Oso Creek and Oso Bay Bacteria
Total Maximum Daily Load Model
Final Report

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Total Maximum Daily Load Program

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Executive Summary

The objective of the project was to develop a numerical model that describes the various sources, sinks and fates of bacteria as it is transported through the Oso watershed by runoff and channel flow. In this project both monthly and daily models were developed. A model was developed using monthly times step. This temporal resolution was best suited for the historic monthly and quarterly bacteria concentration data. The calibrated monthly model was then used to aid in the development of a daily time step model. The daily model was developed to take full advantage of the higher temporal resolution of the data collected during this project.

USGS stream flow data for Oso Creek was used to develop a rainfall runoff relationship. The nontidal portions of the creek were treated as constantly stirred tanks in which the flow from tank to tank could be described using Manning's equation. In the tidal and bay portions of the creek the segments were treated as constantly stirred constant volume tanks. The calculated stream flows in the daily model agreed well with the stream flow measurements collected at the single stream flow gaging station in the basin.

The performance of the model reflects the primary assumption that bacteria loading to the creek is a direct consequence of non-point source pollution generated by runoff from precipitation events. The highest concentrations are observed immediately following a rain event and the concentrations decay thereafter. Initial bacteria concentrations for runoff were generated using literature value Event Mean Concentrations (EMCs) for the primary land uses in the Oso watershed: residential, urban, crop and range. These EMCs were found to be too low to generate the concentrations observed in the creek. To improve the model fit, new EMCs were back-calculated using concentration data available from the first rain event. The new EMCs did generate higher concentrations in the model that were closer to the measured concentrations but still in the case of runoff events the model under predicted the bacteria concentrations. Bay segments with comparatively large volumes were able to assimilate runoff loads much quicker than the creek segments with smaller volumes that rely on decay rates and movement of water to the downstream segment.

The monthly model appeared to capture the average response of the creek and was found to have an RMSE of .751 $\log_{10}$ of the concentration, giving it the capability of estimating runoff bacteria loading to the Oso Bay/ Oso Creek system with reasonable accuracy. It was noted through the course of this project that during dry periods the bacteria inputs to the model are quite low and thus the daily model would predict that the bacteria concentrations in the creek should also be low, however the observed concentrations in the non-tidal portions of the creek indicate the presence of a non-runoff related loading. This additional loading, which may be due to such sources as leaky septic systems or wild or domestic animals, keeps bacteria concentrations elevated between rain events. Avian loading was examined as a potential source for this loading but at the moment there is insufficient data to determine the true nature of this loading.

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1 Introduction

The Clean Water Act (CWA), which has developed over the past thirty, outlined the need for water quality standards to ensure the health and safety of the public. To satisfy this need, the Environmental Protection Agency (EPA) has been entrusted with the responsibility of establishing and enforcing these water quality standards. These water quality standards deal primarily with the quantity of anthropogenic pollutants that may be discharged into the nations water bodies. Under the CWA each state is required by law to periodically evaluate, at an interval no longer than three years, all water bodies within its domain for attainment of the standards established by the EPA. Those bodies that are not in compliance are classified as impaired. A state responsible for an impaired water body is required by the CWA to initiate a Total Maximum Daily Load (TMDL) program. The purpose of a TMDL is to determine the maximum amount or load of a pollutant that a water body can receive daily and still support its beneficial uses. The end goal of the TMDL program is to achieve compliance by allocating the allowed load among all potential sources.

The Texas Commission for Environmental Quality (TCEQ), formerly the Texas National Resource Conservation Commission (TNRCC), is responsible for the identification and remediation of all surface waters in the state of Texas that do not meet the water quality standards established by the EPA. As part of this responsibility the TCEQ has undergone the implementation of TMDL programs for all impaired waters in the state of Texas. Once the TMDL program are completed, the TCEQ will then oversee the issuing of permits to allocate the allowable loadings for the water bodies.

1.1 Objectives

Oso Creek and Oso Bay (segment 2485A and segment 2485 respectively) have been placed on the Draft 2004 Texas Water Quality Inventory and the 303d list of impaired waters for not meeting contact recreation criteria for the indicator bacteria *Enterococci*. The Total Maximum Daily Loads (TMDL) program has been implemented to improve water quality in impaired waters so that they will meet their designated use criteria. This program consists of three parts: Determination of current loadings, allowable loadings, and load reduction; stakeholder development of strategies to meet the required load reduction; and implementation of the load reduction strategies.

To better understand the dynamics of bacteria loading to the creek and bay and test load reduction strategies, a numerical model has been built to describe the various sources, sinks and fates of bacteria as it is transported through the watershed by runoff and channel flow.

The model must:

1. Represent non-point source input of bacteria and water based on land use characteristics.

2. Represent point source input of bacteria and water in the form of permitted discharges.
3. Describe bacteria die-off rates (decay rates) within the system.
4. Calculate bacteria loadings for distinct reaches in the watershed.
5. Be capable of performing simulations based on suggested control actions and management techniques to lower bacteria loadings.
6. Be capable of determining load capacity of the impaired segments.
7. Be capable of determining the waste load allocation and load allocation required to bring these segments into regulatory compliance.

1.2 Study Area

Oso Creek and Oso Bay are located in the Oso Watershed, a small watershed draining approximately 609 km^2 in Nueces County, Texas (Figure 1). Oso Creek begins near the City of Robstown and flows 40 km southeast to Oso Bay in the City of Corpus Christi. It is the main drainage channel for more than 96 km of natural and constructed drainage. There is about 23 km of non-tidal creek flowing into 17 km of tidal creek before discharging to Oso Bay. Oso Bay is a shallow tertiary bay of about 1200 hectares that empties into Corpus Christi Bay.

Topographically, the basin can be characterized as flat to gently sloping remnants of Pleistocene marine terraces. The total change in elevation within the basin, from just northwest of Robstown to Oso Bay (about 40km) is about 28m for an overall slope of about 0.7m/km (0.0007m/m). Geologically the watershed lies on the Pleistocene

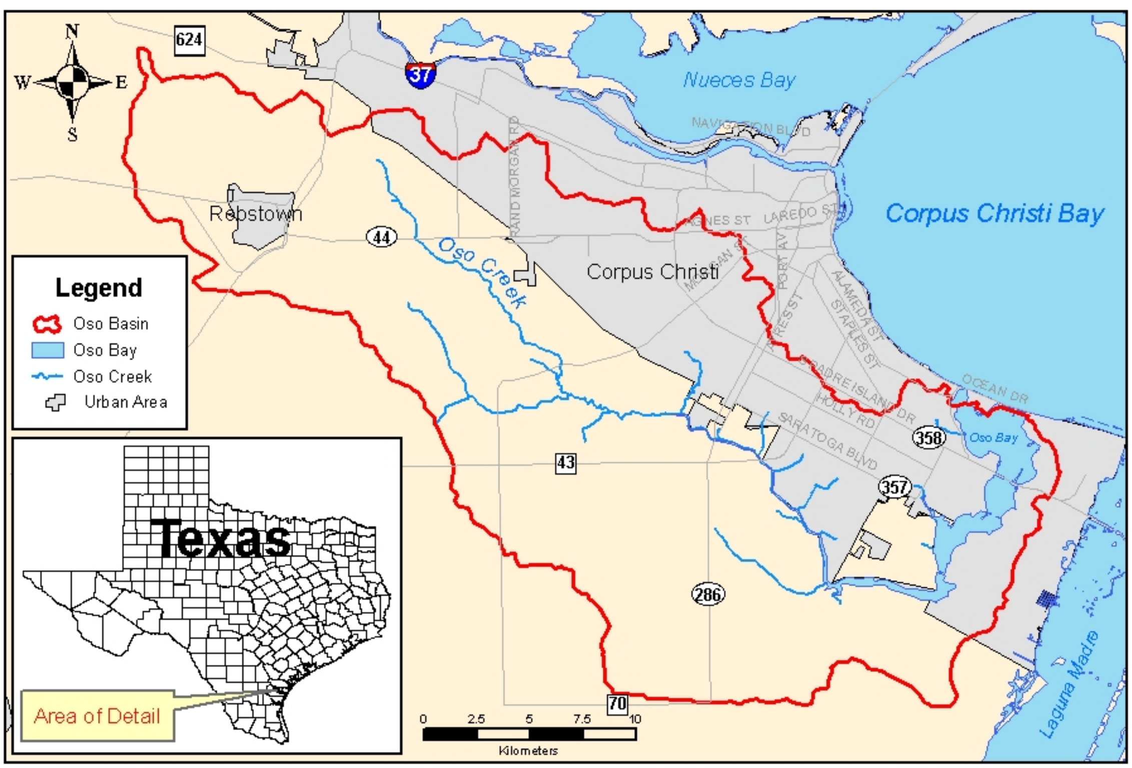


Figure 1. Study Area

Beaumont Formation. The Beaumont Formation in the basin is largely made up of interdistributary muds, abandoned channel-fill muds, and fluvial over bank muds, all of low permeability. Other parts of the basin represent the low-moderate permeability of meander belt, levee, crevasse splay and distributary sand deposits.

2 Methods

The primary methods of investigation for this project consist of a literature review, data review, data preparation, bacteria source identification, and model development. Literature review brings forward related studies and information concerning bacteria loading in other areas as well as related studies in the Oso watershed. Through the literature review, sources of data pertinent to bacteria loading and hydrologic modeling are uncovered. This data is then acquired and reviewed for usefulness in this project as it pertains to the inflow, movement, and outflow of water through the study area; the source, movement and decay of fecal indicator bacteria in this and other similar watersheds; and whether, as a water quality indicator, the data has sufficient distribution both spatially and temporally to meet the project goals.

Types of data incorporated into this project include data from laboratory studies on bacteria growth and distribution, new field data on bacteria concentrations in runoff, spatially distributed data relating to area hydrology, soil characteristics, topography, land usage, vegetative cover, avian distributions, precipitation depths and distribution, and data from other modeling studies similar to this one.

2.1 Literature Review

Studies on *enterococcus* have been reviewed for information explaining their general behavior, including Crysup (2002), Kayser (2003), Bergstein-Ben Dan et al. (1997), Heilman (1999), Peiffer et al. (1988), Alkan et al. (1995), and Cools et al. (2001). Other studies were review for insight in survival techniques including Lleo et al. (1999), Davies et al. (1995), Bordalo et al. (2002), as well as studies by Kay et al. (2004), Lee (2002) that investigated decay rates. Studies about event mean concentrations, which played an important role in determining the loads of the *enterococci*, were assembled to help characterize the load distribution throughout the basin (Baird and Jennings 1996) and (Newell et al. 1992). Gould and Fletcher (1978), Levesque et al. (1993), Levesque et al. (2000), and Harding (2004) completed research about the effects of gull droppings on water quality. These compiled publications provided the baseline information needed to better understand the biological characteristics of *enterococci*, which lead to designing monthly and daily bacteria decay models.

Modeling using GIS assessment has been compiled for TMDL application of various types of water bodies in Texas (Ward and Benaman 1999). Another form of modeling with GIS software includes the use of object oriented modeling of rivers and watersheds (Davis 2000). Numerical models of non-point source loadings have been developed using Geographic Information Systems (GIS) along the Texas coast by Quenzer (1998) and Zoun (2003).

Quenzer (1998) developed a GIS based numerical model to assess non-point source loadings to the Corpus Christi Bay System. This model was developed using a digital elevation model (DEM) of 100m cells is placed over the drainage basin. The DEM was used to describe overland flow directions, sub-watersheds, and accumulation of overland flow. A precipitation – runoff relationship was computed, and average precipitation for each delineated subwatershed was calculated. Based on this relationship, expected runoff was estimated. An Event Mean Concentration (EMC) grid was created based on land use characteristics. The product of the EMC grid and the runoff grid represented the non-point source loadings to the adjacent water bodies.

Zoun (2003) developed a GIS based numerical model of fecal coliform loadings to Galveston Bay. This model is similar to that of Quenzer in the way it represents overland flow and the accumulation of non-point source pollutants, but added some features that specifically address bacteria loadings. In this model Zoun represented bay segments as constantly stirred reactor tanks (CSTR) and incorporated additional loading from avian populations. Avian loading proved to be a significant bacteria source in the Galveston Bay.

2.2 Data Review and Preparation

Data was reviewed based on source, availability, and resolutions required. Major sources of digital data were the Texas Commission on Environmental Quality (TCEQ), the Texas Natural Resource Information System (TNRIS - part of the Texas Water Development Board), the U.S. Geological Survey (USGS), the Texas Forestry Institute (TFI), Texas Department of Transportation (TxDOT), the National Weather Service (NWS), and the Natural Resource Conservation Service (NRCS). Not all data met project requirements and was subject to additional processing to extract subsets of the data, refine data resolution, reproject to the appropriate geographical space, or reprocess to remove undesired artifacts.

Data required for this project comes under three broad areas: description of the hydrologic system; description of indicator bacteria sources and behavior; and description of both storm event, and dry period water quality.

2.2.1 Hydrologic Data

Data to describe the Oso Bay/Oso Creek hydrologic system included spatial datasets like digital elevation models, soil property data, hydrographic network, landuse/landcover, water quality data, and precipitation data. All data except soils data from the NRCS required reprocessing.

2.2.1.1 Digital Elevation Model

Digital elevation models (DEM) were downloaded from the USGS National Elevation Dataset (USGS 2005a.). The National Elevation Dataset (NED) was developed by the

USGS by merging the highest resolution and best quality elevation data available into a seamless raster format. A more detailed elevation model based on LIDAR (Light Detection and Ranging) techniques was provided by the City of Corpus Christi (City of Corpus Christi 2005).

The LIDAR data provided a detailed (2 meter grid spacing) elevation model of about 90% of the basin. Upon detailed analysis of the LIDAR data it was found that significant data processing artifacts in the vicinity of Oso Creek were present. These artifacts are the result of vegetation so thick along the creek that bare earth filtering algorithms could not adequately differential between vegetation canopy and ground level. Since the areas immediately adjacent to the creek were important to the model and reprocessing of the LIDAR data is a lengthy and costly task outside the scope of this project the LIDAR data set was abandoned if favor of the USGS DEM.

The USGS data provided an elevation model with a grid spacing of about 30 meters and 100% coverage of the Oso watershed. Analysis of the USGS DEM reveled some processing artifacts related to integer to floating point grid conversions. In terrain with very low slopes these artifacts represent large areas with virtually no slope. This makes it difficult to perform certain numerical analyses on the DEM that help define hydrologic processes. To correct this, the DEM was reprocessed by reducing it to a triangulated irregular network model (TIN). The TIN defines each data point as a representation of a local minimum, local maximum, a concavity or a convexity. A convexity point and a concavity point adjacent to each other represent the boundary between the low slope area artifacts. The concavity point was then removed from the data and the TIN was reprocessed into a DEM suitable for hydrologic analysis.

2.2.1.2 Soil Property Data

The hydrologic soil dataset was downloaded from the NRCS (NRCS 2005). This data was downloaded in tabular and spatial format. The soil survey for this area was published in 1981 at a 1:24,000 scale. The NRCS classifies the soils into groups based on the soils runoff potential.

2.2.1.3 Hydrographic network

Several hydrographic network data sets for the Oso Creek/Oso Bay watershed were considered including datasets from TNRIS, TxDOT, and the USGS. The National Hydrographic Data Set available from the USGS provides only a medium resolution network for the study area (USGS 2005c). TNRIS provides several data sets including the TxDOT data (TNRIS 2005a). The TxDOT data described the hydrologic network in more detail than the other datasets and when compared to the 1995 DOQQ (digital orthorectified quarter quadrangle) imagery for the study area it matched well. To provide a more detailed and accurate data set, the TxDOT data was edited using the 1995 DOQQ imagery (TNRIS 2005b) to provide a better depiction of the watershed’s drainage network.

2.2.1.4 Land Use/Land Cover

The most recent Land Use/Land Cover (LULC) classification available for the study area by the USGS is for 1992 (USGS 2005e). Considerable development has occurred since then and this data set was considered too dated for this project. The Center for Water Supply Studies created a Land Cover classification of the area for the year 2000 but the classification scheme did not use the standard Anderson classification or the National Land Cover Dataset (NLCD) classification. To provide a current land use classification for this project a 2003 Landsat7 ETM+ (Enhanced Thematic Mapper plus) image was downloaded from the Texas Forestry Institute web site (TFI 2005) that covered the study area (path 26 row 41). The Landsat7 ETM+ imagery is produced by a multispectral radiometer providing 8 spectral bands. Classification used visible and near infrared bands 1 through 5 and band 7 (USGS 2005d). This band range has a spatial resolution of 30 meters. A supervised classification was performed using maximum likelihood method and training sets derived from the USGS 1992 NLCD (USGS 2005e). Training sets were selected from areas that show no land use change during the intervening years. Verification of land covers were performed based on visual review and knowledge of the study area.

2.2.1.5 Meteorological Data

Daily precipitation data was retrieved for the model calibration period from the National Climatic Data Center (NCDC) for five local meteorological data stations (NCDC 2005): Corpus Christi International Airport (Coop ID 412015); Robstown (Coop ID 417677); Flour Bluff (Coop ID 413210); Naval Air Station-Corpus Christi (WBAN 12926); and Chapman Ranch (Coop ID 411651). This data was summed into monthly values and then spatial processed (Inverse Distance Weighting) and formatted into precipitation grids (30 meter spacing) that cover the study area. As the project developed, Nexrad Stage III precipitation data was made available to the Center for Water Supply Studies by the National Weather Service (NWS 2005, Collins 2005) for the calibration period. Nexrad (Next Generation Weather Radar) refers to the Weather Surveillance Radar 88 Doppler (WSR-88D) system. This system was installed throughout the United States and the Caribbean during the 1980’s offering significant improvement over previously deployed weather radars. Specifically, the WSR-88D systems had the ability to detect motion using the Doppler effect. This can give early warning to potentially severe weather. Other improvements include increased sensitivity to view atmospheric conditions, improved resolution and range (250 km), and a volume scanning function that allows three-dimensional analysis of storm structure. Nexrad Stage II precipitation data is a product of WDR-88D system that has been processed using special algorithms to estimate precipitation depths over the range of a WRD-88D installation. These algorithms use on ground precipitation gage data to remove biases in the radar-derived rainfall which tend to vary over the radar domain as a function of range and rainfall type (Fulton et al. 1998). Stage III precipitation data are mosaics from the Stage II product created specifically to provide the NWS river forecast centers with a dataset large enough to cover large river basins (Figure 6). The Stage II and Stage III data provide a spatial resolution of about a 4.7-kilometer grid spacing and rainfall depth estimates measured in 0.01mm increments. Temporal resolution is one hour with time recorded in UTC (Coordinated Universal Time).

2.2.1.6 Gaged Stream Flow

Daily gaged stream flow data was acquired for the period of record from the USGS online stream flow database (USGS 2005b). Only one permanent stream gage is in operation on Oso Creek (USGS Gage 08211520) and is located at the bridge on FM763 near Cuddihy Field just above the tidal segments of the basin. The period of record for this station begins on 9-Sep-1972 and is still operating. This gage measures stream flow from the upper portion of the watershed having an area of about 230 km^2 (~90 sq. miles).

2.2.2 Bacteria Data

Information on sources, measured concentrations and viability of bacteria were necessary to model bacterial loadings in the Oso watershed. This data was collected through literature review, a sanitary survey, the TCEQ Regulatory Activities and Compliance System (TRACS) Database, and the collection of new field data.

2.2.2.1 Bacteria Survival

This type of bacteria can develop a survival strategy known as a viable but nonculturable state (VNC). During times of unfavorable conditions, bacteria can enter VNC state, but the types of parameters that induce VNC depends on the type of bacteria. *Enterococcus faecalis* is capable of entering VNC state. These pathogenic cells remain dormant until favorable conditions are resumed causing the bacteria to start growing again (Lleó 1999).

Another issue of concern is the accumulation of indicator bacteria in freshwater and marine sediments. This occurs due to sorption of the bacteria to suspended particles, which then settle out of the water column. This process could prolong the pathogen survival rate and allow the bacteria to be transported into recreational water (Davies et al. 1995).

2.2.2.2 Decay Rate

The main component in bacterial inactivation in natural water is incident irradiance from sunlight. Bacterial decay is caused by the constant change of this irradiance and is expressed as the time required for the bacterial concentration to decrease by 90% or t_{90} (Kay et al. 2005). The overall first-order decay rate is shown by Equation 1.

Equation 1. First order decay for bacteria.

$$K_B = K_{B1} + K_{BL} + K_{BS} \ K_a$$

where

K_{B1} = death rate as a function of temperature, salinity, and predation

K_{BL} = death rate due to sunlight

K_{BS} = net loss due to settling

K_a = after growth rate (Crysup 2002)

Mortality time or t_{90} is calculated using the Equation 2 (Zoun 2003).

Equation 2. Mortality time.

$$0.10 = \exp(-K_B * t_{90})$$

or

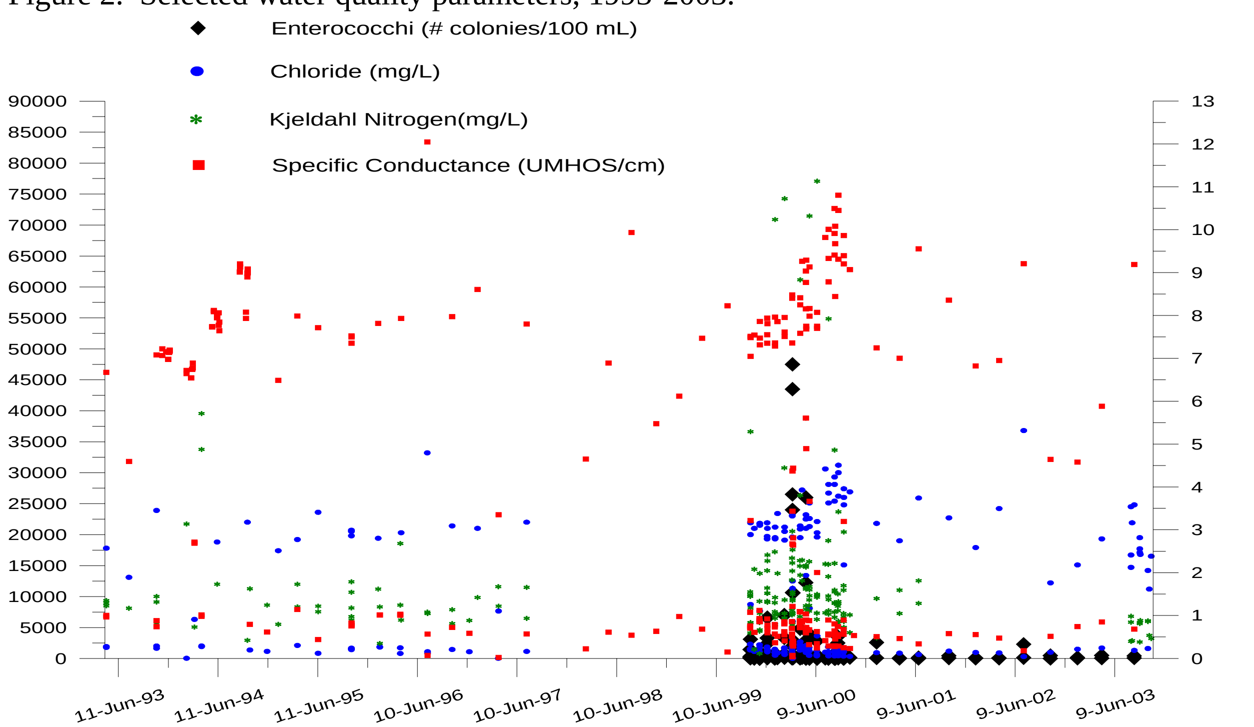
$$t_{90} = \frac{2.3}{K_B}$$

Decay rates and mortality times for *enterococci* have not been established. However, there are established mortality rates for fecal coliform and these rates were used as a proxy for *enterococci*.

2.2.2.3 Water Quality Data

Water quality data has been collected in the Oso Bay hydrologic system for many years and much has been entered into the TCEQ Regulatory Activities and Compliance System (TRACS) Database. The TRACS database contained over 18,000 data values for 197 distinct parameters dating from 21-Oct-1971 to current at various time intervals ranging from hourly measurements to only one analysis in the period of record. Figure 2 shows the variability in frequency of measurement and measured values for the selected parameters over the time period from 1993-2003. This data has been collected under a number of programs and contracts conducted by various agencies, universities, consulting

Figure 2. Selected water quality parameters, 1993-2003.



firms, contractors, municipalities and research groups. Other water quality data were obtained from published reports and theses concerning bacteria concentrations in tidal creeks and estuaries.

2.2.2.4 Additional Data Collection

New field data was acquired under this project to fulfill two requirements. First, a sanitary survey was conducted to provide the study with current information on possible sources of fecal bacteria such as septic systems, waste water treatment plants, areas of livestock concentration (e.g. horse farms, cattle ranches, meat packing plants), and urban runoff outfalls. Second, due to the sparcity of bacteria concentration measurements in Oso Bay/Oso Creek, additional water quality data was collected under an approved Quality Assurance Project Plan (QAPP) to better understand potential loading sources and well as to provide data at more frequent intervals to verify the bacteria loading model.

2.2.2.4.1 Sanitary survey

A sanitary survey was conducted to identify possible sources of bacteria within the watershed. The survey included literature and database searches, historic GIS datasets, and field observations. Literature and database searches produced a list of 10 permitted discharges to Oso Bay and Oso Creek (Table 1) ranging in discharge volumes from 1,500 gallons per day to 540 million gallons per day (MGD). The majority of discharges are from wastewater treatment plants, but the largest volume (540 MGD) is cooling water from the Barney Davis Power Plant which discharges saline water withdrawn from the Laguna Madre, passed through the power plant, its cooling ponds and then discharged into Oso Bay.

The Oso Bay and Oso Creek watershed was first assessed using aerial imagery to examine land use and accessibility for sampling. The Texas A&M University-Corpus Christi Project Managers, the lab Quality Assurance Officer, the Lab Manager and Field Supervisor conducted a field survey on January 7, 2005. Each ambient site was visited and locations along the creek that were accessible by road were noted, and assessed on water access either by wading from the banks or by bridge. Livestock, colonias and any other potential fecal sources were observed, recorded and marked on a map (Figure 3). Geographic coordinates of each potential site were taken by one of the Project Managers (Richard Hay) using a hand held Global Positioning System (GPS) device. A follow-up meeting, using all the collated information, was held to address key issues and rank potential sites.

2.2.2.4.2 *Field data collection*

Field data collection began on 19-May-2005 under an approved Quality Assurance Project Plan (QAPP). Weekly samples were collected at 11 ambient stations on Oso Creek and Oso Bay, and runoff event sampling on significant events at the 11 ambient stations and 11 source assessment sites. Field sites were selected based on the sanitary survey, historic data locations, stakeholder input and consultation with the project manager (Figure 4).

The following sites were identified for source assessment, the choices discussed with the TCEQ Project Manager and presented to the TMDL Stakeholders:

S1 Oso WWTP outfall (addresses potential source and has historical data)
S2 Corpus Christi urban storm water drainage ditch
S3 Robstown urban storm water drainage ditch
S4 Colonia with various livestock and septic systems
S5 Flour Bluff storm water ditch with livestock, primarily horses, grazing close by
S6 Corpus Christi storm water ditch with some nearby livestock
S7 Ditch downstream from Robstown WWTP
S8 Ditch collecting runoff from Elliot landfill
S9 Ditch at Colonia with septic systems
S10 Ditch collecting agriculture field runoff
S11 Creek flowing from Pharos Golf Course into Oso Bay

Permitted Discharger	Permit Number	Permitted Avg. Daily Flow (MGD)
American Electric and Power Barney Davis Power Station (1)	01490-000	540
City of Corpus Christi Oso WWTP (2)	10401-004	16.2
City of Corpus Christi Greenwood WWTP (3)	10401-003	8.0
Texas A&M University CBI La Coss Facility (4)	03656-000	5.04
City of Robstown (5)	10261-001	2.4
Equistar Chemical LP Corpus Christi Plant (6)	02075-003	2.0
Tennessee Pipeline Construction Co. (7)	14228-001	0.06
Corpus Christi Peoples Baptist Church Roloff WWTP (8)	11134-001	0.02
Texas A&M University Agricultural Extension Service (9)	11345-001	0.0015
City of Corpus Christi Storm Water (10)	04200-000	NA

Table 1. NPDES permitted discharges in Oso Creek and Oso Bay.

Figure 3. Location of potential bacteria sources from sanitary survey.

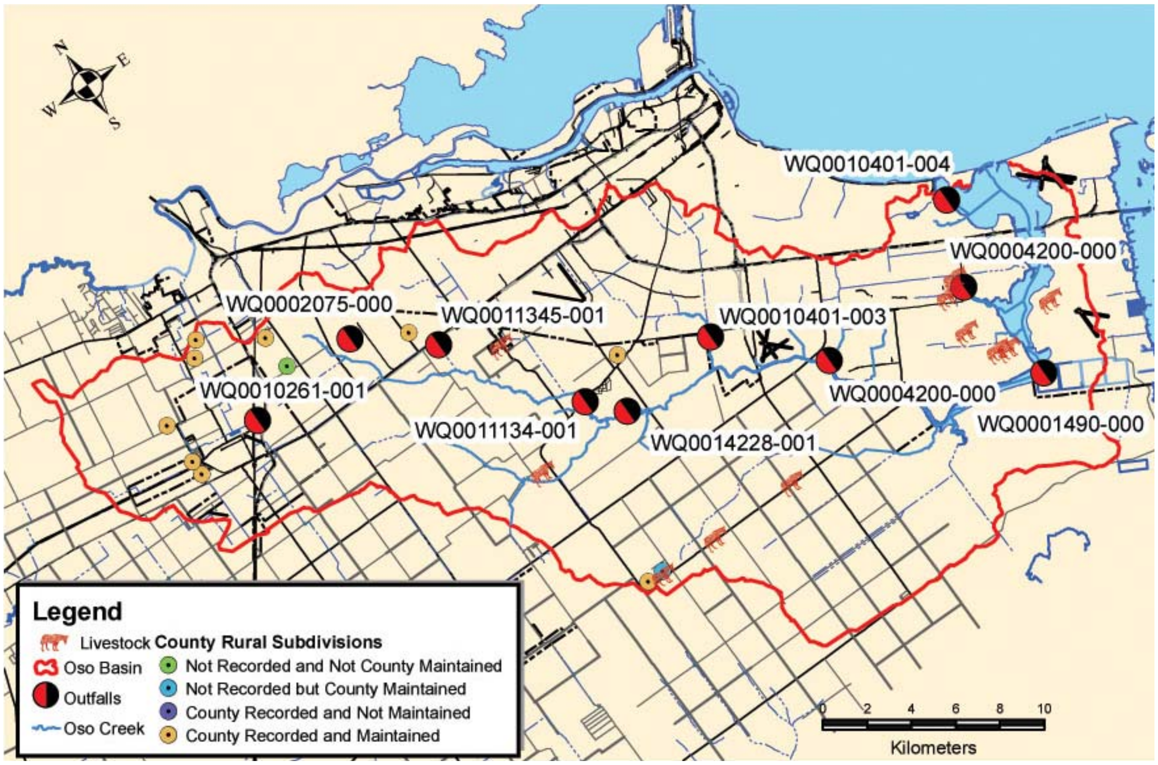
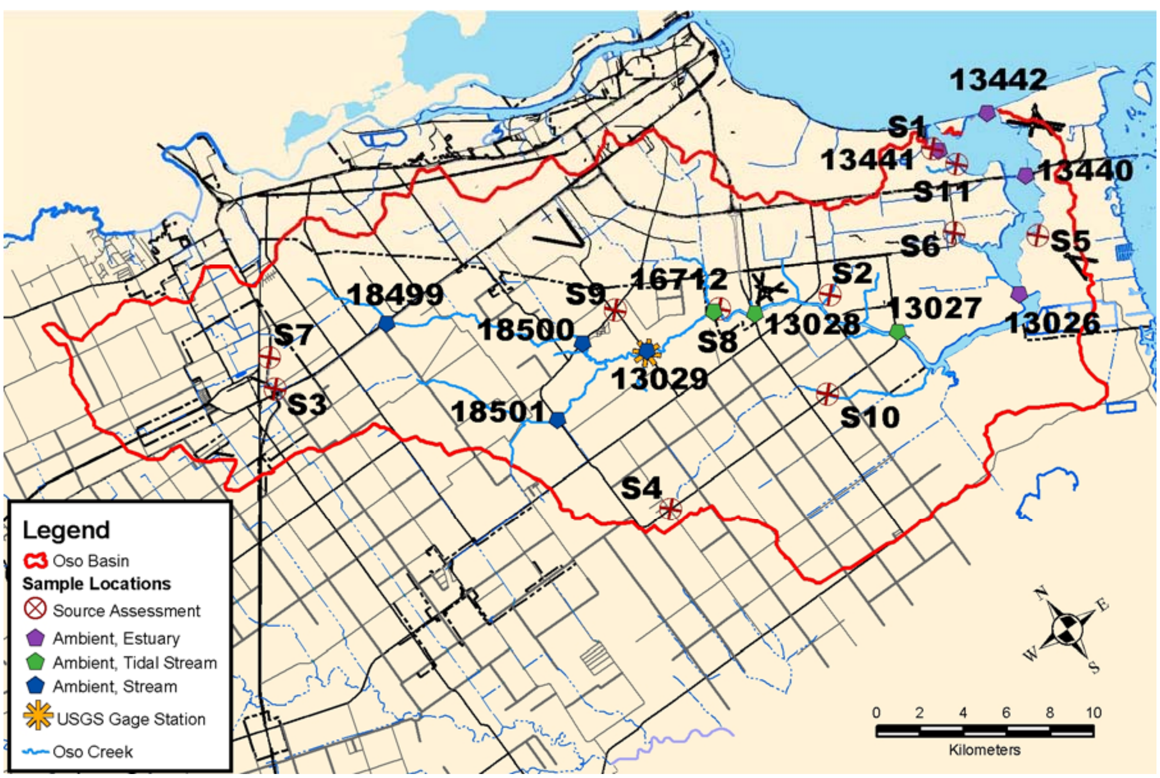


Figure 4. Sampling Locations.



PARAMETER	**UNITS**	**CODE**
Temperature, Water	*degrees centigrade*	*00010*
Temperature, Air	*degrees centigrade*	*00020*
Flow Stream, Instantaneous	*cubic feet per sec*	*00061*
Transparency, Secchi Disc	*meters*	*00078*
Specific Conductance, Field	*uS/cm*	*00094*
Oxygen, Dissolved	*mg/l*	*00300*
Ph	*Standard units*	*00400*
Salinity	*ppt*	*00480*
Flow Severity	*1=no flow, 2=low, 3=normal, 4=flood, 5=high, 6=doppler*	*01351*
Enterococci	*#/100ml*	*31649*
Days Since Precipitation Event	*days*	*72053*
Stream Flow Estimate	*cfs*	*74069*
Rainfall In 1 Day Inclusive Prior To Sample	*inches*	*82553*
Rainfall last 7 Days	*inches*	*82554*
Depth of water	*meters*	*82903*
Wind Direction	*1=N, 2=S, 3=E, 4=W, 5=NE, 6=SE, 7=NW, 8=SW*	*89010*
Flow Method	*1=gage 2=elec 3=mech 4=weir/flu 5=doppler*	*89835*
Maximum Pool Width	*meters*	*89864*
Wind Intensity	*1=calm, 2=slight, 3=mod., 4=strong*	*89965*
Present Weather	*1=clear, 2=ptcldy, 3=cldy, 4=rain*	*89966*
Water Odor	*1=sewage, 2=oil/ chemical, 3=rotten eggs, 4=musky, 5=fishy, 6=none, 7=other*	*89971*
Water Surface	*1=calm, 2=ripple, 3=wave, 4=whitecap*	*89968*
Water Color	*1=brwn 2=red 3=grn 4=blck 5=clr 6=other*	*89969*
Tide Stage	*1=low, 2=falling, 3=slack, 4=rising, 5=high*	*89972*

Table 2. Parameters measured.

Historic sites selected were identified as follows:

13442 Oso Bay at Ocean Drive
13441 Oso Bay at the Hans Suter Park
13440 Oso Bay at South Padre Island Drive
13026 Oso Bay at Yorktown Road

13027 Oso Creek (tidal) at FM 2444
13028 Oso Creek (tidal) at SH 286
16712 Oso Creek (tidal) at La Volla Creek
13029 Oso Creek at FM 763

Additional sites were established on Oso Creek (non-tidal) to evaluate loadings from the upper portions of the basin as follows:

18501 West Oso Creek at FM 665
18500 Oso Creek at FM 665
18499 Oso Creek at SH 44

Each site was sampled and tested for parameters listed in Table 2. All sampling and measurements took place under an approved Oso Creek and Oso Bay Bacteria TMDL Project Quality Assurance Project Plan.

2.3 Data Reduction and Analysis

All data was reduced and analyzed to evaluate processes that may generate bacteria, contribute to flow in the creek, impede or enhance water flow through the Creek/Bay system, or effect the survival of bacteria in this hydrologic system. Much of the data reduction and analysis was performed using the Environmental Systems Research Institute (ESRI) geographic information system (GIS) Arc/Info. Although spatial data was collected in many different geographic projections, it was important to select a common projection for data analysis that gave an accurate representation of area within the study area. Since the area was small, the Texas State Plane South (FIPS zone 4205) North American Datum (NAD) 1983 projection was selected. All spatial datasets have been converted to the Texas State Mapping System (Lambert Conformal Conic) for submittal to the TCEQ. Satellite imagery was analyzed and reduced using sophisticated remote sensing software, Research Systems Inc. Environment for Visualizing Images (ENVI), which also provided the supervised training algorithms for Land Use/Land Cover (LULC) classification.

2.3.1 Hydrologic data

Precipitation for this project was derived from Nexrad Stage III data retrieved from the National Weather Service in XMRG format. This data is structured in hourly interval precipitation accumulation depths using the UTC as the time reference. This data was time shifted to match local time and summed into daily and monthly files using a custom FORTRAN code. This custom code generated an output compatible with the ESRI GIS software Arc/Info ASCII grid format in polar projection. The ASCII grid format was then imported and transposed to the Texas State Plane South projection and subset to an area covering the watershed (Figure 5). Grid spacing for this data is 4762.5 meters. To facilitate grid math operations the precipitation grids were resampled to the grid spacing of other datasets such as the land use/land cover grid or the DEM grid which both have spacings of approximately 30 meters.

A stream network was developed using the reprocessed DEM developed from the USGS NED. The reprocessed DEM was analyzed within the Arc/Info to produce derived grids describing flow direction, flow accumulation, and basin delineation. Pour points were defined by the selected sampling locations so that runoff and loading could be calculated for each area contributing to stream volumes and water quality above the measurement point (sampling location). Oso basin was divided into 14 subbasins (Figure 7) designed to isolate contributing areas at significant sampling points.

Land use/Land cover data generated by the remote sensing software was processed in Arc/Info to make the dataset more manageable by merging small polygons together and classifying areas that are a majority of one class as just one class. Arc/Info functions used were GRIDMAJORITY to better group grid cell clusters, and ELIMINATE to merge small polygons with larger neighboring polygons. Distribution of land use land cover (Table 3 and Figure 8) in Oso basin is dominated by agricultural use, primarily row crops (63%) with another 12% as grasslands and pasture. About 13% of the watershed is occupied by urban development.

