houston	14-Jan-91	Harris	1014	1.5	2000
City of Houston	14-Jan-91	Harris	1007	4.5	113000
City of Houston	14-Jan-91	Harris	1007	7.25	34000
City of Houston	14-Jan-91	Harris	1007	0.3	27000
City of Houston	14-Jan-91	Harris	1007	6.5	242000
City of Houston	14-Jan-91	Harris	1007	7	11000
City of Houston	14-Jan-91	Harris	1007	0.75	19000
City of Houston	14-Jan-91	Harris	1007	9.25	225000
City of Houston	14-Jan-91	Harris	1007	2.5	4000
City of Houston	14-Jan-91	Harris	1007	2.5	93000
City of Houston	14-Jan-91	Harris	1007	8	67000
City of Houston	14-Jan-91	Harris	1007	45.3	679500
City of Houston	14-Jan-91	Harris	1007	6	4000
City of Houston	14-Jan-91	Harris	1006	1.75	28000
City of Houston	14-Jan-91	Harris	1006	7	215000
City of Houston	14-Jan-91	Harris	1006	6.75	173000
City of Houston	14-Jan-91	Harris	1006	11	300000
City of Houston	10-Jan-91	Harris	1102	5	46420
City of Houston	10-Jan-91	Harris	1017	8	362820
City of Houston	10-Jan-91	Harris	1014	3	76910
City of Houston	10-Jan-91	Harris	1014	1	2230
City of Houston	10-Jan-91	Harris	1014	1.5	1180
City of Houston	10-Jan-91	Harris	1007	3	4740
City of Houston	10-Jan-91	Harris	1007	4.5	37800
City of Houston	10-Jan-91	Harris	1007	2	1060
City of Houston	10-Jan-91	Harris	1007	4.5	20900
City of Houston	10-Jan-91	Harris	1007		
City of Houston	10-Jan-91	Harris	1007	6.3	7600
City of Houston	10-Jan-91	Harris	1007	0.25	6410

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	10-Jan-91	Harris	1007	6	208030
City of Houston	10-Jan-91	Harris	1006		
City of Houston	10-Jan-91	Harris	1006	6	272120
City of Houston	10-Jan-91	Harris	1006	11.5	1500000
City of Houston	09-Jan-91	Harris	1102	4	151890
City of Houston	09-Jan-91	Harris	1017	5.5	136920
City of Houston	09-Jan-91	Harris	1014	0.5	8120
City of Houston	09-Jan-91	Harris	1007	0.5	8120
City of Houston	09-Jan-91	Harris	1007	3	111860
City of Houston	09-Jan-91	Harris	1007	3.75	61310
City of Houston	09-Jan-91	Harris	1007	2.5	40610
City of Houston	09-Jan-91	Harris	1007	2.5	56850
City of Houston	09-Jan-91	Harris	1006	7	10000
City of Houston	09-Jan-91	Harris	1006	4.5	
City of Houston	08-Jan-91	Harris	1017	1	600
City of Houston	06-Jan-91	Harris	1007	1	25635
City of Houston	02-Jan-91	Harris	1007	1	530
City of Houston	02-Jan-91	Harris	1007	19	28500
City of Houston	02-Jan-91	Harris	1007	0.5	7900
City of Houston	02-Jan-91	Harris	1007	0.5	4640
City of Houston	02-Jan-91	Harris	1007	14	358890
City of Houston	02-Jan-91	Harris	1006	3	
City of Houston	02-Jan-91	Harris	1006	4	100000
City of Houston	02-Jan-91	Harris	1006	9	230720
City of Houston	02-Jan-91	Harris	1006	0.5	8120
City of Houston	26-Dec-90	Harris	1007	1.5	38450
City of Houston	26-Dec-90	Harris	1006	4	102540
City of Houston	21-Dec-90	Harris	1007	5	605370
City of Houston	06-Dec-90	Harris	1007	2.6	1550
City of Houston	04-Dec-90	Harris	1013	25.5	153000
City of Houston	04-Dec-90	Harris	1007	243	72900
City of Houston	29-Nov-90	Harris	1013	3	900
City of Houston	29-Nov-90	Harris	1007	141.5	254700
City of Houston	16-Nov-90	Harris	1013	93.2	55920
City of Houston	16-Nov-90	Harris	1007	1.25	380
City of Houston	16-Nov-90	Harris	1007	20	60000
City of Houston	15-Nov-90	Harris	1007	119.5	35850
City of Houston	13-Nov-90	Harris	1013	4.7	420
City of Houston	12-Nov-90	Harris	1007	0.5	150
City of Houston	09-Nov-90	Harris	1007	3.5	770000
City of Houston	08-Nov-90	Harris	1102	19	1865000
City of Houston	08-Nov-90	Harris	1007	0.6	12600
City of Houston	08-Nov-90	Harris	1007	6.75	86400
City of Houston	19-Oct-90	Harris	1017	1	16
City of Houston	19-Oct-90	Harris	1013	3	2160
City of Houston	17-Oct-90	Harris	1007	2	5000
City of Houston	17-Oct-90	Harris	1006	4.5	115000
City of Houston	07-Oct-90	Harris	1007	7.5	2550
City of Houston	07-Oct-90	Harris	1007	21	126000
City of Houston	07-Oct-90	Harris	1007	52.5	300000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
City of Houston	01-Oct-90	Harris	1102		6000
City of Houston	25-Sep-90	Harris	1007	72	1100
City of Houston	22-Sep-90	Harris	1007	4	2400
City of Houston	19-Sep-90	Harris	1006	2	229460
City of Houston	19-Sep-90	Harris	1006	3.5	384000
City of Houston	16-Sep-90	Harris	1007	51.5	1540
City of Houston	16-Sep-90	Harris	1007	50.3	1510
City of Houston	13-Sep-90	Harris	1007	0.75	12800
City of Houston	11-Sep-90	Harris	1017	13.5	4050
City of Houston	11-Sep-90	Harris	1017	1.25	38
10123-001	08-Apr-93				
10086-002	24-Jun-93	Fort Bend			
10123-001	22-Jun-93	Matagorda		15	543000
10564-001	09-May-91	Liberty	0801	19	7000
11377-001	29-Sep-92	Liberty	0802	15	140000
11377-001	22-Jun-93	Liberty	0802	24	130000
10395-007	21-Jun-93	Harris	0901		
10395-009	27-Dec-92	Chambers	0901		24000
11713-001	15-Jan-91	Harris	0901		
11713-001	18-Jan-91	Harris	0901	0.5	
11713-001	02-Nov-91	Harris	0901	22	15000
11713-001	18-Jan-92	Harris	0901	6	
11713-001	03-Feb-92	Harris	0901	24	
11713-001	21-Jun-93	Harris	0901	7.5	
10395-009	09-Dec-92	Chambers	0901	7.5	24000
10395-009	15-Dec-92	Chambers	0901	12	30000
10395-009	27-Dec-92	Chambers	0901		24000
10395-009	07-Jan-93	Chambers	0901	6.5	16000
10395-009	29-Jan-93	Chambers	0901	3	7500
10395-009	10-Feb-93	Chambers	0901	7	45000
10395-009	25-Feb-93	Chambers	0901	4.5	11250
10395-009	01-Mar-93	Chambers	0901	2	5000
10395-009	03-Apr-93	Chambers	0901	6	1500
10395-009	07-Apr-93	Chambers	0901	3.5	8750
10395-009	28-May-93	Chambers	0901	0.5	1250
11713-001	03-Oct-91	Harris	0901	20	20000
11713-001	27-Jan-92	Harris	0901	4	
11713-001	02-Jun-92	Harris	0901	24	
11713-001	07-Jan-93	Harris	0901	25	
10395-008	12-Apr-92	Harris	1001	16	1000
10395-008	17-May-92	Harris	1001		6250
10395-008	12-Jun-92	Harris	1001		2000
10395-008	12-Jun-92	Harris	1001	8	1000
13184-001	04-Sep-90	Harris	1001		
13184-001	03-Dec-90	Harris	1001		400
13184-001	09-May-91	Harris	1001		300
10668-001	03-Apr-93	Harris	1001	2	100000