The NLCD classification of land use does not correspond directly to the land use categories used in the non-point source runoff studies (Table 4) therefore some adaptation was required. Urban areas in the non-point source studies were identified as industrial, commercial, and transportation, where as the NLCD classifies these area as one group. In this case the EMC values (fecal coliform) for these classifications were averaged together (23,300 cfu/100ml) to represent the NLCD class 23 (transportation, industrial, commercial – see Table 4). The non-point source class rangeland was made up of

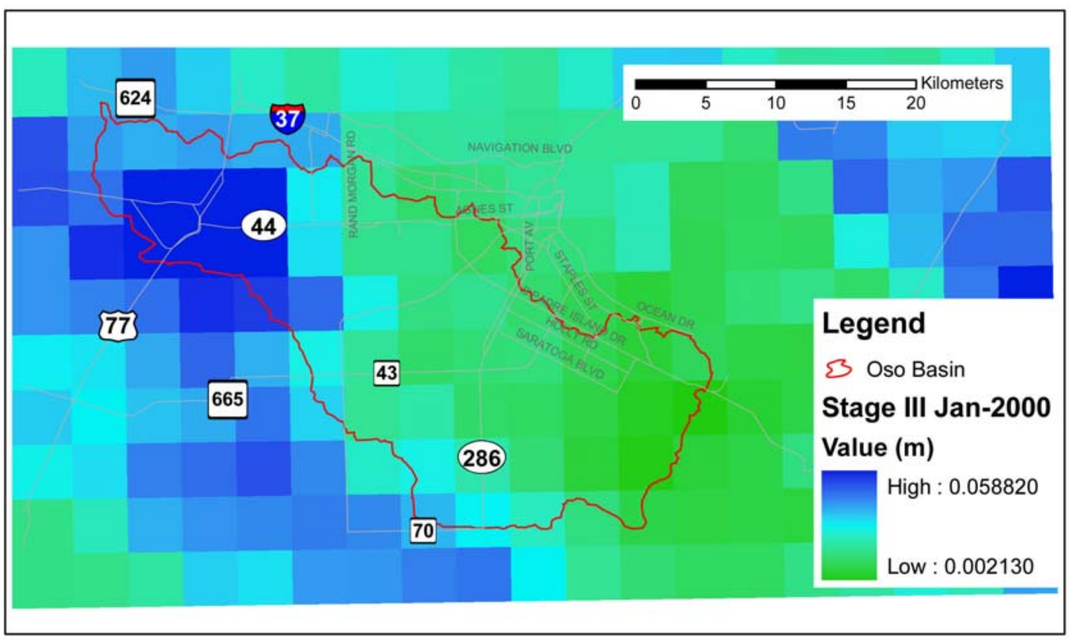
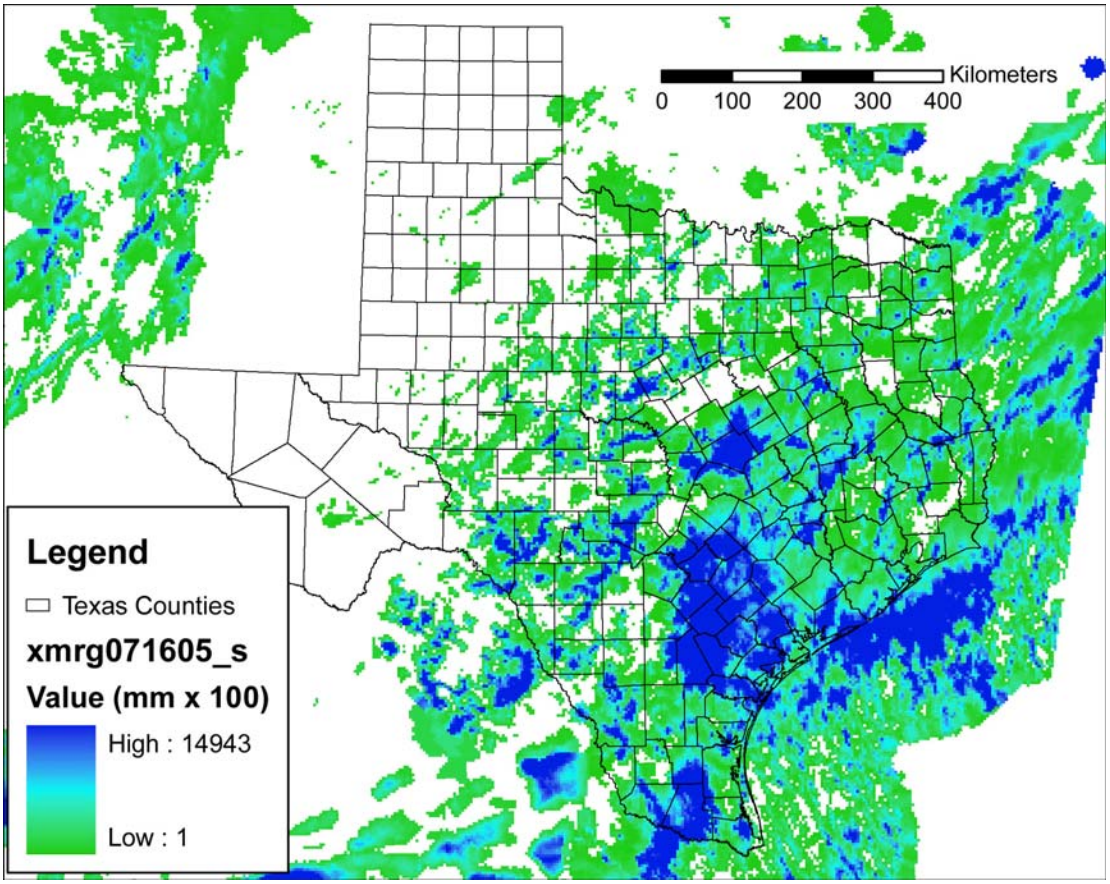


Figure 5. Rainfall distribution based on Nexrad Stage III data using a 4762.5-meter grid spacing over Oso Basin area.

Figure 6. Western Gulf River Forecast Center Nexrad Stage III precipitation for 16-Jul-2005.



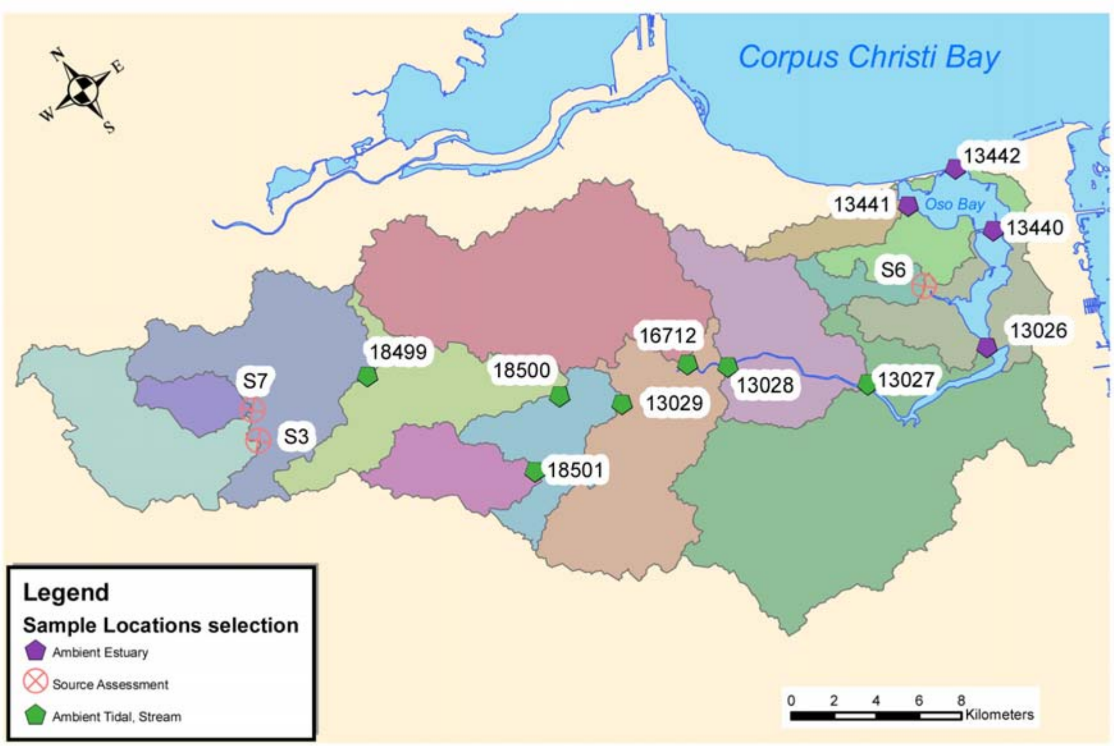


Figure 7. Sub basins with sampling point at outlets (pour points).

NLCD Classifications for Oso Basin

class id	Type	Area (m2)	% of Total
11	Water	12365625	2.03%
21	Low Intensity Residential	11045693	1.81%
22	High Intensity Residential	35128910	5.77%
23	Commercial/Industrial/Transportation	27908531	4.58%
31	Bare Rock/Sand/Clay	12942915	2.13%
32	Quarries/Strip Mines/Gravel Pits	7789829	1.28%
33	Transitional	0	0.00%
41	Deciduous Forest	10150382	1.67%
42	Evergreen Forest	3874244	0.64%
43	Mixed Forest	11596810	1.91%
51	Shrubland	6716444	1.10%
61	Orchards/Vinyards/Others		0.00%
71	Grasslands/Herbaceous	64285045	10.56%
81	Pasture/Hay	8821194	1.45%
82	Row Crops	381741357	62.71%
83	Small Grains		0.00%
84	Fallow		0.00%
85	Urban/Recreational Grass	6654853	1.09%
91	Woody Wetlands	3642858	0.60%
92	Emergent Herbaceous Wetlands	4037207	0.66%
	Total	608701897	100.00%

Table 3. National Land Cover Dataset Classifications in Oso Basin – 2003.

EMC Classifications

EMC Value	Type	NLDC Equivilant	Area (m2)	% of Total
20000	Residential	21,22	46174603	7.59%
6900	Commercial	23	27908531	4.58%
9700	Industrial	23		
53000	Transporation	23		
0	Cropland	82	381741357	62.71%
37	Rangeland	51,71,81,85	86477536	14.21%
0	Not Classified	31,32,41,42,43,91,92,11	66399870	10.91%
		Total	608701897	100.00%

Table 4. EMC values (Baird and Jennings 1995) and their equivalent NLCD code.

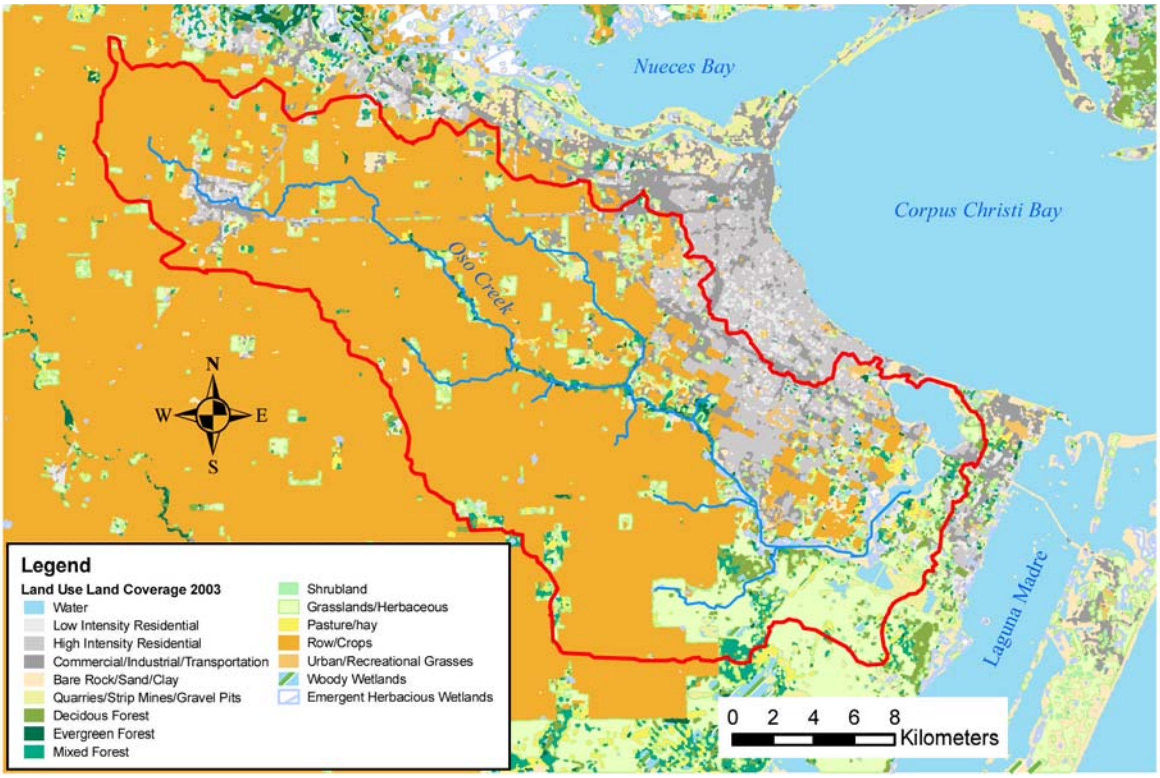


Figure 8. Landuse/Landcover 2003.

shrubland, grasslands, pasture, and urban recreational grasses (NLCD classes 51,71,81,85) using an fecal coliform EMC of 37 cfu/100ml.

Stream flow data for Oso Creek is collected by the USGS at gage station 08211520 located on Oso Creek at FM 763 and archived as average daily stream flow in cubic feet per second (cfs). This data was used to investigate the potential for gain or loss in flow due to ground water flux either to or from the creek and to develop a rainfall-runoff relationship that can be used to predict runoff volumes to the creek based on measured precipitation over the basin. Average daily flow at this station ranged from 0.14 cfs to 6160 cfs with a mean average daily stream flow of 30 cfs. Geometric mean daily stream flow at the station is 3.35 cfs. Peak stream flow for the period of record is 12,100 cfs occurring on 10-Aug-1980.

The relationship between rainfall intensity and stream flow was not as strong as expected for this small basin. A correlation coefficient was calculated between stream flow and precipitation intensity (depth) using flow data from USGS Gage Station 08211520 and Corpus Christi International Airport (Coop ID 412015) precipitation data using lags of +/-10 days. Figure 9 (dashed red line) shows the strength of correlation between the first difference of stream flow and precipitation is greatest at negative one day offset. In other words there is most likely a one day difference between the day of maximum rainfall and the day of maximum stream discharge. However, the strength of correlation is very low at about 0.07 indicating that the timing and magnitude is weakly correlated with rainfall. This could be related to the temporal resolution of the data since the rainfall-runoff response can be measured in hours in a small basin but the data is collected as a daily value. Strong correlation coefficients are generally considered to be those in excess of 0.80 but with the advent of automated data collection and reduced data storage costs, large data sets are now available for these types of evaluations. These large datasets include much more variability over the measurement period, in this case over 11,000 data pairs, and as such, strong correlations can be assumed with coefficient values as low as 0.30. Even with this low correlation coefficient, there is an indication that most of the rainfall-runoff response occurs in the time span of one day with a lag of about one day. This short duration of a runoff event is expected in a small watershed such as the Oso Creek/Oso Bay drainage area. Note that the correlation coefficient for the direct measurement of rainfall and stream flow (blue line in Figure 9) shows a low correlation (negative) over the lag period of –10 to –1 days suggesting discharge over this time period continues with no rainfall input. This can be attributed to the discharge of bank

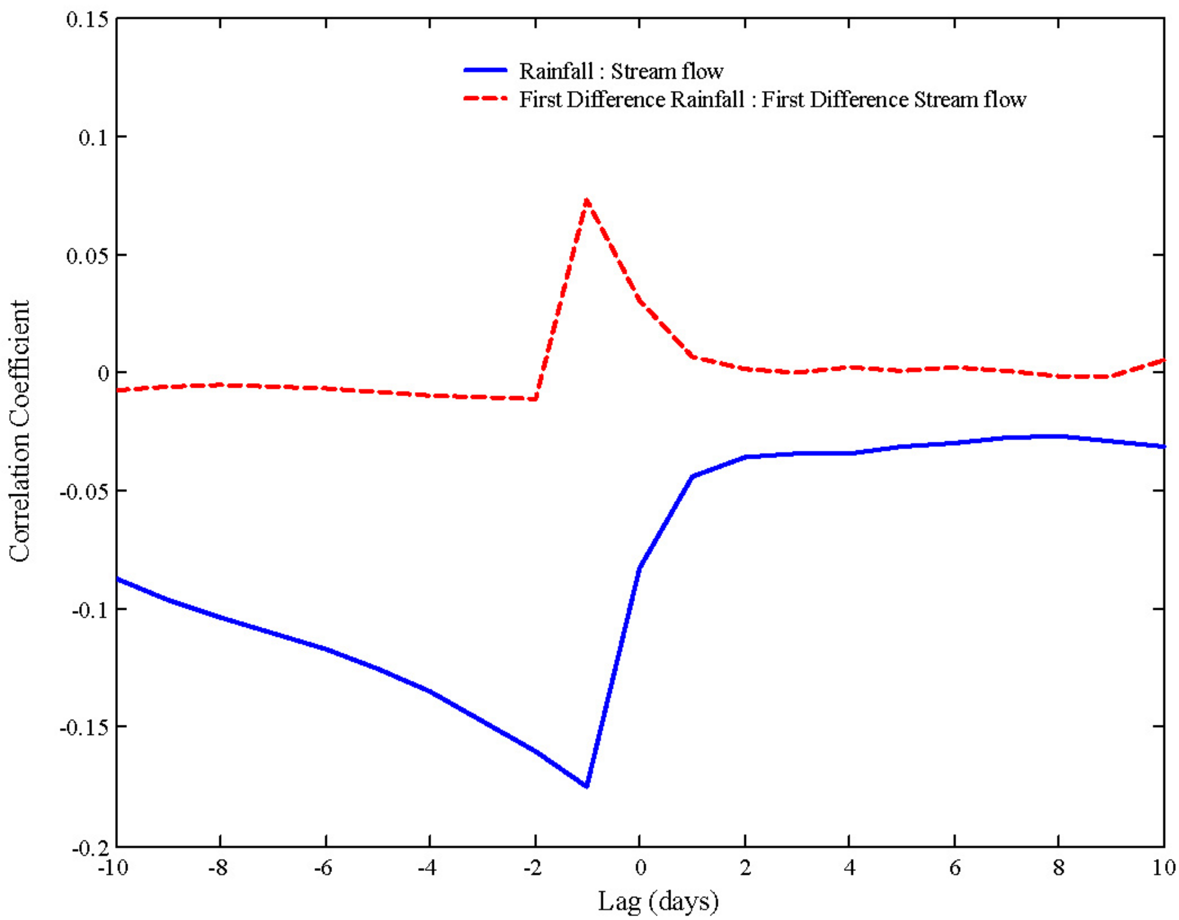


Figure 9. Correlation Coefficient between rainfall and stream flow. Lag (x-axis) ranges from +/- 10 days and strength of correlation (y-axis) range from -0.2 to +0.15.

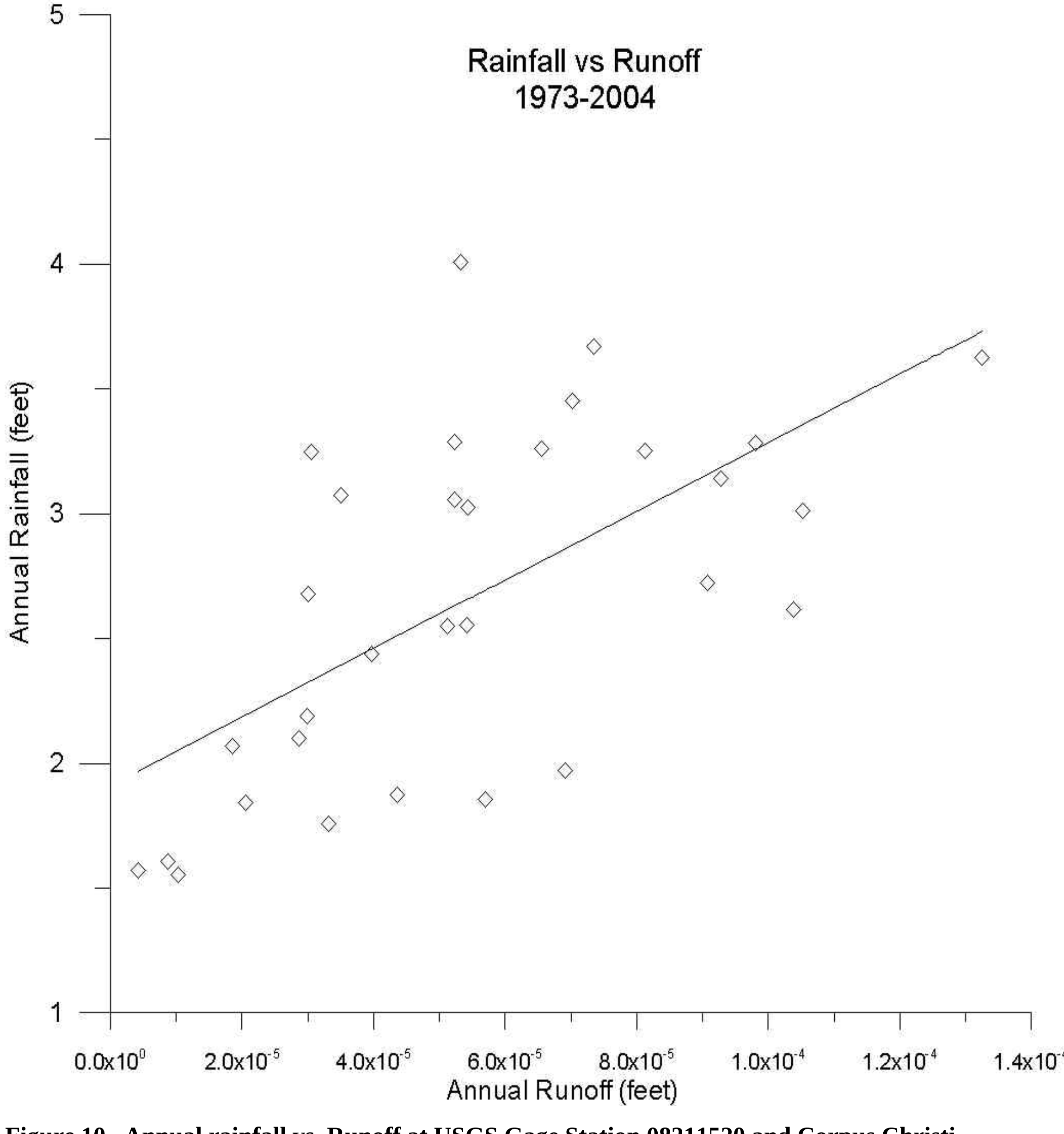


Figure 10. Annual rainfall vs. Runoff at USGS Gage Station 08211520 and Corpus Christi International Airport Rain Gage (412015).

storage and some delayed drainage of croplands.

The annualized rainfall-runoff response (Figure 10) also shows a poorly defined relationship between the two parameters. Since a solid, basin specific, relationship could not be established the Rational Equation (Equation 3) was selected to provide a means of calculating runoff across the basin using precipitation as an input. Further examination of the rainfall-runoff relationship also indicated that significant runoff did not consistently occur with daily rainfall values under 1.5”. Also, distinct relationship between the elapsed time between consecutive rainfalls and runoff intensity was not apparent. Solving the Rational Equation for the runoff coefficient, *C*, (Equation 4) and using only

$$Q = C * I * A$$

where

$Q =$ Peak Runoff Rate

$C =$ Runoff Coefficient

$I =$ Rainfall Intensity

$A =$ Area

Equation 3. The Rational Equation (Fetter 1998).

stream flow and rainfall data where precipitation exceeded 1.5”/day a runoff coefficient (*C*) of 0.0730727 was calculated with a root mean squared error (RMSE) of 47.52.

$$C = \frac{Q}{I * A}$$

where

$Q =$ Peak Runoff Rate

$C =$ Runoff Coefficient

$I =$ Rainfall Intensity

$A =$ Area

Equation 4. Rational Equation solved for *C*.

Small basins with low relief, like the Oso watershed, typically have little net gains or losses of ground water from the water table aquifer. In semiarid to arid environments streams in small basins are generally intermittent in flow and overall losing water from the stream to the water table.

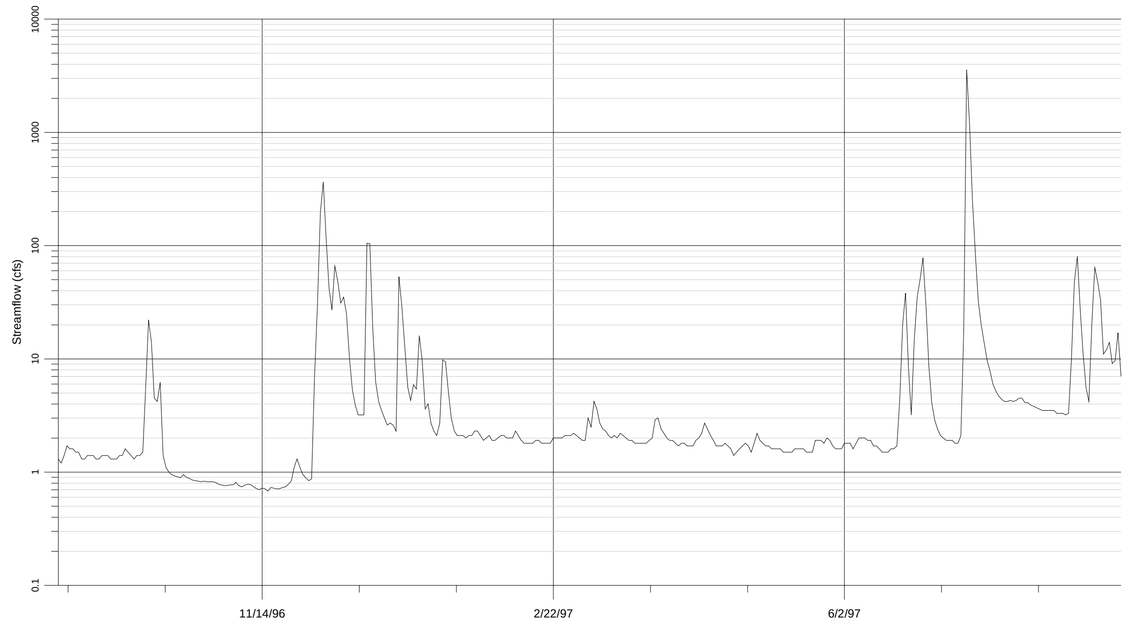


Figure 11. Hydrograph of daily average stream flow on Oso Creek at USGS Gage Station 08211520 from September 1996 to August 1997.

Ground water flux (base flow) to Oso Creek was evaluated using a hydrograph (Figure 11) from USGS Gage Station 08211520 on Oso Creek at FM 763 for the years 1972 through 1999. Calculating an annual base flow recession and then subtracting the previous annual base flow recession from the prior year determined ground water recharge/discharge. The analysis concluded that with average annual rainfall of 31.85 inches per year resulted in a recharge of 0.03 inches per year, for the years 1972 to 1999. While high annual rainfall values resulted in a net increase in flow to Oso Creek, low annual rainfalls resulted in net loss of water from the creek (Table 5). Any contributions to the creek from ground water flux are the result of very short flow path (immediate vicinity of the creek) recharge through infiltration or from bank storage discharge after precipitation events.

Other inflows to Oso Creek and Oso Bay are discharges permitted under the National Pollution Discharge Elimination System (NPDES). Several of these inflows listed in Table 1 contribute the majority of flow to the creek during dry (non-runoff) periods. Inflows from WWTP account for about 19 MGD in the watershed but the discharges at the Greenwood WWTP and the Robstown WWTP provide significant flux to the flow in the upper section of Oso Creek. The Robstown WWTP contributes only about 0.8 MGD (1.24 cfs) to the creek but accounts for most of the measured flow during dry periods (1.5 cfs) at the USGS Gage Station 08211520. Discharge from the Greenwood WWTP adds about 5.6 MGD (8.7 cfs) to the tidal creek segment just downstream of the USGS Gage Station. The most significant discharge to the Oso Creek/Oso Bay system is the cooling water discharge from the Barney Davis Power Generation Plant. The cooling water, which has its source in the Laguna Madre, is discharged at a rate that varies between 250 MGD (390 cfs) to as much as 540 MGD (836 cfs) depending on the power production at

Year	Estimated Recharge (inches)	Rainfall (inches)	Discharge (inches)	% Rainfall as runoff
1974	-0.09	24.81	1.68	6.77%
1975	-0.03	25.19	2.76	10.96%
1976	0.06	39.39	9.24	23.46%
1977	0.03	26.25	2.88	10.97%
1978	0.05	39.14	6.36	16.25%
1979	0.04	39.04	7.8	19.98%
1980	0.008	32.69	8.76	26.80%
1981	-0.05	44.02	0.72	1.64%
1982	-0.03	22.47	4.2	18.69%
1983	0.03	36.91	3.36	9.10%
1984	0.006	22.24	5.52	24.82%
1985	0.07	36.7	5.04	13.73%
1986	0.08	32.15	2.88	8.96%
1987	-0.06	30.66	5.16	16.83%
1988	0.003	19.28	0.84	4.36%
1989	0.06	18.85	0.36	1.91%
1990	-0.07	21.1	3.24	15.36%
1991	-0.05	48.07	5.16	10.73%
1992	0.03	41.42	6.72	16.22%
1993	0.05	37.68	8.88	23.57%
1994	0.06	38.96	3	7.70%
1995	0.02	36.33	5.28	14.53%
1996	-0.09	18.63	0.96	5.15%
1997	0.11	36.16	10.08	27.88%
1998	-0.08	30.61	4.92	16.07%
1999	-0.07	29.27	3.84	13.12%
			Overall Total	**14.45%**

Table 5. Net annual gains and losses from surface water/ground water interaction.

Permit #	WR Issue Date	Owner Name	Amount in Ac-Ft/Yr	Use
4172	1/29/1985	OSO CREEK PROPERTIES LC	645	Irrigation
4172	1/29/1985	OSO CREEK PROPERTIES LC		Recreation
4173	1/29/1985	KINGS CROSSING GOLF & C C	127	Recreation
5031	5/5/1986	ST ANTHONY'S CATHOLIC CHURCH	1	Irrigation
5210	4/17/1989	2-B FARM & RANCH INC	80	Irrigation
5655	6/1/2001	CITY OF CORPUS CHRISTI	67.2	Industrial
5655	6/1/2001	CITY OF CORPUS CHRISTI		Mining
5666	6/29/2001	APEX GOLF PROPERTIES CORPORATION	120	Irrigation
5666	6/29/2001	APEX GOLF PROPERTIES CORPORATION	130	Irrigation
5666	6/29/2001	APEX GOLF PROPERTIES CORPORATION		Recreation

Table 6. Water Rights Permits in Oso Creek.

the plant. This influx of water has a significant effect on water quality as it passes through this tidal segment into Oso Bay.

There are several permitted diversions of water from Oso Creek for various uses including irrigation, industrial, mining, and recreational (Table 1). Annual permitted withdrawal total 1170 acre-feet (1 MGD) or about 1.6 cfs loss from the creek if withdrawals are distributed evenly throughout the year (Table 6). Withdrawal of water from the creek is not expected to have a significant impact on bacteria loading in the creek since bacteria will be removed at an equal rate as the permitted water rights.

2.3.2 Water Quality Data

Historic water quality data was used to help understand how the various chemical and other water column components respond in relation to *enterococcus* bacteria. Water quality parameters were reviewed for completeness of record and frequency of measure. Those parameters that met both standards were compared to *enterococcus* concentrations using a cross correlation matrix. These components included water temperature, dissolved oxygen, conductivity, pH, alkalinity, salinity, ammonia-nitrogen, phosphate, organic carbon, chlorides, fecal coliform, E. coli, phosphorous, days since last precipitation, last day rainfall, and last 7 days rainfall.

Correlation coefficients for the non-tidal station 13029 (Figure 12) located on Oso Creek at FM 763 indicate moderately strong correlations (>0.60) with prior rainfall (one day and seven days previous rainfall) as well as fair correlations (0.4-0.5) with other bacteria indicators (E. coli and fecal coliform). Fair correlations (negative) were found with alkalinity, conductivity and salinity. These correlations indicate that the influx of fresh water (runoff from precipitation) correlates well with increases in bacteria concentrations and decreases in some components indicative of dilution like salinity and conductivity. Correlations with other parameters that may be associated with fecal bacteria, like nutrients, were found to be very low.

In the tidal creek area (see Figure 13, Station 13026), located on Oso Creek at Yorktown Road and just downstream of the cooling water discharge from the Barney Davis Power Plant, strong correlations can be seen between *enterococci* and other bacteria indicators. Also correlation coefficients are strong at this station with nutrients. Strong negative correlations are seen with dilution indicators like salinity, chlorides, and conductivity, even though there is a large discharge of saline water from the Barney Davis Power Plant (Table 1) just upstream of this station.

The bay segment of this system (Figure 14, Station 13400), located on Oso Bay at South Padre Island Drive, shows weak correlations between *enterococci* and most other components. Although correlation with other bacteria indicators was evident, these correlations were only moderate.

From this data it is evident that water quality parameters are not as strongly driven by runoff (the force behind non-point source pollutions) in the Bay segments of the Oso hydrologic system. However the tidal section of Oso Creek does seem to be driven by runoff events as indicated by the strong correlations coefficients, even though there is a large influx of saline water from the Barney Davis Power Plant. Upstream in the non-tidal creek the influence of runoff is evident in the correlations between enterococcus and other parameters although it does not show as strong a correlation at the Oso Creek tidal section. These results suggest that: the large resident volumes of water in Oso Bay moderate the effects of runoff from adjacent catchments; the tidal creek segment is receiving significant non-point source input probably from urban drainage to the creek; and the non-tidal creek is not receiving as high a non-point source loading as the tidal area since it is mostly dedicated to row crop agriculture

2.4 Bacteria sources

2.4.1 Point Sources

Point source loading of bacteria to Oso Creek/Oso Bay occurs at three wastewater treatment plants, one in Robstown, and two in Corpus Christi. These sources consist of daily, regulated discharges, although some unauthorized discharges may occur during storm or maintenance events. Self-reporting data (Beaber 2005) indicate that fecal coliform concentrations range from 0 to 800 cfu/100ml with a mean value of 10.5 and a geometric mean of 3.53. The only other large, permitted discharge along the creek or bay is cooling water from the Barney Davis Power Station which is water pumped from the

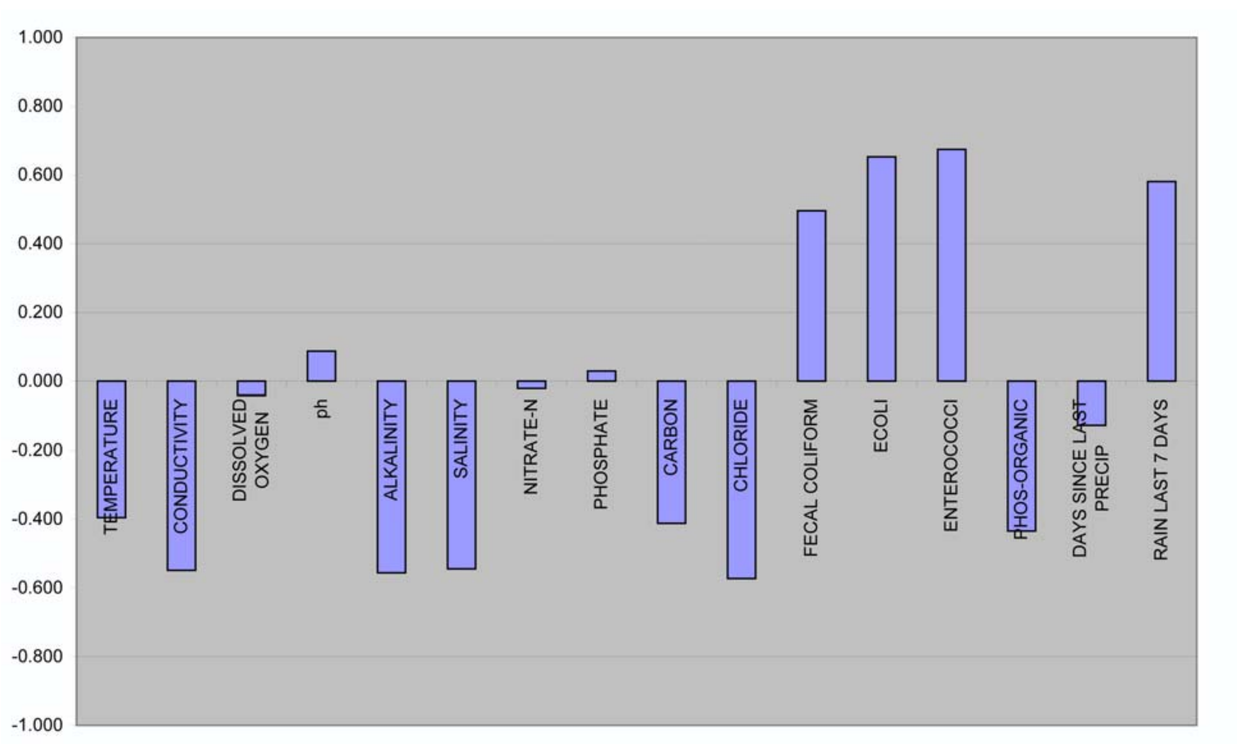


Figure 12. Cross correlation coefficients of parameters with enterococcus concentrations at station 13029 (Oso Creek at FM 763).

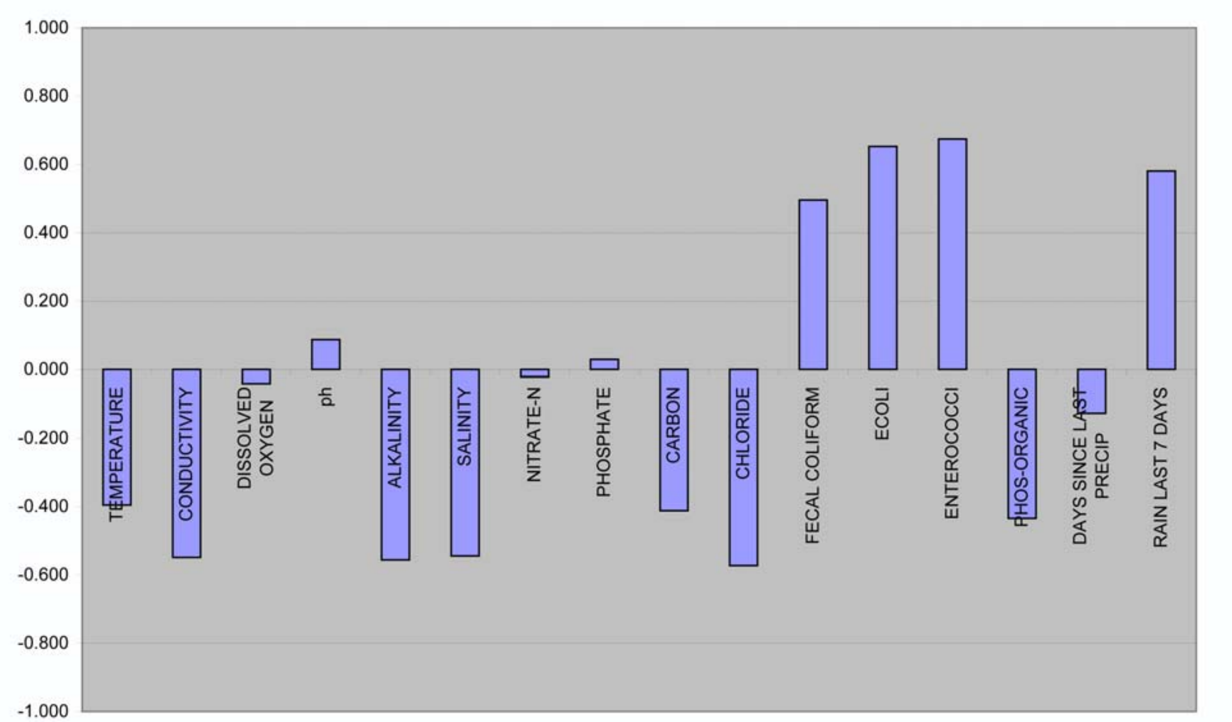


Figure 13. Cross correlation coefficients of parameters with enterococcus concentrations at station 13026 (Oso Bay at Yorktown).

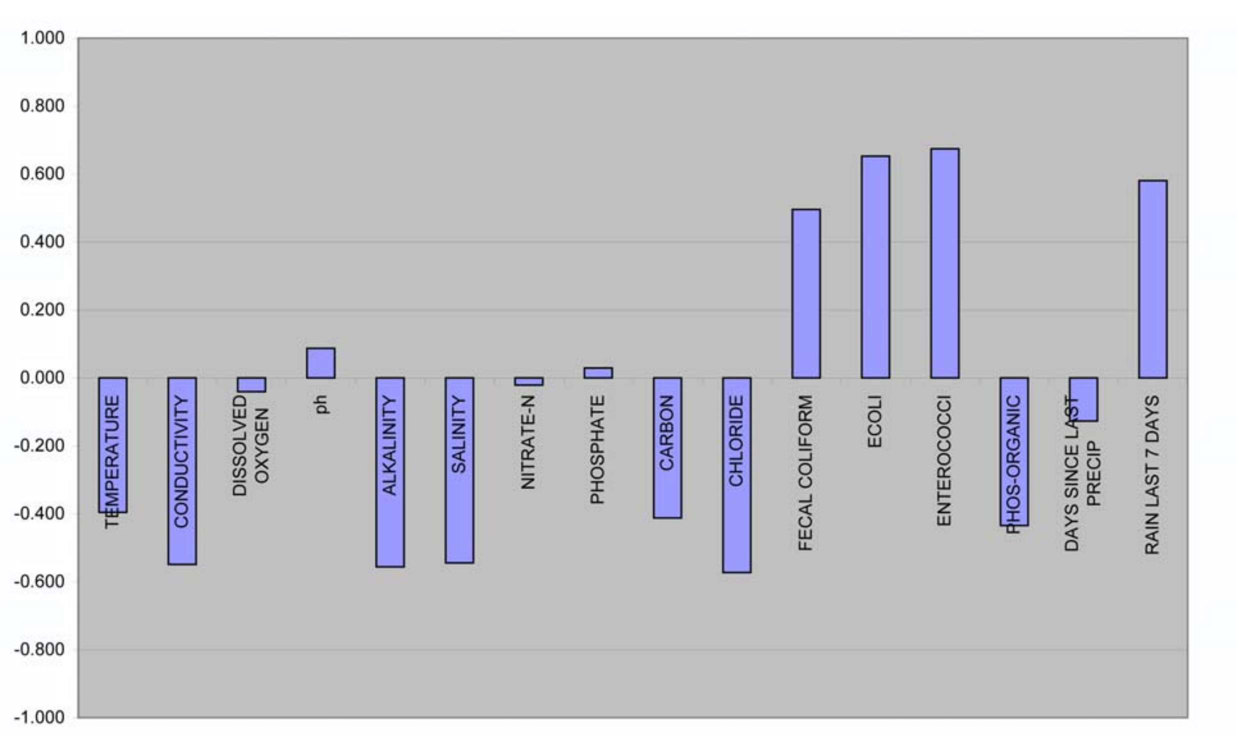


Figure 14. Cross correlation coefficients of parameters with enterococcus concentrations at station 13440 (Oso Bay at South Padre Island Drive).

Laguna Madre through the power station heat exchangers and then discharged through cooling ponds to Oso Bay.

The maximum daily average discharge for the point sources along Oso Creek are as follows: Robstown WWTP – 3.0 MGD; Greenwood WWTP – 8.0 MGD; Barney Davis cooling plant – 540 MGD; and Oso WWTP – 16.2 MGD.

2.4.2 Non-Point Sources

Urban non-point source (NPS) pollution is generated from storm water runoff, which contains dissolved and suspended solids, bacteria, metals, oil and grease, nutrients, oxygen demanding substances, and pesticides. Urban runoff produces a higher volume of water than in rural areas for the same amount of rain because a large extent of the area consists of impenetrable surfaces like parking lots, roads, and other forms of urbanization. Also, drainage systems cause loads to reach receiving waters faster and in a more concentrated state than with natural drainage. Major NPS sources are vehicles, fertilizers and pesticides, animal wastes, construction, and erosion (Baird and Jennings 1996).

According to the Texas State Soil and Water Conservation Board, agriculture NPS pollution consists of nutrients, pesticides, organic matter, and animal wastes. Storm water runoff is also a main source in creating and transporting these loadings to receiving waters. Main areas of concern are animal concentrations, such as dairies, poultry operations and feedlots (Baird and Jennings 1996).

2.5 Model Development

2.5.1 Conceptual Model

Water quality at a discrete point in a watershed is the result of all processes that have

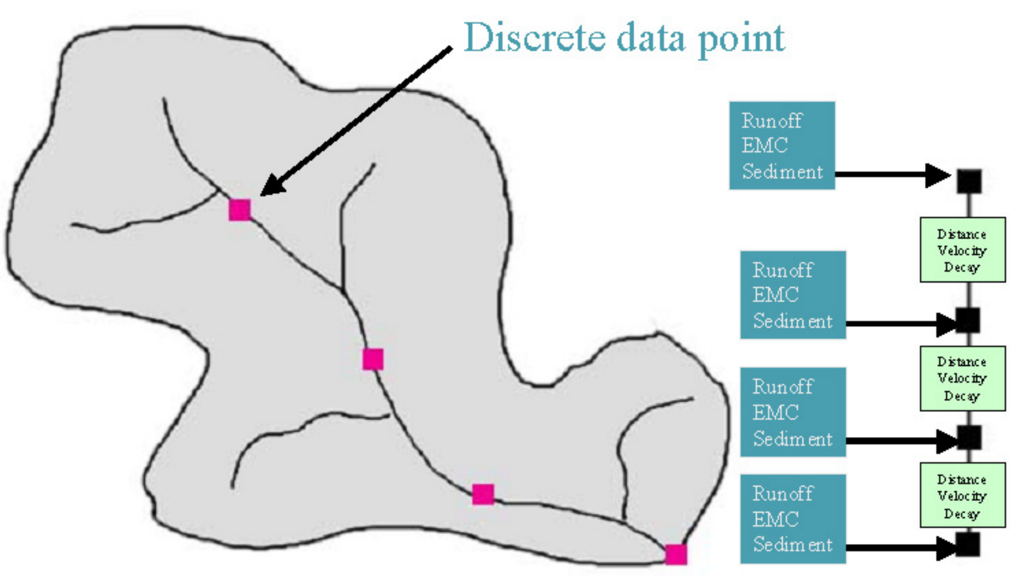


Figure 15. Conceptual model showing sampling points as discrete data points, and runoff and channel flow processes.

occurred upstream of that particular point (Figure 15). Major processes include runoff from precipitation and point source discharges along the stream channel. Other processes influencing water quality can include the effects of wildlife in and around the stream channel, ground water flux to the stream, aerial deposition directly to the stream surface, and accidental or deliberate human actions like pollutant spills. Once the pollutant is in the stream channel, other processes occur. These processes include dilution, decay (die off), sequestration (sedimentation), chemical recombination, uptake or predation by living organisms and in the case of bacteria the potential for growth or temporary inactivation.

A basic conceptual model of bacteria moving through a watershed would begin with the accumulation of non-point source bacteria concentrations in a volume of runoff above a discrete sampling point (data point), placing the accumulated bacteria and runoff volumes into the stream channel along with any point source (WWTP) bacteria concentrations and water volumes that may enter the stream along that segment and allowing the bacteria to die off at a specified decay rate until it reaches the next discrete sampling point (data point). At this next discrete sampling point (data point) all of the runoff and point source water volumes and bacteria from the intervening sub basin are added to the water volumes and decayed bacteria loads passed down from the upstream channel. This process continues until the bacteria load and water volumes reach the last (furthest downstream) station.

2.5.2 Conversion of conceptual model to numerical model

The bacteria loads from each sub-basin drain to certain ambient monitoring stations along impaired segments of the Oso Creek. Using ArcInfo Workstation subwatersheds were delineated for each ambient monitoring station and some targeted stations using a DEM of Oso Watershed. Daily and monthly precipitation data for the region were converted into grid format, and runoff grids are produced using a mathematical relationship formulated between rainfall and runoff (Equation 3). Based on the land uses of the region, land-use coverage was converted into an EMC grid, which assigns bacteria concentrations generated from runoff to corresponding land uses (Table 4). Finally, the runoff grids are multiplied by the EMC grid to produce the bacteria loadings for the watershed on a daily and monthly basis (Zoun 2003).

Sampling sites consist of eleven ambient and ten targeted stations within the watershed. Out of these twenty-one stations, fourteen are pour points for subwatersheds. The loads from each of these areas drain into the Oso Creek and are used as the starting bacteria loads for the respective station. The initial input into the model is the sum of the bacteria loads due to runoff from the three sub-basins in the uppermost northern portion of the watershed, which drains to station 18499, the first ambient non-tidal station along the creek. To find the *enterococci* load at the next downstream station, the initial bacteria load is decayed over the amount of time it takes for the water to flow from station 18499 to nest downstream station (18500). This decayed value is then added to the amount of bacteria that has entered this segment due to runoff between the two stations. This process is continued until the stream reaches the last station (13442), which flows into Corpus Christi Bay. This strategy was applied to the monthly and the daily model.

2.5.3 Application of input data to Numerical Model

2.5.3.1 Watershed Delineation

Oso Watershed was divided into fourteen sub-basins. This was accomplished through the use of a flow direction grid, which determines the flow across the surface in the steepest down slope direction. The flow direction grid was created from a DEM that had most of the sinks removed. Each monitoring station and its coordinate point were used in conjunction with the flow direction grid to delineate a specific subwatershed. Once this was completed, each of the sub-basins was combined and joined to create one coverage and grid of Oso Watershed.

2.5.3.2 Geodatabase

An empty geodatabase was generated with feature class labels, such as Watershed, HydroEdge, HydroJunction, and MonitoringPoint. Each feature class was populated with the aid of a file titled ArcHydroFrameworkSchema by using the Schema wizard in ArcCatalog. It allowed a basic geodatabase to be created. The watershed delineation of the basin was imported into the Watershed feature class. The HydroEdge class contained the shape file of the Oso Creek, and HydroJunction contained the points of interest on the stream, such as the sampling sites, which are also imported into the MonitoringPoint feature class. The HydroJunctions were snapped to the creek. Once the feature classes were populated, general relationships were formed between the HydroJunctions, monitoring points, and watershed. Next, additional feature classes for the precipitation station of interest, outfalls, and time series were included in the geodatabase. As a result, further relationships were built between the time series tables, monitoring points, outfalls, and precipitation stations.

A continuous stream network was created from the Oso Creek and Bay shape file. The ArcMap Editor Toolbar provided the ability to fill in any gaps. A continuous network was used to create a geometric network within ArcCatalog.

2.5.3.3 ArcHydro

The HydroNetwork was created using HydroEdges (creek shape file) and HydroJunctions (created from the creek shape file). Once the hydro network was established, certain functions were performed on the attributes of the shape files. Unique identification numbers called HydroIDs were assigned to all the shape files stored in the geodatabase. This tool was located in the ApUtilities drop down menu. Then, the length from a hydro junction to the outlet of the hydro network was calculated using the ‘Calculate Length Downstream for Junctions’ function in the Attribute Tools menu. This function can only be used if a hydro network has been created. The value calculated was stored in the LengthDown field. Next, from the Attribute Tools menu, the HydroID from the next downstream junction was located and stored in the NextDown field of the junction feature. This is another function that can only be used with a hydro network. The last function used was Store Area Outlets. This located the outlet junctions for a selected set of areas and assigned the HydroID of the junction to the JunctionID field in the corresponding area feature class.

2.5.4 Time Series

Two time series tables were created and stored in the geodatabase. They contained precipitation, stream flow, bacteria (*enterococci*), WWTP discharges, and unauthorized discharges. All the data entered onto a spreadsheet in Excel. The feature ID was the same as the HydroID of the shape file pertaining to the time series data. The tables were converted to text files, and then imported into the geodatabase. The time series was added to ArcMap by using the Tracking Analyst toolbar. The specified shape file and time series table were linked by HydroID and Feature ID.

2.5.4.1 Wastewater Treatment Plants (WWTP) Discharges

Concentrations of *enterococci* were back calculated from the predicted loads to make for easier comparisons between the model results and the historic data. The loads predicted at each station were divided by the total volume of water flowing through the main channel to calculate concentration in a particular segment. For both the monthly and daily models, treated water from the Robstown WWTP was introduced at the first non-tidal station, 18499. The combination of water from the WWTP and the water from the creek were included in the initial channel volume calculated for the model. As the water flows along the creek, water from the Greenwood WWTP is discharged and runs through station 16712. Therefore, monthly and daily discharges were included in the main channel volume calculated for this station. The largest discharge (540 MGD) came from the American Electric and Power Barney Davis Power Station and was included in the main channel volume at station 13026. The last discharge input came from the Oso WWTP.

2.5.4.2 Rainfall – Runoff Relationship

No strong relationship between runoff and precipitation was apparent when runoff was plotted as a function of precipitation (Figure 10). The data points were scattered. As a result, the rainfall – runoff relationship was computed using the Rational Method (Equation 3), which is used to predict peak runoff rates with data of rain intensity and knowledge of the land use categories within the basin.

Historic data consisted of precipitation and rainfall for the region ranging from years 1972 through 2004. The only unknown for the rational equation is the runoff coefficient. Rain and stream flow corresponding to precipitation events that yielded more than 1.5 inches of rain were used in calculating C. Then, the average for these runoff coefficients were calculated and used to generate the runoff grids. The runoff coefficient calculated was 0.073072722.

2.5.4.3 Event Mean Concentration (EMC)

The event mean concentration (EMC) is the total constituent load due to a runoff event for a particular land use divided by the runoff volume for the event. It compares loads between storms for different land uses. The EMC for a rain event is determined by flow-weight averaging concentrations in discrete samples collected over the entire runoff event. The non-point source load may vary due to land use, storm intensity or duration. It may even vary during the event itself. As a result, a single sample may not be representative of the rain event. An EMC is best used to determine average concentrations (Baird and Jennings 1996). Loads are determined using Equation 5.

Equation 5. Bacteria load from runoff.

$$\text{Load} = \text{Runoff volume} * \text{EMC}$$

2.5.4.4 Runoff Grids

The hourly Nexrad Stage III grids were summed to produce daily rainfall grids. Then, daily precipitation was summed for each month during the study period of October 1999 through September 2000 and used to generate monthly precipitation grids. Using ArcGrid, runoff grids were generated using the Rational Equation. Starting with October 1999, each precipitation grid was multiplied by the calculated runoff coefficient and the area of the grid cell size to produce monthly runoff volume throughout the watershed.

Daily runoff grids from the Nexrad Stage III data were used directly in the daily model to create daily runoff grids in ArcGrid using the Rational Equation. Grids were created for the study period of October 1, 1999 through September 30, 2000.

2.5.4.5 Load Grids

The product of the monthly runoff grid and EMC grid produced a load grid for each subwatershed for each month of the study period. Information tables of total loads for each subwatershed for each month were generated using the ZONAL STATISTICS tool in ArcInfo. The function uses the DEM for the entire area, the load grid for each month, and the SUM function to provide the total number of bacteria in each sub-basin (zone) for the each month. The average runoff concentrations of *enterococci* for each subwatershed can be computed from Equation 6.

For each month, at each subwatershed, the initial bacteria load is the sum of the bacteria contained in the runoff. The decaying process begins once the bacteria channel flow. The decayed load at each monitoring station was calculated using Equation 7.

Equation 6. Runoff concentration from loading grid.

$$\text{Concentration (cfu/100 ml)} = [\text{Bacteria Load (cfu)} / \text{Runoff volume } (m^3)] * 10000.$$

Equation 7. Decayed bacteria load.

$$
\begin{aligned}
\mathrm{L} &= \mathrm{Lo} * \exp(-\mathrm{K_B} * \mathrm{t}) \\
&\text{where} \\
L &= \text{decayed load} \\
L_o &= \text{initial load from watershed} \\
K_B &= \text{overall first order decay rate} \\
t &= \text{travel time}
\end{aligned}
$$

For the non-tidal stream stations, time was calculated by dividing the distance between each station by the flow velocity of the stream (Equation 8). Velocity was measured during field sampling activities.

Equation 8. Stream velocity.

$$
\begin{aligned}
V &= \frac{Q}{A} \\
&\text{where} \\
V &= \text{velocity (m/s)} \\
Q &= \text{flow (cubic meters per second)} \\
A &= \text{area of cross section (m).}
\end{aligned}
$$

Travel time for the tidal stations of Oso Creek was estimated using residence times. Residence time is the amount of time taken to completely replace the water in the reservoir. Residence times were calculated for these segments because flow velocities in tidal segments are dependant on the slope of the water surface rather than the slope of the streambed (Equation 9). Five segments were generated based on the upstream and downstream bounding stations: 16712-13028; 13028-13027; 13027-13026; 13026-13440; 13440-13442. Each segment between stations was treated as a bottled reservoir. To calculate residence times, the volumes for the segments were estimated using ArcInfo. Polygons were drawn for each segment from digital orthorectified quarter quadrangle (DOQQ) imagery. The areas were determined for the polygons and used to estimate the volumes (Equation 10).

Equation 9. Residence time.

$$
\begin{aligned}
t_R &= \frac{V_S}{I_t} \\
&\text{where} \\
t_R &= \text{Residence time} \\
V_S &= \text{Volume of segment} \\
I_t &= \text{inflow (due to all sources)}
\end{aligned}
$$

Equation 10. Volume of tidal stream segments.

$$V_S = A_p * \frac{1}{2} D_{MAX}$$

where

V_S = Volume of the tidal stream segment

A_P = Surface area of tidal stream segement

D_{MAX} = maximum depth of each polygon from Adams (2005)

Inflow due to all other sources includes water from upstream, runoff, and wastewater treatment plants (Zoun 2003). Wastewater inputs were Robstown WWTP, Greenwood WWTP, and Barney Davis power plant. These inputs were broken into monthly and daily values.

The same process described above was applied to the daily model with a few exceptions. Instead of using monthly runoff grids, the daily runoff grids were used. Therefore, daily load grids were created. The sum of the total *enterococci* load for each subwatershed for the day was generated using the ZONAL STATISTICS tool in ArcInfo by using a daily load grid. Once the initial bacteria inputs for the model were established, the decay process began. However, instead of looking at the decay process over one time step, the daily model looked at the decaying bacteria over twelve time steps per day. In other words, the model depicted the decaying of the bacteria every two hours throughout each day in the study period. The velocities used for the first four non-tidal stations were calculated using Manning Equation (Equation 11). Daily discharges for the wastewater treatment plants were calculated for inputs into the daily model for residence times and the main channel volume.

2.6 Model Calibration

The selection of a model calibration period was dictated by data availability. The model was calibrated against *enterococci* concentration data collected at 8 locations along Oso Creek/Oso Bay over a one-year period (October 1999 through September 2000) by Crysup (2002). Water samples were collected during the study by Crysup (20002) for 12 (monthly) dry events and 7 wet weather events and enumerated for *E. coli*, fecal

Equation 11. Mannings Equation (Sanders 1998)

$$V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

where

V = stream velocity

R = hydraulic radius

S = energy gradient

n = Mannings roughness coefficient

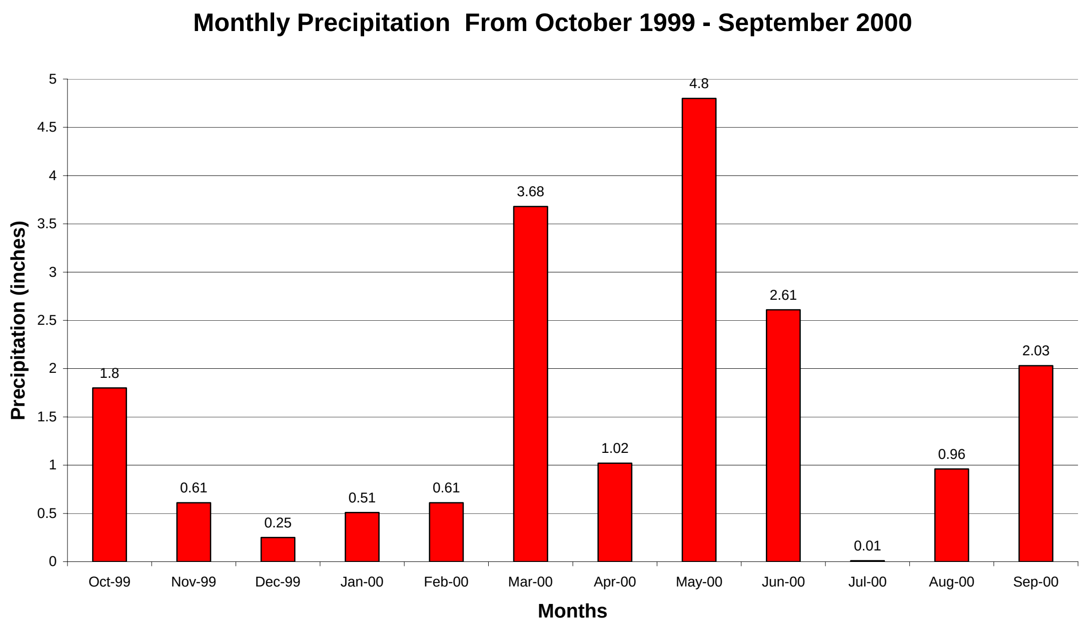


Figure 16. Monthly precipitation depths at Corpus Christi International Airport for the calibration period October 1999 through September 2000.

coliform, and *enterococci* bacteria. This provided 96 dry weather event targets and 56 wet weather event targets for the calibration period. Only one station, 13029 (see Figure 4), was located in a non-tidal reach where flows were recorded by a USGS stream gage station (Figure 11). Monthly precipitation depths at Corpus Christi International Airport (Coop-Id 412015) over the calibration period varied from 0.01" (0.25mm) in July 2000 to 4.0" (101.6mm) in May 2000 (Figure 16).

Initial modeling runs were made with monthly time steps. Bacteria loading calculated by the model for each station was converted to bacteria concentration by substituting segment volume for runoff volume in Equation 6. These results where then compared to

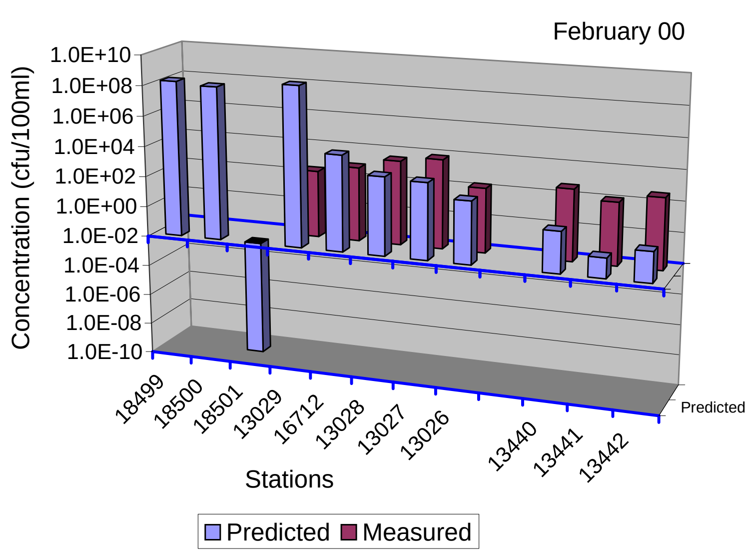


Figure 17. Results of preliminary model run for February 2000.

measured concentrations at each monitoring station. It was noted from early run results that the model over predicted bacteria concentrations in the non-tidal stream and under predicted bacteria concentrations in the bay segments (Figure 17). Since the model was based on land use EMC of fecal coliform bacteria, a new set of land use EMC values for *enterococci* were estimated based on data collected during a runoff event in June 2005.

2.6.1 *Enterococci* EMC Grid

On June 1, 2005 a rain event occurred. This initiated a wet-weather sampling schedule at specific targeted locations (Figure 4). Water samples were collected daily from 06/01/2005-06/03/2005. Sampling location S6 is located near an outlet of a small urban watershed (Figure 7) that contains residential, commercial, industrial, transportation, and rangeland uses (Figure 8). This gave the researchers enough data to approximate EMC values for *enterococc*i on most land uses in the Oso watershed. Equation 12 was used to calculate the total *enterococci* EMC value for the S6 watershed during this rain event. Since this sub basin has many different land uses, the ratio between fecal coliform EMC values and different land use area was used to determine specific contributing land use *enterococci* EMC values from the overall EMC for the sub basin.

Equation 12. Calculation of Event Mean Concentration (Lee et al. 2002).

$$EMC_T = \frac{\Sigma\left[\mathrm{C_t} Q_t \Delta t\right]}{\Sigma\left[Q_t \Delta t\right]}$$

where

$$EMC_T = \text{Total } enterococci \text{ EMC of runoff}$$

$$t = \text{time variable concentration (cfu/100ml)}$$

$$Q_t = \text{time variable flow } (\mathrm{m}^3/\mathrm{day})$$

$$\Delta t = \text{discrete time interval}$$

The *enterococci* EMC values (Table 7) were used to make an *enterococci* EMC grid. This was substituted for the fecal coliform EMC grids that had been used as a proxy for *enterococci*. Although this methodology, along with the timing of the sampling event has some bias toward lower values (concentrations), the *enterococci* EMC values were higher than the fecal coliform values for similar land use. The bacteria loads in each

EMC Classifications

EMC Value	Type	NLCD Equivalent	Area (m2)	% of Total
41320	Residential	21,22	46174603	7.59%
47900	Commercial	23	27908531	4.58%
	Industrial	23		
	Transporation	23		
0	Cropland	82	381741357	62.71%
76	Rangeland	51,71,81,85	86477536	14.21%
0	Not Classified	31,32,41,42,43,91,92,11	66399870	10.91%
		Total	608701897	100.00%

Table 7. Approximated EMC values (cfu/100ml) for *enterococci* based on runoff data collected at source assessment station S6.

subwatershed were re-summed, producing new decayed loads at each station along the creek.

2.6.2 Flow Velocities

The original velocities calculated using Equation 8 were not indicative of the overall stream flow in the non-tidal segments leading to the over estimate of bacteria concentrations at these stations. To correct this, the velocity for these stations was calculated using the Manning Equation (Equation 11) instead of Equation 8. The slope of the water surface was calculated by using the elevations at the beginning of the creek and the end of the bay. Areas used to calculate R (hydraulic radius) were obtained from areas of cross sections measured while collecting flow at the four non-tidal ambient stations. An average of the areas for each station was calculated. Wetted perimeter was calculated using widths and depths of cross sections designated for sampling flow. Average width and depth were used in the Manning Equation. Finally, a best fitting roughness coefficient (n) of 0.045 was chosen from a table of values (Sanders 1998).

2.6.3 Avian Loadings in the Bay

Avian populations can have a significant effect on water quality (Levesque et al. 2000) and may be responsible for the higher than predicted concentrations in the bay segments of the model. Ring-billed gull (Larus delawarensis) populations of as few as 100 individuals can increase fecal coliform concentrations of the adjacent waters to about 5,000 cfu/100ml at a depth of 0.3m (Levesque et al. 1993). The concentration of fecal coliform bacteria in bird feces varies somewhat with the species (Table 8).

Daily loading of bacteria to Oso Bay can be calculated using observations of bird populations, excrement weights, and bacteria concentrations in the excrement. Bird populations were observed once a week in the vicinity of monitoring station 13441 (lower Oso Bay) from October 1, 1999 to September 30, 2000. Reported bird populations ranged from 202 to 2462 individuals and averaged 238 laughing gulls (*Larus*

Table 8. Fecal Coliform concentrations in avian feces.

Common Name	Average Fecal Coliform Concentration (cfu/g)	Species	Source
Ring-billed Gull	3.68E+08	*Larus delawarensis*	Alderisio and DeLuca 1999
Canada Goose	1.53E+04	*Branta canadensis*	Alderisio and DeLuca 1999
Herring Gull	1.77E+09	*Larus argentatus*	Gould and Fletcher 1978
Lesser black-backed gull	5.00E+09	*Larus fuscus*	Gould and Fletcher 1978
Common gull	6.50-E+08	*Larus canus*	Gould and Fletcher 1978
Black-headed gull	3.03E+08	*Larus ridbundus*	Gould and Fletcher 1978
Ring-billed gull	2.10E+08	*Larus delawarensis*	Levesque et al. 2000
Ring-billed gull	7.68E+06*	*Larus delawarensis*	Levesque et al. 1993
Duck	3.30E+07	Unspecified	Geldreich 1966

* Sample weighted average from three collection dates.

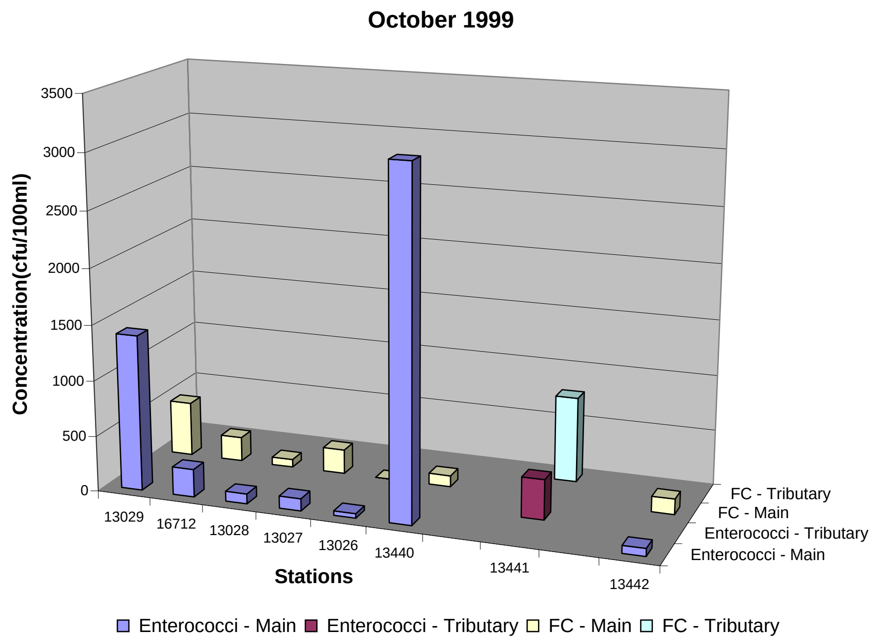


Figure 18. Fecal coliform and enterococci concentrations for October 1999.

atricilla) and 325 other bird species (Harding 2004). Although daily excrement weight and fecal coliform concentrations for laughing gulls were not found in a literature search, a mean body mass of a laughing gull, 325g, reported by Dunning (1993) is similar to the body mass of the common gull tested by Gould and Fletcher (1978) which had a body mass of 310g. The daily weight of excrement and bacteria concentration for a common gull was measured as 11.8g (Gould and Fletcher 1978) and $6.50\text{x}10^8$cfu/g (Gould and Fletcher 1978). Not all excrement enters the water, and Marion et al. (1994) estimated that only 1/3 of the herring gull droppings actually entered the water.

Adding avian loading to the model inputs only slightly improved the bay segments, with exception of station 13441. This could indicate that avian loading is a significant source in the Blind Oso where station 13441 is located and bay circulation is limited but not a major contributor in the open areas of Oso Bay.

2.6.4 Natural variability in the data.

Initial calibration of the model used fecal coliform EMC values as proxies for *enterococci* EMC values. Examination of the target data where both *enterococci* and fecal coliforms were enumerated reveals a certain amount of variability between bacteria concentrations in two samples collected at the same time (Figure 18). Although each sample was tested for different indicator bacteria, both *enterococci* and fecal coliform are indicators of fecal matter in the water column and should have comparable values.

To further explore this variability, results from split samples enumerated for *enterococci* collected in this study were compared. All samples were collected and analyzed under an approved quality assurance project plan and met all criteria specified in the plan. A plot of the difference between the absolute value of the $\log_{10}$ of the split sample concentrations against the $\log_{10}$ of the lower sample concentration shows that results from two tests of water collected at the same time and the same place can differ in value of up to 0.8 log (Figure 19). It can also be seen that this difference is independent of sample concentration and so is probably related to two phenomena. Differences observed between samples of low concentrations are probably due to constraints in the method of analysis, where as differences observed in the higher concentrations are due to a natural variability in the occurrence of bacteria in two samples.

2.7 Sensitivity Analysis

A sensitivity analysis was performed on the monthly and daily models. This analysis is performed to gain a better understanding of the dynamics of each model by varying parameters in the calibrated model and observing the effect on the model results. The greater the effect on model results, the more sensitive the model is to a particular parameter.

Parameters modified for the monthly model included velocity, residence time, volume of the bottled segments, runoff, EMC values, and the overall first order decay rate. These parameters were individually increased and decreased by 1, 5, 10, 20, 30, and 50 %, the model run, and the resulting change in calculated bacteria load noted.

Parameters modified for the daily model were volume of the bottled segments, runoff, total bacteria loading for each subwatershed, and the decay rate. These were increased and decreased by 1, 5, 10, and 50%. All modifications were done in Matlab using a script written to facilitate and shorten calculation times. The sensitivity analysis was conducted over the calibration period (October 1, 1999 through September 30, 2000).

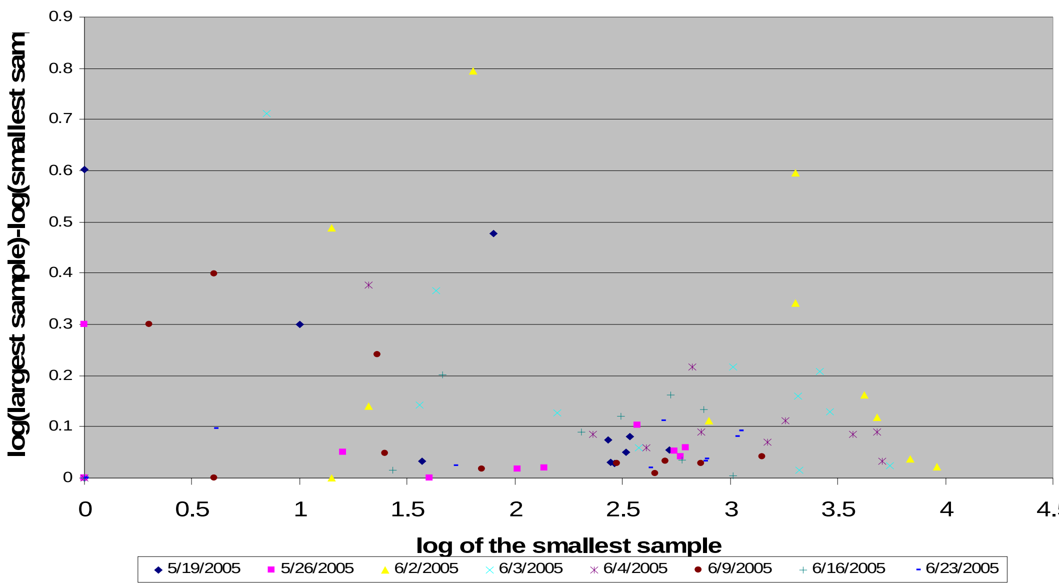


Figure 19. Observed concentration differences in split samples (maximum of 0.8 log).

Graphs for the daily sensitivity analysis were created to exhibit the annual loading changes due to the specified parameter value changes for each station. These were compared to the daily model's predicted annual loadings.

2.7.1 Monthly Model Sensitivity to Velocity

Changing stream velocity influenced results only at the non-tidal stations since tidal segments use residence time to describe water movement through the segment. Stations 18500 and 13029 were most sensitive to changes in velocity. Increasing the stream velocity increased the loading and decreasing the velocity decreased the loading in a stream segment. This is because velocity is a parameter used to determine how long the decay rate is applied, so a fast stream has less bacteria decay time than a slow stream. In October 1999, November 1999, February 2000, and March 2000, changes in velocity showed slight sensitivity at stations 16712 and 13028, which are the next two stations downstream from the non-tidal reach. This trend was exhibited for all the months tested during the sensitivity analysis. However, in July 2000, there was distinct change in load at station 16712 as the velocity increased and decreased by the designated percentage.

2.7.2 Monthly Model Sensitivity to Residence Times

Altering residence times influenced results in the tidal creek reach, with the most significant changes noted at stations 13028 and 13026. In July, station 16712 showed some reaction to changes in residence times, but the differences in loads were very small. There were slight changes in the loads for the bay segments, but these changes were not significant, as the greatest difference was about 1 CFU. Changes in the loads of the other stations resulted in minor differences.

2.7.3 Monthly Model Sensitivity to Channel Volumes

Adjusting the volumes of the segments used to calculate residence times had similar results on the predicted loads as changing the residence times. Loads did change dramatically, with stations 13028 and 13026 being most were the most affected. The bay segments were most affected in July 2000 because that was an extremely dry month and there was hardly any runoff. Overall, the model was not very sensitive to the volumes calculated for each of the tidal segment from 16712 through 13442 in the bay.

2.7.4 Monthly Model Sensitivity to Bacteria Loading (Runoff and EMC)

The model proved to be most sensitive to changes in the bacteria load from the runoff and EMC grids (Figure 21). The model predictions increased or decreased at each station for every month as the bacteria loading was varied. Changing these two parameters caused significant changes because they are the key items in calculating loads (Equation 5). The model showed little sensitivity to changes in runoff volume alone (Figure 20). However, for July, the driest month of 2000, there was very little rainfall, which produced very little runoff. As a result, the bacteria loads decreased in the bay segments.

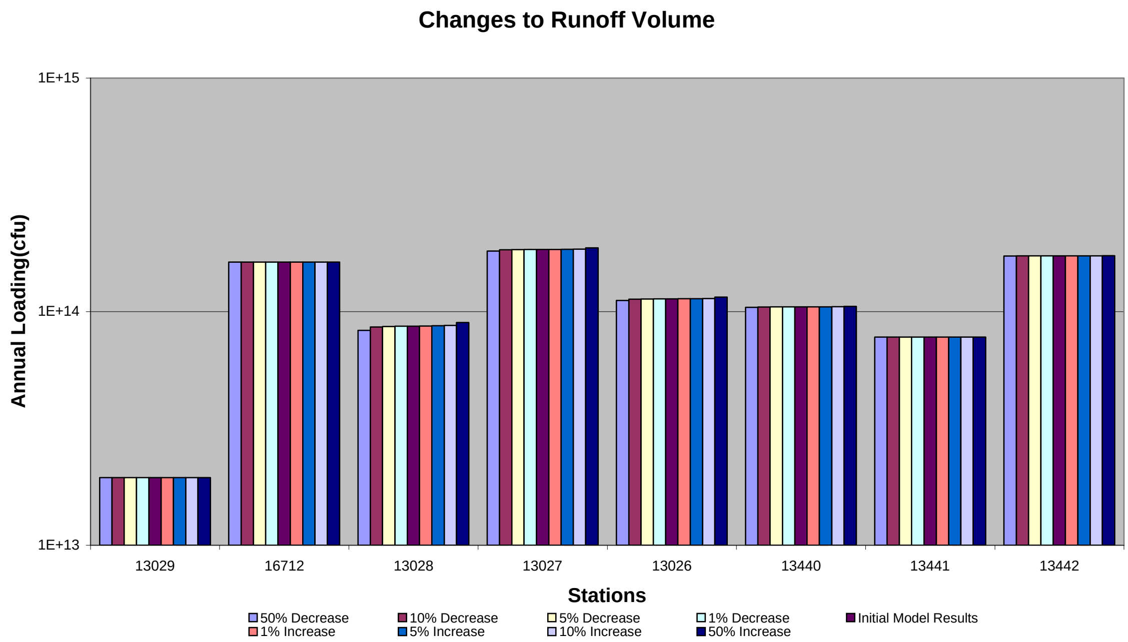


Figure 20. Monthly model sensitivity to runoff volume.

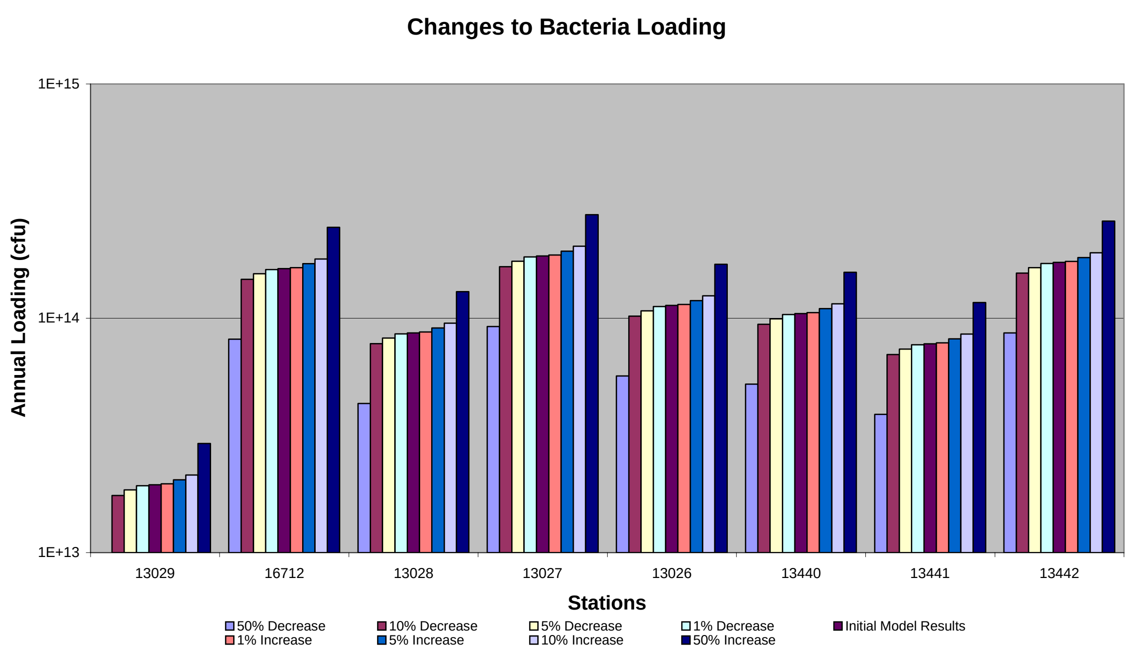


Figure 21. Monthly model sensitivity to bacteria loading.

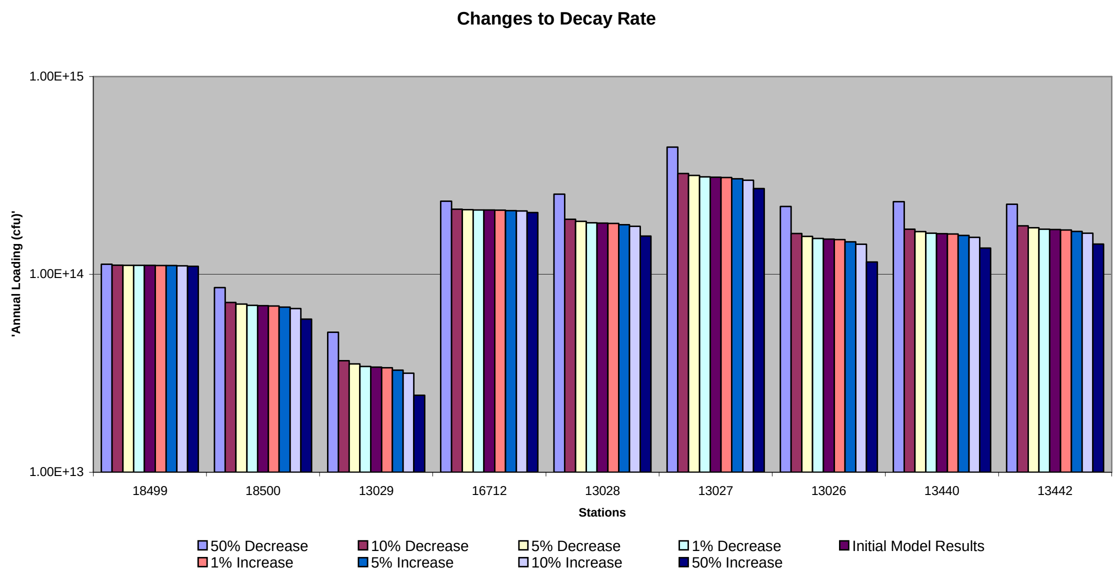


Figure 22. Monthly model sensitivity to decay rate.