10668-001	18-Jan-91	Harris	1001		300
10668-001	11-Mar-91	Harris	1001		
10668-001	02-May-91	Harris	1001		1000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10668-001	27-May-91	Harris	1001		50
10668-001	20-Jun-91	Harris	1001		1500
10668-001	25-Jun-91	Harris	1001	0.5	2000
10668-001	24-Nov-91	Harris	1001	5	300
10668-001	26-Mar-92	Harris	1001	1	1000
10668-001	01-Jun-92	Harris	1001		
10668-001	04-Apr-93	Harris	1001		100200
11329-001	21-Jun-93	Harris	1001	2	
11329-001	10-Jan-91	Harris	1001		
11329-001	18-Jan-91	Harris	1001	0.5	
11329-001	05-Apr-91	Harris	1001		
11329-001	05-Apr-91	Harris	1001		10000
11329-001	24-Apr-91	Harris	1001		
11329-001	24-Apr-91	Harris	1001		2764800
11329-001	27-May-91	Harris	1001		
11329-001	01-Jan-92	Harris	1001		
11329-001	18-Jan-92	Harris	1001		
11329-001	01-Feb-92	Harris	1001		
11329-001	01-Mar-92	Harris	1001		
11329-001	01-Dec-92	Harris	1001		
11388-001	17-Jun-93	Harris	1001	120	112500
10395-008	17-May-92	Harris	1001	2.5	6250
10668-001	01-Mar-93	Harris	1001	21	100000
10668-001	02-Mar-93	Harris	1001		100000
11329-001	24-Apr-91	Harris	1001	9	100000
11329-001	21-May-91	Harris	1001		2800080
11329-001	21-Dec-91	Harris	1001	21	5000
10668-001	02-Dec-91	Harris	1001	1.5	200
11388-001	23-Jul-92	Harris	1001	0.5	300
11388-001	03-Aug-92	Harris	1001	4	36000
11388-001	09-Nov-92	Harris	1001	5.5	28800
11388-001	20-Nov-92	Harris	1001		400
11388-001	21-Nov-92	Harris	1001	12	10800
11388-001	09-Dec-92	Harris	1001		28800
11388-001	14-Dec-92	Harris	1001		36000
11388-001	07-Jan-93	Harris	1001	16.5	13050
11388-001	08-Jan-93	Harris	1001	3.5	2100
11388-001	09-Jan-93	Harris	1001	7	6300
11388-001	10-Jan-93	Harris	1001	5	3000
11388-001	20-Jan-93	Harris	1001	1	15600
11388-001	29-Jan-93	Harris	1001	0.5	16200
11388-001	29-Jan-93	Harris	1001	12.5	16200
11388-001	25-Feb-93	Harris	1001	7.5	28800
11388-001	01-Mar-93	Harris	1001	7.5	28800
11388-001	22-Mar-93	Harris	1001	22.5	19350
11388-001	03-Apr-93	Harris	1001	10	29700
11388-001	07-Apr-93	Harris	1001	6.5	16650
11388-001	08-Apr-93	Harris	1001	18.5	21600
11388-001	02-May-93	Harris	1001	7.5	6750
11388-001	10-May-93	Harris	1001	28	15300

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
11388-001	24-May-93	Harris	1001	3	21600
11388-001	10-Jun-93	Harris	1001	9	21600
11388-001	10-Jun-93	Harris	1001	9	8100
11388-001	11-Jun-93	Harris	1001	22.5	21600
11388-001	11-Jun-93	Harris	1001	22.5	20250
11388-001	16-Jun-93	Harris	1001	21.5	
11388-001	24-Jun-93	Harris	1001	24	21600
11388-001	26-Jun-93	Harris	1001	26	21600
10104-001	19-Nov-92	Harris	1001		1440000
10104-001	16-Feb-92	Harris	1001	6.5	195000
10104-001	09-Dec-92	Harris	1001	5	90000
10104-001	14-Dec-92	Harris	1001		1440000
10104-001	07-Jan-93	Harris	1001		864000
10104-001	29-Jan-93	Harris	1001		432000
10104-001	25-Feb-93	Harris	1001		1440000
10104-001	01-Mar-93	Harris	1001		720000
10104-001	23-Mar-93	Harris	1001	8	360000
10104-001	04-Apr-93	Harris	1001	3.5	1008000
10104-001	08-Apr-93	Harris	1001	14	640000
10104-001	26-Dec-90	Harris	1001	6.5	
10104-001	27-Dec-90	Harris	1001	7	3600000
10104-001	02-Jan-91	Harris	1001	9	4320000
10104-001	02-Jan-91	Harris	1001	21	
10104-001	09-Jan-91	Harris	1001	10.5	4320000
10104-001	10-Jan-91	Harris	1001	12	4320000
10104-001	14-Jan-91	Harris	1001	25.5	4320000
10104-001	18-Jan-91	Harris	1001	28	4320000
10104-001	04-Feb-91	Harris	1001	31.5	4320000
10104-001	21-Feb-91	Harris	1001	2	3600000
10104-001	04-Apr-91	Harris	1001	44	720000
10104-001	14-Apr-91	Harris	1001	10	285000
10104-001	18-Apr-91	Harris	1001	3	45000
10104-001	18-Apr-91	Harris	1001	3	
10104-001	08-May-91	Harris	1001	13	1000000
10104-001	08-May-91	Harris	1001	25.5	
10104-001	15-May-91	Harris	1001	5	720000
10104-001	16-May-91	Harris	1001	3.5	
10104-001	16-May-91	Harris	1001	3.5	720000
10104-001	22-Jun-91	Harris	1001	6.5	720000
10104-001	04-Jul-91	Harris	1001	19	1728000
10104-001	17-Nov-91	Harris	1001	6.5	
10104-001	21-Dec-91	Harris	1001	21	864000
10104-001	21-Dec-91	Harris	1001	23	864000
10104-001	26-Dec-91	Harris	1001	19	1440000
10104-001	26-Dec-91	Harris	1001	19	720000
10104-001	08-Jan-92	Harris	1001		
10104-001	08-Jan-92	Harris	1001	10	1440000
10104-001	12-Jan-92	Harris	1001	11	
10104-001	12-Jan-92	Harris	1001	11	520000
10104-001	27-Jan-92	Harris	1001	29	720000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10104-001	03-Feb-92	Harris	1001		1440000
10104-001	11-Feb-92	Harris	1001	9	15810000
10104-001	22-Feb-92	Harris	1001	12	1440000
10104-001	24-Feb-92	Harris	1001		1440000
10104-001	28-Mar-92	Harris	1001	12.5	2880000
10104-001	28-Mar-92	Harris	1001	12.5	2880000
10104-001	05-Apr-92	Harris	1001	7	2880000
10104-001	05-Apr-92	Harris	1001	8	2888000
10104-001	02-Jun-92	Harris	1001		288000
10104-001	02-Jun-92	Harris	1001	6.5	1440000
10104-001	07-Jun-92	Harris	1001	13	924000
10104-001	07-Jun-92	Harris	1001	14	1584000
10104-001	11-Jun-92	Harris	1001	8	1440000
10104-001	12-Jun-92	Harris	1001	5	1440000
10104-001	12-Jun-92	Harris	1001	72	1440000
10104-001	02-Aug-92	Harris	1001	14	
10104-001	20-Jan-93	Harris	1001		288000
12070-002	22-Mar-93	Harris	1006		
11473-001	08-Dec-91	Harris	1006		
11473-001	09-Dec-91	Harris	1006		
12218-001	04-Apr-91	Harris	1006		10000
12218-001	07-Apr-92	Harris	1006		
10519-002	01-Sep-90	Harris	1006		
10519-002	01-Sep-90	Harris	1006		
10519-002	01-Sep-90	Harris	1006		
10519-002	13-Sep-90	Harris	1006	0.5	500
10519-002	10-Oct-90	Harris	1006	0.5	100
10519-002	15-Oct-90	Harris	1006	0.5	100
10519-002	17-Oct-90	Harris	1006	2	1500
10519-002	09-Nov-90	Harris	1006	3	2500
10519-002	10-Nov-90	Harris	1006	1	700
10519-002	02-Jan-91	Harris	1006		
10519-002	09-Jan-91	Harris	1006		
10519-002	11-Jan-91	Harris	1006		
10519-002	18-Jan-91	Harris	1006	5	10500
10519-002	02-Feb-91	Harris	1006	8	9000