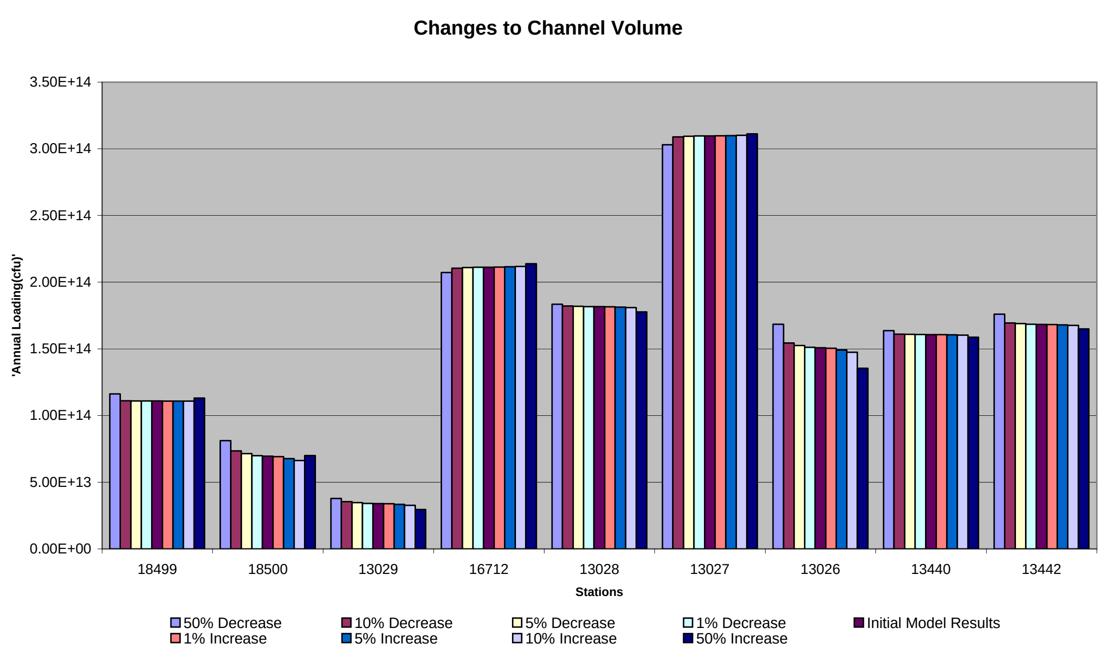


Figure 23. Daily model sensitivity analysis for channel volumes

2.7.5 Monthly Model Sensitivity to Decay Rate

The last parameter to be altered was the decay rate or the die-off rate of the bacteria. Increasing the decay rate caused the loads to decay faster; whereas, decreasing the decay rate made the bacteria die off much slower. Not every station was affected by the changes. The most sensitive stations to changes in decay rate were 18500 and 13029 in the non-tidal segments and stations 13028 and 13026 in the tidal segments (Figure 22). The bay segments showed little sensitivity to the decay rate.

2.7.6 Daily Model Sensitivity to Changes in Volumes

Overall, the model was not very sensitive to ± 1, 5, 10% changes in the channel volumes (Figure 23). The exceptions were non-tidal stations 18500 and 13029, and tidal station 13026. As the channel volume increased, the non-tidal stations showed a slight decrease in the annual loadings, whereas the decrease for station 13026 was more pronounced. Increasing the channel volume by 50% caused the bacteria loads to increase for stations 18499, 18500, 16712, and 13027 and decrease in the bay and at stations 13029 and 13028. Decreasing the channel volume by 50% produced the higher bacteria loads, relative to the other volume modifications, at all the non-tidal stations (18499-13029) and all the bay stations (13026-13442). The mid-tidal stations showed lower loads for a 50% decrease.

2.7.7 Daily Model Sensitivity to Changes in Runoff

The non-tidal stations were the least sensitive to any changes in runoff volume (Figure 24). The mid-tidal stations (16712-13027) were not greatly affected as well. However, 16712 and 13027 demonstrated a slight decrease in annual bacteria loadings, whereas 13028 exhibited the opposite reaction. The bacteria loadings increased as runoff volumes increased. Overall, the bay stations were the most sensitive to runoff changes. In general, the bacteria loads increased as these volumes increased.

2.7.8 Daily Model Sensitivity to Changes in Total Bacteria Loadings

The daily model was the most sensitive to changes in total load for each subwatershed within Oso watershed

Figure 26). The general pattern was that the bacteria loads increased as the total bacteria loads for the subwatersheds increased. Adjusting the total loads by ± 50% produced the most drastic changes.

2.7.9 Daily Model Sensitivity to Changes in Decay Rate

Decay rate proved to be the second most sensitive parameter in the model. Each station along the creek showed a general decrease in annual bacteria loads as the decay rate increased. However, station 18499, did not have much of a reaction to changing the decay rate. The bacteria loads at this station were unaffected (Figure 25)

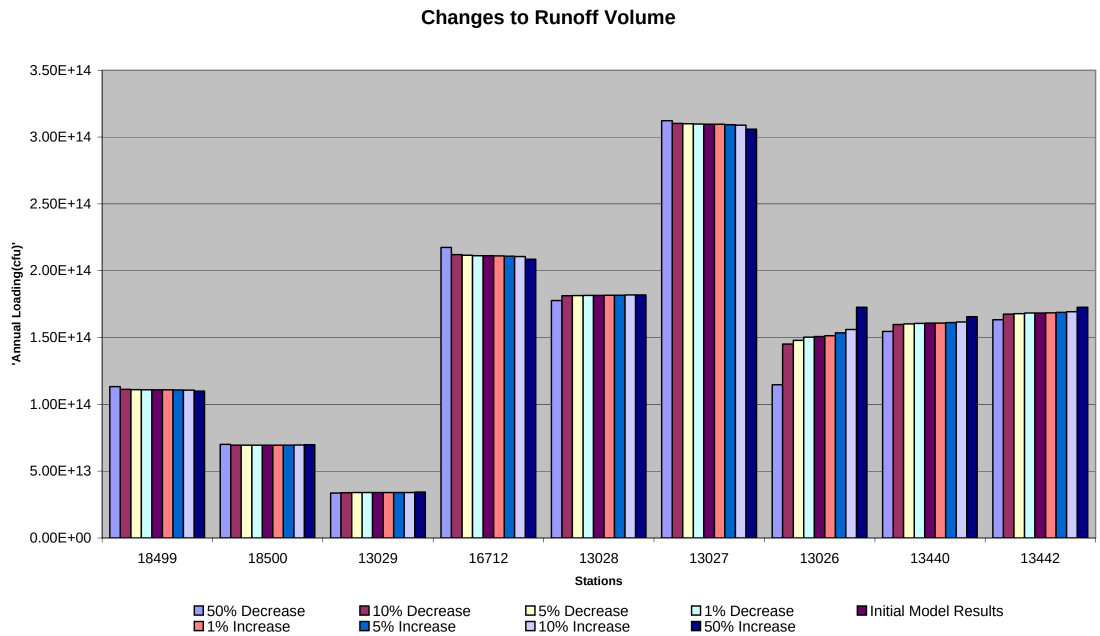


Figure 24. Daily model sensitivity analysis for runoff volumes.

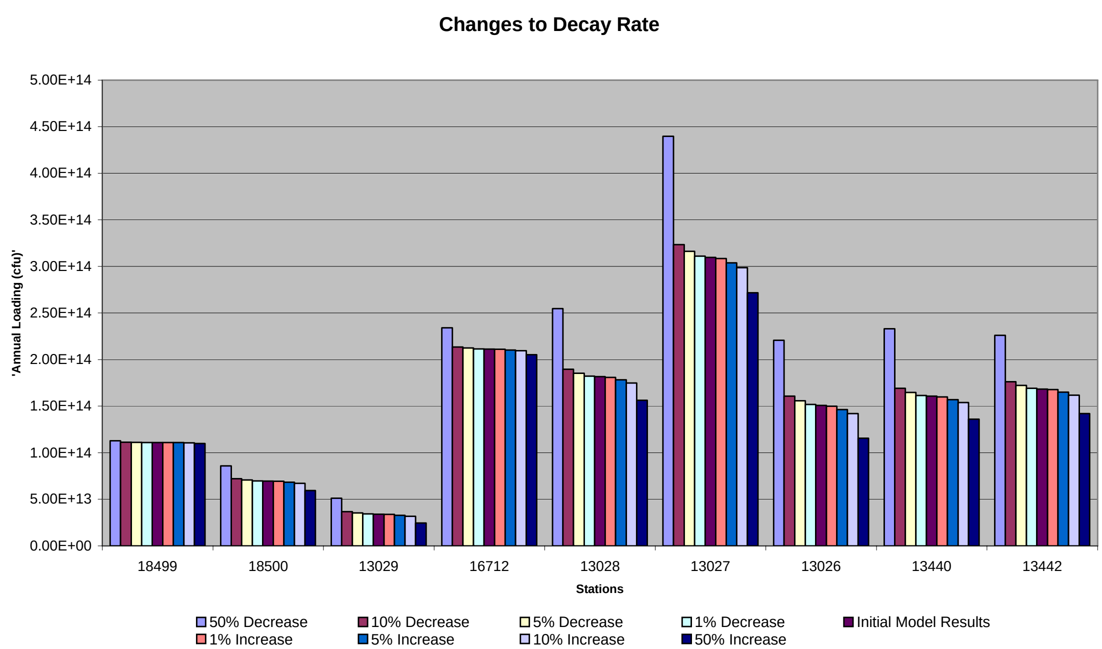


Figure 25. Daily model sensitivity analysis for decay rate

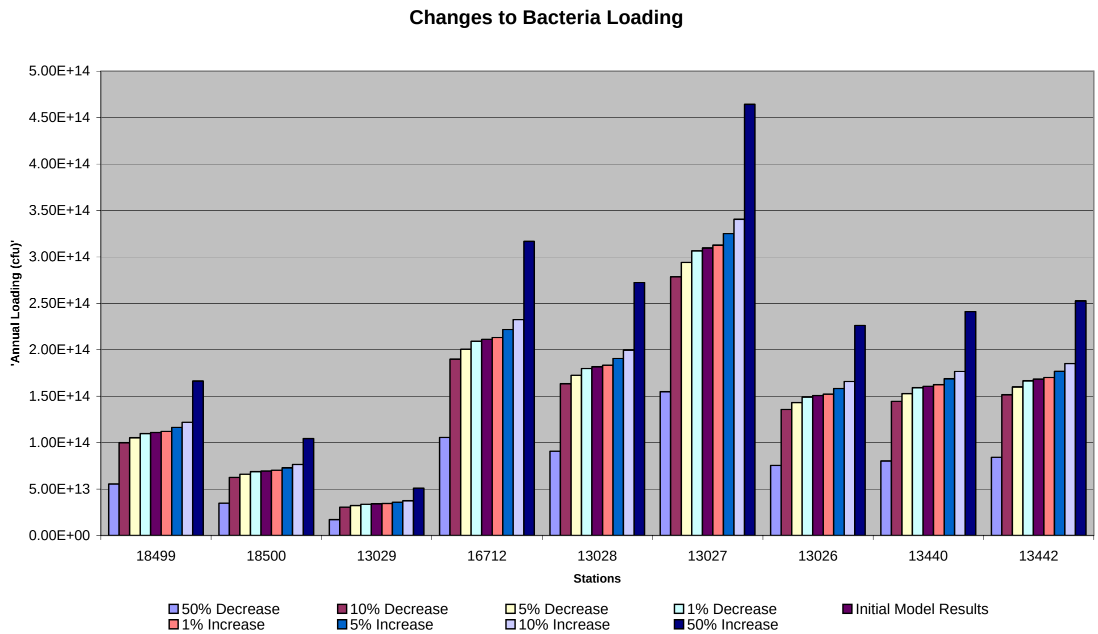


Figure 26. Daily model sensitivity analysis for bacteria loading

2.8 Verification

Verification of the model included testing the model on data collected from sampling events from May 19, 2005 through July 28, 2005. Even though sampling continued through August 25, 2005, precipitation data was only available through July 28, 2005. Comparison of the monthly model to the measured values was made using Root Mean Squared Error (Equation 13). Using RMSE as a measure of model fit, the lower values of RMSE are better. Since the statistical population of concentrations, both measured and

Equation 13. Root Mean Squared Error (RMSE).

$$RMSE = \sqrt{\frac{\sum_{1}^{n}\left[C_p - C_m\right]^2}{n}}$$

where

$RMSE$ = Root mean squared error

n = number of tests

C_p = predicted concentration

C_m = measured concentrations

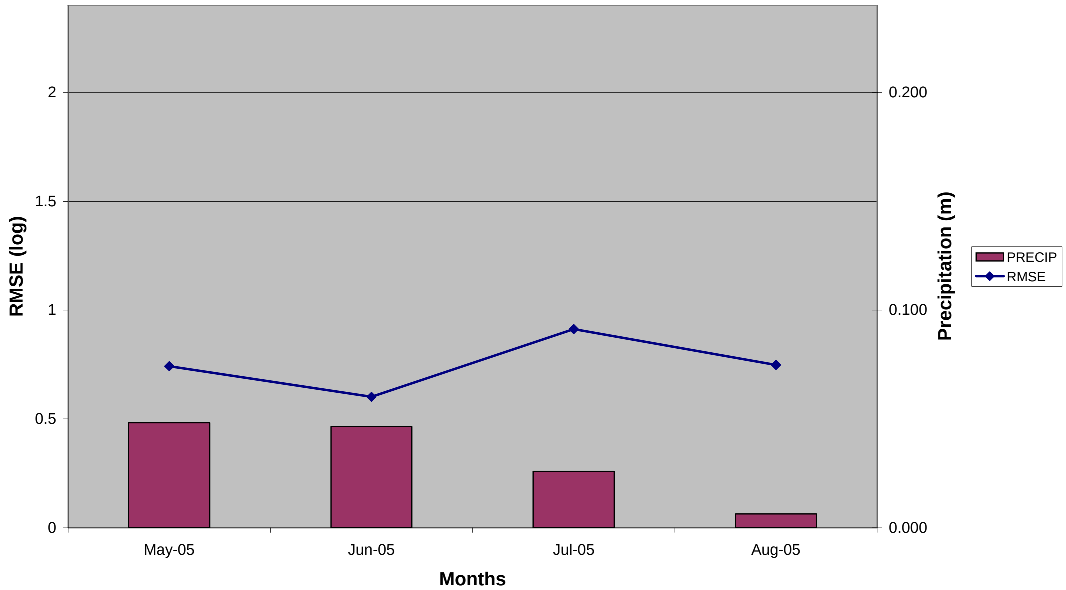


Figure 27. RMSE for Monthly Model during verification period May 2005 to August 2005.

modeled, fall in a general log normal distribution RMSE of the $\log_{10}$ of the concentration was used. For the months of May through August 2005 the overall model showed a good fit with an RMSE of 0.751 $\log_{10}$ of the concentration. This value is less than the 0.8 $\log_{10}$ variation in the data (Figure 19). The model showed independence from wet and dry periods, showing low RMSE for each of the months tested (Figure 27).

3 Results

3.1 Loadings in Non-tidal segments

3.1.1 Monthly Model

The loadings in the non-tidal segments were high throughout the entire study period of October 1999 through September 2000. The loads would start at high numbers at station 18499, the most upstream non-tidal station, and then start to decrease until station 13029 at FM 763, which was also the last downstream non-tidal station. Station 18501, West Oso Creek at US 665, had loads either as high as 13029 or even higher. West Oso Creek is a tributary, and the water contributed to the main channel volume. As a result, the bacteria from station 18501 was transported and decayed as the water moved to station 13029. However, with even high loads at 18501 and the bacteria coming from station 18500, which was immediately upstream of 13029, the load at 13029 was lower. Therefore, the model responded well to the bacteria die-off rate computed, which was based on 90% decrease in bacteria load over a 3-day period. Station 13029, which was also located near the only USGS gage station in the study area, was the only non-tidal station with historic bacteria data. After comparing the model to historic data for this station, model simulations under predicted the loads for every month except July 2000, which was the driest month for the year.

3.1.2 Daily Model

The model simulated the flow of the water through the creek efficiently, and there was reasonable decay of the bacteria from station to station. Initially, the model under predicted the loads for both runoff and dry events. After several simulations during the calibration period, the model captured the runoff event process. In other words, bacteria loads increased with rain and decreased once the runoff ceased. However, it still under predicts the bacteria loadings during a rain event. Maximum concentrations are higher than possible using the established *enterococci* EMC grid. The EMC values calculated were based on median values for fecal coliform using a log normal distribution (Baird and Jennings 1996). However, due to the decaying of the *enterococci*, an EMC value is probably not suited for the daily model. Some of the measured high concentrations seem to have no traditional sources. For example, there were instances at stations 13028, 13026, and 13440 during March 2000 that exhibited peaks in the bacteria during a dry event. The model under predicted the bacteria concentrations by at least one order of magnitude during the fall months and most of the winter months for all the stations.

3.2 Loadings in Tidal Segments

3.2.1 Monthly Model

The stations in the tidal segments consisted of stations 16712, 13028, 13027, 13026, 13440, 13441, and 13442. Overall, the model responded well to the bacteria die-off rate calculated. For all the months in the calibration period, there is an increase in the concentrations from station 13029 to 16712. However, after adding the treated wastewater from the Greenwood WWTP at station 16712, the *enterococci* concentration decreases before reaching station 13028, but is followed by an immediate increase at station 13027, the next station downstream. The model over predicts for all the months except December, which is one of the months when bird migration takes place, and February, which is one of the coldest months of the year. During July and August, the model would over predict and under predict loads. However, the model simulations were within an order of magnitude of the measured loads. July was the driest month of the study period, and August is generally one of the hottest months in South Texas.

The model consistently under predicted the concentrations and loads in the bay segments. The highest measured load came from station 13441, which is treated as a tributary in this model since it is not along the main channel of flow. However, the model was several orders of magnitude different from the measured concentrations. Since the model is mainly a runoff-based model, this would suggest that there is another bacteria source at this station.

3.2.2 Daily Model

The same results from the non-tidal segments applied to the tidal segments. The upstream tidal segments had high concentrations, but there was no traditional source to explain these values. However, the new EMC grid provided better predictions for the Oso Bay stations in the daily model. Yet, the concentrations decay to very low values between runoff events. The model's predictions were best fitted to measured values at stations 13026 and 13027 for all the months in the calibration period. Avian loading provided a minimum loading for the bay segments and added only an order of magnitude increase in runoff bacteria. Although the addition of avian loading improved the modeled results for station 13441, it did not improve results at the other bay stations, indicating avian loading may not be a significant influence on the other stations in the bay. In general, the concentrations were too low, especially for the fall and most of the winter months.

The model predicted a steeper die-off for the bacteria after a rain event than was seen in the measured data. For the rain event, model predictions for 13440 and 13442 were less than an order of magnitude different than the actual data.

3.3 Effect of Different EMC Grids

The first monthly models developed were based upon a fecal coliform EMC grid for the Oso Watershed using EMC values from a Corpus Christi Bays National Estuary Program study completed (Baird and Jennings 1996). Fecal coliform was used because there were not any *enterococci* EMC values to reference in association to different land uses for this study area. However, this resulted in extremely low load results from the model. After the first rain event, the bacteria concentration data were used to estimate a new EMC grid for *enterococci* specific to this study area. The EMC values for the designated land use doubled in concentration. As a result, the *enterococci* predictions increased to better correlate to the measured bacteria loads for the months during the study period. The new EMC grid generated was used on all model simulations since the first rain event. It was also used in the creation of the daily model.

4 Analysis

4.1 Historical Data

Overall, the model simulated the natural decay process of the bacteria reasonably well. For the rain events during the calibration period, the model predicted that the bacteria concentrations would increase due to runoff, and start to decay once the rain event ceased. However, these predicted results were lower than the measured values. This can be attributed to the EMC grid calculated for the land use-land cover of the Oso watershed. The initial event mean concentrations were based upon fecal coliform EMC distributions throughout the watershed. Since the literature event mean concentrations values were actually mean values, they may not be representative of the in-stream bacteria concentrations during a rain event. Also, since bacteria concentrations, unlike chemical concentrations, begin to decay as soon as they leave their preferred environment, calculations of the event mean loading for bacteria may be bias toward lower values. Another reason that the model is under predicting concentrations during a rain event could be accredited to the difficulty in pinpointing when the peak runoff occurs. As a result, the decay process might be delayed in the model. However, the overall first order decay rate is maintained within the model. Figure 28 shows the decay in the calculated bacteria concentrations for two rain events in March 2000 at a non-tidal station. After the model reaches a peak, the decay process is evident and follows the same pattern as the measured concentrations. The decay process seen in the non-tidal stations are emulated at the mid-tidal stations (Figure 29) and the bay stations (Figure 32).

4.2 Avian Loading

Using avian loading as an additional input improved the model simulations for the bay stations 13440 (Figure 31). The model simulated the increase in bacteria concentration during the rain event and the decrease of the bacteria once runoff had stopped flowing. The model prediction for the peak bacteria concentration was much closer to the peak measured value. Compared to the measured values, the avian input allowed the model to better capture the decay process. However, for station 13026 in the mid-tidal segment of the creek, the avian loading did not improve the predictions for bacteria concentrations (Figure 30).

4.3 Recent Sampling Data

Overall, the model responded better to data collected during the course of this study than to the historical data. The simulations provided better predictions for the beginning of the rain event before the bacteria began to decay, but it also maintained its ability to capture the decaying process. This could be attributed to collection of the data on a weekly basis. For the non-tidal stations, the model captured the behavior of the bacteria from the last two weeks of May through the only rain event, which took place during June 1-4, 2005, and from mid-July and forward. However, during June and the first two weeks of July, the model was not simulating the bacteria concentrations that were measured. This indicated the presence of an additional loading source unrelated to runoff (Figure 33, Figure 34, Figure 35, Figure 36, Figure 37, and Figure 39). This might not have been noticed with monthly data collection. The model predictions for the tidal section fared better than the non-tidal. The model captured the bacteria behavior during the rain event and most of the non-rain events. The model corresponded well to measurements from the bay stations (Figure 38, Figure 40, and Figure 41). However, this could be due to the fact that the concentrations in the bay stations were extremely low.

Model v. Measured at 13029

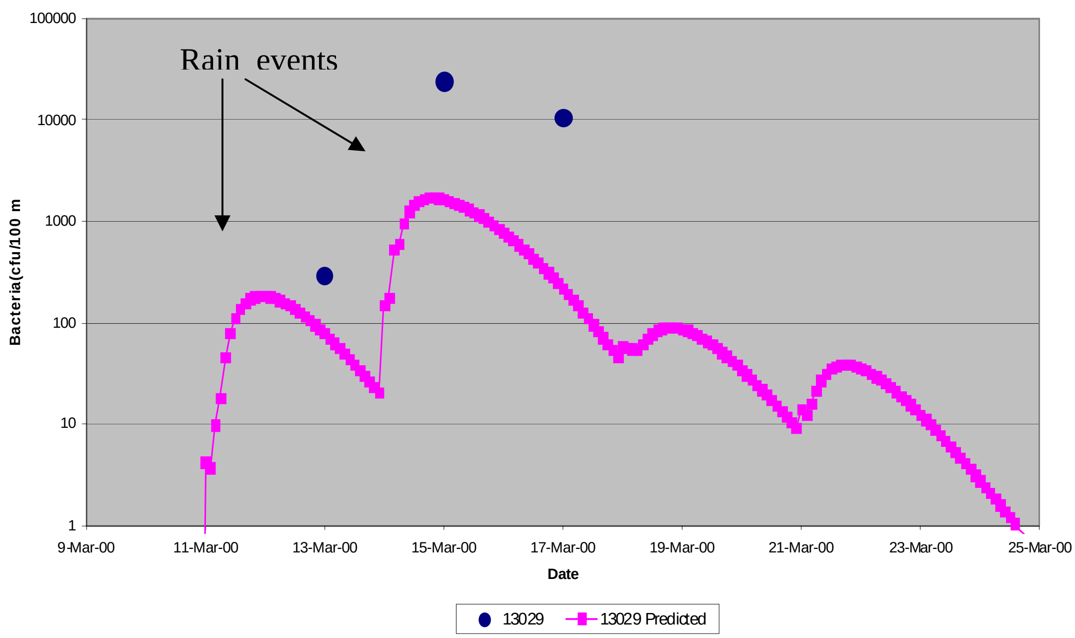


Figure 28. Calibration results for non-tidal station 13029 (Oso Creek at FM 763) during two rain events in March 2000.

Model v. Measured at 13026

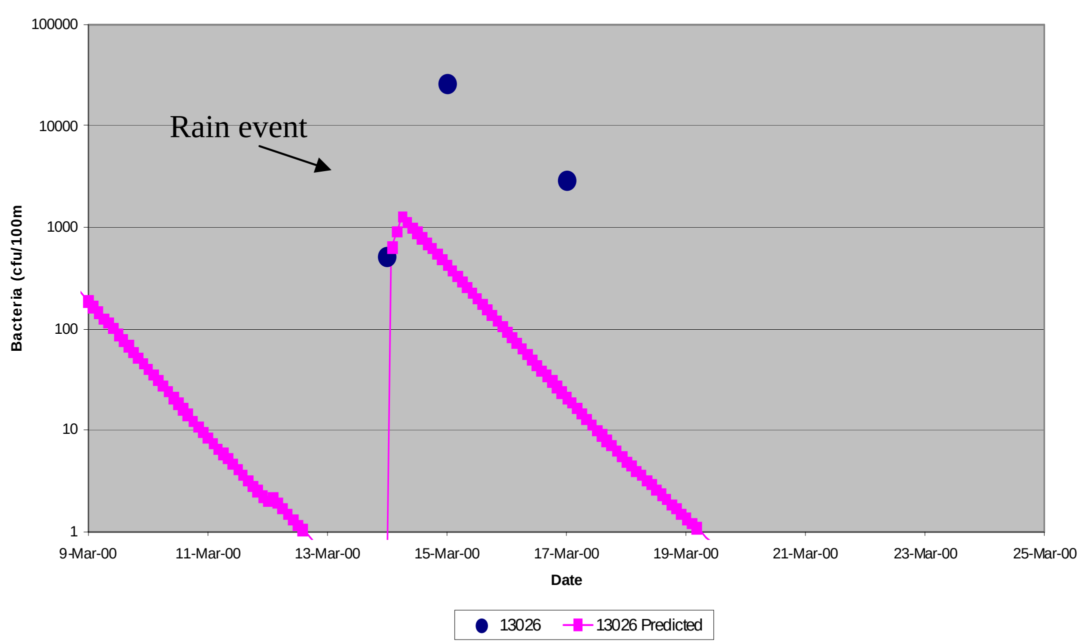


Figure 29. Calibration results for mid-tidal station 13026 (Cayo Del Oso at Yorktown Bridge in

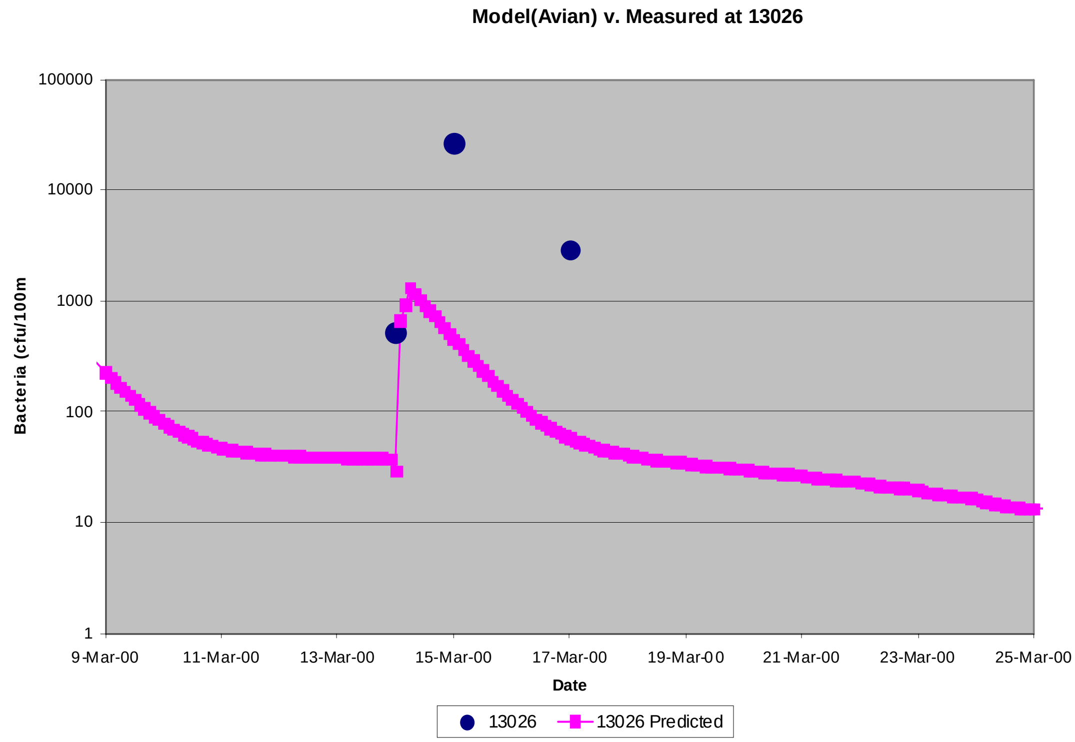


Figure 30. Calibration results, including avian loading, for mid-tidal station 13026 (Cayo Del Oso at Yorktown Bridge in Corpus Christi) during rain event for March 2000.

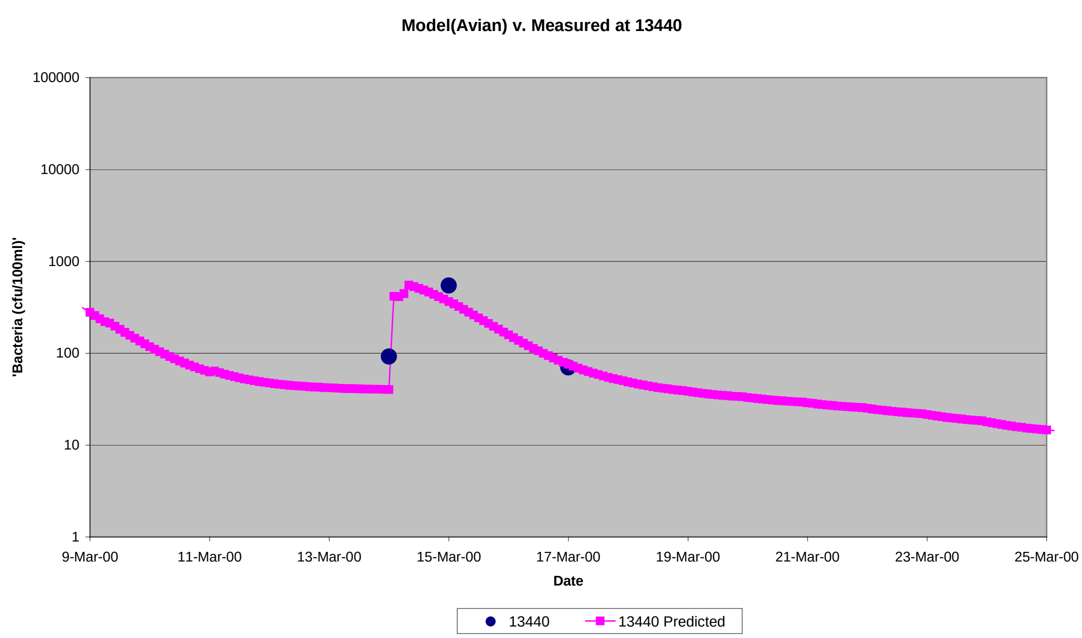


Figure 31. Calibration results, including avian loading, for bay station 13440 (Oso Bay at South Padre Island Drive [SH 358]) during rain event in March 2000.

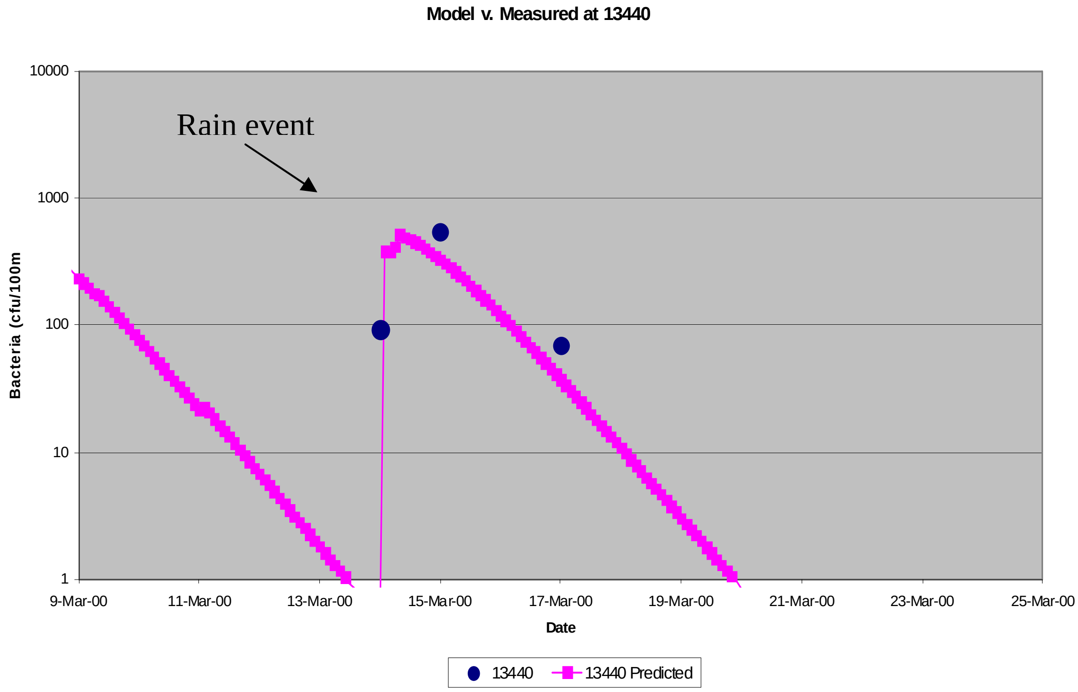


Figure 32. Calibration results for bay station 13440 (Oso Bay at South Padre Island Drive [SH 358]) during rain event in March 2000.

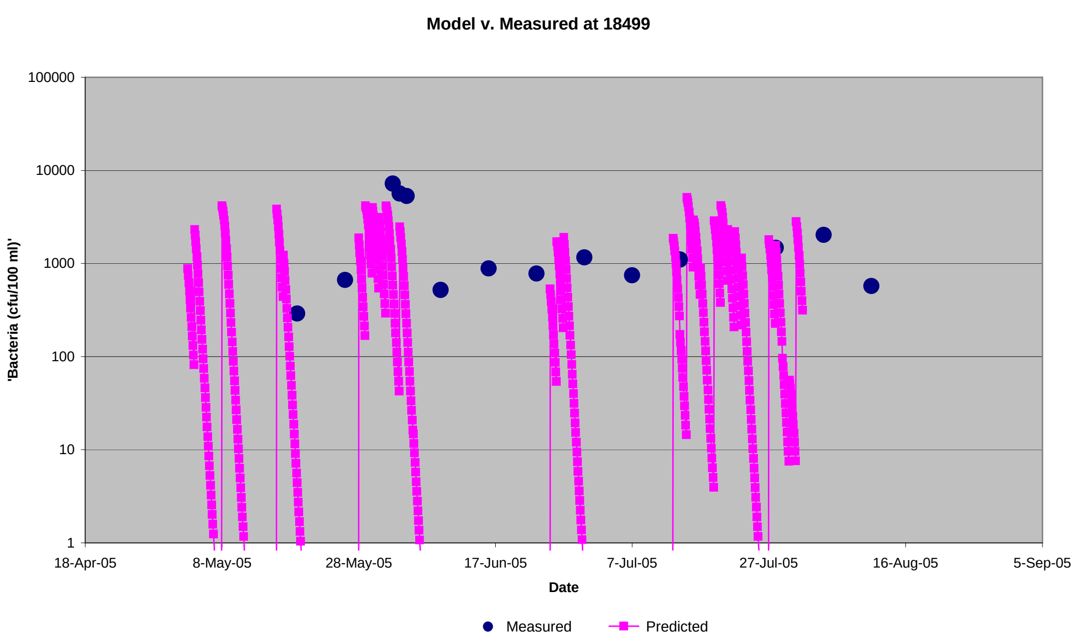


Figure 33. Verification period for station 18499 (Oso Creek at SH 44).

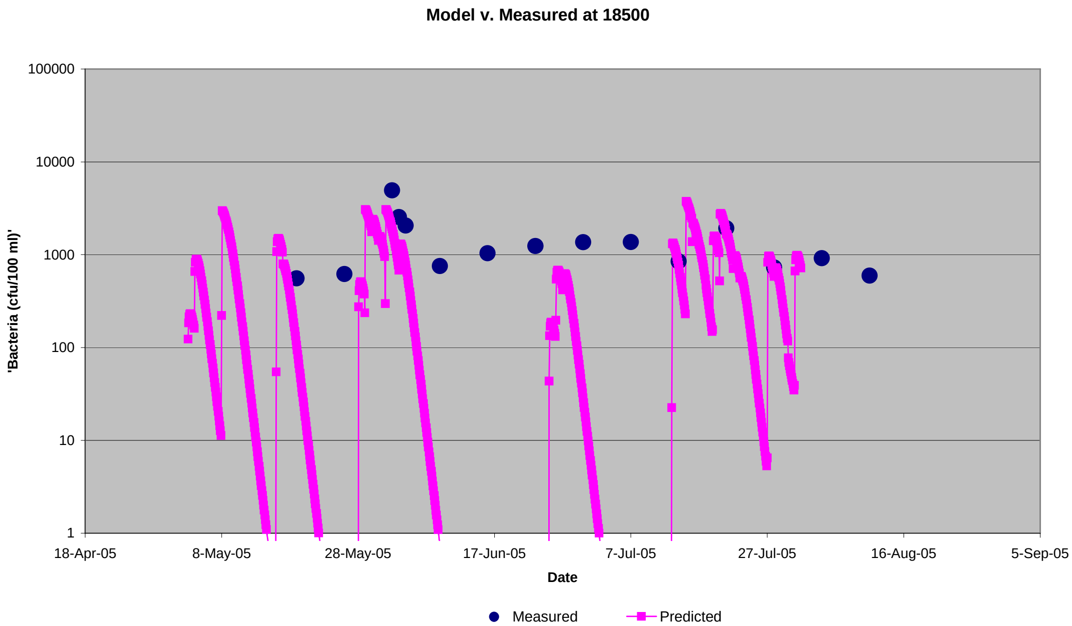


Figure 34. Verification Period for station 18500 (Oso Creek at SH 665).

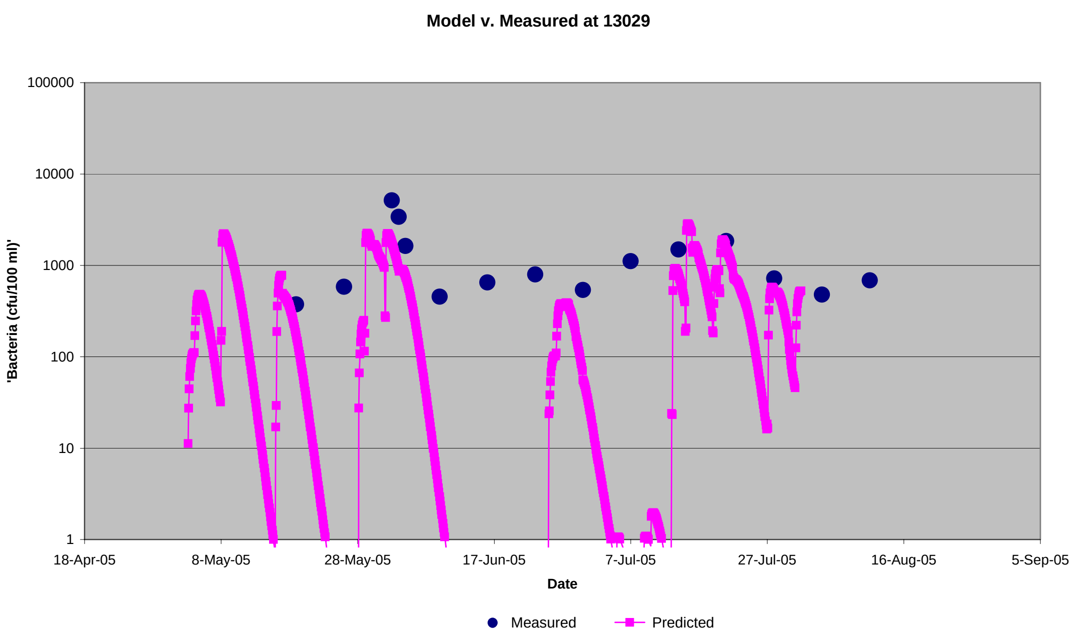


Figure 35. Verification Period for Station 13029 (Oso Creek at FM 763).

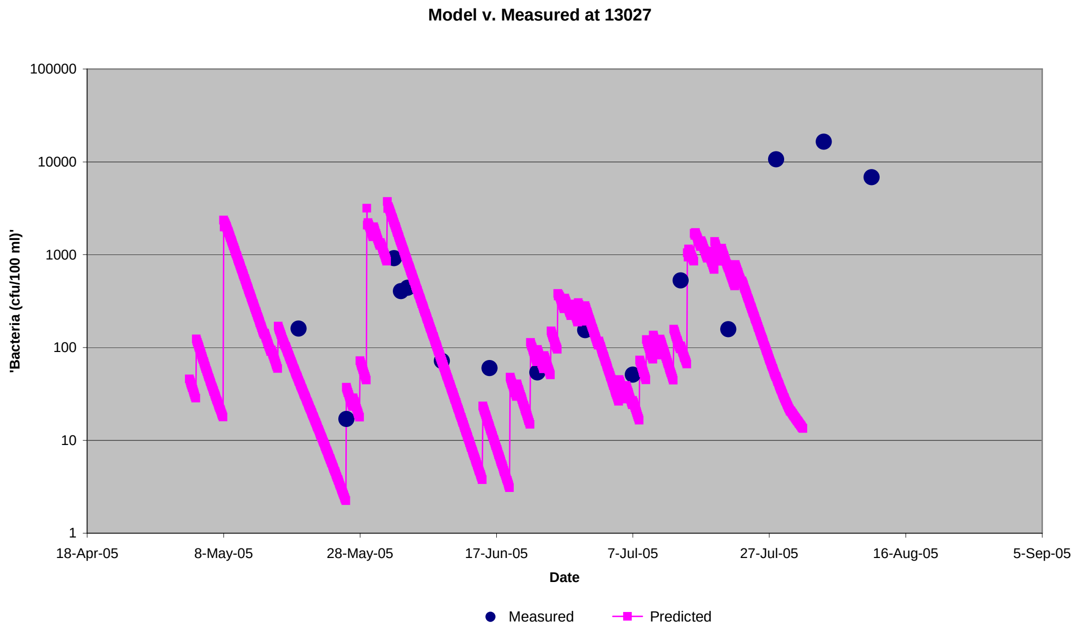


Figure 36. Verification Period for Station 13027 (Oso Creek at FM 2444 South of Corpus Christi).

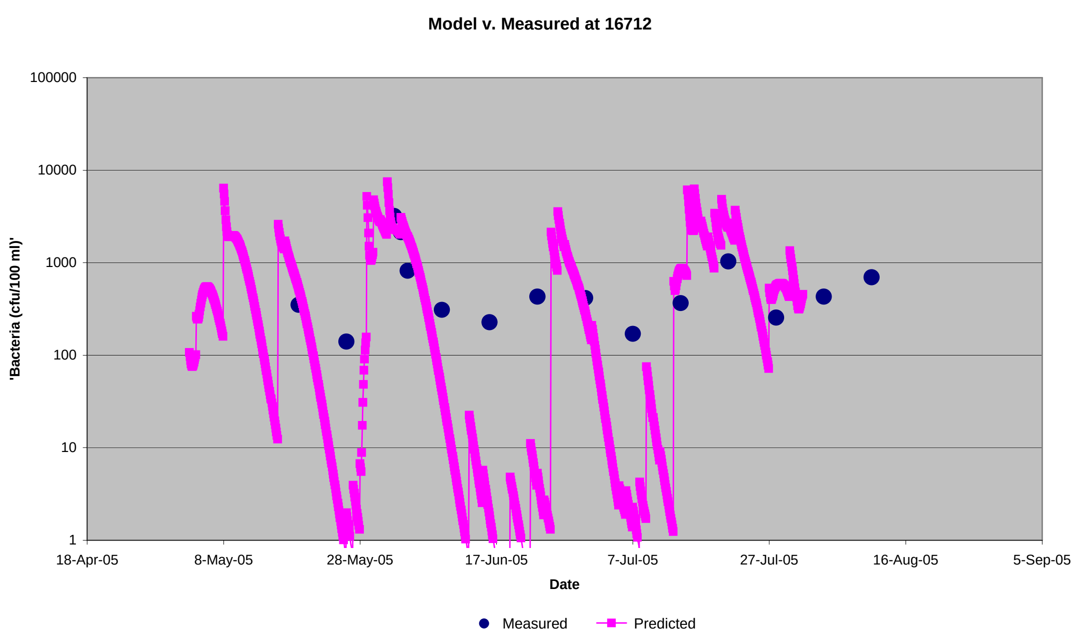


Figure 37. Verification Period for Station 16712 (Oso Creek at Elliot Landfill West of SH 286).

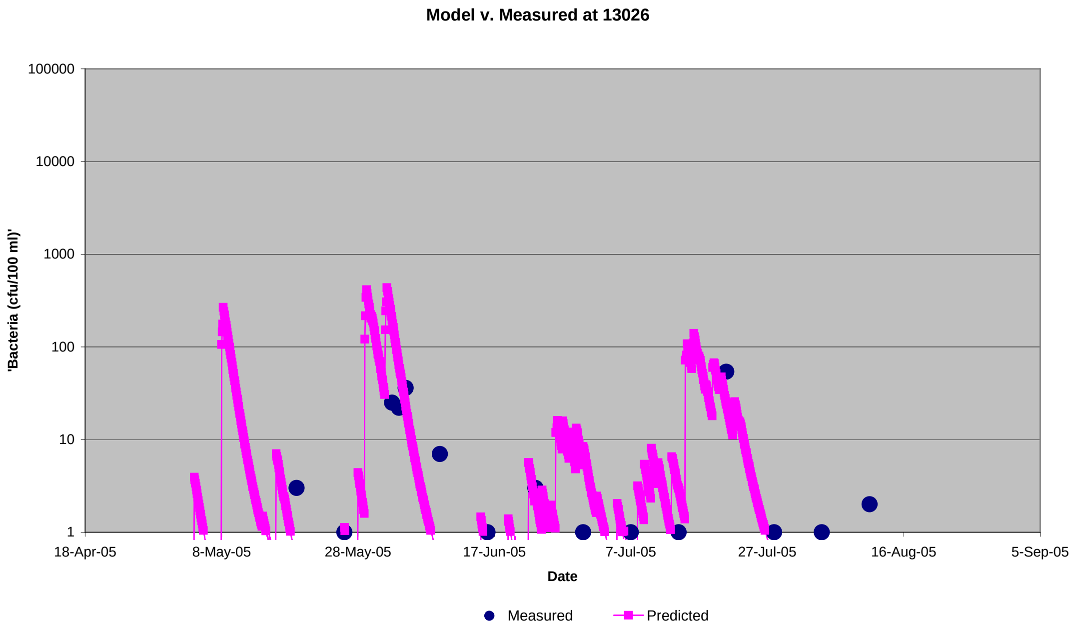


Figure 38. Verification Period for Station 13026 (Cayo Del Oso at Yorktown Bridge in Corpus Christi).

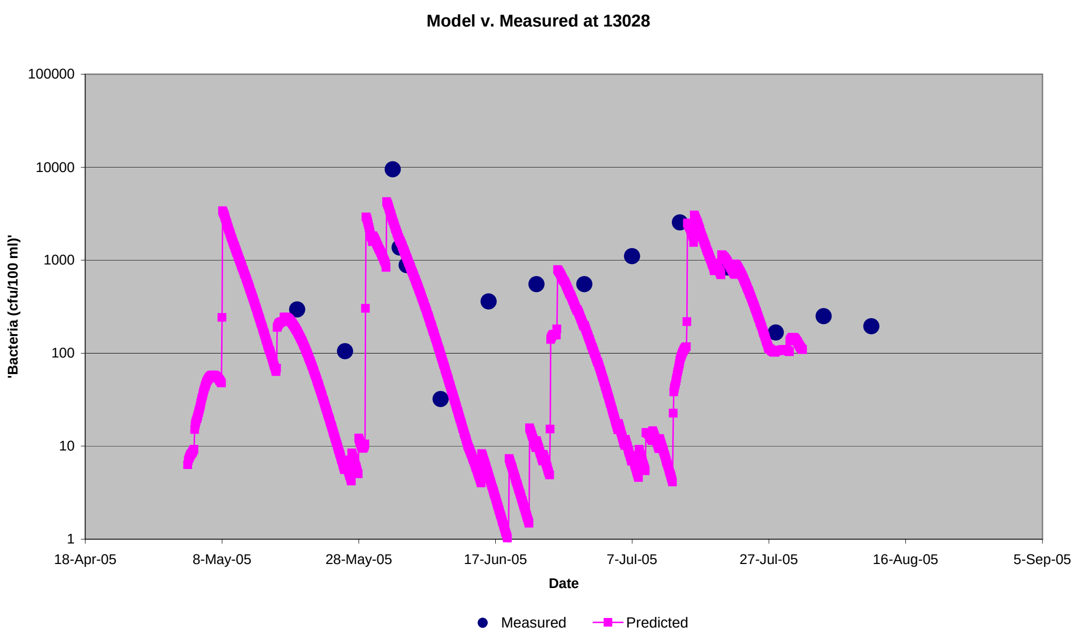


Figure 39. Verification Period for Station 13028 (Oso Creek at SH 286 South of Corpus Christi).

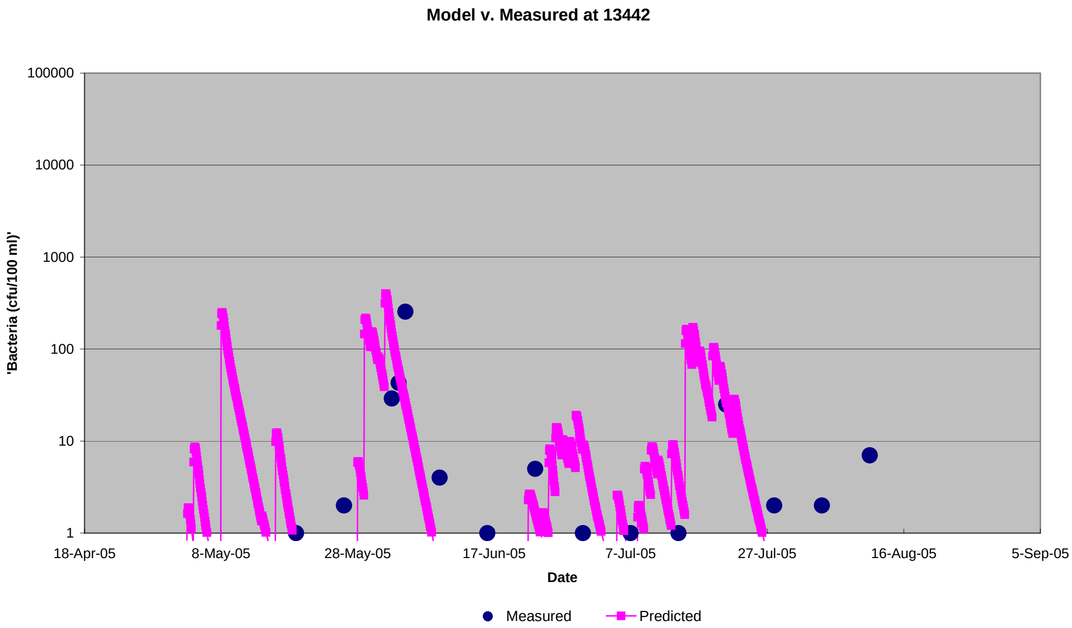


Figure 40. Verification Period for Station 13442 (Oso Bay at Ocean Drive).

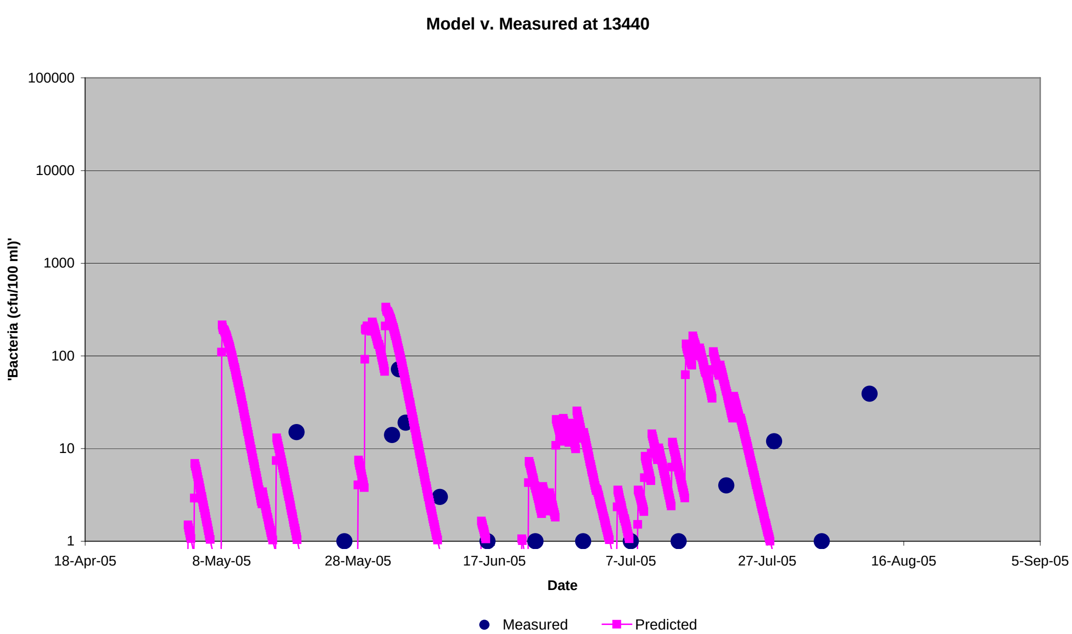


Figure 41. Verification Period for Station 13440 (Oso Bay at Padre Island Drive [SH 358]).

5 Conclusions

The bacteria loading model developed for the Oso Creek/Oso Bay system was calibrated over one year of monthly data with a few additional event measurements and verified with only four months of weekly data and some event sampling. The primary assumption of the conceptual model is that bacteria loading to the creek is a direct consequence of non-point source pollution generated by runoff from precipitation events.

Evaluation of the model shows that simulations during rainfall events reflect the primary assumption of the conceptual model. This response can be seen at all monitoring stations that were evaluated. Point source inputs (permitted discharges) influenced the simulated results by providing some continued flow through the creek and dilution of loads as they passed from one segment to the next. Just as runoff events initiated large non-point source loading to the creek, bacteria decay (die off rates) were primarily responsible for the decrease in bacteria load as they passed from one segment to the next, moving downstream and through Oso Bay. Another important factor is the volume of each segment in relation to the volume of runoff it receives during a rain event. Areas of comparatively large volumes were able to assimilate the runoff loads much quicker than the segments with smaller volumes that relied on decay rates and movement of water to the downstream segment.

During dry periods the model tended to under predict bacteria loadings by various amount. This suggests the presence of other loading elements that are not traditional non-point sources. Since there is no runoff as a transport agent these other loading elements must distribute their load directly to the water bodies. Also, apparent from the model, is that concentrations in the tidal and non-tidal creek build during dry periods. During a runoff event concentrations increase, as expected, with the initial movement of water to the channels and then decrease rapidly as the bacteria die off and are flushed to the next segment. Once the stream flows return to normal the concentrations rise. From this we can hypothesize that the loading occurs as a small flux that is evident during low flow periods, although this phenomena has only been observed in the data collected for model verification with a high temporal resolution sampling schedule.

Potential loading elements that can provide a small but constant flux to the tidal and non-tidal segments are ground water base flow carrying bacteria from leaky septic systems, or avian loading due to direct input of birds wading in the creek or roosting in wooded areas over the creek. Other elements could include livestock wading or exercising in the stream channel or wild animals seeking water or a cool refuge from the summer heat in the creek.

Dry periods in the calibration period also suggested, at times, additional loadings in the Oso Bay segments and this appeared to demonstrate some seasonality as well. Avian loadings in the bay were roughly calculated in this model based on one station and applied to the three bay segments to test this concept. The addition of the avian loadings did keep concentrations from decaying to very low numbers as is evident in some of the measurements in the calibration period. The temporal resolution of the calibration data did not allow for developing any detail in loading flux and distribution based on avian load, but does suggest that this could be a significant source of bacteria seasonally.

Overall the model performs well in estimating non-point source loadings from runoff to each segment in the watershed. Point source loadings are also incorporated into the model to account for bacteria loading and added water volume to the creek and allowing the model to estimate total loadings in each segment due to point source and runoff loadings. Other loadings to the creek not related to runoff or known point sources are evident, but are not currently represented in the model. Until this loading is quantified the model can only estimate total loadings for non-point source runoff and known point source loadings.

5.1 Recommendations

Further investigation of low peak load calculations in the model is necessary to meet the temporal resolution of the model (2 hour time steps). This could be accomplished by further investigation of the EMC data used in this model and recalculating some of the data to reflect decay rates of bacteria during EMC measurements. Additionally, EMC values for *enterococci* in this model were estimated based on one runoff event. Confidence in these values could be greatly improved if several other runoff events were considered.

The model has shown that avian loadings can be a significant contributor to bacteria in the bay during certain periods of the year. Temporal and spatial distribution of this flux should be further investigated and applied to the model. Also, further study should be given to the low flux that appears during dry periods that maintain high *enterococci* concentrations in the creek segments.

EMC concentrations for residential areas are based on urban residential areas rather than rural subdivisions using on-site sewage facilities. Two source assessment sites are available to estimate an EMC from a rural subdivision provided a sufficient rain event occurs. Additional data should be collect during bird migration season to help estimate avian loadings to the bay and data should be collected during cold period to evaluate whether the bacteria die off rate significantly affected by temperature. Model verification should be performed over a full year data set to assess its performance through other seasons.

References

Adams, J. 2005. Division of Nearshore Research. Personal Communication.

Alkan, U., D.J. Elliott, L.M. Evison 1995. Survival of enteric bacteria in relation to simulated solar radiation and other environmental factors in marine waters. Water Research 29(9): 2071-2081.

Alderisio, K. A. and N. DeLuca, 1999. Seasonal enumeration of fecal coliform bacteria from the feces of ring-billed gulls (Larus delawarensis) and Canada geese (Branta canadensis). Applied and Environmental Microbiology 65(12).

Baird, C., M. Jennings 1996. Characterization of nonpoint sources and loadings to Corpus Christi Bay National Estuary Program study area. Corpus Christi Bay National Estuary Program, CCBNEP-05.

Beaber, C. 2005. Personal communication. Excel spreadsheets of Self Monitoring Data for the Greenwood WWTP, Corpus Christi, TX.

Bergstein-Ben Dan, T., D. Wynne, Y. Manor 1997. Survival of enteric bacteria and viruses in Lake Kinneret, Israel. Water Research 31(11): 2755-2760.

Bordalo, A., R. Onrassami, C. Dechsakulwatana 2002. Survival of faecal indicator bacteria in tropical estuarine waters (Bangpakong River, Thailand). Journal of Applied Microbiology 93: 864-871.

City of Corpus Christi 2005. Terra Point Lidar data of Corpus Christi Area, 2001. 3-DVD set.

Collins, W. 2005. National Weather Service Nexrad Stage III data, Western Gulf Region Forecast Center on CD. Personal communication.

Cools, D., R. Merckx, K. Vlassak, and J. Verhaegen 2001. Survival of *E. coli* and *Enterococcus* spp. derived from pig slurry in soils of different texture. Applied Soil Ecology 17: 53-62.

Crysup, K. 2002. Fecal coliforms, enterococci and e. coli as indicators of water quality in Oso Creek/Oso Bay watershed, Corpus Christi, Texas. Masters Thesis. Texas A&M University-Corpus Christi.

Davies, C., J. Long, M. Donald, and N. Ashbolt 1995. Survival of fecal microorganisms in marine and freshwater sediments. Applied and Environmental Microbiology 61(5): 1888-1896.

Davis, K. 2000. Object-oriented modeling of rivers and watersheds in geographic information systems. Masters Thesis. University of Texas at Austin.

Dunning, J.B. 1993. CRC Handbook of Avian Body Masses. CRC Press.

Fetter, C. 1988. Applied Hydrogeology. New York, New York: Macmillan Publishing Company.

Fulton, R., J. Breidenbach, D. Seo, D. Miller. 1998. The WRS-88D Rainfall Algorithm. Weather and Forecasting 13:337-395.

Geldreich, E.E. 1966. Sanitary significance of faecal coliforms in the environment. U.S. Department Int. Fedn Wat. Pollut. Contr. Admin., Wat. Pollut. Control Res. Ser. Publ. No. WP-20-3 pp 102-103.

Gould, D. and M. Fletcher 1978. Gull droppings and their effects on water quality. Water Research 12: 665-672.

Harding, M. 2004. Effects of hydrology and prey density on shorebird distribution in the blind Oso, Oso Bay, Corpus Christi, Texas. Texas A&M University-Corpus Christi.

Heilman, S. 1999. Fecal coliforms, enterococci, *E. coli* and total coliforms as indicators of water quality in Oso Bay, Corpus Christi, Texas. Masters Thesis. Texas A&M University-Corpus Christi.

Kay, D., J. Bartram, A. Pruss, N. Ashbolt, M. Wyer, J. Fleisher, L. Fewtrell, A. Rodgers and G. Rees 2004. Derivation of numerical values for the World Health Organization guidelines for recreational waters. Water Research 38: 1296-1304.

Kay, D., C. Stapleton, M. Wyer, A. McDonald, J. Crowther, N. Paul, K. Jones, C. Francis, J. Watkins, J. Wilkinson, N. Humphrey, B. Lin, L. Yang, R. Falconer, and S, Gardner 2005. Decay of intestinal enterococci concentrations in high-energy estuarine and coastal waters: towards real-time T_{90} values for modelling faecal indicators in recreational waters. Water Research 39: 655-667.

Kayser, F. 2003. Safety aspects of enterococci from the medical point of view. International Journal of Food Microbiology 88: 255-262.

Lee, J. 2002. First flush analysis of urban storm runoff. The Science of the Total Environment 293: 163-175.

Levesque, B., P. Brousseau, P. Simard, E. Dewailly, M. Meisels, D. Ramsay, and Jean Joly 1993. Impact of the ring-billed gull (Larus delawarensis) on the microbiological quality of recreational water. Applied and Environmental Microbiology 59(4): 1228-1230.

Levesque, B., P. Brousseau, F. Bernier, E. Dewailly, and J. Joly, 2000. Study of the bacterial content of ring-billed gull droppings in relation to recreational water quality. Water Research 34(4): 1089-1096.

Lleó, M., M. Tafi, C. Signoretto, C. Dal Cero, P. Canepari 1999. Competitive polymerase chain reaction for quantification of nonculturable *enterococcus faecalis* cells in lake water. FEMS Microbiology Ecology 30: 345-353.

Marion, L, P. Clergeau, L. Brient, and G. Bertru 1994. The importance of avian-contributed nitrogen (N) and phosphorus (P) to Lake Gran-Lieu, France. Hydrobiologia 279/280:133-147.

NCDC 2005. http://waterdata.usgs.gov/tx/nwis/uv/?site_no=08211520&PARAmeter_cd=00065,00060. National Climatic Data Center. Internet site.

Newell, C., H. Rifai, P. Bedient 1992. Characterization of non-point sources and loadings to Galveston Bay. Galveston Bay National Estuary Program, GBNEP-15.

NRCS 2005. http://soildatamart.nrcs.usda.gov/Download.aspx?Survey=TX355&UseState=TX . Natural Resource Conservation Service, Soil Survey of Nueces County, Texas. Internet site.

NWS 2005. http://dipper.nws.noaa.gov/hdsb/data/nexrad/nexrad.html. National Oceanic and Atmospheric Administration Hydrologic Data Systems Group, Nexrad Stage III Archive. Internet site

Peiffer, S., T. Bergstein-Ben Dan, T. Frevert, and B. Cavari 1988. Survival of *e. coli* and enterococci in sediment-water systems of Lake Kinneret under (Feedback) controlled concentrations of hydrogen sulfide. Water Research 22(2): 233-240.

Quenzer, A. 1998. A GIS assessment of the total loads and water quality in the Coprus Christi Bay system. Center for Research in Water Resources, Online Report 98-1.

Sanders, L. 1998. A manual of field hydrogeology. Upper Saddle River, NJ: Prentice-Hall.

TFI 2005. http://www.fri.sfasu.edu/data/sensor/l7/p026/r041/y2003/d089/ . Stephan F. Austin State University Forestry Research Institute Texas View Remote Sensing Consortium Landsat ETM+ scene, path 024, row 041, year 2003, day 089. Internet site.

TNRIS 2005a. http://www.tnris.state.tx.us/DigitalData/TxDOT/txdot.htm. Texas Natural Resource Information System digital cultural features developed by Texas Department of Transportation. Internet Site.

TNRIS 2005b. http://www.tnris.state.tx.us/DigitalData/doqs.htm. Texas Natural Resource Information System Digital Orthophoto Quadrangles. Internet Site.

USGS 2005a. ftp://ftp.tnris.org/Topography/NED_30m/dem2797.zip . Texas Natural Resource Information System, USGS National Elevation Dataset, 27°N 97°W block. Internet site.

USGS 2005b. http://waterdata.usgs.gov/tx/nwis/uv/?site_no=08211520&PARAmeter_cd=00065,00060. Daily stream flow data for United States Geological Survey Stream Gage 08211520 on Oso Creek. Internet site.

USGS 2005c. http://nhdgeo.usgs.gov/. United States Geological Survey, National Hydrography Dataset, Medium Resolution for Hydrologic Unit Code 12110202. Internet site.

USGS 2005d. http://eros.usgs.gov/products/satellite/landsat7.html. United States Geological Survey Earth Resource Observation and Science Data Center, Enhanced Thematic Mapper Plus (ETM+) product description. Internet site.

USGS 2005e. http://eros.usgs.gov/products/landcover/nlcd.html. United States Geological Survey Earth Resource Observation and Science Data Center, National Land Cover Dataset, 1992. Internet Site.

Ward, G., J. Benaman 1999. A survey and review of modeling for TMDL application in Texas watercourses. Center for Research in Water Resources, Online Report 99-8.

Zoun, R. 2003. Estimation of fecal coliform loadings to Galveston Bay. Masters Thesis. University of Texas at Austin.

Appendix I

Daily discharge from the Robstown Waste Water Treatment Plant

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
9/1/2000	910000	0	
9/2/2000	1070000	0	
9/3/2000	1025000	0	
9/4/2000	982000	0	
9/5/2000	994000	0	
9/6/2000	978000	0	
9/7/2000	867000	0	
9/8/2000	1213000	1.125	
9/9/2000	1067000	0	
9/10/2000	1074000	0	
9/11/2000	905000	0	
9/12/2000	1038000	0	
9/13/2000	1319000	0	
9/14/2000	1451000	1	
9/15/2000	1640000	0	
9/16/2000	1351000	0	
9/17/2000	1376000	0	
9/18/2000	1690000	0	
9/19/2000	977000	0	
9/20/2000	1307000	0	
9/21/2000	1303000	0	
9/22/2000	1593000	-999	trace of rain
9/23/2000	1013000	0	
9/24/2000	1084000	0	
9/25/2000	1067000	0	
9/26/2000	1019000	-999	trace of rain
9/27/2000	965000	0	
9/28/2000	931000	0	
9/29/2000	1001000	0	
9/30/2000	896000	0	
10/1/2000	1973000	0	
10/2/2000	1026000	0	
10/3/2000	1016000	0	
10/4/2000	1099000	0	
10/5/2000	985000	0	
10/6/2000	978000	0	
10/7/2000	2290000	5	
10/8/2000	1324000	0.5	
10/9/2000	1424000	0.125	
10/10/2000	1438000	0	
10/11/2000	1372000	0	
10/12/2000	1284000	0	
10/13/2000	1103000	0	
10/14/2000	1132000	0.5	
10/15/2000	1143000	0.25	
10/16/2000	1086000	0	
10/17/2000	1014000	0	
10/18/2000	994000	0	
10/19/2000	1013000	0	
10/20/2000	1480000	0	
10/21/2000	1029000	0	

Day	Volume (G/D)	Rain Fall	Remarks
10/22/2000	993000	0	
10/23/2000	1058000	0	
10/24/2000	1108000	-999	trace of rain
10/25/2000	1030000	0	
10/26/2000	950000	0	
10/27/2000	996000	0	
10/28/2000	1065000	0	
10/29/2000	1007000	0	
10/30/2000	1143000	0	
10/31/2000	1022000	0	
11/1/2000	1046000	0	
11/2/2000	1055000	0	
11/3/2000	1252000	0	
11/4/2000	3085000	6	
11/5/2000	3034000	0	
11/6/2000	2917000	0.75	
11/7/2000	2422000	0	
11/8/2000	1331000	0	
11/9/2000	3085000	0	
11/10/2000	10333000	0	
11/11/2000	1134000	0	
11/12/2000	1088000	0	
11/13/2000	998000	0	
11/14/2000	1020000	0	
11/15/2000	1065000	0	
11/16/2000	1046000	0	
11/17/2000	1015000	-999	trace of rain
11/18/2000	1294000	0.5	
11/19/2000	1222000	0	
11/20/2000	1063000	0	
11/21/2000	1064000	0	
11/22/2000	1087000	0	
11/23/2000	1131000	0	
11/24/2000	1043000	0	
11/25/2000	1024000	0	
11/26/2000	1072000	0	
11/27/2000	988000	0	
11/28/2000	1017000	0	
11/29/2000	1058000	0	
11/30/2000	926000	0	
12/1/2000	909000	0	
12/2/2000	951000	0	
12/3/2000	1062000	0	
12/4/2000	999000	0	
12/5/2000	1045000	0	
12/6/2000	1100000	-999	trace of rain
12/7/2000	1001000	0	
12/8/2000	1006000	0	
12/9/2000	988000	0	
12/10/2000	921000	0	
12/11/2000	975000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
12/12/2000	949000	0	
12/13/2000	940000	0	
12/14/2000	996000	-999	trace of rain
12/15/2000	953000	0	
12/16/2000	978000	0	
12/17/2000	970000	0	
12/18/2000	1030000	0	
12/19/2000	932000	0	
12/20/2000	964000	0	
12/21/2000	952000	0	
12/22/2000	927000	0	
12/23/2000	1019000	-999	trace of rain
12/24/2000	968000	0	
12/25/2000	924000	0	
12/26/2000	1160000	-999	trace of rain
12/27/2000	1009000	0	
12/28/2000	929000	0	
12/29/2000	1024000	0	
12/30/2000	999000	0	
12/31/2000	994000	0	
1/1/2001	958000	0	
1/2/2001	1089000	0	
1/3/2001	1030000	0	
1/4/2001	1016000	-999	trace of rain
1/5/2001	1011000	0	
1/6/2001	905000	0	
1/7/2001	968000	0	
1/8/2001	1034000	0	
1/9/2001	1000000	0	
1/10/2001	1009000	0	
1/11/2001	949000	0	
1/12/2001	942000	0	
1/13/2001	907000	0	
1/14/2001	941000	0	
1/15/2001	950000	0	
1/16/2001	972000	0	
1/17/2001	1000000	0	
1/18/2001	926000	0	
1/19/2001	979000	0	
1/20/2001	938000	0	
1/21/2001	1034000	0	
1/22/2001	1025000	0	
1/23/2001	98000	0	
1/24/2001	999000	0	
1/25/2001	949000	0	
1/26/2001	929000	0	
1/27/2001	947000	0	
1/28/2001	1002000	0	
1/29/2001	974000	0	

Day	Volume (G/D)	Rain Fall	Remarks
1/30/2001	1133000	0	
1/31/2001	824000	0	
2/1/2001	-999	-999	no data
2/2/2001	-999	-999	no data
2/3/2001	-999	-999	no data
2/4/2001	-999	-999	no data
2/5/2001	-999	-999	no data
2/6/2001	-999	-999	no data
2/7/2001	-999	-999	no data
2/8/2001	-999	-999	no data
2/9/2001	-999	-999	no data
2/10/2001	-999	-999	no data
2/11/2001	-999	-999	no data
2/12/2001	-999	-999	no data
2/13/2001	-999	-999	no data
2/14/2001	-999	-999	no data
2/15/2001	-999	-999	no data
2/16/2001	-999	-999	no data
2/17/2001	-999	-999	no data
2/18/2001	-999	-999	no data
2/19/2001	-999	-999	no data
2/20/2001	-999	-999	no data
2/21/2001	-999	-999	no data
2/22/2001	-999	-999	no data
2/23/2001	-999	-999	no data
2/24/2001	-999	-999	no data
2/25/2001	-999	-999	no data
2/26/2001	-999	-999	no data
2/27/2001	-999	-999	no data
2/28/2001	-999	-999	no data
3/1/2001	963000	-999	trace of rain
3/2/2001	994000	0	
3/3/2001	1054000	0	
3/4/2001	943000	0	
3/5/2001	966000	0	
3/6/2001	976000	0	
3/7/2001	888000	0	
3/8/2001	1011000	0	
3/9/2001	928000	0	
3/10/2001	1016000	0	
3/11/2001	1015000	0	
3/12/2001	992000	0	
3/13/2001	954000	0	
3/14/2001	960000	0	
3/15/2001	950000	0	
3/16/2001	969000	0	
3/17/2001	986000	0	
3/18/2001	971000	0	
3/19/2001	944000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
3/20/2001	992000	0	
3/21/2001	964000	0	
3/22/2001	912000	0	
3/23/2001	927000	0	
3/24/2001	976000	0	
3/25/2001	989000	0	
3/26/2001	988000	0.25	
3/27/2001	1159000	0.75	
3/28/2001	1126000	0.25	
3/29/2001	918000	0	
3/30/2001	971000	0	
3/31/2001	913000	0	
4/1/2001	957000	0	
4/2/2001	978000	0	
4/3/2001	999000	0	
4/4/2001	976000	0	
4/5/2001	933000	0	
4/6/2001	870000	0	
4/7/2001	987000	0	
4/8/2001	934000	0	
4/9/2001	954000	0	
4/10/2001	943000	0	
4/11/2001	878000	-999	scattered rain
4/12/2001	947000	0	
4/13/2001	977000	0	
4/14/2001	1017000	0	
4/15/2001	969000	0	
4/16/2001	1054000	0	
4/17/2001	1006000	0	
4/18/2001	806000	0	
4/19/2001	979000	0	
4/20/2001	936000	0	
4/21/2001	906000	0	
4/22/2001	960000	0	
4/23/2001	956000	0	
4/24/2001	913000	0	
4/25/2001	954000	0	
4/26/2001	936000	0	
4/27/2001	856000	0	
4/28/2001	852000	0	
4/29/2001	961000	0	
4/30/2001	956000	-999	scattered rain
5/1/2001	909000	0	
5/2/2001	935000	0	
5/3/2001	868000	0	
5/4/2001	922000	0	
5/5/2001	920000	0	
5/6/2001	1113000	0	

Day	Volume (G/D)	Rain Fall	Remarks
5/7/2001	1023000	0	
5/8/2001	979000	0	
5/9/2001	937000	0	
5/10/2001	947000	0	
5/12/2001	1201000	0	
5/13/2001	926000	0	
5/14/2001	1081000	0	
5/15/2001	1061000	0	
5/16/2001	998000	0	
5/17/2001	961000	0	
5/18/2001	984000	0	
5/19/2001	943000	0	
5/20/2001	935000	0	
5/21/2001	1022000	0	
5/22/2001	1003000	0	
5/23/2001	925000	0	
5/24/2001	940000	0	
5/25/2001	960000	0	
5/26/2001	927000	0	
5/27/2001	976000	0	
5/28/2001	1023000	0	
5/29/2001	1006000	0	
5/30/2001	922000	0	
5/31/2001	764000	0	
6/1/2001	1070000	0	
6/2/2001	954000	0	
6/3/2001	894000	0	
6/4/2001	1013000	0	
6/5/2001	930000	0	
6/6/2001	921000	0	
6/7/2001	956000	0	
6/8/2001	1260000	0.125	
6/9/2001	964000	0	
6/10/2001	993000	0	
6/11/2001	1139000	0	
6/12/2001	1106000	0	
6/13/2001	832000	0	
6/14/2001	936000	0	
6/15/2001	1374000	0	
6/16/2001	945000	0	
6/17/2001	866000	0	
6/18/2001	983000	0	
6/19/2001	936000	0	
6/20/2001	1329000	0	
6/21/2001	1350000	1	
6/22/2001	984000	0	
6/23/2001	938000	0	
6/24/2001	889000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
6/25/2001	1090000	0	
6/26/2001	981000	0	
6/27/2001	1001000	0	
6/28/2001	955000	0	
6/29/2001	958000	0	
6/30/2001	988000	0	
7/1/2001	950000	0.5	
7/2/2001	1239000	0	
7/3/2001	1401000	0	
7/4/2001	1185000	0	
7/5/2001	989000	0	
7/6/2001	1004000	0	
7/7/2001	1006000	0	
7/8/2001	937000	0	
7/9/2001	1017000	0	
7/10/2001	1058000	0	
7/11/2001	1013000	0	
7/12/2001	1030000	0	
7/13/2001	918000	0	
7/14/2001	1909000	0	
7/15/2001	1450000	0	
7/16/2001	1054000	0	
7/17/2001	990000	0	
7/18/2001	988000	0	
7/19/2001	1054000	0	
7/20/2001	860000	0	
7/21/2001	940000	0	
7/22/2001	1071000	0	
7/23/2001	1047000	0	
7/24/2001	999000	0	
7/25/2001	986000	0	
7/26/2001	981000	0	
7/27/2001	2106000	0	
7/28/2001	991000	0	
7/29/2001	1076000	0	
7/30/2001	1017000	0	
7/31/2001	977000	0	
8/1/2001	983000	0	
8/2/2001	1055000	0	
8/3/2001	940000	-999	trace of rain
8/4/2001	981000	0	
8/5/2001	1057000	0	
8/6/2001	1071000	0	
8/7/2001	1064000	0	
8/8/2001	1033000	0	
8/9/2001	991000	0	
8/10/2001	1059000	0	
8/11/2001	1047000	0	
8/12/2001	1107000	0	

Day	Volume (G/D)	Rain Fall	Remarks
8/13/2001	1068000	0	
8/14/2001	1008000	0	
8/15/2001	1073000	0	
8/16/2001	1107000	0	
8/17/2001	1050000	0	
8/18/2001	1026000	0	
8/19/2001	1103000	0	
8/20/2001	1103000	0	
8/21/2001	1104000	0	
8/22/2001	1051000	0	
8/23/2001	991000	0	
8/24/2001	1038000	0	
8/25/2001	1048000	0.75	
8/26/2001	1049000	0	
8/27/2001	1148000	0	
8/28/2001	1594000	0.8	
8/29/2001	1672000	-999	trace of rain
8/30/2001	1911000	2.75	
8/31/2001	1902000	6	
9/1/2001	2857000	1.5	
9/2/2001	2841000	0	
9/3/2001	1721000	0	
9/4/2001	2637000	0	
9/5/2001	2339000	0	
9/6/2001	1340000	0	
9/7/2001	1028000	0	
9/8/2001	1940000	0	
9/9/2001	1228000	0	
9/10/2001	1101000	0	
9/11/2001	1101000	0	
9/12/2001	1005000	0	
9/13/2001	1030000	0	
9/14/2001	1002000	0	
9/15/2001	992000	0	
9/16/2001	1063000	0	
9/17/2001	1054000	0	
9/18/2001	1019000	0	
9/19/2001	1040000	0	
9/20/2001	952000	0	
9/21/2001	946000	0	
9/22/2001	900000	0	
9/23/2001	1839000	-999	trace of rain
9/24/2001	996000	0	
9/25/2001	943000	0	
9/26/2001	940000	0	
9/27/2001	986000	0	
9/28/2001	981000	0	
9/29/2001	924000	0	
9/30/2001	941000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
10/1/2001	1004000	0	
10/2/2001	994000	0	
10/3/2001	980000	0	
10/4/2001	1018000	0	
10/5/2001	1187000	0	
10/6/2001	1016000	0	
10/7/2001	1043000	0	
10/8/2001	1010000	0	
10/9/2001	970000	0	
10/10/2001	967000	0	
10/11/2001	1018000	0	
10/12/2001	1102000	0	
10/13/2001	979000	0	
10/14/2001	1072000	0	
10/15/2001	976000	0	
10/16/2001	918000	0	
10/17/2001	980000	0	
10/18/2001	978000	0	
10/19/2001	855000	0	
10/20/2001	904000	0	
10/21/2001	963000	0	
10/22/2001	1026000	0	
10/23/2001	963000	0	
10/24/2001	973000	0	
10/25/2001	1806000	0	
10/26/2001	1325000	0	
10/27/2001	987000	0	
10/28/2001	979000	0	
10/29/2001	978000	0	
10/30/2001	981000	0	
10/31/2001	857000	0	
11/1/2001	996000	0	
11/2/2001	987000	0	
11/3/2001	1030000	0.25	
11/4/2001	962000	0	
11/5/2001	959000	0	
11/6/2001	975000	0	
11/7/2001	981000	0	
11/8/2001	970000	0	
11/9/2001	1096000	0	
11/10/2001	1027000	0	
11/11/2001	847000	0	
11/12/2001	1864000	0.25	
11/13/2001	1006000	1.75	
11/14/2001	1078000	0	
11/15/2001	2498000	4.75	
11/16/2001	2984000	2	
11/17/2001	2855000	0	
11/18/2001	2758000	0	