10519-002	06-Feb-91	Harris	1006	0.5	700
10519-002	21-Feb-91	Harris	1006	7	13500
10519-002	06-Mar-91	Harris	1006	0.5	700
10519-002	01-Nov-91	Harris	1006		
10519-002	21-Dec-91	Harris	1006	0.5	1000
10519-002	26-Dec-91	Harris	1006	0.5	1000
10519-002	12-Jan-92	Harris	1006	1	
10519-002	03-Feb-92	Harris	1006	5	4000
10519-002	24-Feb-92	Harris	1006	2	15500
10519-002	14-Oct-92	Harris	1006	10	750
10519-002	01-Mar-93	Harris	1006		2000
10519-002	22-Mar-93	Harris	1006	1	2000
10519-002	22-Mar-93	Harris	1006	1	1000
10519-002	29-Mar-93	Harris	1006	6	700

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10519-002	31-Mar-93	Harris	1006	4	800
10519-002	04-Apr-93	Harris	1006	2	8000
11302-001	18-Mar-91	Harris	1006		1000
11302-001	17-Nov-91	Harris	1006		16450
11302-001	09-Dec-91	Harris	1006	0.5	1100
11201-001	14-Jun-93	Harris	1006		3000
11201-001	19-Jul-91	Harris	1006		
11201-001	04-Feb-92	Harris	1006		
11201-001	05-Mar-92	Harris	1006		
11201-001	20-May-92	Harris	1006		
11201-001	20-Jun-93	Harris	1006	1	5000
10919-001	25-Feb-93	Harris	1006		200000
10919-001	01-Mar-93	Harris	1006		350000
10184-001	01-Feb-91	Harris	1006		
10184-001	22-Sep-91	Harris	1006	9	
11818-001	17-Feb-93	Harris	1006		
11727-001	14-Nov-91	Harris	1006		
11904-001	02-May-93	Harris	1006	2.5	2000
11533-001	25-Mar-91	Harris	1006		
11533-001	27-Mar-91	Harris	1006	8	1000
12145-001	20-Sep-90	Harris	1006		1000
12145-001	07-Jun-93	Harris	1006	12	10000
12127-001	03-Jan-93	Harris	1006		
12292-001	02-Oct-91	Harris	1006		400
12292-001	22-Oct-91	Harris	1006		11000
10105-001	20-Jun-93	Harris	1006	1	106000
10105-001	21-Jun-93	Harris	1006	4	39000
10558-001	11-Mar-91	Harris	1006	3	
10558-001	05-Apr-91	Harris	1006		36000
10558-001	03-Feb-92	Harris	1006	4	
10558-001	18-May-93	Harris	1006	4	17280
11026-001	20-May-90	Harris	1006		
11026-001	13-May-91	Harris	1006		3840
11026-001	08-Jun-92	Harris	1006		
10105-001	18-Apr-91	Harris	1006	7	
10105-001	08-Jan-92	Harris	1006	6	
10105-001	05-Feb-92	Harris	1006		
10105-001	22-Feb-92	Harris	1006	7.5	
10105-001	20-Nov-92	Harris	1006	15	2041000
10105-001	07-Jan-93	Harris	1006	4	249000
10105-001	25-Feb-93	Harris	1006	5.5	1600000
10105-001	01-Mar-93	Harris	1006		4600000
10105-001	02-Mar-93	Harris	1006	6	288000
10105-001	22-Mar-93	Harris	1006	5.5	1890000
10105-001	04-Apr-93	Harris	1006	10	2700000
10105-001	07-Apr-93	Harris	1006	4	1300000
10105-001	02-May-93	Harris	1006	0.5	48000
10105-001	18-May-93	Harris	1006	9	1300000
10105-001	23-May-93	Harris	1006	1	159000
10105-001	25-May-93	Harris	1006	6	486000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10105-001	30-May-93	Harris	1006	1.5	13000
10763-002	21-Jun-93	Harris	1006	7.5	
11355-001	26-Feb-91	Harris	1006		
11355-001	22-Feb-92	Harris	1006		500
11355-001	21-Oct-92	Harris	1006		450
11355-001	21-Nov-92	Harris	1006	12	750
11355-001	23-Mar-93	Harris	1006		200
12122-001	07-Oct-91	Harris	1006		21600
12122-001	04-Oct-92	Harris	1006		
11682-001	21-Jul-92	Harris	1006		1900
11682-001	16-Dec-92	Harris	1006	5	1000
10419-001	11-Mar-92	Harris	1006	0.5	1000
10905-001	06-Apr-91	Harris	1006		
10905-001	16-Jun-91	Harris	1006		
10905-001	18-Jun-91	Harris	1006		
10905-001	21-Dec-91	Harris	1006		200
10905-001	17-Apr-92	Harris	1006	19	4000
10905-001	10-Jun-92	Harris	1006	1	1500
10518-001	02-Mar-92	Harris	1006		
10053-002	27-Jan-92	Harris	1006	2	6000
10053-002	27-Jan-92	Harris	1006	2	6000
10053-002	27-Jan-92	Harris	1006	6	18000
10053-002	27-Jan-92	Harris	1006	6	36000
10053-002	27-Jan-92	Harris	1006	8	24000
10053-002	04-Feb-92	Harris	1006	8	24000
10053-002	04-Feb-92	Harris	1006	8	24000
10053-002	04-Feb-92	Harris	1006	8	24000
10053-002	04-Feb-92	Harris	1006	18	108000
10053-002	04-Feb-92	Harris	1006	20	24000
10053-002	04-Feb-92	Harris	1006	20	36000
10053-002	04-Feb-92	Harris	1006	20	24000
10053-002	04-Feb-92	Harris	1006	20	120000
10053-002	04-Feb-92	Harris	1006	30	90000
10053-002	04-Feb-92	Harris	1006	40	120000
10053-002	11-Feb-92	Harris	1006	6	10800
10053-002	11-Feb-92	Harris	1006	6	7200
10053-002	11-Feb-92	Harris	1006	8	24000
10053-002	11-Feb-92	Harris	1006	10	15000
10053-002	11-Feb-92	Harris	1006	10	18000
10053-002	11-Feb-92	Harris	1006	10	12000
10053-002	11-Feb-92	Harris	1006	16	48000
10053-002	11-Feb-92	Harris	1006	20	12000
10053-002	11-Feb-92	Harris	1006	20	60000
10053-003	02-Jun-92	Harris	1006	2	6000
10053-003	02-Jun-92	Harris	1006	8	24000
10053-003	02-Jun-92	Harris	1006	8	24000
10053-003	02-Jun-92	Harris	1006	8	48000
10053-003	02-Jun-92	Harris	1006	8	24000
10053-003	02-Jun-92	Harris	1006	8	24000
10053-003	02-Jun-92	Harris	1006	18	108000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10053-005	22-Feb-92	Harris	1006	4	2400
10053-005	22-Feb-92	Harris	1006	4	2400
10053-005	22-Feb-92	Harris	1006	6	3600
10053-005	22-Feb-92	Harris	1006	6	7200
10053-005	22-Feb-92	Harris	1006	6	7200
10053-005	22-Feb-92	Harris	1006	6	18000
10053-005	22-Feb-92	Harris	1006	8	24000
10053-005	22-Feb-92	Harris	1006	12	36000
10053-005	22-Feb-92	Harris	1006	15	90000
10053-005	22-Feb-92	Harris	1006	20	24000
10053-005	22-Feb-92	Harris	1006	20	240000
10053-005	24-Feb-92	Harris	1006	1	3000
10053-005	24-Feb-92	Harris	1006	4	2400
10053-005	24-Feb-92	Harris	1006	8	24000
10053-005	24-Feb-92	Harris	1006	10	12000
10053-005	24-Feb-92	Harris	1006	10	12000
10053-005	24-Feb-92	Harris	1006	10	18000
10053-005	24-Feb-92	Harris	1006	14	21000
10053-005	24-Feb-92	Harris	1006	20	120000
10053-005	24-Feb-92	Harris	1006	20	24000
10053-005	24-Feb-92	Harris	1006	20	60000
10053-005	24-Feb-92	Harris	1006	20	240000
12450-001	25-Oct-91	Harris	1006	0.5	1000
11701-001	05-Feb-91	Harris	1006		
11701-001	18-Feb-92	Harris	1006		
11701-001	01-Mar-92	Harris	1006		
11701-001	29-Jun-92	Harris	1006		
11701-001	21-Jul-92	Harris	1006		
11701-001	04-Aug-92	Harris	1006		