Day	Volume (G/D)	Rain Fall	Remarks
11/19/2001	1769000	0	
11/20/2001	1057000	0	
11/21/2001	1103000	-999	trace of rain
11/22/2001	1122000	0	
11/23/2001	1040000	0	
11/24/2001	1025000	0	
11/25/2001	1116000	0	
11/26/2001	1069000	0	
11/27/2001	974000	0	
11/28/2001	960000	0	
11/29/2001	1019000	0	
11/30/2001	971000	0	
12/1/2001	1025000	-999	trace of rain
12/2/2001	1498000	0	
12/3/2001	1055000	-999	trace of rain
12/4/2001	1047000	0	
12/5/2001	1015000	0	
12/6/2001	976000	0	
12/7/2001	1023000	0	
12/8/2001	1056000	0.25	
12/9/2001	998000	0	
12/10/2001	1001000	0	
12/11/2001	1058000	0.25	
12/12/2001	1028000	0	
12/13/2001	1033000	0	
12/14/2001	960000	0	
12/15/2001	1125000	0	
12/16/2001	1091000	0	
12/17/2001	1116000	0	
12/18/2001	1072000	0	
12/19/2001	916000	0	
12/20/2001	1012000	0	
12/21/2001	1018000	0	
12/22/2001	1003000	0	
12/23/2001	981000	0	
12/24/2001	1057000	0	
12/25/2001	1001000	0	
12/26/2001	1103000	0	
12/27/2001	1068000	0	
12/28/2001	1107000	0	
12/29/2001	1031000	0	
12/30/2001	1050000	0	
12/31/2001	957000	0	
1/1/2002	843000	0	
1/2/2002	833000	0	
1/3/2002	872000	0	
1/4/2002	950000	0	
1/5/2002	950000	0	
1/6/2002	1019000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
1/7/2002	1044000	0	
1/8/2002	989000	0	
1/9/2002	892000	0	
1/10/2002	1206000	-999	scattered rain
1/11/2002	1048000	1	
1/12/2002	967000	0	
1/13/2002	969000	0	
1/14/2002	985000	0	
1/15/2002	1062000	0	
1/16/2002	1035000	-999	scattered rain
1/17/2002	1103000	0.25	
1/18/2002	1186000	0	
1/19/2002	1064000	0	
1/20/2002	1411000	0	
1/21/2002	696000	0	
1/22/2002	1425000	0	
1/23/2002	1063000	0	
1/24/2002	1007000	0	
1/25/2002	1027000	0	
1/26/2002	1012000	0	
1/27/2002	959000	0	
1/28/2002	1063000	0	
1/29/2002	956000	0	
1/30/2002	1056000	0	
1/31/2002	930000	0	
2/1/2002	938000	0.25	
2/2/2002	978000	0	
2/3/2002	1357000	0	
2/4/2002	929000	0	
2/5/2002	945000	-999	trace of rain
2/6/2002	940000	-999	drizzle
2/7/2002	947000	0	
2/8/2002	948000	0	
2/9/2002	1552000	0	
2/10/2002	935000	0	
2/11/2002	595000	0	
2/12/2002	895000	0	
2/13/2002	865000	0	
2/14/2002	859000	0	
2/15/2002	816000	0	
2/16/2002	953000	0	
2/17/2002	1018000	0	
2/18/2002	1007000	0	
2/19/2002	999000	0	
2/20/2002	926000	0	
2/21/2002	942000	0	
2/22/2002	933000	0	
2/23/2002	958000	0	
2/24/2002	982000	0	
2/25/2002	942000	0	
2/26/2002	948000	0	
2/27/2002	1094000	-999	trace of rain
2/28/2002	979000	-999	trace of rain
3/1/2002	993000	-999	trace of rain
3/2/2002	866000	0	
3/3/2002	900000	0	
3/4/2002	1077000	0	
3/5/2002	947000	0	
3/6/2002	996000	0	
3/7/2002	556000	0	
3/8/2002	895000	0	
3/9/2002	850000	0	
3/10/2002	897000	0	
3/11/2002	1003000	0	
3/12/2002	960000	0	
3/13/2002	1028000	0	
3/14/2002	413000	0	
3/15/2002	970000	0	
3/16/2002	976000	0	
3/17/2002	973000	0	
3/18/2002	978000	0	
3/19/2002	919000	0	
3/20/2002	921000	0	
3/21/2002	902000	0	
3/22/2002	845000	0	
3/23/2002	887000	0	
3/24/2002	1014000	0	
3/25/2002	922000	0	
3/26/2002	948000	0	
3/27/2002	814000	0	
3/28/2002	943000	0	
3/29/2002	981000	0	
3/30/2002	925000	0	
3/31/2002	875000	0	
4/1/2002	980000	0	
4/2/2002	932000	0	
4/3/2002	900000	0	
4/4/2002	907000	0	
4/5/2002	859000	0	
4/6/2002	934000	0	
4/7/2002	926000	0	
4/8/2002	988000	0	
4/9/2002	982000	0	
4/10/2002	963000	0	
4/11/2002	888000	0	
4/12/2002	992000	0	
4/13/2002	923000	0	
4/14/2002	831000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
4/15/2002	974000	0	
4/16/2002	958000	0	
4/17/2002	967000	0	
4/18/2002	959000	0	
4/19/2002	942000	0	
4/20/2002	1042000	0	
4/21/2002	1023000	0	
4/22/2002	907000	0	
4/23/2002	951000	0	
4/24/2002	982000	0	
4/25/2002	934000	0	
4/26/2002	928000	0	
4/27/2002	1015000	0	
4/28/2002	967000	0	
4/29/2002	935000	0	
4/30/2002	895000	0	
5/1/2002	1056000	0	
5/2/2002	935000	0	
5/3/2002	1002000	0	
5/4/2002	1008000	0	
5/5/2002	989000	0	
5/6/2002	1048000	0	
5/7/2002	988000	0	
5/8/2002	845000	0	
5/9/2002	936000	0	
5/10/2002	961000	0	
5/11/2002	957000	0	
5/12/2002	987000	0	
5/13/2002	1072000	0	
5/14/2002	990000	0	
5/15/2002	972000	0	
5/16/2002	1086000	1.5	
5/17/2002	1220000	0	
5/18/2002	1025000	0	
5/19/2002	1023000	0	
5/20/2002	1244000	0	
5/21/2002	1018000	0	
5/22/2002	888000	0	
5/23/2002	1006000	0.75	
5/24/2002	884000	0	
5/25/2002	904000	0	
5/26/2002	894000	0	
5/27/2002	870000	0	
5/28/2002	757000	0	
5/29/2002	1136000	0	
5/30/2002	997000	0	
5/31/2002	880000	0	
6/1/2002	928000	0	
6/2/2002	878000	0	

Day	Volume (G/D)	Rain Fall	Remarks
6/3/2002	905000	0	
6/4/2002	939000	0	
6/5/2002	1063000	0	
6/6/2002	887000	0	
6/7/2002	981000	0	
6/8/2002	927000	0	
6/9/2002	938000	0	
6/10/2002	903000	0	
6/11/2002	960000	0	
6/12/2002	920000	0	
6/13/2002	1102000	0	
6/14/2002	817000	0	
6/15/2002	957000	0	
6/16/2002	944000	0	
6/17/2002	918000	0	
6/18/2002	901000	0	
6/19/2002	986000	0	
6/20/2002	950000	0	
6/21/2002	928000	0	
6/22/2002	993000	0	
6/23/2002	735000	0	
6/24/2002	893000	0	
6/25/2002	898000	0	
6/26/2002	873000	0	
6/27/2002	849000	0	
6/28/2002	906000	0	
6/29/2002	1182000	0	
6/30/2002	863000	0	
7/1/2002	886000	0	
7/2/2002	954000	0	
7/3/2002	980000	0	
7/4/2002	903000	-999	trace of rain
7/5/2002	988000	0	
7/6/2002	1062000	0	
7/7/2002	969000	0	
7/8/2002	997000	0	
7/9/2002	1003000	-999	scattered rain
7/10/2002	1186000	0.75	
7/11/2002	984000	0	
7/12/2002	1011000	0	
7/13/2002	872000	0	
7/14/2002	973000	0	
7/15/2002	1037000	1.5	
7/16/2002	1351000	0.75	
7/17/2002	895000	0	
7/18/2002	1008000	0	
7/19/2002	998000	0	
7/20/2002	993000	0	
7/21/2002	929000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
7/22/2002	970000	0	
7/23/2002	1115000	0	
7/24/2002	906000	0	
7/25/2002	1047000	0	
7/26/2002	1057000	0	
7/27/2002	1020000	0	
7/28/2002	970000	0	
7/29/2002	935000	0	
7/30/2002	1013000	0	
7/31/2002	929000	0	
8/1/2002	964000	0	
8/2/2002	870000	0	
8/3/2002	981000	0	
8/4/2002	916000	0	
8/5/2002	690000	0	
8/6/2002	1195000	0	
8/7/2002	1360000	-999	trace of rain
8/8/2002	1071000	-999	trace of rain
8/9/2002	1940000	0	
8/10/2002	1182000	0.25	
8/11/2002	1572000	0.25	
8/12/2002	930000	0	
8/13/2002	865000	0	
8/14/2002	2156000	0	
8/15/2002	2374000	0	
8/16/2002	896000	0	
8/17/2002	919000	0	
8/18/2002	948000	0	
8/19/2002	938000	0	
8/20/2002	962000	0	
8/21/2002	929000	0	
8/22/2002	918000	0	
8/23/2002	867000	0	
8/24/2002	927000	0	
8/25/2002	802000	0	
8/26/2002	934000	0	
8/27/2002	937000	0	
8/28/2002	998000	0	
8/29/2002	999000	0	
8/30/2002	909000	0	
8/31/2002	1029000	0	
9/1/2002	978000	-999	trace of rain
9/2/2002	948000	0	
9/3/2002	898000	0	
9/4/2002	933000	0	
9/5/2002	927000	0	
9/6/2002	939000	0	
9/7/2002	940000	0	
9/8/2002	1021000	0	

Day	Volume (G/D)	Rain Fall	Remarks
9/9/2002	1121000	0.25	
9/10/2002	1042000	0	
9/11/2002	906000	0	
9/12/2002	926000	0	
9/13/2002	908000	0	
9/14/2002	975000	0	
9/15/2002	3027000	3	
9/16/2002	3231000	1.75	
9/17/2002	3081000	5	
9/18/2002	2942000	0	
9/19/2002	2597000	0	
9/20/2002	2854000	0	
9/21/2002	1600000	0	
9/22/2002	1396000	1.25	
9/23/2002	2864000	0	
9/24/2002	1981000	0	
9/25/2002	1334000	0	
9/26/2002	1107000	0	
9/27/2002	950000	0	
9/28/2002	970000	0	
9/29/2002	980000	0	
9/30/2002	967000	0	
10/1/2002	1011000	0	
10/2/2002	915000	0	
10/3/2002	962000	0	
10/4/2002	919000	0	
10/5/2002	884000	0	
10/6/2002	966000	0	
10/7/2002	966000	-999	trace of rain
10/8/2002	958000	0	
10/9/2002	986000	0	
10/10/2002	906000	0	
10/11/2002	898000	0	
10/12/2002	996000	0	
10/13/2002	960000	0	
10/14/2002	944000	0	
10/15/2002	994000	0	
10/16/2002	888000	0	
10/17/2002	966000	0	
10/18/2002	943000	0	
10/19/2002	2031000	2.25	
10/20/2002	1782000	-999	trace of rain
10/21/2002	1119000	-999	trace of rain
10/22/2002	2149000	0.5	
10/23/2002	2977000	3.5	
10/24/2002	2640000	4.25	
10/25/2002	2917000	0	
10/26/2002	3055000	0	
10/27/2002	2870000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
10/28/2002	2489000	0	
10/29/2002	2165000	0	
10/30/2002	1468000	0	
10/31/2002	1134000	0	
11/1/2002	946000	0	
11/2/2002	2247000	0	
11/3/2002	2225000	0	
11/4/2002	3050000	0	
11/5/2002	2926000	0	
11/6/2002	1725000	0	
11/7/2002	1250000	0	
11/8/2002	1103000	0	
11/9/2002	1078000	0	
11/10/2002	1066000	0	
11/11/2002	978000	0	
11/12/2002	1173000	0	
11/13/2002	735000	0	
11/14/2002	1079000	0	
11/15/2002	701000	0	
11/16/2002	896000	0	
11/17/2002	941000	0	
11/18/2002	935000	0	
11/19/2002	936000	0	
11/20/2002	1096000	0	
11/21/2002	936000	0	
11/22/2002	910000	0	
11/23/2002	936000	0	
11/24/2002	966000	0	
11/25/2002	1000000	0	
11/26/2002	832000	0	
11/27/2002	915000	0	
11/28/2002	867000	0	
11/29/2002	896000	0	
11/30/2002	1000000	0	
12/1/2002	857000	0	
12/2/2002	951000	0	
12/3/2002	951000	0	
12/4/2002	969000	0	
12/5/2002	828000	0	
12/6/2002	853000	0	
12/7/2002	832000	0	
12/8/2002	1770000	0.25	
12/9/2002	2837000	2.5	
12/10/2002	1341000	0	
12/11/2002	1106000	0	
12/12/2002	1115000	0	
12/13/2002	957000	0	
12/14/2002	983000	0	
12/15/2002	956000	0	
12/16/2002	975000	0	
12/17/2002	950000	0	
12/18/2002	917000	0	
12/19/2002	900000	0	
12/20/2002	1173000	0	
12/21/2002	943000	0	
12/22/2002	853000	0	
12/23/2002	1000000	0	
12/24/2002	1019000	0	
12/25/2002	960000	0	
12/26/2002	1013000	0	
12/27/2002	1053000	0	
12/28/2002	1028000	0	
12/29/2002	967000	0	
12/30/2002	1432000	-999	trace of rain
12/31/2002	1325000	0	
1/1/2003	1209000	0	
1/2/2003	1378000	0	
1/3/2003	884000	0	
1/4/2003	986000	0	
1/5/2003	1030000	0	
1/6/2003	906000	0	
1/7/2003	819000	0	
1/8/2003	978000	0	
1/9/2003	857000	0	
1/10/2003	762000	0	
1/11/2003	899000	0.75	
1/12/2003	1033000	0.5	
1/13/2003	988000	0	
1/14/2003	529000	0	
1/15/2003	998000	0	
1/16/2003	935000	0	
1/17/2003	909000	0	
1/18/2003	923000	0	
1/19/2003	903000	0	
1/20/2003	983000	0	
1/21/2003	956000	0	
1/22/2003	898000	0	
1/23/2003	898000	0	
1/24/2003	826000	-999	drizzle
1/25/2003	970000	-999	drizzle
1/26/2003	1086000	-999	drizzle
1/27/2003	857000	-999	drizzle
1/28/2003	971000	0	
1/29/2003	955000	0	
1/30/2003	901000	0	
1/31/2003	806000	0	
2/1/2003	851000	0	
2/2/2003	950000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
2/3/2003	862000	0	
2/4/2003	786000	0	
2/5/2003	880000	0	
2/6/2003	850000	0	
2/7/2003	1155000	0	
2/8/2003	941000	0.25	
2/9/2003	972000	0.75	
2/10/2003	998000	0	
2/11/2003	886000	0	
2/12/2003	915000	0	
2/13/2003	860000	0	
2/14/2003	1110000	0	
2/15/2003	2128000	1.25	
2/16/2003	1101000	0	
2/17/2003	965000	0	
2/18/2003	956000	0	
2/19/2003	899000	0	
2/20/2003	914000	0	
2/21/2003	907000	0	
2/22/2003	878000	0	
2/23/2003	909000	0	
2/24/2003	824000	-999	drizzle
2/25/2003	800000	-999	drizzle
2/26/2003	831000	-999	drizzle
2/27/2003	910000	0	
2/28/2003	731000	-999	drizzle
3/1/2003	-999	-999	no data
3/2/2003	-999	-999	no data
3/3/2003	-999	-999	no data
3/4/2003	-999	-999	no data
3/5/2003	-999	-999	no data
3/6/2003	-999	-999	no data
3/7/2003	-999	-999	no data
3/8/2003	-999	-999	no data
3/9/2003	-999	-999	no data
3/10/2003	-999	-999	no data
3/11/2003	-999	-999	no data
3/12/2003	-999	-999	no data
3/13/2003	-999	-999	no data
3/14/2003	-999	-999	no data
3/15/2003	-999	-999	no data
3/16/2003	-999	-999	no data
3/17/2003	-999	-999	no data
3/18/2003	-999	-999	no data
3/19/2003	-999	-999	no data
3/20/2003	-999	-999	no data
3/21/2003	-999	-999	no data
3/22/2003	-999	-999	no data
3/23/2003	-999	-999	no data

Day	Volume (G/D)	Rain Fall	Remarks
3/24/2003	-999	-999	no data
3/25/2003	-999	-999	no data
3/26/2003	-999	-999	no data
3/27/2003	-999	-999	no data
3/28/2003	-999	-999	no data
3/29/2003	-999	-999	no data
3/30/2003	-999	-999	no data
3/31/2003	-999	-999	no data
4/1/2003	813000	0	
4/2/2003	889000	0	
4/3/2003	841000	0	
4/4/2003	796000	0	
4/5/2003	923000	0	
4/6/2003	867000	0	
4/7/2003	938000	-999	trace of rain
4/8/2003	802000	0	
4/9/2003	807000	0	
4/10/2003	803000	0	
4/11/2003	868000	-999	trace of rain
4/12/2003	820000	0	
4/13/2003	790000	0	
4/14/2003	841000	0	
4/15/2003	847000	0	
4/16/2003	787000	0	
4/17/2003	834000	0	
4/18/2003	752000	0	
4/19/2003	820000	0	
4/20/2003	784000	0	
4/21/2003	372000	0	
4/22/2003	1185000	0	
4/23/2003	776000	0	
4/24/2003	844000	0	
4/25/2003	770000	0	
4/26/2003	750000	0	
4/27/2003	766000	0	
4/28/2003	820000	0	
4/29/2003	941000	0	
4/30/2003	754000	0	
5/1/2003	751000	0	
5/2/2003	567000	0	
5/3/2003	546000	0	
5/4/2003	265000	0	
5/5/2003	654000	0	
5/6/2003	234000	0	
5/7/2003	1121000	0	
5/8/2003	1121000	0	
5/9/2003	938000	0	
5/10/2003	953000	0	
5/11/2003	913000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
5/12/2003	962000	0	
5/13/2003	984000	0	
5/14/2003	804000	0	
5/15/2003	986000	0	
5/16/2003	902000	0	
5/17/2003	948000	0	
5/18/2003	935000	0	
5/19/2003	737000	0	
5/20/2003	998000	0	
5/21/2003	876000	0	
5/22/2003	858000	0	
5/23/2003	893000	0	
5/24/2003	968000	0	
5/25/2003	938000	0	
5/26/2003	973000	0	
5/27/2003	914000	0	
5/28/2003	929000	0	
5/29/2003	866000	0	
5/30/2003	836000	0	
5/31/2003	851000	0	
6/1/2003	890000	0	
6/2/2003	848000	0	
6/3/2003	947000	0	
6/4/2003	897000	0	
6/5/2003	908000	0	
6/6/2003	914000	0	
6/7/2003	893000	0	
6/8/2003	982000	0	
6/9/2003	1015000	0	
6/10/2003	984000	0	
6/11/2003	999000	0	
6/12/2003	1016000	0	
6/13/2003	1115000	1	
6/14/2003	924000	0	
6/15/2003	874000	0	
6/16/2003	1309000	0	
6/17/2003	914000	0	
6/18/2003	946000	0	
6/19/2003	897000	0	
6/20/2003	958000	0	
6/21/2003	913000	0	
6/22/2003	954000	0	
6/23/2003	981000	0	
6/24/2003	957000	0	
6/25/2003	1023000	0	
6/26/2003	926000	0	
6/27/2003	980000	0	
6/28/2003	906000	0	
6/29/2003	891000	0	

Day	Volume (G/D)	Rain Fall	Remarks
6/30/2003	931000	0	
7/1/2003	1196000	0	
7/2/2003	971000	0	
7/3/2003	959000	1	
7/4/2003	1215000	3.5	
7/5/2003	1718000	0	
7/6/2003	1062000	-999	trace of rain
7/7/2003	970000	0	
7/8/2003	938000	0	
7/9/2003	931000	0	
7/10/2003	1018000	0	
7/11/2003	993000	0	
7/12/2003	922000	0	
7/13/2003	924000	0	
7/14/2003	925000	0	
7/15/2003	1041000	0.75	
7/16/2003	1230000	1.25	
7/17/2003	1155000	-999	trace of rain
7/18/2003	858000	0	
7/19/2003	909000	0	
7/20/2003	938000	0	
7/21/2003	1005000	0	
7/22/2003	992000	0	
7/23/2003	1061000	0	
7/24/2003	949000	0	
7/25/2003	895000	0	
7/26/2003	960000	0	
7/27/2003	994000	0	
7/28/2003	1064000	-999	trace of rain
7/29/2003	1023000	0	
7/30/2003	993000	0	
7/31/2003	1031000	0	
8/1/2003	937000	0	
8/2/2003	876000	0	
8/3/2003	977000	0	
8/4/2003	1020000	0	
8/5/2003	1059000	0	
8/6/2003	1023000	0	
8/7/2003	947000	0	
8/8/2003	1050000	0	
8/9/2003	953000	0	
8/10/2003	1110000	0	
8/11/2003	1120000	0	
8/12/2003	1018000	0	
8/13/2003	966000	0	
8/14/2003	1202000	1	
8/15/2003	1003000	0	
8/16/2003	942000	0	
8/17/2003	1058000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
8/18/2003	1023000	0	
8/19/2003	1047000	0	
8/20/2003	837000	0	
8/21/2003	1018000	0	
8/22/2003	1007000	0	
8/23/2003	1095000	0	
8/24/2003	1013000	0.25	
8/25/2003	1027000	0.75	
8/26/2003	945000	0	
8/27/2003	1037000	0	
8/28/2003	1016000	0	
8/29/2003	953000	0	
8/30/2003	943000	0	
8/31/2003	1082000	1	
9/1/2003	1426000	0	
9/2/2003	1421000	0	
9/3/2003	1068000	0	
9/4/2003	1199000	0	
9/5/2003	1081000	0.125	
9/6/2003	1005000	0	
9/7/2003	982000	0	
9/8/2003	1027000	0	
9/9/2003	954000	0.25	
9/10/2003	804000	0	
9/11/2003	1276000	0	
9/12/2003	1836000	4.5	
9/13/2003	1730000	0	
9/14/2003	1070000	0	
9/15/2003	1307000	1	
9/16/2003	945000	-999	trace of rain
9/17/2003	975000	0	
9/18/2003	2814000	1.5	
9/19/2003	2092000	1.25	
9/20/2003	1652000	0.75	
9/21/2003	2534000	0	
9/22/2003	1805000	0	
9/23/2003	1315000	0	
9/24/2003	1099000	0	
9/25/2003	1073000	0	
9/26/2003	945000	0	
9/27/2003	1012000	0	
9/28/2003	1040000	0	
9/29/2003	973000	0	
9/30/2003	914000	0	
10/1/2003	947000	0	
10/2/2003	1030000	0	
10/3/2003	897000	0	
10/4/2003	1890000	0	
10/5/2003	1105000	0	

Day	Volume (G/D)	Rain Fall	Remarks
10/6/2003	935000	0	
10/7/2003	939000	0	
10/8/2003	1016000	-999	scattered rain
10/9/2003	1007000	-999	trace of rain
10/10/2003	947000	0	
10/11/2003	1048000	-999	scattered rain
10/12/2003	1701000	0	
10/13/2003	1434000	0	
10/14/2003	1003000	-999	drizzle
10/15/2003	1002000	0	
10/16/2003	1019000	0	
10/17/2003	954000	0	
10/18/2003	989000	0	
10/19/2003	989000	0	
10/20/2003	1007000	0	
10/21/2003	957000	0	
10/22/2003	992000	0	
10/23/2003	899000	0	
10/24/2003	1043000	0	
10/25/2003	1134000	0	
10/26/2003	1320000	0	
10/27/2003	1855000	0	
10/28/2003	865000	0	
10/29/2003	899000	0	
10/30/2003	996000	0	
10/31/2003	856000	0	
11/1/2003	994000	0	
11/2/2003	1038000	0	
11/3/2003	966000	0	
11/4/2003	965000	0	
11/5/2003	943000	0	
11/6/2003	950000	0	
11/7/2003	859000	-999	trace of rain
11/8/2003	966000	-999	trace of rain
11/9/2003	1140000	0	
11/10/2003	885000	0	
11/11/2003	950000	0	
11/12/2003	930000	0	
11/13/2003	973000	0	
11/14/2003	877000	0	
11/15/2003	900000	0	
11/16/2003	1024000	0	
11/17/2003	1765000	0	
11/18/2003	1037000	0	
11/19/2003	964000	0	
11/20/2003	980000	0	
11/21/2003	946000	0	
11/22/2003	932000	0	
11/23/2003	916000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
11/24/2003	952000	0	
11/25/2003	998000	0	
11/26/2003	950000	0	
11/27/2003	977000	0	
11/28/2003	978000	0	
11/29/2003	1000000	0	
11/30/2003	990000	0	
12/1/2003	998000	0.25	
12/2/2003	926000	0	
12/3/2003	943000	0	
12/4/2003	992000	0	
12/5/2003	750000	0	
12/6/2003	936000	0	
12/7/2003	947000	0	
12/8/2003	912000	0	
12/9/2003	827000	0	
12/10/2003	927000	0	
12/11/2003	803000	0	
12/12/2003	992000	0	
12/13/2003	840000	-999	trace of rain
12/14/2003	920000	0	
12/15/2003	944000	0	
12/16/2003	873000	0	
12/17/2003	977000	0	
12/18/2003	908000	0	
12/19/2003	985000	0	
12/20/2003	1028000	0	
12/21/2003	958000	0	
12/22/2003	863000	0	
12/23/2003	801000	0	
12/24/2003	729000	0	
12/25/2003	764000	0	
12/26/2003	860000	0	
12/27/2003	675000	0	
12/28/2003	888000	0	
12/29/2003	832000	0.25	
12/30/2003	756000	0	
12/31/2003	920000	0	
1/1/2004	854000	0	
1/2/2004	812000	0	
1/3/2004	744000	0	
1/4/2004	694000	0	
1/5/2004	695000	0	
1/6/2004	616000	0	
1/7/2004	830000	0	
1/9/2004	904000	0	
1/10/2004	854000	0	
1/11/2004	938000	0	
1/12/2004	963000	0	

Day	Volume (G/D)	Rain Fall	Remarks
1/13/2004	1108000	0	
1/14/2004	829000	-999	trace of rain
1/15/2004	931000	0	
1/16/2004	1079000	0.625	
1/17/2004	995000	0	
1/18/2004	921000	0	
1/19/2004	1014000	0	
1/20/2004	958000	0	
1/21/2004	873000	0	
1/22/2004	900000	0.125	
1/23/2004	953000	-999	trace of rain
1/24/2004	1138000	-999	trace of rain
1/25/2004	1078000	0	
1/26/2004	930000	0	
1/27/2004	841000	0	
1/28/2004	834000	0	
1/29/2004	860000	0	
1/30/2004	884000	0	
1/31/2004	880000	0	
2/1/2004	896000	0	
2/2/2004	897000	0	
2/3/2004	843000	0	
2/4/2004	858000	-999	drizzle
2/5/2004	870000	0	
2/6/2004	833000	0	
2/7/2004	917000	0	
2/8/2004	932000	0	
2/9/2004	936000	-999	trace of rain
2/10/2004	1028000	-999	trace of rain
2/11/2004	908000	0	
2/12/2004	931000	0	
2/13/2004	935000	0	
2/14/2004	959000	0	
2/15/2004	993000	0	
2/16/2004	893000	0	
2/17/2004	903000	0	
2/18/2004	944000	0	
2/19/2004	947000	0	
2/20/2004	869000	0	
2/21/2004	889000	0	
2/22/2004	919000	0	
2/23/2004	875000	0	
2/24/2004	2091000	2.75	
2/25/2004	1799000	0	
2/26/2004	1100000	0	
2/27/2004	898000	0	
2/28/2004	909000	0	
2/29/2004	940000	0	
3/1/2004	923000	-999	trace of rain

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
3/2/2004	1024000	0	
3/3/2004	922000	0	
3/4/2004	902000	-999	trace of rain
3/5/2004	921000	0	
3/6/2004	928000	0	
3/7/2004	965000	0	
3/8/2004	953000	0	
3/9/2004	992000	0	
3/10/2004	922000	0	
3/11/2004	831000	0	
3/12/2004	890000	-999	drizzle
3/13/2004	922000	0	
3/14/2004	1407000	1.25	
3/15/2004	1229000	0	
3/16/2004	1060000	0	
3/17/2004	1071000	0	
3/18/2004	1019000	0	
3/19/2004	1007000	0	
3/20/2004	917000	0	
3/21/2004	953000	0	
3/22/2004	958000	0	
3/23/2004	909000	0	
3/24/2004	954000	0	
3/25/2004	1040000	0	
3/26/2004	1254000	0	
3/27/2004	947000	0	
3/28/2004	976000	0	
3/29/2004	983000	-999	trace of rain
3/30/2004	860000	0	
3/31/2004	919000	0	
4/1/2004	902000	0	
4/2/2004	778000	0	
4/3/2004	910000	-999	drizzle
4/4/2004	1360000	0	
4/5/2004	1067000	0.75	
4/6/2004	2288000	0	
4/7/2004	1187000	0	
4/8/2004	1006000	0	
4/9/2004	969000	0	
4/10/2004	996000	0	
4/11/2004	872000	-999	trace of rain
4/12/2004	898000	-999	trace of rain
4/13/2004	874000	0	
4/14/2004	1003000	0	
4/15/2004	1386000	0	
4/16/2004	1063000	0	
4/17/2004	1364000	0	
4/18/2004	1507000	0	
4/19/2004	1068000	0	

Day	Volume (G/D)	Rain Fall	Remarks
4/20/2004	1182000	0	
4/21/2004	1156000	0	
4/22/2004	1096000	0	
4/23/2004	1048000	0	
4/24/2004	1452000	0	
4/25/2004	1786000	6.5	
4/26/2004	1904000	-999	trace of rain
4/27/2004	2635000	0	
4/28/2004	1406000	0	
4/29/2004	1252000	0	
4/30/2004	1066000	0	
5/1/2004	2714000	0	
5/2/2004	2156000	0	
5/3/2004	1345000	0	
5/4/2004	1182000	0	
5/5/2004	1214000	0	
5/6/2004	1141000	0	
5/7/2004	2270000	0	
5/8/2004	2805000	1	
5/9/2004	2784000	0.5	
5/10/2004	2230000	0	
5/11/2004	1511000	0	
5/12/2004	1572000	0	
5/13/2004	1766000	0	
5/14/2004	2690000	1.5	
5/15/2004	1435000	0	
5/16/2004	1218000	0	
5/17/2004	1216000	0	
5/18/2004	1000000	0	
5/19/2004	1140000	0	
5/20/2004	761000	0	
5/21/2004	1037000	0	
5/22/2004	796000	0	
5/23/2004	936000	0	
5/24/2004	987000	0	
5/25/2004	980000	0	
5/26/2004	1028000	0	
5/27/2004	926000	0	
5/28/2004	1014000	0	
5/29/2004	1000000	0	
5/30/2004	941000	0	
5/31/2004	1038000	0	
6/1/2004	-999	-999	no data
6/2/2004	-999	-999	no data
6/3/2004	-999	-999	no data
6/4/2004	-999	-999	no data
6/5/2004	-999	-999	no data
6/6/2004	-999	-999	no data
6/7/2004	-999	-999	no data

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
6/8/2004	-999	-999	no data
6/9/2004	-999	-999	no data
6/10/2004	-999	-999	no data
6/11/2004	-999	-999	no data
6/12/2004	-999	-999	no data
6/13/2004	-999	-999	no data
6/14/2004	-999	-999	no data
6/15/2004	-999	-999	no data
6/16/2004	-999	-999	no data
6/17/2004	-999	-999	no data
6/18/2004	-999	-999	no data
6/19/2004	-999	-999	no data
6/20/2004	-999	-999	no data
6/21/2004	-999	-999	no data
6/22/2004	-999	-999	no data
6/23/2004	-999	-999	no data
6/24/2004	-999	-999	no data
6/25/2004	-999	-999	no data
6/26/2004	-999	-999	no data
6/27/2004	-999	-999	no data
6/28/2004	-999	-999	no data
6/29/2004	-999	-999	no data
6/30/2004	-999	-999	no data
7/1/2004	1218000	0	
7/2/2004	1228000	0	
7/3/2004	971000	0	
7/4/2004	943000	0	
7/5/2004	958000	0	
7/6/2004	989000	0	
7/7/2004	973000	0	
7/8/2004	979000	0	
7/9/2004	941000	0	
7/10/2004	1038000	-999	scattered rain
7/11/2004	939000	0.25	
7/12/2004	931000	0	
7/13/2004	963000	0	
7/14/2004	1038000	0	
7/15/2004	934000	0	
7/16/2004	873000	0	
7/17/2004	944000	0	
7/18/2004	926000	0	
7/19/2004	968000	0	
7/20/2004	960000	0	
7/21/2004	1074000	0	
7/22/2004	861000	0	
7/23/2004	994000	0	
7/24/2004	925000	0	
7/25/2004	977000	0	
7/26/2004	1004000	0	

Day	Volume (G/D)	Rain Fall	Remarks
7/27/2004	1006000	0	
7/28/2004	1000000	0	
7/29/2004	983000	0	
7/30/2004	991000	0	
7/31/2004	1192000	0	
8/1/2004	963000	0	
8/2/2004	1022000	0	
8/3/2004	975000	0	
8/4/2004	985000	0	
8/5/2004	993000	0	
8/6/2004	981000	0	
8/7/2004	854000	0	
8/8/2004	1322000	0	
8/9/2004	1097000	0.5	
8/10/2004	1279000	0	
8/11/2004	1307000	0	
8/12/2004	1003000	0	
8/13/2004	891000	0	
8/14/2004	1005000	0	
8/15/2004	973000	0	
8/16/2004	1087000	0	
8/17/2004	863000	0	
8/18/2004	997000	0	
8/19/2004	860000	0	
8/20/2004	952000	0	
8/21/2004	888000	0	
8/22/2004	991000	0	
8/23/2004	913000	0	
8/24/2004	946000	0	
8/25/2004	890000	0	
8/26/2004	905000	0	
8/27/2004	929000	0	
8/28/2004	1010000	0	
8/29/2004	1283000	0.25	
8/30/2004	940000	0.75	
8/31/2004	1022000	0.25	
9/1/2004	1140000	-999	trace of rain
9/2/2004	965000	0.5	
9/3/2004	1027000	0.125	
9/4/2004	1592000	0.75	
9/5/2004	1041000	-999	trace of rain
9/6/2004	1039000	0	
9/7/2004	933000	-999	trace of rain
9/8/2004	891000	0	
9/9/2004	915000	0	
9/10/2004	893000	0	
9/11/2004	881000	0	
9/12/2004	937000	0	
9/13/2004	1116000	0.5	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
9/14/2004	987000	0	
9/15/2004	866000	0	
9/16/2004	962000	0	
9/17/2004	895000	0	
9/18/2004	953000	0	
9/19/2004	1247000	0	
9/20/2004	981000	0	
9/21/2004	1307000	0	
9/22/2004	917000	0	
9/23/2004	1089000	-999	trace of rain
9/24/2004	962000	0	
9/25/2004	1393000	0	
9/26/2004	1368000	0.75	
9/27/2004	1021000	0	
9/28/2004	973000	0	
9/29/2004	979000	0	
9/30/2004	1005000	0	
10/1/2004	1508000	0	
10/2/2004	1108000	0	
10/3/2004	977000	-999	trace of rain
10/4/2004	992000	0	
10/5/2004	1239000	0.25	
10/6/2004	1095000	0.25	
10/7/2004	1094000	-999	trace of rain
10/8/2004	978000	0.25	
10/9/2004	986000	0	
10/10/2004	911000	0	
10/11/2004	901000	0	
10/12/2004	914000	0	
10/13/2004	981000	0	
10/14/2004	950000	1	
10/15/2004	923000	0	
10/16/2004	965000	0	
10/17/2004	979000	0	
10/18/2004	1013000	0	
10/19/2004	1003000	0	
10/20/2004	1005000	0	
10/21/2004	950000	0	
10/22/2004	911000	0	
10/23/2004	993000	0	
10/24/2004	918000	0	
10/25/2004	964000	0	
10/26/2004	1033000	0	
10/27/2004	954000	-999	trace of rain
10/28/2004	886000	0	
10/29/2004	992000	0	
10/30/2004	895000	0	
10/31/2004	835000	0	
11/1/2004	1042000	0.25	

Day	Volume (G/D)	Rain Fall	Remarks
11/2/2004	968000	0.25	
11/3/2004	943000	0	
11/4/2004	946000	0	
11/5/2004	984000	0	
11/6/2004	821000	0	
11/7/2004	969000	0	
11/8/2004	890000	0	
11/9/2004	989000	0	
11/10/2004	936000	0	
11/11/2004	922000	0	
11/12/2004	564000	0	
11/13/2004	1206000	0	
11/14/2004	1181000	-999	sprinkles
11/15/2004	1070000	0.75	
11/16/2004	1033000	0	
11/17/2004	952000	0	
11/18/2004	971000	0	
11/19/2004	1109000	0	
11/20/2004	1266000	0	
11/21/2004	1101000	0	
11/22/2004	1049000	0	
11/23/2004	985000	0	
11/24/2004	961000	0	
11/25/2004	888000	0	
11/26/2004	907000	0	
11/27/2004	934000	0	
11/28/2004	936000	0	
11/29/2004	928000	0	
11/30/2004	948000	0.5	
12/1/2004	911000	0	
12/2/2004	990000	0	
12/3/2004	928000	-999	trace of rain
12/4/2004	847000	-999	trace of rain
12/5/2004	910000	-999	trace of rain
12/6/2004	911000	-999	trace of rain
12/7/2004	910000	0	
12/8/2004	866000	0	
12/9/2004	829000	0	
12/10/2004	858000	0	
12/11/2004	832000	0	
12/12/2004	891000	0	
12/13/2004	877000	0	
12/14/2004	873000	0	
12/15/2004	796000	0	
12/16/2004	883000	0	
12/17/2004	848000	0	
12/18/2004	868000	0	
12/19/2004	892000	0	
12/20/2004	936000	0	

Appendix I Daily discharge from the Robstown Waste Water Treatment Plant

Day	Volume (G/D)	Rain Fall	Remarks
12/21/2004	900000	0	
12/22/2004	871000	-999	trace of rain
12/23/2004	945000	0	
12/24/2004	956000	0	
12/25/2004	950000	-999	5" snow
12/26/2004	901000	0	
12/27/2004	967000	0	
12/28/2004	1335000	0	
12/29/2004	360000	0	
12/30/2004	1377000	0	
12/31/2004	947000	0	
1/1/2005	866000	0	
1/2/2005	936000	-999	trace of rain
1/3/2005	972000	0	
1/4/2005	894000	0	
1/5/2005	961000	0	
1/6/2005	839000	0	
1/7/2005	850000	0	
1/8/2005	900000	0	
1/9/2005	964000	0	
1/10/2005	949000	0	
1/11/2005	947000	0	
1/12/2005	1196000	0	
1/13/2005	962000	1.125	
1/14/2005	994000	0	
1/15/2005	1110000	0	
1/16/2005	861000	0	
1/17/2005	807000	0	
1/18/2005	1073000	0	
1/19/2005	1048000	0	
1/20/2005	997000	0	
1/21/2005	989000	0	
1/22/2005	997000	0	
1/23/2005	936000	0	
1/24/2005	964000	0	
1/25/2005	927000	0	
1/26/2005	994000	0	
1/27/2005	1096000	0	
1/28/2005	981000	0.5	
1/29/2005	843000	0	
1/30/2005	997000	0	
1/31/2005	1057000	0.5	
2/1/2005	724000	0.25	
2/2/2005	973000	0.125	
2/3/2005	943000	0	
2/4/2005	535000	0	
2/5/2005	1205000	0	
2/6/2005	953000	0	
2/7/2005	458000	-999	trace of rain

Day	Volume (G/D)	Rain Fall	Remarks
2/8/2005	1314000	-999	trace of rain
2/9/2005	920000	0	
2/10/2005	935000	0	
2/11/2005	928000	0	
2/12/2005	921000	0	
2/13/2005	1011000	0	
2/14/2005	956000	0	
2/15/2005	1000000	0	
2/16/2005	916000	0	
2/17/2005	905000	0	
2/18/2005	906000	-999	trace of rain
2/19/2005	912000	0.125	
2/20/2005	918000	-999	trace of rain
2/21/2005	942000	0	
2/22/2005	836000	0	
2/23/2005	965000	0	
2/24/2005	1639000	0.5	
2/25/2005	1113000	0	
2/26/2005	1392000	2	
2/27/2005	1924000	0	
2/28/2005	1561000	0	
3/1/2005	1091000	0	
3/2/2005	992000	0	
3/3/2005	962000	0	
3/4/2005	926000	0.25	
3/5/2005	866000	0	
3/6/2005	1053000	0	
3/7/2005	965000	0	
3/8/2005	899000	0.125	
3/9/2005	1011000	0	
3/10/2005	906000	0	
3/11/2005	851000	0	
3/12/2005	919000	0	
3/13/2005	918000	0	
3/14/2005	916000	0	
3/15/2005	1001000	0.5	
3/16/2005	983000	0.5	
3/17/2005	932000	0	
3/18/2005	859000	0	
3/19/2005	2025000	1.25	
3/20/2005	2261000	0	
3/21/2005	1315000	-999	drizzle
3/22/2005	1046000	0	
3/23/2005	918000	0	
3/24/2005	931000	0	
3/25/2005	997000	0	
3/26/2005	924000	0	
3/27/2005	857000	0	
3/28/2005	945000	0	

Day	Volume (G/D)	Rain Fall	Remarks
3/29/2005	925000	0	
3/30/2005	881000	0	
3/31/2005	900000	0	

Appendix II

Discharges from the Greenwood Waste Water Treatment Plant

Appendix II – Discharge Measurements from the Greenwood WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD | **TX PERMIT#:10401-03** | **EPA PERMIT#: TX0047074** | **January-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	4.132	3472	160	2	2	69	176	3	4	103	0.49	16.89	
2	4.022	2777	259	3		101	240	6		201	0.46	15.43	
3	4.405	3819	268	2		73	404	6		220	0.80	29.39	
4	4.063	3472	272	3		102	726	8		271	0.40	13.55	
5	4.726	3611	267	3		118	472	12		473	2.40	94.60	
6	4.578	3541	294	2		76	724	7		267	0.58	22.14	
7	4.523	3472	306	2		75	716	10		377	0.69	26.03	0.25
8	4.309	3472	270	2	2	72	444	8	8	287	0.37	13.30	
9	4.282	3194	259	2		71	480	7		250	1.10	39.28	
10	4.699	3472	275	2		78	472	5		196	0.46	18.03	
11	4.766	3472	250	3		119	400	9		358	0.20	7.95	
12	4.656	3819	273	3		116	412	5		194	0.10	3.88	
13	4.696	3472	298	2		78	512	5		196	0.17	6.66	
14	4.302	3472	267	2		72	384	9		323	0.13	4.66	
15	3.779	2986	222	2	2	63	304	3	6	95	0.10	3.15	
16	3.653	2777	314	3		91	420	6		183	0.72	21.94	
17	4.308	3472	276	2		72	428	4		144	0.18	6.47	
18	4.690	3472	330	2		78	556	6		235	0.11	4.30	
19	4.600	3472	275	2		77	424	5		192	0.10	3.84	
20	4.562	3750	300	3		114	1160	4		152	0.19	7.23	
21	3.990	3125	284	2		67	432	4		133	0.23	7.65	
22	3.808	3472	246	2	2	64	340	5	5	159	0.15	4.76	
23	3.802	3125	289	2		63	448	6		190	0.10	3.17	
24	4.469	3819	251	2		75	444	5		186	0.13	4.85	
25	4.906	3125	594	5		205	1152	5		205	1.70	69.56	
26	4.601	3472	299	4		153	344	4		153	0.62	23.79	
27	4.712	3471	241	2		79	252	4		157	0.29	11.40	0.30
28	4.171	3263	216	2		70	228	3		104	0.25	8.70	
29	4.010	3472	236	2	3	67	216	3	4	100	0.27	9.03	
30	3.923	3125	219	2		65	244	3		98	0.19	6.22	
31	4.440	3472	296	4		148	286	4		148	0.51	18.89	
TOTAL	134.583	105407	8606	76	12	2772	14240	174	28	6352	14.19	526.72	0.55
AVERAGE	4.341	3400	278	2	2	89	459	6	6	205	0.46	16.99	
MAX.	4.906	3819	594	5	3	205	1160	12	8	473	2.40	94.60	
MIN.	3.653	2777	160		2	63	176	3	4	95	0.10	3.15	
%red				99.12				98.78					

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD | **TX PERMIT#:10401-03** | **EPA PERMIT#: TX0047074** | **Feb. 2000**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	4.711	3819	221	6		236	276	56		2200	2.20	86.44	0.15
2	4.775	3858	150	3		119	120	17		677	0.97	38.63	0.45
3	4.380	3472	222	2		73	192	3		110	0.51	18.63	
4	4.062	3472	206	4		136	212	2		68	0.39	13.21	
5	3.611	3125	162	2	3	60	94	16	14	482	0.42	12.65	
6	3.689	3125	272	2		62	228	4		123	0.54	16.61	
7	4.069	3472	284	3		102	616	5		170	2.40	81.45	
8	4.238	3472	591	3		106	980	19		672	3.50	123.71	
9	4.130	3125	323	4		138	1345	12		413	0.80	27.56	
10	4.129	3472	323	4		138	1407	31		1068	0.48	16.53	
11	3.946	3333	268	2		66	440	5		165	0.25	8.23	
12	3.863	3680	273	2	3	64	372	4	11	129	0.29	9.34	
13	3.813	3125	293	2		64	336	5		159	0.67	21.31	
14	4.197	3125	261	2		70	324	4		140	0.16	5.60	
15	4.133	3125	285	2		69	336	7		241	0.10	3.45	
16	4.307	3472	261	2		72	352	13		467	0.21	7.54	
17	4.289	3472	258	2		72	344	5		179	0.27	9.66	
18	4.025	3472	298	2		67	440	4		134	0.21	7.05	
19	3.551	2777	226	2	2	59	586	4	6	118	0.27	8.00	
20	3.647	3472	304	2		61	360	2		61	0.26	7.91	
21	3.849	3125	264	2		64	340	5		161	0.24	7.70	
22	3.865	3125	288	3		97	332	17		548	0.25	8.06	
23	3.824	2986	269	2		64	324	5		159	0.33	10.52	
24	3.544	2777	233	2		59	252	6		177	0.34	10.05	
25	3.768	3055	244	3		94	268	31		974	0.28	8.80	
26	3.643	3125	252	3	2	91	384	16	12	486	0.24	7.29	
27	3.345	2777	280	3		84	384	11		307	0.24	6.70	
28	3.583	2777	312	3		90	444	8		239	0.94	28.09	
29	3.979	3125	268	3		100	396	12		398	0.75	24.89	
TOTAL	114.965	94337	7891	77	11	2574	12484	329	44	11224	18.51	635.59	0.60
AVERAGE	3.964	3253	272	3	3	89	430	11	11	387	0.64	21.92	
MAX.	4.775	3858	591	6	3	236	1407	56	14	2200	3.50	123.71	
MIN.	3.345	2777	150		2	59	94	2	6	61	0.10	3.45	
%red				99.02				97.36					

Appendix II – Discharge Measurements from the Greenwood WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD | TX PERMIT#:10401-03 | EPA PERMIT#: TX0047074 | March-00

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 7-DAY AVG mg/l	NH3 FINAL lbs	RAINFALL inches
1	3.931	3055	230	2		66	392	7		229	0.30		9.84	
2	4.031	3125	298	4		134	492	7		235	0.14		4.71	
3	3.583	3125	300	2		60	536	6		179	0.13		3.88	
4	3.578	3125	240	2	3	60	460	5	8	149	0.10	0.37	2.98	
5	3.456	2638	294	2		58	440	7		202	0.10		2.88	
6	3.826	3125	322	2		64	528	6		191	0.10		3.19	
7	3.726	2777	309	2		62	496	8		249	0.15		4.66	
8	3.859	3125	284	2		64	408	5		161	0.18		5.79	
9	3.999	3472	288	3		100	352	3		100	0.36		12.01	
10	3.954	3125	280	3		99	336	3		99	0.32		10.55	
11	3.602	2986	270	3	2	90	212	3	5	90	0.11	0.19	3.30	
12	3.489	2777	224	3		87	244	2		58	0.14		4.07	
13	4.135	3472	309	3		103	356	2		69	0.34		11.73	
14	14.551	6944	352	5		607	756	18		2184	0.80		97.08	3.00
15	8.403	6944	115	8		561	228	23		1612	0.38		26.63	
16	6.005	6944	196	4		200	372	8		401	2.10		105.17	
17	4.732	3125	194	4		158	364	7		276	1.60		63.14	
18	4.836	3125	420	5	5	202	780	7	10	282	2.70	1.15	108.90	
19	4.136	3472	457	3		103	760	8		276	0.98		33.80	
20	4.679	3472	364	4		156	688	10		390	3.90		152.19	
21	4.420	3819	236	5		184	336	9		332	0.39		14.38	
22	4.223	3125	226	4		141	380	4		141	0.14		4.93	
23	4.114	3472	227	3		103	280	4		137	0.19		6.52	
24	4.208	3750	208	3		105	160	3		105	0.45		15.79	
25	3.647	2916	230	3	4	91	316	4	6	122	0.18	0.89	5.47	
26	3.492	2916	224	3		87	292	4		116	0.37		10.78	
27	4.439	3472	273	4		148	532	28		1037	0.49		18.14	
28	4.506	3333	194	7		263	544	21		789	0.33		12.40	
29	4.570	3472	237	4		152	832	5		191	0.11		4.19	
30	4.906	3472	328	4		164	1260	6		245	2.40		98.20	
31	4.785	3125	219	4		160	348	4		160	0.34		13.57	
TOTAL	143.821	110825	8348	110	13	4633	14480	237	29	10809	20.32	2.60	870.89	3.00
AVERAGE	4.639	3575	269	4	3	149	467	8	7	349	0.66	0.65	28.09	
MAX.	14.551	6944	457	8	5	607	1260	28	10	2184	3.90	1.15	152.19	
MIN.	3.456	2638	115		2	58	160	2	5	58	0.10	0.19	2.88	
%red				98.68				98.36						

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD | TX PERMIT#:10401-03 | EPA PERMIT#: TX0047074 | April-00

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	4.312	3472	234	4	4	144	228	3	10	108	0.16	5.75	
2	4.476	3819	207	3		112	208	3		112	0.17	6.35	0.10
3	4.504	3472	250	3		113	456	4		150	0.31	11.64	
4	3.381	3125	231	3		85	340	4		113	0.11	3.10	
5	2.943	2222	321	3		74	584	3		74	0.20	4.91	
6	3.164	2083	280	2		53	376	2		53	0.20	5.28	
7	3.010	2361	242	2		50	518	4		100	0.22	5.52	
8	3.798	2083	155	2	3	63	192	5	4	158	0.19	6.02	
9	2.744	2083	204	2		46	220	4		92	0.24	5.49	
10	3.169	2500	258	2		53	310	2		53	0.33	8.72	
11	3.074	2430	254	3		77	300	6		154	0.11	2.82	
12	4.272	4513	244	3		107	360	2		71	0.45	16.03	0.60
13	2.930	2222	208	2		49	204	2		49	0.22	5.38	
14	2.991	2083	163	2		50	160	2		50	0.20	4.99	
15	2.943	2083	180	2	2	49	170	2	3	49	0.46	11.29	
16	2.857	2083	228	2		48	160	2		48	0.13	3.10	
17	3.137	2430	266	3		78	216	2		52	0.13	3.40	
18	3.155	2361	322	2		53	580	3		79	*		
19	3.124	2430	259	2		52	324	4		104	0.10	2.61	
20	2.939	2083	225	2		49	276	3		74	0.10	2.45	
21	3.054	2777	528	3		76	1100	4		102	0.42	10.70	
22	2.856	2083	213	2	2	48	256	4	3	95	0.34	8.10	
23	2.929	1944	194	2		49	236	5		122	0.34	8.31	
24	3.008	2083	226	2		50	276	4		100	0.30	7.53	
25	3.097	2430	260	2		52	232	3		77	0.20	5.17	
26	3.076	2361	221	2		51	312	6		154	0.11	2.82	
27	2.922	2083	199	3		73	228	4		97	1.60	38.99	
28	2.764	2083	177	2		46	208	3		69	0.10	2.31	
29	2.866	2083	205	2	2	48	216	3	4	72	0.10	2.39	
30	2.850	2083	205	2		48	244	4		95	0.10	2.38	
31													
TOTAL	96.345	73948	7159	71	9	1944	9490	102	24	2727	7.64	203.53	0.70
AVERAGE	3.212	2465	239	2	2	65	316	3	5	91	0.26	7.02	
MAX.	4.504	4513	528	4	3	144	1100	6	10	158	1.60	38.99	
MIN.	2.744	1944	155		2	46	160	2	3	48	0.10	2.31	
%red				99.01				98.93					

Appendix II – Discharge Measurements from the Greenwood WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **May-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	2.915	2083	282	2		49	236	3		73	0.10	2.43	0.43
2	3.362	2777	225	3		84	220	4		112	0.10	2.80	0.55
3	3.033	2222	222	2		51	240	2		51	0.11	2.78	
4	3.203	2430	199	2		53	160	3		80	0.17	4.54	
5	2.857	2291	208	2		48	292	2		48	0.15	3.57	
6	2.829	2291	201	2	2	47	140	2	3	47	0.14	3.30	
7	2.685	2083	218	2		45	192	2		45	0.12	2.69	
8	3.042	2222	218	2		51	212	2		51	0.12	3.04	
9	2.837	2083	233	2		47	258	3		71	0.12	2.84	
10	3.260	2291	216	2		54	268	5		136	0.10	2.72	
11	2.930	2361	261	2		49	232	3		73	0.10	2.44	
12	3.008	2083	220	2		50	176	3		75	0.10	2.51	0.55
13	3.450	2777	180	2	2	58	220	2	3	58	0.10	2.88	
14	2.632	1944	175	2		44	200	4		88	0.10	2.20	
15	2.912	2083	190	2		49	228	3		73	0.13	3.16	
16	2.295	1736	198	2		38	232	4		77	0.16	3.06	
17	2.389	1736	232	3		60	232	3		60	0.16	3.19	
18	2.327	1944	228	2		39	244	3		58	0.10	1.94	
19	2.891	1666	208	2		48	254	4		96	0.12	2.89	1.65
20	5.042	3472	154	3	2	126	328	9	4	378	0.65	27.33	
21	3.154	2430	143	3		79	200	3		79	0.10	2.63	
22	3.134	2222	158	2		52	224	3		78	0.10	2.61	
23	3.087	2222	186	2		51	236	2		51	0.10	2.57	
24	2.535	1944	203	2		42	180	2		42	0.10	2.11	
25	2.401	1875	199	2		40	208	2		40	0.10	2.00	
26	2.306	1597	170	2		38	152	2		38	0.10	1.92	
27	2.110	1388	160	2	2	35	124	2	2	35	0.10	1.76	
28	2.157	1597	190	2		36	380	2		36	0.10	1.80	
29	3.213	2152	176	2		54	400	2		54	0.10	2.68	
30	3.331	2777	146	2		56	208	3		0	0.12	3.33	
31	3.321	2430	180	2		55	64	2		0	0.10	2.77	
TOTAL	90.648	67209	6179	66	9	1628	6940	91	12	2204	4.07	108.52	3.18
AVERAGE	2.924	2168	199	2	2	53	224	3	3	71	0.13	3.50	
MAX.	5.042	3472	282	3	2	126	400	9	4	378	0.65	27.33	
MIN.	2.110	1388	143		2	35	64	2	2	0	0.10	1.76	
%red				98.93				98.69					

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **June-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	3.099	2430	248	2		52	276	2		52	0.10	2.58	
2	3.182	2500	258	2		53	304	2		53	0.10	2.65	
3	2.993	2222	228	2	2	50	228	2	2	50	0.10	2.50	
4	2.887	2083	202	2		48	176	2		48	0.10	2.41	
5	3.277	2083	208	2		55	212	2		55	0.10	2.73	
6	3.324	1736	226	2		55	340	2		55	0.10	2.77	
7	2.638	6944	301	3		66	460	6		132	4.00	88.00	
8	3.772	1944	281	3		94	278	2		63	0.29	9.12	
9	4.518	3125	224	2		75	284	3		113	0.10	3.77	
10	6.468	6875	148	2	2	108	284	33	7	1780	0.54	29.13	
11	4.496	3680	163	2		75	212	6		225	0.12	4.50	
12	4.943	4027	203	5		206	220	5		206	2.20	90.69	
13	4.160	3125	181	2		69	204	6		208	0.34	11.80	
14	3.169	3665	215	2		53	248	2		53	0.10	2.64	
15	2.496	5208	227	3		62	280	3		62	0.29	6.04	
16	3.194	2500	252	2		53	300	2		53	0.15	4.00	
17	2.702	2083	171	2	3	45	204	3	4	68	*	0.00	
18	2.884	2013	190	2		48	184	3		72	0.13	3.13	
19	2.722	2222	274	2		45	424	3		68	0.18	4.09	
20	3.298	2916	208	2		55	196	2		55	0.10	2.75	
21	3.333	1875	441	2		56	404	3		83	0.13	3.61	
22	3.352	1805	252	2		56	356	3		84	0.25	6.99	
23	3.142	2083	254	2		52	916	4		105	0.12	3.14	
24	2.944	2083	187	2	2	49	188	4	3	98	*	0.00	
25	2.914	2083	176	2		49	124	2		49	0.10	2.43	
26	3.172	1736	150	2		53	488	2		53	0.10	2.65	
27	3.078	1736	217	2		51	200	2		51	0.10	2.57	
28	3.115	1388	209	2		52	188	2		52	0.10	2.60	
29	3.197	1736	207	2		53	260	2		53	0.10	2.67	
30	3.119	1736	252	2		52	320	3		78	0.10	2.60	
TOTAL	101.588	81642	6753	66	9	1892	8758	118	16	4178	10.24	304.56	0.00
Avg	3.386	2721	225	2	2	63	292	4	4	139	0.37	10.15	
MAX.	6.468	6944	441	5	3	206	916	33	7	1780	4.00	90.69	
MIN.	2.496	1388	148	2	2	45	124	2	2	48	0.10	0.00	
%red				99.02				98.65					

Appendix II – Discharge Measurements from the Greenwood WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **Jul-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	2.225	1736	230	2	2	37	232	3	2	56	0.10	1.86	
2	2.257	1736	212	2		38	284	4		75	0.10	1.88	
3	2.197	1388	226	2		37	292	4		73	0.20	3.66	
4	2.080	1319	198	2		35	188	4		69	0.10	1.73	
5	2.376	1875	246	3		59	632	4		79	0.10	1.98	
6	2.365	1736	232	2		39	444	2		39	0.10	1.97	
7	2.257	1736	146	4		75	132	4		75	0.10	1.88	
8	1.865	1388	212	2	2	31	252	2	3	31	0.10	1.56	
9	2.656	2083	157	2		44	152	3		66	0.10	2.22	
10	2.859	2083	176	2		48	176	2		48	0.10	2.38	
11	2.377	2083	236	2		40	264	3		59	0.10	1.98	
12	2.281	1736	242	2		38	688	2		38	0.10	1.90	
13	2.122	1736	211	2		35	276	3		53	0.20	3.54	
14	2.258	1666	211	2		38	184	3		56	0.10	1.88	
15	2.105	1388	128	2	2	35	144	2	3	35	0.16	2.81	
16	2.017	1527	173	2		34	204	3		50	0.16	2.69	
17	3.266	1388	257	2		54	524	6		163	2.20	59.92	
18	2.657	2083	201	2		44	1512	4		89	0.11	2.44	
19	1.882	1597	218	2		31	312	6		94	0.10	1.57	
20	2.438	5347	237	2		41	544	6		122	2.30	46.77	
21	2.208	1388	244	2		37	536	3		55	0.18	3.31	
22	2.176	1597	179	2	2	36	952	2	4	36	0.17	3.09	
23	2.824	2777	163	2		47	396	4		94	0.20	4.71	
24	2.343	1736	226	2		39	344	2		39	0.16	3.13	
25	2.594	2083	291	2		43	404	3		65	0.15	3.25	
26	1.837	1736	187	2		31	212	2		31	0.17	2.60	
27	2.945	1597	154	2		49	328	2		49	0.13	3.19	
28	2.522	1875	301	2		42	612	2		42	0.10	2.10	
29	3.227	2638	148	3	2	81	1050	12	4	323	3.80	102.27	
30	3.413	3125	220	3		85	1110	2		57	4.20	119.55	
31	3.329	2430	234	2		56	420	2		56	0.10	2.78	
TOTAL	75.958	60613	6496	67	11	1380	13800	106	16	2221	15.99	396.61	0.00
AVG	2.450	1955	210	2	2	45	445	3	3	72	0.52	12.79	
MAX.	3.413	5347	301	4	2	85	1512	12	4	323	4.20	119.55	
MIN.	1.837	1319	128		2	31	132	2	2	31	0.10	1.56	
%red				98.97				99.23					

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **August-00**

DATE	FLOW MGD	PEAK FLOW GPM	RAW mg/l	FINAL mg/l	7-DAY AVG mg/l	FINAL lbs	RAW mg/l	FINAL mg/l	7-DAY AVG mg/l	FINAL lbs	FINAL mg/l	FINAL lbs	Rainfall inches
1	2.054	2430	150	3		51	244	8		137	0.13	2.23	
2	3.421	5833	146	2		57	248	5		143	0.10	2.85	
3	2.501	1597	220	2		42	232	2		42	0.20	4.17	
4	2.390	1736	244	2		40	364	2		40	0.10	1.99	
5	2.278	1597	187	2	2	38	176	2	3	38	0.10	1.90	
6	2.240	1388	187	2		37	336	2		37	0.10	1.87	
7	2.481	2083	230	2		41	268	2		41	0.10	2.07	
8	2.479	2083	266	2		41	288	2		41	0.10	2.07	
9	2.512	1736	206	2		42	364	2		42	0.10	2.10	
10	2.653	2083	200	2		44	388	3		66	0.10	2.21	
11	2.377	1597	217	2		40	356	3		59	0.10	1.98	
12	2.078	4597	177	2	2	35	472	3	2	52	0.10	1.73	
13	2.146	1736	192	2		36	700	3		54	0.10	1.79	
14	3.024	2430	261	2		50	816	2		50	0.10	2.52	0.85
15	4.076	3125	274	3		102	772	7		238	0.10	3.40	0.16
16	3.507	2430	304	2		58	868	4		117	0.10	2.92	
17	2.715	1944	262	2		45	488	3		68	0.10	2.26	
18	2.539	1736	236	2		42	440	2		42	0.10	2.12	
19	2.295	1528	262	2	2	38	752	2	3	38	0.10	1.91	
20	2.250	1388	300	2		38	1180	2		38	0.10	1.88	
21	2.288	2083	192	2		38	216	2		38	0.10	1.91	
22	2.455	1736	150	3		61	494	3		61	0.10	2.05	
23	2.332	1736	147	2		39	216	3		58	0.30	5.83	
24	2.309	1736	189	2		39	368	2		39	0.20	3.85	
25	2.121	1736	190	2		35	240	7		124	0.10	1.77	
26	1.998	1319	184	2	2	33	276	2	3	33	0.10	1.67	
27	2.045	1736	135	2		34	256	4		68	0.10	1.71	
28	2.898	2083	255	3		73	476	3		73	0.20	4.83	
29	2.884	1597	174	2		48	224	4		96	0.10	2.41	
30	3.464	3125	168	2		58	470	2		58	0.20	5.78	
31	3.118	1736	241	2		52	330	3		78	0.10	2.60	
TOTAl	79.928	65700	6546	66	9	1429	13318	96	12	2111	3.73	80.38	1.01
AVG	2.578	2119	211	2	2	46	430	3	3	68	0.12	2.59	
MAX.	4.076	5833	304	3	2	102	1180	8	3	238	0.30	5.83	
MIN.	1.998	1319	135		2	33	176	2	2	33	0.10	1.67	
%red				98.99				99.28					

Appendix II – Discharge Measurements from the Greenwood WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **Sep-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	3.111	1875	187	2		52	350	8		208	0.10	2.59	
2	2.896	1736	204	2	2	48	752	2	4	48	0.10	2.42	
3	2.873	1736	199	2		48	320	2		48	0.20	4.79	
4	3.047	1736	166	2		51	320	2		51	0.10	2.54	
5	3.256	1875	152	2		54	236	2		54	0.10	2.72	
6	2.330	3472	96	2		39	352	3		58	0.10	1.94	
7	3.227	2777	96	2		54	352	2		54	1.50	40.37	
8	3.064	2569	332	2		51	1900	5		128	0.10	2.56	
9	2.774	2638	168	2	2	46	236	2	3	46	0.10	2.31	
10	2.379	1944	154	2		40	108	2		40	0.10	1.98	
11	2.671	2083	153	2		45	212	2		45	0.10	2.23	
12	2.539	2083	*	*		0	256	4		85	0.10	2.12	
13	2.495	1736	144	2		42	170	2		42	0.10	2.08	0.89
14	2.549	1736	147	2		43	208	3		64	0.10	2.13	
15	3.532	3472	157	2		59	670	2		59	0.20	5.89	
16	1.925	1388	147	2	2	32	336	2	2	32	0.10	1.61	
17	1.817	1388	250	2		30	436	3		45	0.10	1.52	
18	2.249	1666	291	2		38	452	4		75	0.10	1.88	
19	2.287	1736	291	2		38	452	4		76	0.10	1.91	
20	2.399	1736	236	2		40	296	4		80	0.40	8.00	
21	2.223	2083	264	2		37	564	3		56	0.10	1.85	
22	1.489	1180	208	2		25	226	3		37	0.10	1.24	
23	1.335	1180	165	2	2	22	196	2	3	22	0.10	1.11	
24	1.942	1527	148	2		32	170	4		65	0.10	1.62	
25	2.375	1736	226	2		40	276	2		40	0.10	1.98	0.27
26	1.688	1388	200	2		28	212	4		56	0.10	1.41	
27	2.128	1736	190	2		35	276	3		53	0.10	1.77	
28	1.032	1319	170	2		17	432	3		26	0.30	2.58	
29	2.556	1736	*	*		0	998	4		85	0.50	10.66	
30	2.624	2083	133	2	2	44	216	2	3	44	0.10	2.19	
31													
TOTAL	72.812	57350	5274	56	10	1130	11980	90	15	1821	5.50	120.00	1.16
AVG	2.427	1912	188	2	2	38	399	3	3	61	0.18	4.00	
MAX.	3.532	3472	332	2	2	59	1900	8	4	208	1.50	40.37	
MIN.	1.032	1180	96		2	0	108	2	2	22	0.10	1.11	
%red				98.94				99.25					

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 7-DAY AVG mg/l	NH3 FINAL lbs	RAINFALL inches
1	2.424	1944	164	3		61	420	3		61	0.10		2.02	
2	3.475	2916	188	2		58	528	3		87	0.20		5.80	
3	3.501	1388	148	2		58	212	3		88	0.10		2.92	
4	3.382	2430	156	2		56	244	4		113	0.10		2.82	
5	3.321	2430	227	3		83	352	2		55	0.10		2.77	
6	3.015	2430	262	4		101	348	3		75	0.10		2.51	0.25
7	2.635	2291	411	2	3	44	192	4	3	88	0.10	0.11	2.20	0.07
8	2.545	2083	108	2		42	136	3		64	0.10		2.12	0.39
9	3.472	2777	246	4		116	272	4		116	0.10		2.90	0.71
10	4.425	2777	*	*			440	9		332	0.10		3.69	0.02
11	4.549	4166	260	2		76	314	7		266	0.70		26.56	0.58
12	3.634	2986	198	2		61	266	6		182	0.10		3.03	
13	3.342	2710	224	2		56	344	5		139	0.10		2.79	
14	3.089	2430	146	2	2	52	202	2	5	52	0.10	0.19	2.58	
15	2.800	2430	168	2		47	314	4		93	0.10		2.34	
16	3.068	2430	420	3		77	236	4		102	0.10		2.56	
17	2.875	2430	229	2		48	220	2		48	0.10		2.40	
18	2.888	2083	180	2		48	224	3		72	0.05		1.20	
19	2.785	2083	180	2		46	4680	3		70	0.07		1.63	
20	2.820	2013	188	2		47	596	3		71	0.08		1.88	
21	2.640	2291	172	2	2	44	208	3	3	66	0.06	0.08	1.32	
22	2.757	2083	173	3		69	164	5		115	0.06		1.38	
23	2.935	2430	205	2		49	292	5		122	0.05		1.22	0.05
24	2.894	2222	182	2		48	614	5		121	0.05		1.21	
25	2.823	2222	152	3		71	538	3		71	0.10		2.35	
26	2.836	2361	229	3		71	236	2		47	0.10		2.37	
27	2.795	2083	158	2		47	160	2		47	0.10		2.33	
28	2.551	2083	120	2	2	43	88	2	3	43	0.01	0.07	0.21	
29	2.307	1944	148	2		38	196	2		38	0.10		1.92	
30	2.888	2430	204	2		48	540	3		72	0.10		2.41	
31	2.764	2430	181	2		46	224	4		92	0.10		2.31	
TOTAL	94.235	73806	6027	70	9	1750	13800	113	15	3007	3.43	0.45	95.74	2.07
AVG	3.040	2381	201	2	2	58	445	4	4	97	0.11	0.11	3.09	
MAX.	4.549	4166	420	4	3	116	4680	9	5	332	0.70	0.19	26.56	
MIN.	2.307	1388	108		2	38	88	2	3	38	0.01	0.07	0.21	
%red				98.84				99.18						

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **Nov-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	2.802	2430	203	3		70	432	7		164	0.40	9.35	
2	2.875	2083	161	2		48	264	4		96	0.10	2.40	
3	2.945	2083	330	2		49	448	4		98	0.10	2.46	
4	3.531	3958	330	4	2	118	648	7	4	206	0.10	2.94	1.00
5	4.303	2430	304	3		108	796	10		359	0.10	3.59	1.00
6	3.730	2847	206	2		62	1012	6		187	0.10	3.11	
7	3.235	2430	219	2		54	528	15		405	0.10	2.70	0.10
8	2.805	2291	233	*			416	*			0.10	2.34	
9	2.819	2222	228	2		47	512	5		118	0.10	2.35	
10	2.853	1736	240	2		48	348	2		48	0.10	2.38	
11	2.560	2083	164	2	2	43	252	2	7	43	0.10	2.14	
12	2.611	2083	196	2		44	372	2		44	0.10	2.18	
13	2.783	2083	191	2		46	232	8		186	0.10	2.32	
14	2.806	2083	210	3		70	472	14		328	0.10	2.34	
15	3.351	2430	244	2		56	792	6		168	0.10	2.79	
16	3.506	2777	271	3		88	248	6		175	0.10	2.92	0.40
17	3.775	3125	234	2		63	536	13		409	0.10	3.15	0.25
18	4.315	2847	226	2	2	72	472	15	9	540	0.10	3.60	0.55
19	3.516	2917	201	2		59	424	9		264	0.10	2.93	
20	3.322	2917	252	3		83	436	7		194	0.10	2.77	
21	3.468	2917	288	3		87	588	15		434	1.90	54.95	
22	3.740	2777	200	2		62	344	12		374	2.80	87.34	
23	3.118	2847	312	2		52	808	9		234	0.10	2.60	0.04
24	3.118	2430	247	2		52	408	9		234	0.10	2.60	
25	2.987	2083	285	2	2	50	400	4	9	100	0.10	2.49	
26	3.046	2430	212	2		51	504	6		152	0.10	2.54	
27	3.482	2777	242	2		58	424	7		203	0.10	2.90	
28	3.519	2777	186	2		59	300	12		352	0.10	2.93	
29	2.994	2083	252	3		75	576	3		75	0.10	2.50	
30	2.807	2083	158	3		70	388	2		47	0.10	2.34	
31													
TOTAL	96.722	75059	7025	68	9	1842	14380	221	30	6234	7.80	223.96	3.34
AVG	3.224	2502	234	2	2	64	479	8	7	215	0.26	7.47	
MAX.	4.315	3958	330	4	2	118	1012	15	9	540	2.80	87.34	
MIN.	2.560	1736	158		2	43	232	2	4	43	0.10	2.14	
%red				99.00				98.41					

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **Dec-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 7-DAY AVG mg/l	NH3 FINAL lbs	RAINFALL inches
1	2.725	2986	148	2		45	1680	4		91	0.10		2.27	0.05
2	2.447	1944	191	2	2	41	552	3	5	61	0.10	0.10	2.04	
3	2.594	2361	204	3		65	280	8		173	0.10		2.16	0.19
4	3.110	2430	291	3		78	272	19		493	0.10		2.59	
5	3.308	2430	224	2		55	452	13		359	0.50		13.79	
6	3.317	2222	180	2		55	612	5		138	0.20		5.53	
7	3.215	2291	219	2		54	316	8		215	0.10		2.68	
8	3.596	2777	163	2		60	392	4		120	0.10		3.00	
9	3.678	2777	188	2	2	61	336	3	9	92	0.10	0.17	3.07	
10	3.917	2430	186	2		65	184	8		261	0.10		3.27	
11	4.285	3125	186	2		71	264	6		214	0.10		3.57	
12	4.030	3125	182	3		101	252	11		370	0.10		3.36	
13	3.869	2777	214	3		97	324	6		194	0.10		3.23	
14	4.017	3125	244	2		67	304	7		235	0.10		3.35	
15	3.460	2638	251	2		58	724	10		289	0.10		2.89	
16	3.118	2361	188	2	2	52	404	8	8	208	0.10	0.10	2.60	
17	3.090	2569	164	2		52	244	10		258	0.10		2.58	
18	3.331	2777	130	2		56	400	10		278	0.10		2.78	
19	3.322	2768	248	3		83	264	10		277	0.10		2.77	
20	3.263	2918	218	3		82	247	9		245	0.10		2.72	
21	3.204	2291	180	2		53	217	11		294	0.20		5.34	
22	3.503	2777	276	2		58	307	6		175	0.20		5.84	
23	3.226	2777	206	2	2	54	280	5	9	135	0.20	0.14	5.38	
24	3.037	2777	190	2		51	200	5		127	0.20		5.07	
25	3.036	2430	174	2		51	237	4		101	0.10		2.53	
26	5.074	6875	235	6		254	475	17		719	3.50		148.11	1.00
27	3.999	3472	153	2		67	672	5		167	0.20		6.67	
28	4.064	2777	174	2		68	256	7		237	0.10		3.39	
29	3.516	3125	204	2		59	332	8		235	0.20		5.86	
30	3.052	2083	150	2	3	51	276	7	8	178	0.10	0.63	2.55	
31	4.103	3333	113	2		68	736	9		308	3.10		106.08	0.27
TOTAL	107.506	87548	6074	72	12	2131	12491	246	38	7245	10.60	1.14	367.08	1.51
AVG	3.468	2824	196	2	2	69	403	8	8	234	0.34	0.23	11.84	
MAX.	5.074	6875	291	6	3	254	1680	19	9	719	3.50	0.63	148.11	
MIN.	2.447	1944	113		2	41	184	3	5	61	0.10	0.10	2.04	
%red				98.81				98.03						

Appendix II – Discharge Measurements from the Greenwood WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **Jan-05**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	5.458	4463	155	2	2	91	255	2	5	91	0.20	9.10	0.00
2	6.983	4667	153	3		175	192	4		233	0.20	11.65	0.00
3	5.097	7.491	182	2		85	220	4		170	0.20	8.50	0.00
4	5.179	4425	192	2		86	292	12		518	0.20	8.64	0.00
5	5.913	6178	224	2		99	380	7		345	0.20	9.86	0.00
6	5.879	5489	224	2		98	328	6		294	0.20	9.81	0.00
7	5.593	6033	210	2		93	216	3		140	0.20	9.33	0.00
8	5.321	8199	207	2	2	89	336	4	6	178	0.20	8.88	0.00
9	5.483	7985	148	2		91	212	5		229	0.20	9.15	0.00
10	5.884	4840	214	2		98	266	3		147	0.20	9.81	0.00
11	6.133	6053	196	3		153	312	10		511	0.20	10.23	0.00
12	6.224	7487	196	3		156	187	6		311	0.30	15.57	0.00
13	5.405	5411	152	2		90	184	6		270	0.20	9.02	0.00
14	4.725	6726	296	2		79	304	8		315	0.20	7.88	0.00
15	4.862	4435	204	2	2	81	214	8	7	324	0.20	8.11	0.00
16	5.346	6274	194	2		89	225	2		89	0.20	8.92	0.00
17	5.972	6422	274	2		100	267	3		149	0.50	24.90	0.00
18	6.145	5118	191	2		102	243	4		205	0.30	15.37	0.00
19	6.058	5476	200	2		101	293	3		152	0.20	10.10	0.00
20	6.178	6380	192	2		103	226	2		103	0.20	10.30	0.00
21	5.871	8510	172	2		98	208	2		98	0.20	9.79	0.00
22	5.475	7636	133	2	2	91	192	5	3	228	0.20	9.13	0.00
23	5.303	6415	126	2		88	176	4		177	0.20	8.85	0.00
24	5.278	7250	174	3		132	262	5		220	0.20	8.80	0.00
25	4.894	8791	230	3		122	274	2		82	1.50	61.22	0.00
26	5.474	6155	198	2		91	272	3		137	0.20	9.13	0.00
27	6.275	6767	148	2		105	210	3		157	0.20	10.47	0.50
28	6.073	6568	220	2		101	280	4		203	0.20	10.13	0.00
29	5.562	5541	168	3	2	139	220	4	4	186	0.20	9.28	0.00
30	5.762	4731	208	3		144	258	6		288	0.20	9.61	0.50
31	6.141	5933	188	3		154	212	9		461	0.20	10.24	0.25
TOTAL	175.946	186365	5969	70	11	3327	7716	149	24	7013	8.00	371.80	1.25
AVG	5.676	6012	193	2	2	107	249	5	5	226	0.26	11.99	
MAX.	6.983	8791	296	3	2	175	380	12	7	518	1.50	61.22	
MIN.	4.725	7	126	2	2	79	176	2	3	82	0.20	7.88	
%red				98.83				98.07					

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **Feb-05**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	5.944	4582	136	3		149	136	13		644	0.20	9.91	0.00
2	5.966	8137	228	3		149	252	3		149	0.20	9.95	0.00
3	8.948	5750	208	3		224	236	6		448	0.20	14.93	0.00
4	5.427	6422	202	2		91	324	6		272	0.20	9.05	0.00
5	5.540	7006	204	2	3	92	240	6	7	277	0.20	9.24	0.00
6	5.949	6860	178	2		99	224	3		149	0.20	9.92	0.00
7	5.944	8372	214	2		99	276	3		149	0.20	9.91	0.00
8	6.099	5525	226	2		102	208	12		610	0.20	10.17	0.00
9	5.514	6631	262	2		92	312	2		92	0.20	9.20	0.00
10	5.176	3592	176	2		86	226	2		86	0.20	8.63	0.00
11	5.357	7831	116	2		89	198	2		89	0.20	8.94	0.00
12	5.318	5871	*	*	2	0	236	4	4	177	0.20	8.87	0.01
13	5.394	5097	174	2		90	202	3		135	0.20	9.00	0.00
14	5.294	7715	217	2		88	258	4		177	0.20	8.83	0.00
15	5.278	5227	146	2		88	222	4		176	0.20	8.80	0.00
16	5.016	6051	212	2		84	244	5		209	0.20	8.37	0.00
17	5.308	5964	274	3		133	424	6		266	0.20	8.85	0.00
18	5.516	5541	208	3		138	210	10		460	0.20	9.20	0.00
19	5.437	6095	168	2	2	91	205	7	6	317	0.20	9.07	0.00
20	5.487	4986	190	3		137	270	8		366	0.20	9.15	0.00
21	5.939	7500	212	2		99	248	8		396	0.20	9.91	0.00
22	5.200	4902	244	4		173	244	12		520	0.20	8.67	0.00
23	5.577	5077	226	3		140	250	9		419	0.20	9.30	0.00
24	8.887	11988	193	3		222	280	9		667	0.70	51.88	1.00
25	6.246	6359	245	3		156	322	4		208	0.20	10.42	0.50
26	15.956	13837	183	3	3	399	332	7	8	932	1.10	146.38	1.00
27	7.897	8987	146	3		198	186	2		132	0.20	13.17	0.00
28	6.328	10528	230	3		158	328	3		158	0.20	10.56	0.00
TOTAL	175.942	192433	5418	68	10	3667	7093	163	25	8682	7.00	450.30	2.51
AVG	6.284	6873	201	3	3	131	253	6	6	310	0.25	16.08	
MAX.	15.956	13837	274	4	3	399	424	13	8	932	1.10	146.38	
MIN.	5.016	3592	116	2	2	0	136	2	4	86	0.20	8.37	