11701-001	13-Oct-92	Harris	1006		
11701-001	21-Oct-92	Harris	1006		100
11701-001	12-Jan-93	Harris	1006		
11701-001	20-Jan-93	Harris	1006		
10694-001	04-Feb-92	Harris	1006		
10694-001	11-Feb-92	Harris	1006		
12026-001	03-Feb-92	Harris	1006		25000
11682-001	09-Sep-91	Harris	1006	4	1000
11682-001	25-Dec-92	Harris	1006		24000
11682-001	19-Jan-93	Harris	1006	4	2400
10105-001	19-Jun-93	Harris	1006	8	768000
10763-002	12-Jan-91	Harris	1006		
10763-002	03-Dec-91	Harris	1006	2.5	
11302-001	15-Jun-91	Harris	1006	2	17000
11818-001	10-Nov-91	Harris	1006		10000
11904-001	16-Sep-91	Harris	1006	4	7600
12145-001	04-Apr-92	Harris	1006		2500
12145-001	07-Apr-92	Harris	1006	24	2500
12145-001	16-Jun-92	Harris	1006	1	500
12736-001	26-Dec-90	Harris	1006		2000
12292-001	15-Feb-93	Harris	1006	5	64000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10451-001	01-Feb-92	Harris	1006		400000
11026-001	14-Oct-92	Harris	1006		
13368-001	04-Jun-91	Harris	1006	1	2000
11355-001	13-Apr-92	Harris	1006		
12206-001	04-Jan-93	Harris	1006	19	20000
11701-001	23-Feb-93	Harris	1006	11	80000
12996-001	29-Apr-92	Harris	1006	48	
11154-001	11-Jan-93	Harris	1006	1	
10518-001	22-Mar-93	Harris	1006		7200
10518-001	21-Jun-93	Harris	1006		8640
10518-001	21-Jun-93	Harris	1006		770
10518-001	21-Jun-93	Harris	1006		1440
10518-001	21-Jun-93	Harris	1006		14400
10694-001	03-Feb-92	Harris	1006		
10694-001	03-Feb-92	Harris	1006		
10694-001	04-Feb-92	Harris	1006		
10694-001	11-Feb-92	Harris	1006		
10694-001	11-Feb-92	Harris	1006		
10105-001	21-Feb-91	Harris	1006	8	
10105-001	04-Apr-91	Harris	1006		864000
10105-001	18-Apr-91	Harris	1006		
11682-001	24-Oct-90	Harris	1006	12	
10519-002	14-Oct-92	Harris	1006	5	500
10053-005	06-Sep-90	Harris	1006		10000
10053-005	24-Feb-92	Harris	1006	7	1750000
10053-005	12-Jun-93	Harris	1006	18	82500
11201-001	02-Dec-90	Harris	1006	22	50000
12465-001	01-Sep-90	Harris	1006		1000
13561-001	04-Nov-91	Harris	1006	1	15000
13561-001	04-Mar-92	Harris	1006	5	
10550-001	03-Jan-90	Harris	1007	16	12500000
10550-001	11-Sep-90	Harris	1007	3	1500000
10550-001	10-Jan-91	Harris	1007	14	10900000
10550-001	15-Jan-91	Harris	1007	9	7000000
10550-001	18-Jan-91	Harris	1007	15	11700000
10550-001	04-Feb-91	Harris	1007	18	14000000
10550-001	21-Feb-91	Harris	1007	13	10000000
10550-001	04-Apr-91	Harris	1007	19	14800000
10550-001	05-Apr-91	Harris	1007	22	17100000
10550-001	11-Apr-91	Harris	1007	10	7800000
10550-001	14-Apr-91	Harris	1007	19	14800000
10550-001	18-Apr-91	Harris	1007	9	7000000
10550-001	15-Jun-91	Harris	1007	11	8600000
10550-001	16-Jun-91	Harris	1007	11	8600000
10550-001	24-Jun-91	Harris	1007	4.5	3500000
10550-001	17-Nov-91	Harris	1007	18.5	6500000
10550-001	22-Dec-91	Harris	1007	7.5	855000
10550-001	22-Dec-91	Harris	1007	7.5	855000
10550-001	26-Dec-91	Harris	1007	7.5	490000
10550-001	26-Dec-91	Harris	1007	8	490000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10550-001	27-Jan-92	Harris	1007	8.5	1020000
10550-001	03-Feb-92	Harris	1007	6.5	400000
10550-001	04-Feb-92	Harris	1007	1	44000
10550-001	11-Feb-92	Harris	1007	4	75000
10550-001	22-Feb-92	Harris	1007	10	560000
10550-001	24-Feb-92	Harris	1007	5	57000
10550-001	04-Mar-92	Harris	1007	10.5	4900000
10550-001	05-Mar-92	Harris	1007	0.5	3500
10550-001	28-Mar-92	Harris	1007	4.5	52000
10550-001	05-Apr-92	Harris	1007	3.5	800000
10550-001	17-Apr-92	Harris	1007	5.5	400000
10550-001	18-Apr-92	Harris	1007	1.5	20000
10550-001	16-May-92	Harris	1007	9	350000
10550-001	28-May-92	Harris	1007	1.5	11000
10550-001	29-May-92	Harris	1007	1.5	6000
10550-001	02-Jun-92	Harris	1007	6	322000
10550-001	08-Aug-92	Harris	1007	4	350000
10550-001	11-Sep-92	Harris	1007	13	200
10550-001	28-Sep-92	Harris	1007	8	250
10550-001	01-Nov-92	Harris	1007	2	519000
10550-001	21-Nov-92	Harris	1007	7.5	2000000
10550-001	22-Nov-92	Harris	1007	3	350000
10550-001	07-Jan-93	Harris	1007	8.5	340000
10550-001	07-Jan-93	Harris	1007	8.5	340000
10550-001	25-Feb-93	Harris	1007	12.5	2400000
10550-001	26-Feb-93	Harris	1007	0.5	35000
10550-001	01-Mar-93	Harris	1007	13.5	2200000
10550-001	02-Mar-93	Harris	1007	13.5	1620000
10550-001	22-Mar-93	Harris	1007	3	172000
10550-001	23-Mar-93	Harris	1007	4.5	100000
10550-001	04-Apr-93	Harris	1007	6.5	26000
10550-001	07-Apr-93	Harris	1007	6.5	2700000
10550-001	08-Apr-93	Harris	1007	7	1800000
11461-001	29-Jun-93	Harris	1007	2	1200
11461-001	17-Feb-92	Harris	1007	4	18000
11599-001	01-Jan-92	Harris	1007	8	200
10086-002	03-Feb-92	Fort Bend	1007	10	
11998-001	19-Jun-91	Harris	1007	4	
11998-001	22-Feb-92	Harris	1007	2	
11998-001	04-Mar-92	Harris	1007	3	
11998-001	13-Mar-92	Harris	1007	8	
11998-001	11-Jun-93	Harris	1007	3	75000
10570-001	16-May-91	Harris	1007		
10570-001	28-May-92	Harris	1007	3.5	10000
12235-001	15-Oct-90	Harris	1007		
10495-037	10-Jun-93	Harris	1007		1000
12379-001	02-Jun-92	Fort Bend	1007		
12499-001	15-Jan-91	Harris	1007		150
12499-001	05-Oct-91	Harris	1007		
11599-001	12-Jan-91	Harris	1007	2	1000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
11599-001	15-Jan-91	Harris	1007		
11998-001	11-Jun-93	Harris	1007	3	
12250-001	29-Nov-92	Harris	1007		50000
12250-001	10-Jan-93	Harris	1007	10	25000
11553-001	23-Jun-93	Fort Bend	1007	1	8000
10570-001	26-May-92	Harris	1007	2.5	1000
12641-001	14-May-92	Harris	1007		6000
12641-001	21-Jul-92	Harris	1007	4.25	3000
12641-001	20-Sep-92	Harris	1007	1	680
11005-001	15-Jan-91	Harris	1013		
11005-001	16-Jan-91	Harris	1013	15.3	75000
11005-001	03-Sep-91	Harris	1013		300
11538-001	07-May-93	Harris	1013		10000
10794-001	04-Feb-91	Harris	1013		500000
10794-001	04-Feb-91	Harris	1013		500000
10794-001	15-Mar-91	Harris	1013		250000
10794-001	15-Mar-91	Harris	1013		250000
10794-001	13-May-91	Harris	1013		
10876-001	30-May-92	Harris	1013		100
10876-001	01-Jun-92	Harris	1013		500
10876-001	16-Jun-92	Harris	1013		1000
10876-001	17-Nov-92	Harris	1013		500
10876-002	17-Jun-92	Harris	1013		1000
12714-001	28-Dec-92	Harris	1013	2	350
12714-001	24-Mar-93	Harris	1013	4.5	5400
11273-001	15-Nov-91	Harris	1013		
11485-001	13-Nov-90	Harris	1013		7200
12121-001	22-Jul-91	Harris	1013		
12121-001	25-Mar-92	Harris	1013		2500
12121-001	26-Mar-92	Harris	1013	0.5	10000
12139-001	01-Apr-91	Harris	1013		
12139-001	01-Jun-91	Harris	1013		
13509-001	20-Feb-92	Harris	1013		
13509-001	25-Feb-92	Harris	1013		
11051-001	23-Jan-91	Harris	1013		3000
11051-001	25-Jun-91	Harris	1013		
11979-001	01-Jun-91	Harris	1013		1500
11979-001	24-Jul-91	Harris	1013		2500
11979-001	08-Jan-92	Harris	1013		5000
11979-001	19-Jul-92	Harris	1013	2	
12342-001	30-May-92	Harris	1013		200
12342-001	01-Jun-92	Harris	1013		500
10794-001	17-Jan-92	Harris	1013		
10794-001	26-Jan-92	Harris	1013	12	
10794-001	04-Feb-92	Harris	1013	12	
10794-001	13-Apr-92	Harris	1013		
10794-001	02-Jun-92	Harris	1013	2.5	
10794-001	20-Nov-92	Harris	1013		
10794-001	01-Mar-93	Harris	1013		
10794-001	22-Mar-93	Harris	1013		

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10794-001	08-Apr-93	Harris	1013		
11538-001	21-Sep-90	Harris	1013		75000
10876-002	05-Aug-91	Harris	1013		25000
10876-002	10-Oct-92	Harris	1013		3000
11538-001	21-Jun-93	Harris	1013	1.5	1350
12304-001	21-Dec-92	Harris	1014		100
12304-001	14-Jan-93	Harris	1014		100
12304-001	03-May-93	Harris	1014	2	200
12298-001	01-Sep-90	Fort Bend	1014		
12289-001	06-Sep-91	Harris	1014	7	1000
12289-001	16-Oct-91	Harris	1014		200
11792-001	18-Nov-91	Harris	1014	3	72000
11792-001	24-Jul-92	Harris	1014		
11792-001	21-Sep-92	Harris	1014	1.5	
11486-001	27-Jun-93	Harris	1014	0.5	300
11486-001	12-Nov-90	Harris	1014		
11486-001	21-May-91	Harris	1014		1000
11486-001	07-Feb-92	Harris	1014	0.5	2000
11486-001	20-Mar-92	Harris	1014	0.5	150
11486-001	30-Apr-92	Harris	1014	0.5	5000
11486-001	30-Apr-92	Harris	1014	0.5	5000
11486-001	01-May-92	Harris	1014	0.5	1500
11486-001	01-May-92	Harris	1014	0.5	1500
11619-001	07-Aug-92	Harris	1014	1.5	50
12209-001	19-Mar-93	Harris	1014	72	10000
12209-001	02-Apr-93	Harris	1014		150
11836-001	01-Aug-92	Harris	1014		
11836-001	04-Aug-92	Harris	1014	11.5	38000
11836-001	01-Nov-92	Harris	1014	26.5	3600
12802-001	04-Oct-91	Harris	1014		200
10932-001	11-Nov-91	Harris	1014		38500
10932-001	19-Nov-91	Harris	1014		19000
10932-001	20-Dec-91	Harris	1014		
11290-001	18-Mar-91	Harris	1014	3	500
11290-001	24-Mar-91	Harris	1014		100
11290-001	30-Jul-91	Harris	1014	3	1000
11290-001	29-Jan-92	Harris	1014	3	10000
11290-001	23-Feb-92	Harris	1014	4.5	100
11290-001	03-Nov-92	Harris	1014	3	200
11290-001	03-Nov-92	Harris	1014	3.5	200
11290-001	29-Dec-92	Harris	1014	2	120
11290-001	26-Mar-93	Harris	1014	3	750
10706-001	03-Aug-92	Harris	1014		150
11893-001	06-Jul-91	Harris	1014		
11893-001	08-Jul-91	Harris	1014		
11893-001	04-Jan-92	Harris	1014		
11893-001	22-Feb-92	Harris	1014		
11893-001	04-Mar-92	Harris	1014		
11893-001	17-Apr-92	Harris	1014		
11893-001	28-May-92	Harris	1014		

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10584-001	04-Feb-91	Harris	1014		
10584-001	22-Mar-91	Harris	1014		
10584-001	26-Mar-91	Harris	1014		
10584-001	11-Mar-92	Harris	1014		
10584-001	09-Jul-92	Harris	1014		
13484-001	12-Sep-91	Harris	1014		
11455-001	14-Jun-93	Harris	1014	4.5	100
11455-001	14-Jun-93	Harris	1014	5.5	100
11758-001	13-May-91	Harris	1014		30
11758-001	09-Jan-92	Harris	1014		30000
12140-001	15-Mar-91	Harris	1014	4	480
12140-001	15-Jun-91	Harris	1014		
12140-001	28-Feb-92	Harris	1014	2	1500
11284-001	05-Nov-90	Harris	1014		300
11284-001	14-Apr-91	Harris	1014		
11284-001	30-Dec-91	Harris	1014		500
11284-001	01-Jan-92	Harris	1014		
11284-001	22-Feb-92	Harris	1014		5000
11284-001	01-Aug-92	Harris	1014		
11632-001	17-Apr-91	Harris	1014		10000
11632-001	02-Sep-91	Harris	1014		10000
11290-001	05-Dec-91	Harris	1014	2.5	1050
11290-001	17-Oct-92	Harris	1014	3	200
11290-001	09-Jul-91	Harris	1014	5.5	1000
11290-001	31-Jul-91	Harris	1014	4.5	1000
11290-001	04-Nov-91	Harris	1014	3.5	300
11290-001	21-Nov-92	Harris	1014	1	45000
11290-001	30-Dec-92	Harris	1014	1	450
11290-001	08-Feb-93	Harris	1014	4	1200
11290-001	26-Apr-93	Harris	1014	3	660
11893-001	06-Jul-91	Harris	1014	17	100000
11883-001	11-Nov-91	Harris	1014	5	5000
11486-001	11-Nov-91	Harris	1014	5	5000
11290-001	23-Mar-91	Harris	1014	1	3600
11290-001	23-Mar-91	Harris	1014	4	100
11290-001	04-Mar-92	Harris	1014	7	500
10706-001	01-Mar-93	Harris	1014		83000
10706-001	03-Apr-93	Harris	1014	28	1000000
11893-001	04-Jan-92	Harris	1014	30.5	10000
11893-001	22-Feb-92	Harris	1014	6	
11893-001	04-Mar-92	Harris	1014		
11893-001	17-Apr-92	Harris	1014	6.5	100000
11893-001	28-May-92	Harris	1014	2	
10706-001	03-Mar-93	Harris	1014	28	800000
11947-001	09-Sep-91	Harris	1014	0.5	2500
11947-001	02-Nov-91	Harris	1014	3.5	200
11947-001	02-Dec-91	Harris	1014	1.5	200
11947-001	09-Dec-91	Harris	1014	2	5400
11947-001	11-Apr-92	Harris	1014	5.5	3000
11947-001	17-Apr-92	Harris	1014	0.5	2500

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
11947-001	07-Nov-92	Harris	1014		1800
11947-001	05-May-93	Harris	1014	0.5	4200
11947-001	06-May-93	Harris	1014	1.5	100
11486-001	12-Apr-92	Harris	1014	4	240
11486-001	30-Apr-92	Harris	1014		1175
11836-001	26-Mar-93	Harris	1014		2000
12124-001	04-Jun-91	Harris	1014	1	500
12124-001	11-Nov-91	Harris	1014	3	2700
12124-001	09-Nov-92	Harris	1014	0.5	375
11290-001	11-Dec-92	Harris	1014	3	1800
11152-001	29-Dec-92	Harris	1014	2	240
11284-001	04-Aug-92	Harris	1014	3	400
11893-001	01-Jan-93	Harris	1014	1.5	
11284-001	10-Jan-91	Harris	1014		
11284-001	20-Jan-92	Harris	1014		960
12304-001	21-Nov-92	Harris	1014	1	40000