Appendix II – Discharge Measurements from the Greenwood WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **Mar-05**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	6.719	8190	196	3		168	224	10		560	0.20	11.21	0.00
2	7.881	9743	182	2		131	262	7		460	1.70	111.74	0.25
3	7.506	9760	178	2		125	265	4		250	2.10	131.46	0.00
4	6.333	6992	148	2		106	242	3		158	0.20	10.56	0.00
5	6.315	8655	150	2	2	105	237	3	5	158	0.20	10.53	0.00
6	6.921	8472	161	3		173	253	5		289	0.20	11.54	0.25
7	6.738	8081	211	2		112	233	2		112	0.20	11.24	0.00
8	6.035	7169	191	2		101	233	3		151	0.20	10.07	0.00
9	6.592	10006	236	2		110	294	2		110	0.30	16.49	0.00
10	6.370	8912	220	2		106	312	2		106	0.20	10.63	0.00
11	5.928	6310	226	3		148	300	4		198	0.20	9.89	0.00
12	5.923	9573	158	3	2	148	184	4	3	198	0.20	9.88	0.00
13	5.768	7484	258	3		144	184	6		289	0.20	9.62	0.00
14	5.625	7226	151	3		141	166	4		188	0.90	42.22	0.00
15	6.941	5944	240	3		174	312	13		753	2.10	121.56	1.25
16	6.517	5737	176	3		163	276	11		598	2.80	152.18	0.00
17	5.606	5575	192	3		140	324	7		327	2.90	135.59	0.00
18	5.678	6631	202	2		95	360	2		95	1.40	66.30	0.00
19	8.063	12216	235	2	3	134	564	2	6	134	0.80	53.80	1.75
20	8.375	9603	170	2		140	368	2		140	0.30	20.95	0.00
21	7.071	7293	161	2		118	296	3		177	0.20	11.79	0.00
22	5.882	7251	229	2		98	332	4		196	0.20	9.81	0.00
23	6.144	6424	255	2		102	380	3		154	0.20	10.25	0.00
24	6.094	9204	158	2		102	233	5		254	0.30	15.25	0.00
25	5.813	7585	358	2		97	303	3		145	0.70	33.94	0.00
26	5.708	7019	203	2	2	95	300	2	3	95	0.20	9.52	0.00
27	5.558	4693	176	2		93	310	2		93	0.20	9.27	0.00
28	5.555	6886	180	2		93	285	2		93	0.60	27.80	0.00
29	5.568	6494	224	2		93	350	2		93	0.40	18.57	0.00
30	5.838	5843	168	2		97	354	3		146	0.20	9.74	0.00
31	6.039	7080	170	2		101	315	2		101	0.20	10.07	0.00
TOTAL	197.104	238051	6163	71	10	3754	9051	127	17	6820	20.70	1123.47	3.50
AVG	6.358	7679	199	2	2	121	292	4	4	220	0.67	36.24	
MAX.	8.375	12216	358	3	3	174	564	13	6	753	2.90	152.18	
MIN.	5.555	4693	148	2	2	93	166	2	3	93	0.20	9.27	
%red				98.85				98.60					

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **Apr-05**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	5.734	7387	158	2		96	252	2		96	0.20	9.56	0.00
2	5.121	7909	158	2	2	85	264	2	2	85	0.20	8.54	0.00
3	6.083	7548	196	2		101	232	2		101	0.20	10.15	0.00
4	5.722	8590	167	2		95	268	3		143	0.20	9.54	0.00
5	5.844	5651	211	2		97	300	3		146	0.30	14.62	0.00
6	5.743	10677	164	2		96	308	5		239	0.20	9.58	0.00
7	5.271	9656	185	2		88	340	5		220	0.20	8.79	0.00
8	5.521	6962	342	2		92	480	2		92	0.40	18.42	0.00
9	5.648	7091	220	2	2	94	352	2	3	94	0.60	28.26	0.00
10	5.782	6305	320	2		96	576	3		145	0.70	33.76	0.00
11	6.199	6335	218	2		103	276	4		207	0.20	10.34	0.00
12	5.888	8220	249	2		98	428	5		246	0.20	9.82	0.00
13	6.327	7995	247	2		106	344	8		422	0.20	10.55	0.00
14	5.598	6736	233	2		93	343	4		187	0.20	9.34	0.00
15	5.632	9919	212	2		94	285	3		141	0.40	18.79	0.00
16	5.523	6736	180	2	2	92	253	2	4	92	0.20	9.21	0.00
17	5.337	5267	156	2		89	255	3		134	0.70	31.16	0.00
18	6.539	8902	200	2		109	273	4		218	1.40	76.35	0.00
19	6.799	8016	233	2		113	264	2		113	1.40	79.39	0.00
20	6.607	9889	210	2		110	228	2		110	3.40	187.35	0.00
21	6.187	7784	210	2		103	220	2		103	3.40	175.44	0.00
22	5.776	5197	244	2		96	296	2		96	0.20	9.63	0.00
23	5.303	5994	142	2	2	88	172	2	2	88	0.20	8.85	0.00
24	5.286	4506	188	2		88	280	2		88	0.50	22.04	0.00
25	6.799	6685	216	2		113	260	3		170	0.50	28.35	0.00
26	6.151	5106	191	2		103	300	6		308	1.00	51.30	0.00
27	6.253	5703	190	2		104	404	2		104	1.40	73.01	0.00
28	6.500	5601	194	2		108	268	4		217	0.20	10.84	0.00
29	5.803	5383	244	2		97	404	2		97	0.20	9.68	0.00
30	5.151	5115	174	2	2	86	420	3	3	129	0.40	17.18	0.00
TOTAL	176.127	212865	6252	60	10	2938	9345	94	15	4633	19.50	999.85	0.00
AVG	5.871	7096	208	2	2	98	312	3	3	154	0.65	33.33	
MAX.	6.799	10677	342	2	2	113	576	8	4	422	3.40	187.35	
MIN.	5.121	4506	142	2	2	85	172	2	2	85	0.20	8.54	
%red				99.04				98.99					

Appendix II – Discharge Measurements from the Greenwood WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:GREENWOOD **TX PERMIT#:10401-03** **EPA PERMIT#: TX0047074** **May-05**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	CBOD RAW mg/l	CBOD FINAL mg/l	CBOD 7-DAY AVG mg/l	CBOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS 7-DAY AVG mg/l	TSS FINAL lbs	NH3 FINAL mg/l	NH3 FINAL lbs	RAINFALL inches
1	5.398	5725	226	2		90	300	2		90	0.50	22.51	0.00
2	5.665	4439	270	2		94	536	4		189	0.70	33.07	0.00
3	6.133	5732	288	2		102	456	4		205	0.20	10.23	0.00
4	5.757	8500	288	2		96	460	4		192	0.20	9.60	0.00
5	5.801	5709	293	2		97	370	5		242	0.30	14.51	0.00
6	6.048	5644	207	2		101	391	3		151	0.20	10.09	0.00
7	5.999	4948	212	2	2	100	284	2	3	100	0.20	10.01	0.00
8	7.367	8116	194	2		123	413	4		246	1.50	92.16	0.00
9	4.923	3626	180	2		82	222	4		164	1.40	57.48	0.75
10	6.353	9145	192	2		106	258	3		159	1.60	84.77	0.00
11	6.227	6369	154	2		104	225	4		208	2.20	114.25	0.00
12	6.610	7284	196	2		110	383	4		221	2.50	137.82	0.00
13	5.804	6031	210	3		145	308	4		194	3.40	164.58	0.00
14	5.277	5800	144	2	2	88	236	4	4	176	4.20	184.84	0.00
15	5.270	5449	230	2		88	292	2		88	0.50	21.98	0.00
16	5.851	5302	198	2		98	248	3		146	0.20	9.76	0.00
17	5.656	6137	199	3		142	328	2		94	1.00	47.17	0.00
18	5.887	9005	198	2		98	292	5		245	0.20	9.82	0.00
19	5.164	8167	180	2		86	236	4		172	0.20	8.61	0.00
20	5.178	5598	136	2		86	228	3		130	0.20	8.64	0.00
21	4.495	5421	126	2	2	75	176	2	3	75	0.20	7.50	0.00
22	5.314	5178	230	2		89	368	2		89	0.20	8.86	0.00
23	5.395	5258	244	2		90	512	5		225	0.80	36.00	0.00
24	5.604	5992	270	2		93	458	4		187	0.20	9.35	0.00
25	5.284	6151	248	2		88	544	3		132	0.20	8.81	0.00
26	6.068	6014	186	2		101	280	4		202	0.20	10.12	0.00
27	6.354	5801	176	2		106	280	2		106	0.20	10.60	0.00
28	6.026	5731	160	2	2	101	245	2	3	101	0.20	10.05	0.16
29	6.720	6920	168	2		112	270	2		112	0.20	11.21	0.75
30	6.383	7475	183	2		106	280	3		160	0.20	10.65	0.00
31	5.725	5261	194	2		95	327	5		239	1.20	57.30	0.00
TOTAL	179.736	191928	6380	64	8	3094	10206	104	13	5039	25.20	1232.35	1.66
AVG	5.798	6191	206	2	2	100	329	3	3	163	0.81	39.75	
MAX.	7.367	9145	293	3	2	145	544	5	4	246	4.20	184.84	
MIN.	4.495	3626	126	2	2	75	176	2	3	75	0.20	7.50	
%red				99.00				98.98					

Appendix III

Discharges from the Oso Waste Water Treatment Plant

Appendix III – – Discharge Measurements from the Oso WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:OSO **TX PERMIT#:10401-004** **EPA PERMIT#: TX0047058** **January-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	11.764	8169	233	7	7	687	216	14	1374	
2	10.826	7518	256	8		722	560	12	1083	
3	10.658	7401	253	9		800	540	17	1511	
4	10.972	7619	320	14		1281	380	24	2196	
5	10.716	7442	298	16		1430	314	29	2592	
6	11.402	7918	352	9		856	396	14	1331	
7	10.483	7280	338	15		1311	290	24	2098	
8	10.728	7450	242	7	11	626	112	6	537	
9	12.051	8369	295	12		1206	248	19	1910	
10	12.051	8369	199	11		1106	296	17	1709	
11	11.427	7935	258	11		1048	256	13	1239	
12	10.921	7584	334	13		1184	294	18	1639	
13	10.352	7189	360	13		1122	332	53	4576	
14	10.234	7107	290	17		1451	516	30	2561	
15	10.229	7103	292	8	12	682	252	14	1194	
16	9.794	6801	269	10		817	224	17	1389	
17	11.429	7937	285	17		1620	248	20	1906	
18	11.415	7927	270	10		952	252	26	2475	
19	10.853	7537	255	9		815	228	8	724	
20	10.711	7438	253	18		1608	240	22	1965	
21	10.926	7588	332	12		1093	242	8	729	
22	10.608	7367	261	11	12	973	268	15	1327	
23	11.225	7795	169	9		843	174	21	1966	
24	10.488	7283	266	11		962	286	21	1837	
25	10.468	7269	282	11		960	280	12	1048	
26	10.493	7287	263	19		1663	256	19	1663	
27	10.669	7409	288	12		1068	200	22	1958	
28	9.934	6899	319	7		580	360	13	1077	
29	10.891	7563	314	10	11	908	286	29	2634	
30	11.060	7681	298	8		738	286	16	1476	
31	10.434	7246	303	20		1740	292	20	1740	
TOTAL	336.212	233481	8747	364	54	32854	9124	593	53463	0.00
AVERAGE	10.846	7532	282	12	11	1060	294	19	1725	
MAX.	12.051	8369	360	20	12	1740	560	53	4576	
MIN.	9.794	6801	169	7	7	580	112	6	537	
%red				95.84				93.50		

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:OSO TX PERMIT#:10401-004 EPA PERMIT#: TX0047058 February-00

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	10.600	10417	300	6		530	773	14	1238	
2	11.629	10417	301	9		873	727	23	2231	
3	11.176	10417	218	8		746	396	30	2796	
4	10.263	9722	244	6		514	256	17	1455	
5	10.867	1111	260	12	10	1088	318	37	3353	
6	10.283	11806	243	5		429	282	19	1629	
7	11.070	11806	244	6		554	346	18	1662	
8	10.233	10417	261	7		597	252	13	1109	
9	10.839	11806	252	6		542	260	19	1718	
10	10.952	11806	272	22		2009	268	20	1827	
11	10.501	11806	3014	14		1226	384	20	1752	
12	11.010	11806	263	7	10	643	212	16	1469	
13	11.436	10417	374	7		668	272	14	1335	
14	10.799	10417	358	9		811	400	11	991	
15	10.872	11806	298	9		816	288	12	1088	
16	10.218	11111	266	8		682	276	10	852	
17	10.835	11111	249	10		904	257	15	1355	
18	10.987	11111	286	8		733	298	14	1283	
19	10.899	11111	273	8	8	727	298	14	1273	
20	10.866	10417	274	13		1178	240	14	1269	
21	10.191	10417	264	7		595	212	11	935	
22	11.050	11111	243	7		645	212	11	1014	
23	10.765	9722	268	9		808	308	11	988	
24	9.865	9722	250	8		658	216	11	905	
25	10.208	11111	227	7		596	252	10	851	
26	10.927	10417	290	6	8	547	380	12	1094	
27	10.661	11806	298	7		622	236	11	978	
28	10.509	13194	282	7		614	298	13	1139	
29	10.469	10417	231	7		611	242	13	1135	
TOTAL	310.980	308755	10603	245	36	21965	9159	453	40723	0.00
AVERAGE	10.723	10647	366	8	9	757	316	16	1404	
MAX.	11.629	13194	3014	22	10	2009	773	37	3353	
MIN.	9.865	1111	218	5	8	429	212	10	851	
%red				97.69				95.05		

Appendix III – – Discharge Measurements from the Oso WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:OSO **TX PERMIT#:10401-004** **EPA PERMIT#: TX0047058** **March-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	10.209	7090	250	20		1703	310	95	8089	
2	11.016	7650	266	7		643	270	20	1837	
3	10.341	7181	271	6		517	304	13	1121	
4	10.522	7307	276	5	8	439	268	12	1053	
5	11.484	7975	257	2		192	250	7	670	
6	10.646	7393	263	6		533	280	13	1154	
7	10.232	7106	239	5		427	270	10	853	
8	10.595	7358	234	4		353	246	12	1060	
9	11.161	7751	268	6		558	268	9	838	
10	9.940	6903	369	4		332	332	8	663	
11	10.663	7405	294	3	4	267	244	8	711	
12	11.020	7653	234	4		368	252	9	827	
13	11.241	7806	283	4		375	256	9	844	
14	24.975	17344	219	11		2291	333	39	8123	3.50
15	19.293	13398	124	9		1448	234	17	2735	
16	8.302	5765	186	5		346	227	11	762	
17	11.463	7960	222	4		382	250	13	1243	
18	11.518	7960	250	3	6	288	240	10	961	
19	11.029	7659	224	4		368	243	8	736	
20	10.679	10187	259	9		802	244	8	713	
21	10.591	10417	320	5		442	296	10	883	
22	10.841	10185	182	4		362	166	6	542	
23	11.034	10208	208	3		276	172	6	552	
24	10.687	9861	248	4		357	180	9	802	
25	10.458	9722	228	3	5	262	236	6	523	
26	11.424	10417	224	4		381	224	10	953	
27	11.660	10417	222	4		389	234	8	778	
28	11.576	10417	184	5		483	246	8	772	
29	10.960	10972	235	4		366	228	13	1188	
30	10.362	10108	223	3		259	232	6	519	
31	10.752	9722	262	3		269	312	4	359	
TOTAL	356.674	279297	7524	163	23	16476	7847	417	42866	3.50
AVERAGE	11.506	9010	243	5	6	531	253	13	1383	
MAX.	24.975	17344	369	20	8	2291	333	95	8123	
MIN.	8.302	5765	124	2	4	192	166	4	359	
%red				97.83				94.69		

Appendix III – – Discharge Measurements from the Oso WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:OSO **TX PERMIT#:10401-004** **EPA PERMIT#: TX0047058** Apr-00

DATE	EFF MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
26-Mar				4				10		
27-Mar				4				8		
28-Mar				5				8		
29-Mar				4				13		
30-Mar				3				6		
31-Mar	11.584			3				4		
1	11.799	10880	254	3	4	290	248	8	773	0.25
2	14.119	15277	211	4		394	200	8	787	
3	10.867	17361	242	3		353	224	8	942	0.25
4	11.647	12965	220	3		272	190	13	1178	
5	11.825	10340	245	5		486	248	6	583	
6	12.100	11111	257	4		394	253	7	690	
7	12.121	10111	262	4		404	220	6	605	
8	12.203	10571	274	2	4	202	162	4	404	
9	12.637	10725	316	6		611	244	6	611	
10	12.415	11188	242	4		422	232	9	949	
11	16.854	11883	368	22		2278	282	8	828	
12	12.566	17361	250	6		843	214	7	984	0.75
13	12.497	11111	284	12		1258	200	8	838	
14	12.340	10417	216	4		417	192	5	521	
15	12.834	11111	270	5	8	515	236	6	617	
16	13.169	11805	248	6		642	210	5	535	
17	12.559	11574	204	11		1208	212	7	769	
18	12.780	10570	239	9		943	208	8	838	
19	12.987	9799	248	10		1066	492	10	1066	
20	12.723	9722	211	8		866	254	7	758	
21	13.562	10600	215	9		955	214	9	955	
22	11.970	11011	258	8	9	905	270	13	1470	
23	14.054	10648	208	8		799	258	11	1098	
24	12.701	10880	224	9		1055	232	20	2344	
25	11.902	11265	242	9		953	264	13	1377	
26	12.368	13812	252	9		893	268	11	1092	
27	12.020	11111	190	8		825	268	12	1238	
28	13.620	10417	214	7		702	268	10	1002	
29	13.548	11111	257	6	8	682	282	11	1249	
30		13888	230	9		1017	250	15	1695	
31										
TOTAL	380.371	350625	7351	213	32	22648	7295	271	28799	1.25
AVERAGE	12.679	11688	245	7	6	755	243	9	960	0.42
MAX.	16.854	17361	368	22	9	2278	492	20	2344	0.75
MIN.	10.867	9722	190	2	4	202	162	4	404	0.25

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:OSO **TX PERMIT#:10401-004** **EPA PERMIT#: TX0047058** **May-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	12.977	11111	304	11		1191	239	12	1299	0.25
2	13.778	11111	237	16		1839	252	15	1724	0.25
3	18.017	10416	280	12		1803	276	16	2404	
4	13.494	10494	226	10		1125	216	9	1013	
5	13.124	10416	192	10		1095	174	9	985	
6	13.779	11111	298	10	11	1149	184	11	1264	
7	12.599	11805	275	11		1156	246	12	1261	
8	12.694	12291	233	14		1482	230	15	1588	
9	13.883	12500	246	12		1389	256	17	1968	
10	12.863	12500	245	14		1502	212	20	2146	
11	13.810	12885	251	17		1958	196	13	1497	
12	13.648	11111	260	16		1821	198	12	1366	
13	14.952	11806	248	14	14	1746	188	13	1621	2.00
14	13.868	12037	252	17		1966	258	15	1735	
15	13.443	12269	300	20		2242	318	19	2130	
16	13.621	12191	286	20		2272	292	19	2158	
17	13.527	11805	266	21		2369	236	20	2256	
18	14.283	11420	260	20		2382	186	11	1310	
19	13.354	11111	180	14		1559	142	13	1448	1.00
20	20.448	18750	172	16	18	2729	196	17	2899	
21	14.029	12963	225	20		2340	238	15	1755	
22	14.078	13117	236	17		1996	276	20	2348	
23	14.541	14583	266	18		2183	226	15	1819	
24	13.644	12500	247	17		1934	208	11	1252	
25	13.137	11806	249	14		1534	278	12	1315	
26	13.637	12500	180	13		1479	168	3	341	
27	13.232	13194	311	19	17	2097	261	21	2317	
28	13.566	13034	237	16		1810	200	18	2037	
29	13.966	13889	236	16		1864	174	16	1864	
30	14.669	13503	222	16		1957	282	19	2324	
31	12.492	13194	215	15		1563	172	13	1354	
TOTAL	433.153	383423	7635	476	60	55532	6978	451	52799	3.50
AVERAGE	13.973	12368	246	15	15	1791	225	15	1703	0.88
MAX.	20.448	18750	311	21	18	2729	318	21	2899	2.00
MIN.	12.492	10416	172	10	11	1095	142	3	341	0.25
%red				93.77				93.54		

Appendix III – – Discharge Measurements from the Oso WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT										
PLANT:OSO		TX PERMIT#:10401-004			EPA PERMIT#: TX0047058				June-00	
DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	12.949	9757	240	15		1620	320	13	1404	
2	12.714	12500	289	14		1484	252	11	1166	
3	13.429	13040	300	16	15	1792	300	12	1344	
4	13.317	12638	242	13		1444	200	9	1000	
5	13.212	13194	287	14		1543	188	11	1212	
6	13.565	13889	275	23		2602	244	10	1131	
7	13.004	12340	243	13		1410	184	11	1193	
8	13.267	10569	280	15		1660	206	12	1328	
9	13.053	11111	193	11		1197	164	10	1089	0.25
10	14.512	16667	230	13	15	1573	252	13	1573	0.75
11	12.530	11111	217	11		1150	186	11	1150	
12	12.400	10648	243	13		1344	234	14	1448	
13	11.986	10722	264	10		1000	228	11	1100	
14	12.526	11111	261	12		1254	236	10	1045	
15	12.737	9722	281	10		1062	254	12	1275	
16	13.006	11111	328	10		1085	236	13	1410	
17	13.595	11806	266	10	11	1134	228	17	1927	
18	13.370	11111	270	10		1115	226	11	1227	
19	13.263	11240	234	7		774	216	12	1327	
20	12.901	9722	208	12		1291	208	12	1291	
21	13.262	12115	322	14		1548	320	12	1327	
22	13.050	11111	235	12		1306	236	14	1524	
23	13.022	10417	305	15		1629	272	14	1520	
24	13.155	11188	232	12	12	1317	248	15	1646	
25	13.045	11722	246	13		1414	203	14	1523	
26	12.554	11340	247	20		2094	230	16	1675	
27	12.805	10417	262	12		1282	222	15	1602	
28	12.281	10417	250	14		1434	200	16	1639	
29	12.877	11111	236	15		1611	194	14	1504	
30	13.400	11111	241	13		1453	218	13	1453	
31										
TOTAL	390.787	344958	7727	392	53	42621	6905	378	41051	1.00
AVERAGE	13.026	11499	258	13	13	1421	230	13	1368	0.50
MAX.	14.512	16667	328	23	15	2602	320	17	1927	0.75
MIN.	11.986	9722	193	7	11	774	164	9	1000	0.25
%red				94.93				94.53		

Appendix III – – Discharge Measurements from the Oso WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT										
PLANT:OSO		TX PERMIT#:10401-004			EPA PERMIT#: TX0047058				July-00	
DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	13.64	12144	208	13	14	1479	222	18	2048	
2	13.50	11420	150	7		788	116	10	1126	
3	13.64	10569	198	10		1138	110	10	1138	
4	12.76	11574	308	10		1065	256	11	1171	
5	12.64	10262	259	13		1371	220	12	1265	
6	13.11	10725	227	16		1749	208	6	656	
7	13.10	10798	152	10		1093	130	10	1093	
8	13.22	11187	152	15	12	1654	54	14	1543	
9	12.95	11416	272	16		1728	222	13	1404	
10	12.83	10951	270	15		1605	257	10	1070	
11	12.78	11111	299	15		1598	238	12	1279	
12	13.09	11111	292	16		1747	474	17	1856	
13	13.30	10498	465	12		1331	344	12	1331	
14	12.73	10503	184	10		1062	200	8	849	
15	13.13	11111	265	15	14	1643	234	11	1205	
16	13.05	11111	252	11		1197	216	9	980	
17	12.89	11111	235	12		1290	284	12	1290	
18	13.00	10648	413	11		1193	452	9	976	
19	12.54	10494	284	11		1150	318	14	1464	
20	13.90	12144	247	8		927	328	15	1738	
21	12.77	11497	274	10		1065	262	14	1491	
22	13.06	10648	334	9	10	980	378	11	1198	
23	13.14	11458	217	12		1315	190	21	2300	
24	12.77	11420	270	10		1065	268	13	1385	
25	9.51	10108	284	9		714	240	14	1111	
26	13.01	10108	272	8		868	252	8	868	
27	12.60	10340	135	7		736	224	9	946	
28	12.79	11700	234	8		853	256	9	960	
29	12.96	12000	212	7	9	757	280	11	1189	
30	12.93	11960	250	11		1186	264	11	1186	
31	12.54	11188	290	11		1151	320	11	1151	0.00
TOTAL	399.889	343315	7904	348	59	37496	7817	365	39266	0.00
AVERAGE	12.900	11075	255	11	12	1210	252	12	1267	0.00
MAX.	13.895	12144	465	16	14	1749	474	21	2300	0.00
MIN.	9.511	10108	135	7	9	714	54	6	656	0.00
%red				95.60				95.33		

Appendix III – – Discharge Measurements from the Oso WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:OSO **TX PERMIT#:10401-004** **EPA PERMIT#: TX0047058** **August-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	12.969	11800	230	10		1082	736	10	1082	
2	12.227	11700	200	16		1632	676	14	1428	
3	12.441	11300	206	14		1453	720	13	1349	
4	11.901	11300	274	15		1489	552	10	993	
5	12.224	11800	229	12	13	1223	330	15	1529	
6	12.747	12809	136	12		1276	102	10	1063	
7	13.552	10648	263	15		1695	296	8	904	
8	13.059	12600	201	16		1743	196	9	980	
9	13.319	12700	212	15		1666	290	10	1111	
10	13.662	12423	242	13		1481	390	9	1025	
11	12.726	11400	178	9		955	190	8	849	
12	13.102	12200	198	6	12	656	228	9	983	
13	13.561	9954	194	10		1131	230	14	1583	
14	13.977	11574	166	7		816	216	11	1282	
15	14.039	12200	162	6		703	160	8	937	0.13
16	12.351	11800	198	6		618	160	7	721	
17	12.854	12100	184	5		536	168	5	536	
18	12.466	10958	188	5		520	244	6	624	
19	13.368	11959	170	7	7	780	172	10	1115	
20	13.002	12654	234	4		434	228	6	651	
21	12.448	11883	231	7		727	230	7	727	
22	12.257	11728	172	6		613	170	10	1022	
23	12.116	11883	273	6		606	710	7	707	
24	12.431	11806	144	9		933	188	16	1659	
25	11.916	10108	203	4		398	204	7	696	
26	12.278	11959	216	5	6	512	180	8	819	
27	12.490	12268	188	3		312	196	14	1458	
28	11.778	11400	176	6		589	212	7	688	
29	11.808	10700	158	4		394	232	6	591	
30	12.653	11111	200	4		422	204	7	739	
31	12.002	10416	320	4		400	212	5	500	
TOTAL	393.724	361141	6346	261	37	27795	9022	286	30351	0.13
AVERAGE	12.701	11650	205	8	9	897	291	9	979	0.13
MAX.	14.039	12809	320	16	13	1743	736	16	1659	0.13
MIN.	11.778	9954	136	3	6	312	102	5	500	0.13
%red				95.89				96.83		

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:OSO **TX PERMIT#:10401-004** **EPA PERMIT#: TX0047058** **September-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	11.388	9182	235	4		380	224	6	570	
2	11.842	10648	218	3	4	296	184	4	395	
3	11.633	9097	196	5		485	152	10	970	
4	12.224	10500	193	4		408	308	6	612	
5	11.314	11100	230	4		377	252	6	566	
6	12.066	10800	170	3		302	232	6	604	
7	11.995	10900	216	6		600	216	4	400	
8	12.809	10000	270	5		534	296	4	427	
9	13.278	11700	261	6	5	664	312	8	886	
10	13.085	11800	294	8		873	196	6	655	
11	12.399	11100	273	6		620	316	6	620	
12	12.905	11800	282	8		861	320	8	861	
13	12.812	11265	273	5		534	288	5	534	0.25
14	12.135	10957	201	5		506	288	10	1012	
15	13.033	10000	236	4		435	228	5	543	0.35
16	12.696	9700	214	5	6	529	254	4	424	
17	12.509	9568	259	4		417	240	5	522	
18	12.048	10500	236	4		402	192	4	402	
19	11.548	10600	226	4		385	274	2	193	
20	12.057	10000	224	3		302	328	5	503	
21	11.827	10800	269	4		395	284	5	493	
22	12.328	10300	271	3		308	232	3	308	
23	13.134	10800	222	2	3	219	216	3	329	
24	12.856	9027	145	3		322	102	5	536	
25	11.693	11574	288	4		390	268	4	390	
26	11.682	10494	266	4		390	272	5	487	
27	10.794	10494	261	4		360	284	5	450	
28	11.269	9568	240	3		282	216	2	188	
29	10.654	10000	*	*		0	164	2	178	
30	11.821	11000	292	4	4	394	284	3	296	
31										
TOTAL	363.834	315274	6961	127	22	12972	7422	151	15354	0.60
AVERAGE	12.128	10509	240	4	4	432	247	5	512	0.30
MAX.	13.278	11800	294	8	6	873	328	10	1012	0.35
MIN.	10.654	9027	145	2	3	0	102	2	178	0.25
%red				98.18				97.97		

Appendix III – – Discharge Measurements from the Oso WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT										
PLANT:OSO		TX PERMIT#:10401-004			EPA PERMIT#: TX0047058				October-00	
DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	11.936	10417	290	5		498	292	2	199	
2	10.778	10880	260	4		360	264	7	629	
3	10.915	10800	230	3		273	264	5	455	
4	11.152	10100	202	5		465	180	3	279	
5	12.314	10200	311	4		411	184	4	411	
6	11.988	11000	270	3		300	180	4	400	
7	12.016	9722	310	3	4	301	224	4	401	
8	12.747	9722	278	2		213	224	3	319	
9	13.631	10262	276	2		227	136	2	227	0.35
10	14.101	10031	240	2		235	400	3	353	0.50
11	12.668	11420	292	4		423	250	3	317	
12	12.148	10957	256	4		405	206	12	1216	0.25
13	11.838	10400	290	5		494	628	4	395	
14	11.959	10800	172	2	3	199	194	3	299	
15	11.840	11111	178	3		296	172	5	494	
16	12.491	12423	256	4		417	120	3	313	
17	11.593	12423	343	4		387	328	3	290	
18	11.673	12654	219	2		195	218	2	195	
19	11.179	11188	251	2		186	268	2	186	
20	11.174	11180	272	3		280	208	3	280	
21	12.041	11574	218	4	3	402	104	6	603	
22	12.392	12500	283	3		310	208	2	207	
23	11.847	12500	288	2		198	240	2	198	
24	11.578	11960	276	3		290	212	10	966	
25	11.336	11960	231	2		189	218	5	473	
26	11.530	11728	271	2		192	192	2	192	
27	11.220	11000	258	3		281	82	3	281	
28	11.583	11600	247	3	3	290	188	2	193	
29	12.305	11497	259	2		205	176	4	410	
30	10.585	10648	254	2		177	256	5	441	
31	10.341	10571	277	3		259	208	3	259	
TOTAL	366.899	345228	8058	95	13	9355	7024	121	11879	1.10
AVERAGE	11.835	11136	260	3	3	302	227	4	383	0.37
MAX.	14.101	12654	343	5	4	498	628	12	1216	0.50
MIN.	10.341	9722	172	2	3	177	82	2	186	0.25
%red				98.82				98.28		

Appendix III – – Discharge Measurements from the Oso WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:OSO **TX PERMIT#:10401-004** **EPA PERMIT#: TX0047058** **November-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	RAINFALL inches
29				2				4	
30				2				5	
31				3				3	
1	11.043	10100	273	3		276	188	5	
2	10.894	10800	186	3		273	188	3	
3	11.109	10400	320	3		278	264	2	
4	18.402	27000	218	8	3	1228	164	4	2.75
5	14.154	14892	239	5		590	368	2	1.25
6	19.525	22377	228	4		651	200	2	
7	12.089	11343	181	3		302	208	2	
8	12.580	11011	222	3		315	140	2	
9	12.454	11034	233	2		208	184	3	
10	11.226	10000	224	2		187	148	2	
11	11.780	10000	265	2	3	196	220	2	
12	12.141	11574	238	3		304	198	2	
13	11.355	16185	248	3		284	238	3	
14	11.042	9200	264	3		276	170	3	
15	11.283	9722	254	3		282	142	3	
16	11.428	9491	298	4		381	182	3	
17	18.700	12963	211	3		468	164	3	
18	18.241	10031	225	4	3	609	168	4	
19	14.002	10880	301	5		584	272	2	1.00
20	11.116	9954	244	5		464	200	4	
21	11.471	12654	257	4		383	240	4	
22	12.047	10571	242	4		402	164	2	
23	11.540	11343	314	4		385	288	3	
24	11.124	10108	286	4		371	172	4	
25	11.259	10185	314	4	4	376	230	3	
26	11.440	10802	215	3		286	262	2	
27	10.995	10031	280	4		367	244	2	
28	10.472	10140	216	6		524	190	3	
29	10.612	9645	290	8		708	8	3	
30	10.766	8951	334	3		269	276	3	
31									
TOTAL	376.290	353387	7620	115	14	12227	6080	85	5.00
AVERAGE	12.543	11780	254	4	4	408	203	3	1.67
MAX.	19.525	27000	334	8	4	1228	368	5	2.75
MIN.	10.472	8951	181	2	3	187	8	2	1.00
%red				98.49				98.60	

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:OSO **TX PERMIT#:10401-004** **EPA PERMIT#: TX0047058** **December-00**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	10.857	10957	292	6		543	248	2	181	
2	10.397	9877	257	3	5	260	168	2	173	
3	10.906	9799	308	6		546	200	2	182	
4	10.669	10031	330	4		356	240	3	267	0.25
5	10.588	9877	242	4		353	146	3	265	
6	10.882	9568	266	3		272	306	3	272	
7	10.460	9414	211	2		174	222	3	262	
8	10.472	9799	*	2		175	253	2	175	
9	10.620	9645	315	3	3	266	394	3	266	
10	11.890	10262	317	4		397	1502	3	297	
11	11.000	9722	254	3		275	241	4	367	
12	11.253	9414	348	7		657	230	2	188	
13	10.407	10031	247	2		174	218	2	174	
14	10.299	9259	242	3		258	184	13	1117	
15	10.434	8796	300	5		435	218	3	261	
16	10.861	10494	297	4	4	362	294	4	362	
17	11.375	10031	344	2		190	260	6	569	
18	11.279	9722	248	3		282	244	2	188	
19	10.422	6019	286	4		348	176	2	174	
20	9.402	6944	197	3		235	120	3	235	
21	10.762	8642	182	6		539	150	4	359	
22	10.338	10031	230	4		345	102	3	259	
23	10.725	12114	497	4	4	358	168	2	179	
24	11.371	11728	304	2		190	246	2	190	
25	10.917	10880	298	4		364	160	3	273	
26	10.446	12809	238	3		261	178	2	174	
27	11.228	11574	255	3		281	256	2	187	
28	10.976	10802	309	4		366	236	9	824	
29	10.916	10494	244	2		182	168	3	273	
30	10.974	11034	252	3	3	275	264	5	458	
31	11.125	15856	137	2			172	2		
TOTAL	334.251	315625	8247	110	19	9718	7964	104	9150	0.25
AVERAGE	10.782	10181	275	4	4	324	257	3	305	0.25
MAX.	11.890	15856	497	7	5	657	1502	13	1117	0.25
MIN.	9.402	6019	137	2	3	174	102	2	173	0.25
%red				98.71				98.69		

Appendix III – – Discharge Measurements from the Oso WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:OSO **TX PERMIT#:10401-004** **EPA PERMIT#: TX0047058** **March-05**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	11.790	10108	216	5		492	240	3	295	
2	11.940	18210	168	6		597	246	9	896	1.25
3	14.000	11111	206	4		467	355	5	584	
4	11.830	10031	168	4		395	240	5	493	
5	12.350	10417	182	3	5	309	243	4	412	
6	12.830	11111	176	5		535	216	4	428	0.13
7	12.470	10648	311	4		416	643	4	416	
8	11.400	9722	263	4		380	378	4	380	
9	11.900	10030	225	3		298	252	3	298	
10	11.730	9722	208	4		391	252	2	196	
11	11.810	10262	209	5		492	224	3	295	
12	11.640	11111	257	5	4	485	548	4	388	
13	11.770	11806	169	4		393	248	5	491	
14	11.350	10570	172	5		473	204	5	473	
15	11.260	10570	331	6		563	468	7	657	0.15
16	11.460	10416	162	5		478	272	6	573	
17	11.340	10725	186	4		378	242	3	284	
18	11.890	10339	140	5		496	262	3	297	
19	18.190	22993	179	7	5	1062	254	4	607	1.50
20	18.02	15046	121	4		601	214	7	1052	
21	14.030	12885	195	8		936	202	8	936	
22	11.630	11111	170	8		776	248	10	970	
23	12.390	10956	168	7		723	200	2	207	
24	12.510	10416	198	6		626	314	7	730	
25	11.460	10416	94	6		573	77	5	478	
26	11.980	12191	211	6	6	599	523	7	699	
27	10.620	10417	164	6		531	222	5	443	
28	11.110	11111	218	6		556	298	6	556	
29	11.420	11149	226	6		571	300	4	381	
30	10.270	11805	154	4		343	212	5	428	
31	11.160	10339	193	6		558	272	6	558	
TOTAL	379.550	357744	6040	161	20	16497	8869	155	15904	3.03
AVERAGE	12.244	11540	195	5	5	532	286	5	513	0.76
MAX.	18.190	22993	331	8	6	1062	643	10	1052	1.50
MIN.	10.270	9722	94	3	4	298	77	2	196	0.13
%red				97.33				98.25		

Appendix III – – Discharge Measurements from the Oso WWTP

CITY OF CORPUS CHRISTI-MONTHLY EPA & TNRCC OPERATING REPORT

PLANT:OSO **TX PERMIT#:10401-004** **EPA PERMIT#: TX0047058** **April-05**

DATE	EFF FLOW MGD	2 Hour PEAK FLOW GPM	BOD RAW mg/l	BOD FINAL mg/l	BOD 7-DAY AVG mg/l	BOD FINAL lbs	TSS RAW mg/l	TSS FINAL mg/l	TSS FINAL lbs	RAINFALL inches
1	10.250	9182	141	4		342	196	4	342	
2	10.840	11111	160	3	5	271	228	2	181	
3	11.690	11574	272	5		487	276	3	292	
4	10.710	10416	194	5		447	188	2	179	
5	10.160	10493	228	8		678	404	4	339	
6	10.790	10648	128	7		630	292	7	630	
7	10.020	9799	278	5		418	370	6	501	
8	10.330	9567	230	5		431	320	3	258	
9	11.250	10417	167	3	5	281	248	3	281	
10	11.870	10416	194	5		495	240	3	297	
11	10.340	10417	201	7		604	234	6	517	
12	10.540	10416	144	6		527	196	6	527	
13	10.400	10648	172	7		607	206	6	520	
14	10.470	9645	164	5		437	190	5	437	
15	10.330	8564	101	3		258	77	3	258	
16	11.090	11111	197	5	5	462	255	3	277	
17	11.130	10185	147	4		371	182	3	278	
18	10.510	9645	161	4		351	194	4	351	
19	9.810	11033	129	5		409	128	4	327	
20	11.41	9490	190	6		571	180	2	190	
21	11.400	10725	174	5		475	200	3	285	
22	10.740	10108	220	6		537	236	3	269	
23	10.710	11188	234	7	5	625	228	4	357	
24	10.610	10648	201	6		531	248	5	442	0.13
25	11.190	11651	162	5		467	192	3	280	
26	10.910	10417	188	8		728	180	5	455	
27	10.340	9568	166	6		517	280	6	517	
28	10.150	10030	186	6		508	180	6	508	
29	10.800	10108	175	8		721	234	8	721	
30	10.420	10648	180	6	6	521	234	6	521	
31										
TOTAL	321.210	309868	5484	165	28	14709	6816	128	11341	0.13
AVERAGE	10.707	10329	183	6	6	490	227	4	378	0.13
MAX.	11.870	11651	278	8	6	728	404	8	721	0.13
MIN.	9.810	8564	101	3	5	258	77	2	179	0.13
%red				96.99				98.12		

Appendix IV

Discharges from the Barney Davis Power Plant

LAKEflowPROJECT.xls

TOPAZ POWER GROUP, LLC

BARNEY M. DAVIS, LP

001 COOLING POND DISCHARGE MONTHLY FLOWS----JAN 1999 THRU JULY 2005

	1999	2000	2001	2002	2003	2004	2005
JANUARY	13886.7	12034.4	12347.4	11221.8	5132.2	6309.0	8035.2
FEBRUARY	9277.1	11515.4	11114.8	8890.2	4995.9	4511.2	7029.8
MARCH	6573.3	11266.6	11444.3	8370.2	5265.2	7266.6	7372.9
APRIL	8989.5	14019.1	7208.4	11732.0	4944.2	6897.1	6527.6
MAY	13659.1	15109.5	10571.9	15266.9	11261.0	8328.5	7792.0
JUNE	14553.1	14622.9	14573.9	14055.3	11253.8	10127.9	10739.8
JULY	14814.2	15139.9	15191.9	9455.6	9890.5	8203.9	11474.2
AUGUST	14428.4	14793.6	15232.2	9573.6	9703.8	8071.8	
SEPTEMBER	14689.0	13967.7	13892.8	8353.6	7464.8	8025.5	
OCTOBER	15212.5	9927.7	15130.4	9404.4	8439.0	8240.9	
NOVEMBER	14081.2	14201.5	14749.7	4763.8	8600.8	7776.0	
DECEMBER	12865.1	13993.9	14401.4	6485.5	7699.7	9175.5	