12370-001	19-Jun-93	Fort Bend	1014	43	129000
11571-001	01-Feb-92	Harris	1101		
11571-001	28-Feb-92	Harris	1101		
11571-001	01-Jul-92	Harris	1101		
11571-001	02-Nov-92	Harris	1101	1	10000
11571-001	02-Nov-92	Harris	1101	13	350000
11571-001	08-Jan-93	Harris	1101	11	500000
11571-001	21-Jun-93	Harris	1101	2.5	300
10568-003	13-Nov-92	Galveston	1101		41000
10568-003	22-Nov-92	Galveston	1101		10300
10568-005	15-Jan-91	Galveston	1101		
10568-005	04-Feb-91	Galveston	1101	2	1000
10568-005	24-Jun-91	Galveston	1101	1	
10568-005	25-Jun-91	Galveston	1101	1	10000
10568-005	05-Sep-91	Galveston	1101	3	1000
10568-005	08-Dec-91	Galveston	1101	1.5	100
10568-005	04-Feb-92	Galveston	1101	7	800
10568-005	02-Jun-92	Galveston	1101	1	30000
10568-005	21-Jun-92	Galveston	1101	2	1000
10568-005	22-Jul-92	Galveston	1101		
10568-005	13-Nov-92	Galveston	1101	12	41000
10568-005	15-Dec-92	Galveston	1101	1	1600
10568-005	10-Feb-93	Galveston	1101	0.5	500
10568-005	26-Apr-93	Galveston	1101	2	2000
10568-005	05-May-93	Galveston	1101	0.5	4200
10526-001	06-Nov-91	Harris	1101	2	
10520-001	01-Sep-90	Harris	1101		
10520-001	01-Dec-90	Harris	1101		
10520-001	08-Dec-90	Harris	1101		450000
10520-001	26-Mar-91	Harris	1101	2	6300
10520-001	05-Apr-91	Harris	1101	18	2430000
10520-001	06-Sep-91	Harris	1101	1	3000
10520-001	17-Dec-91	Harris	1101		
11571-001	02-Nov-92	Harris	1101	12	

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10568-003	05-Apr-92	Galveston	1101	11	378700
10568-003	27-May-92	Galveston	1101		616500
10568-003	07-Jan-93	Galveston	1101	3	413000
10568-003	13-Jan-93	Galveston	1101	4	207600
10568-005	05-Aug-91	Galveston	1101	4.5	250
10568-005	21-Aug-91	Galveston	1101	1	500
10568-005	22-Aug-91	Galveston	1101	1	500
10568-005	19-Sep-91	Galveston	1101	0.5	100
10568-005	24-Feb-92	Galveston	1101	2	800
10568-005	05-Apr-92	Galveston	1101	5	2400
10568-005	20-Apr-92	Galveston	1101	0.5	200
10568-005	21-Jun-92	Galveston	1101	2	1440000
10568-005	11-Sep-92	Galveston	1101	1	200
10568-005	11-Nov-92	Galveston	1101	2	600
10568-005	22-Nov-92	Galveston	1101		10000
10568-005	29-Jan-93	Galveston	1101	2.5	1500
10568-005	08-Feb-93	Galveston	1101	2.5	1800
10568-005	26-Apr-93	Galveston	1101	2	2000
10568-005	30-Apr-93	Galveston	1101	5.5	5000
10568-005	15-May-93	Galveston	1101	2.5	1000
10520-001	23-Dec-90	Harris	1101		140000
10520-001	23-Dec-90	Harris	1101	3	140000
10520-001	26-Dec-90	Harris	1101		
10520-001	15-Jan-91	Harris	1101	3	340000
10520-001	24-Feb-92	Harris	1101	3.5	
11571-001	30-Sep-91	Harris	1101		
11571-001	06-Jan-93	Harris	1101	7	50000
10568-005	30-Mar-92	Galveston	1101		50000
10568-005	03-May-92	Galveston	1101		5000
10568-005	19-Jun-92	Galveston	1101		600
10568-005	28-Sep-92	Galveston	1101	10	250
12332-001	14-Apr-92	Brazoria	1102		50
12332-001	30-Nov-92	Brazoria	1102	3.5	1000
12332-001	03-Mar-93	Brazoria	1102	3.5	200
12710-001	08-May-91	Brazoria	1102		
12710-001	01-Dec-91	Brazoria	1102		
10134-002	19-Dec-90	Brazoria	1102	24	
10134-002	06-Jan-91	Brazoria	1102	6	156000
10134-002	10-Jan-91	Brazoria	1102	6	101000
10134-002	20-Jan-91	Brazoria	1102	6	417000
10134-002	04-Feb-91	Brazoria	1102	8	164000
10134-002	20-Feb-91	Brazoria	1102	8	920330
10134-002	05-Apr-91	Brazoria	1102	2	
10134-002	05-Apr-91	Brazoria	1102	4	6250
10134-002	06-Apr-91	Brazoria	1102	10	740000
10134-002	01-May-91	Brazoria	1102	4	
10134-002	08-May-91	Brazoria	1102	2	790300
10134-002	01-Jan-92	Brazoria	1102	2	740000
10134-002	06-Apr-92	Brazoria	1102	2	
10134-002	07-Jan-93	Brazoria	1102	10	100000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10134-003	08-Jan-91	Brazoria	1102	2	13000
10134-003	04-Feb-91	Brazoria	1102	8	164000
10134-003	27-Jan-92	Brazoria	1102	24	100000
10134-003	04-Feb-92	Brazoria	1102	9	33000
10134-003	17-Apr-92	Brazoria	1102	4	4166
10134-003	09-May-93	Brazoria	1102	2	15000
10134-003	09-May-93	Brazoria	1102	4	2500
10134-002	25-Mar-91	Brazoria	1102	48	
10134-002	09-Jan-93	Brazoria	1102	0.5	2000
10134-003	27-Dec-90	Brazoria	1102	9	100000
10134-003	05-Apr-91	Brazoria	1102	3	75525
10134-003	09-Jan-92	Brazoria	1102		50000
12332-001	08-Jan-92	Brazoria	1102	0.5	1910
12332-001	08-Dec-92	Brazoria	1102	4.5	50
12332-001	03-Apr-93	Brazoria	1102	2	25200
12332-001	20-Jun-93	Brazoria	1102	1	13000
10173-001	05-Apr-92	Galveston	1103	6	
10173-001	05-Apr-92	Galveston	1103	8	
10173-001	05-Apr-92	Galveston	1103	21	
10173-001	05-Apr-92	Galveston	1103	33	
10173-001	19-Apr-92	Galveston	1103	8	
10173-001	27-May-92	Galveston	1103	7	
10173-001	27-May-92	Galveston	1103	7	
10173-001	27-May-92	Galveston	1103	7	
10173-001	27-May-92	Galveston	1103	7	
10173-001	27-May-92	Galveston	1103	22	
10173-001	28-May-92	Galveston	1103	12	
10173-001	01-Jun-92	Galveston	1103	35	
10173-001	02-Jun-92	Galveston	1103		
10173-001	02-Jun-92	Galveston	1103	7	
10173-001	02-Jun-92	Galveston	1103	7	
10173-001	02-Jun-92	Galveston	1103	8	
10173-001	02-Jun-92	Galveston	1103	9	
10173-001	06-Jun-92	Galveston	1103	24	
10173-001	21-Jun-92	Galveston	1103	12	
10173-001	21-Jun-92	Galveston	1103	12	
10173-001	21-Jun-92	Galveston	1103	12	
10173-001	21-Jun-92	Galveston	1103	12	
10173-001	21-Jun-92	Galveston	1103	12	
10173-001	22-Jun-92	Galveston	1103		
10173-001	27-Jul-92	Galveston	1103	3	
10173-001	27-Jul-92	Galveston	1103	3	
10173-001	27-Jul-92	Galveston	1103	8	8800000
10173-001	04-Sep-92	Galveston	1103	10	8800000
10173-001	19-Nov-92	Galveston	1103	10	
10173-001	19-Nov-92	Galveston	1103	10	
10173-001	19-Nov-92	Galveston	1103	10	
10173-001	19-Nov-92	Galveston	1103	10	
10173-001	19-Nov-92	Galveston	1103	10	
10173-001	07-Jan-93	Galveston	1103	10	

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10173-001	07-Jan-93	Galveston	1103	10	
10173-001	07-Jan-93	Galveston	1103	10	
10173-001	07-Jan-93	Galveston	1103	10	
10173-001	10-Feb-93	Galveston	1103	3	
10173-001	10-Feb-93	Galveston	1103	3	
10173-001	10-Feb-93	Galveston	1103	3	
10173-001	01-Mar-93	Galveston	1103	3	
10173-001	01-Mar-93	Galveston	1103	3	
10173-001	01-Mar-93	Galveston	1103	4	
10173-001	01-Mar-93	Galveston	1103	6	
10173-001	01-Mar-93	Galveston	1103	8	
10173-001	01-Mar-93	Galveston	1103	8	
10173-001	01-Mar-93	Galveston	1103	8	
10173-001	05-Apr-93	Galveston	1103	5	
10173-001	07-Apr-93	Galveston	1103	4	
10173-001	07-Apr-93	Galveston	1103	4	
10173-001	07-Apr-93	Galveston	1103	8	
10173-001	07-Apr-93	Galveston	1103	12	
10568-007	13-Nov-92	Galveston	1103	14	
10568-007	02-Feb-91	Galveston	1103		1000
10568-007	02-Nov-92	Galveston	1103	2	900
10568-007	13-Nov-92	Galveston	1103	12	30000
10568-007	14-Nov-92	Galveston	1103	2	11000
10175-003	24-Apr-91	Harris	1104		
10175-003	28-Feb-92	Harris	1104		
10175-003	30-Sep-91	Harris	1104		
10175-003	22-Feb-91	Harris	1104		48000
10175-003	08-Jan-92	Harris	1104	4.5	200
10175-003	06-Mar-93	Harris	1104	1	24600
12818-001	07-Aug-91	Brazoria	1105		35000
12420-001	26-Aug-91	Brazoria	1105	5	225
11251-001	28-Mar-91	Brazoria	1107	4.5	100
10700-001	13-Jan-91	Brazoria	1108		
12780-001	26-May-91	Brazoria	1108		
10539-001	01-Oct-90	Harris	1113		
10539-001	18-Oct-90	Harris	1113		
10539-001	15-Jul-91	Harris	1113		
10539-001	16-Jul-91	Harris	1113		
10539-001	06-Nov-91	Harris	1113		
10539-001	03-Mar-92	Harris	1113		
11851-001	06-Apr-91	Harris	1113		22400
10539-001	06-Nov-91	Harris	1113	2.5	94000
10539-001	03-Mar-92	Harris	1113		20000
10539-001	05-Dec-92	Harris	1113	1.5	6000
10539-001	12-Jul-93	Harris	1113	2.5	100
10539-001	15-Jul-91	Harris	1113	3	750000
10627-001	01-Jan-92	Galveston	2421		
10627-001	22-Jan-92	Galveston	2421		
10627-001	22-Jan-92	Galveston	2421	8	1000
10627-001	01-Feb-92	Galveston	2421		

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10627-001	03-Feb-92	Galveston	2421	48	10000
10627-001	12-Feb-92	Galveston	2421		
10627-001	26-Feb-92	Galveston	2421		
10627-001	01-Apr-92	Galveston	2421		
10627-001	20-Apr-92	Galveston	2421	6	2000
10627-001	01-Jun-92	Galveston	2421		
10627-001	29-Jan-93	Galveston	2421		
10770-001	07-Jan-91	Galveston	2421	4.5	
10770-001	07-Jan-93	Galveston	2421	11	14400
10770-001	07-Jan-93	Galveston	2421	32	7200
10770-001	19-Jun-93	Galveston	2421	4	144000
12039-001	11-Jun-91	Galveston	2421	0.5	300
12039-001	06-Jul-91	Galveston	2421		
12039-001	09-Jul-91	Galveston	2421		
12039-001	12-Jun-93	Galveston	2421	3	500
10206-001	04-Jan-93	Harris	2421	19.5	64935
10671-001	05-Apr-92	Harris	2421		
10671-001	01-Jun-92	Harris	2421		
10671-001	09-Apr-93	Harris	2421		750
10206-001	05-Apr-91	Harris	2421		288000
10206-001	06-Sep-91	Harris	2421		60000
10206-001	26-Dec-91	Harris	2421		79200
10206-001	05-Jan-92	Harris	2421		50400
10206-001	08-Jan-92	Harris	2421		127800
10206-001	11-Jan-92	Harris	2421		115200
10206-001	15-Jan-92	Harris	2421		377934
10206-001	17-Jan-92	Harris	2421		302400
10206-001	03-Feb-92	Harris	2421		331200
10206-001	22-Feb-92	Harris	2421		60000
10206-001	24-Feb-92	Harris	2421		295200
10206-001	04-Mar-92	Harris	2421		156600
10206-001	05-Apr-92	Harris	2421		238525
10206-001	27-May-92	Harris	2421		178350
10206-001	02-Jun-92	Harris	2421		268275
10206-001	06-Jun-92	Harris	2421		198450
10206-001	12-Jun-92	Harris	2421		18000
10206-001	15-Jun-92	Harris	2421		246300
10206-001	11-Aug-92	Harris	2421	7	4050
10206-001	05-Oct-92	Harris	2421		55200
10206-001	12-Nov-92	Harris	2421		79920
10206-001	09-Dec-92	Harris	2421		59790
10206-001	07-Jan-93	Harris	2421		470589
10206-001	20-Jan-93	Harris	2421		100128
10206-001	29-Jan-93	Harris	2421		33806
10206-001	01-Mar-93	Harris	2421		88199
10206-001	23-Mar-93	Harris	2421		18144
10206-001	03-Apr-93	Harris	2421		239897
10206-001	07-Apr-93	Harris	2421		148467
10206-001	05-Feb-91	Harris	2421	21.5	258000
10206-001	21-Feb-91	Harris	2421	24	288000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10206-001	05-Apr-91	Harris	2421	24	288000
10206-001	08-May-91	Harris	2421	16	192000
10206-001	06-Sep-91	Harris	2421	20	60000
10206-001	26-Dec-91	Harris	2421	44	79200
10206-001	05-Jan-92	Harris	2421	28	50400
10206-001	14-Jan-92	Harris	2421	64	115200
10206-001	21-Jan-92	Harris	2421	84	302400
10206-001	24-Jan-92	Harris	2421	51	91800
10206-001	26-Jan-92	Harris	2421	97.5	175500
10206-001	03-Feb-92	Harris	2421	92	331200
10206-001	11-Feb-92	Harris	2421	89.5	161100
10206-001	22-Feb-92	Harris	2421		55000
10206-001	24-Feb-92	Harris	2421		295200
10206-001	06-Mar-92	Harris	2421		156600
10206-001	28-Mar-92	Harris	2421		126000
10206-001	05-Apr-92	Harris	2421		238525
10206-001	20-Apr-92	Harris	2421		75600
10206-001	01-Nov-92	Harris	2421	11	36630
10206-001	20-Nov-92	Harris	2421		257980
10206-001	10-Feb-93	Harris	2421	10.5	14282
10206-001	16-Feb-93	Harris	2421	5.5	7482
11477-001	18-Nov-90	Galveston	2424	6	3000
11477-001	05-May-91	Galveston	2424	1	
11477-001	28-Feb-92	Galveston	2424	2	21600
11477-001	24-Jul-92	Galveston	2424		100
10174-001	26-Jul-92	Galveston	2424	6	200
10688-005	07-Jul-91	Galveston	2424		5000
10690-001	27-Dec-90	Galveston	2424		360000
10690-001	10-Jan-91	Galveston	2424		1876000
10690-001	11-Jan-91	Galveston	2424		1296000
10690-001	12-Jan-91	Galveston	2424		2106000
10690-001	13-Jan-91	Galveston	2424		468000
10690-001	15-Jan-91	Galveston	2424		1865000
10690-001	16-Jan-91	Galveston	2424		
10690-001	18-Jan-91	Galveston	2424		642000
10690-001	31-May-93	Galveston	2424	1	
10690-001	01-Jun-93	Galveston	2424	3.5	
10410-001	30-Oct-91	Galveston	2424	21	198000
10410-001	31-Oct-91	Galveston	2424		
10410-001	08-Jan-92	Galveston	2424	3	6500
10410-001	06-Feb-92	Galveston	2424		36000
11477-001	28-Feb-92	Galveston	2424	6.5	20000
10690-001	12-Sep-90	Galveston	2424		1731000
10690-001	08-Nov-90	Galveston	2424	11	14400
10690-001	09-Jan-91	Galveston	2424		1258000
10690-001	14-Jan-91	Galveston	2424		1958000
10690-001	17-Jan-91	Galveston	2424	10	717000
10690-001	18-Jan-91	Galveston	2424		1584000
10690-001	18-Jun-93	Galveston	2424		
10690-001	26-Dec-90	Galveston	2424	12	624000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10690-001	03-Jan-91	Galveston	2424		516000
10690-001	07-Jan-91	Galveston	2424	22	1056000
10106-001	22-Apr-93	Harris	2425	1.5	1300
10106-001	22-Jun-93	Harris	2425	1	
10106-001	06-Jan-91	Harris	2425	24	331000
10106-001	10-Jan-91	Harris	2425	24	500000
10106-001	18-Jan-91	Harris	2425	2	
10106-001	04-Feb-91	Harris	2425	24	414000
10106-001	21-Feb-91	Harris	2425	24	319000
10106-001	05-Apr-91	Harris	2425	24	421000
10106-001	06-Sep-91	Harris	2425	3	349000
10106-001	17-Dec-91	Harris	2425	24	
10106-001	27-Jan-92	Harris	2425	4	
10106-001	03-Feb-92	Harris	2425	24	
10106-001	24-Feb-92	Harris	2425	12	
10106-001	02-Jun-92	Harris	2425	6	
10106-001	07-Jan-93	Harris	2425	6	
10106-001	03-Apr-93	Harris	2425	14	75000
10395-002	27-Jan-92	Harris	2426	20.5	50000
10395-002	04-Feb-92	Harris	2426	1	200
10395-002	24-Feb-92	Harris	2426	37.5	93750
10395-002	28-Mar-92	Harris	2426	18.5	46250
10395-002	28-Mar-92	Harris	2426	19	3600000
10395-002	05-Apr-92	Harris	2426	12.5	31250
10395-002	13-Apr-92	Harris	2426		5000
10395-002	12-Jun-92	Harris	2426	1.5	2500
10395-002	19-Nov-92	Harris	2426	6.5	2625
10395-002	03-Jan-93	Harris	2426		3000
10395-002	07-Jan-93	Harris	2426	7	3000
10395-002	25-Feb-93	Harris	2426		
10395-002	15-Jun-93	Harris	2426	1	800
11195-001	02-Feb-92	Harris	2426		350
11195-001	25-Jan-93	Harris	2426		
11195-001	01-Feb-93	Harris	2426		
11195-001	22-Mar-93	Harris	2426		
11195-001	08-Jun-93	Harris	2426		1000
10395-002	03-Feb-92	Harris	2426		72000
10395-002	23-Feb-92	Harris	2426		72000
10395-002	29-Jan-93	Harris	2426	4	9400
10395-002	10-Feb-93	Harris	2426	2	5000
10395-002	10-Feb-93	Harris	2426	2	5000
10395-002	16-Feb-93	Harris	2426	2	5000
10395-002	01-Mar-93	Harris	2426	16	40625
10395-002	22-Mar-93	Harris	2426	5	1250
10395-002	03-Apr-93	Harris	2426	19.5	48750
10395-002	18-May-93	Harris	2426	2	5000
10395-002	07-Jan-92	Harris	2426	14	55000
10395-002	25-Jun-93	Harris	2426	1	450
10395-002	03-Feb-92	Harris	2426		28800
10395-002	03-Feb-92	Harris	2426		300060

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10395-002	03-Feb-92	Harris	2426	4	28800
10395-002	04-Feb-92	Harris	2426	1	7200
10395-002	04-Feb-92	Harris	2426	1	500
10395-002	04-Feb-92	Harris	2426	9	7200
10395-002	05-Feb-92	Harris	2426	2	2880
10395-002	11-Feb-92	Harris	2426		
10395-002	11-Feb-92	Harris	2426		7200
10395-002	28-Mar-92	Harris	2426	9	
10395-002	28-Mar-92	Harris	2426	9	22500
10395-002	05-Apr-92	Harris	2426	12	30000
10395-002	17-Apr-92	Harris	2426	1	2500
10395-002	19-Apr-92	Harris	2426	6	13700
10395-002	17-May-92	Harris	2426	1	500
10395-002	17-May-92	Harris	2426	2.5	6250
10395-002	02-Jun-92	Harris	2426	8	20000
10395-002	02-Jun-92	Harris	2426	9	20000
10395-002	12-Jun-92	Harris	2426	1.5	2500
10395-002	14-Dec-92	Harris	2426	2	5000
10395-002	15-Dec-92	Harris	2426	5	12500
10395-002	25-Feb-93	Harris	2426	7	3000
10395-002	01-Mar-93	Harris	2426	7	3000
10395-002	07-Apr-93	Harris	2426	2.5	3000
10395-007	22-Oct-90	Harris	0901	1	8500
10395-007	25-Jun-91	Harris	0901	1	
10395-007	03-Feb-92	Harris	0901	84.5	204700
10395-007	04-Feb-92	Harris	0901	24	33700
10395-007	05-Feb-92	Harris	0901	2	240
10395-007	10-Feb-92	Harris	0901	10	25000
10395-007	10-Feb-92	Harris	0901	10	25000
10395-007	10-Feb-92	Harris	0901	10	25000
10395-007	10-Feb-92	Harris	0901	20	50000
10395-007	13-Apr-92	Harris	0901		25000
10395-007	17-Apr-92	Harris	0901	1	2500
10395-007	19-Apr-92	Harris	0901	5.5	13700
10395-007	24-Apr-92	Harris	0901		60000
10395-007	01-May-92	Harris	0901	1	
10395-007	12-Jun-92	Harris	0901	1.5	2500
10395-007	12-Jun-92	Harris	0901	24	55000
10395-007	07-Aug-92	Harris	0901		
10395-007	05-Apr-93	Harris	0901	2	6500
10395-007	07-Apr-93	Harris	0901	2.5	3000
10395-007	03-Feb-91	Harris	0901		720000
10395-007	04-Feb-92	Harris	0901	7	108000
10395-007	11-Feb-92	Harris	0901		60000
10395-007	17-Apr-92	Harris	0901	3	8700
10395-007	19-Apr-92	Harris	0901	7	17500
10395-007	17-May-92	Harris	0901	16	31250
10395-007	28-May-92	Harris	0901	8	22500
10395-007	01-Jun-92	Harris	0901	11	25000
10395-007	02-Jun-92	Harris	0901	18	45000

Appendix 2. Information on bypass reports within study area.

PERMIT	Date	COUNTY	SEGMENT	Duration (Hrs)	Gallons Discharged
10395-007	06-Jun-92	Harris	0901	20	50000
10395-007	09-Jun-92	Harris	0901	2	5000
10395-007	12-Jun-92	Harris	0901	15	5500
10395-007	02-Aug-92	Harris	0901	8	18750
10395-007	03-Aug-92	Harris	0901	5.5	12500
10395-007	22-Sep-92	Harris	0901	2	5000
10395-007	15-Oct-92	Harris	0901	3	63000
10395-007	19-Nov-92	Harris	0901	20.5	55000
10395-007	09-Dec-92	Harris	0901	9.5	22500
10395-007	14-Dec-92	Harris	0901	34	90000
10395-007	04-Jan-93	Harris	0901	8.5	21000
10395-007	07-Jan-93	Harris	0901	24	60000
10395-007	09-Jan-93	Harris	0901	14	34300
10395-007	18-Jan-93	Harris	0901	10	25000
10395-007	20-Jan-93	Harris	0901	18.5	46200
10395-007	29-Jan-93	Harris	0901	24	60000
10395-007	10-Feb-93	Harris	0901	7	45000
10395-007	16-Feb-93	Harris	0901	11	32500
10395-007	25-Feb-93	Harris	0901	4.5	11250
10395-007	01-Mar-93	Harris	0901	27	68750
10395-007	01-Mar-93	Harris	0901	27	68750
10395-007	20-Mar-93	Harris	0901	10	25000
10395-007	22-Mar-93	Harris	0901	14.5	36250
10395-007	03-Apr-93	Harris	0901	26	65000
10395-007	07-Apr-93	Harris	0901	10.5	26250
10395-007	02-May-93	Harris	0901	12	30000
10395-007	10-May-93	Harris	0901	4.5	11250
10395-007	18-May-93	Harris	0901	10	25000
10395-007	14-Aug-91	Harris	0901	3	200
11167-001	04-Oct-90	Harris	0902	2.5	1000

Note: Entries lacking data indicate information not available.