Survey of Small Galveston Bay Tributaries Under Conditions Representative of Wastewater Discharge Permit Renewal

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In cooperation with the Texas Clean Rivers Program and the Houston-Galveston Area Council (H-GAC), the City of Houston supported by PBS&J performed a study of flow and water quality in the urbanized tributaries to Galveston Bay. The study was performed under conditions that approximated as closely as possible, the 7-day, 2-year low flows (7Q2) that are the specified conditions for issuing wastewater discharge permits. The purpose of the study was to develop first-hand information on the flows and quality conditions that actually exist on many effluent-dominated tributaries.

The study included flow measurements and water sample collection and analysis. It was performed in two separate but coordinated parts. The western part of the Houston metropolitan area was sampled and analyzed by Omega and PBS&J, while the study on the eastern part of the area was conducted by the USGS. This paper presents only the results of the western part of the area.

To derive a 7Q2 value from daily stream flow data in a statistically correct manner requires a substantial period of record, generally at least ten years of data. This period of continuous flow record is generally not available for most discharge locations. To address the problem it is common for the Texas Natural Resource Conservation Commission (TNRCC) and the US Environmental Protection Agency (EPA) to employ available data to approximate the 7Q2 value at a discharge point. For example, if a gaged 7Q2 value is known at some point downstream which receives other discharges, the TNRCC employs wastewater discharge data to adjust the 7Q2 to a value at the desired discharge point. Since the daily effluent discharge data are generally not available concurrently with stream data, the TNRCC uses the lowest monthly average wastewater flow in the previous two years of record as an approximation to the wastewater flow during dry periods. Clearly, this is an approximation. The 30-day average wastewater flow in the previous two years is a statistical departure from the 7Q2. Also, the use of full upstream wastewater discharges does not consider potentially significant processes such as infiltration and evaporation losses and the addition of baseflow.

While this approach provides a needed low-flow value, the accuracy of the estimate and procedures has not been verified by direct measurement. The project's primary objective is to obtain direct measurements of actual dry-weather 7Q2 flows in smaller ungaged areas that have a significant number of wastewater discharges. Along with stream flow, samples for hardness, chlorides, and TSS as well as standard probe parameters (conductivity, DO,

temperature and pH) were collected. These data were collected throughout the study area, under an approved Quality Assurance Project Plan (QAPP), (USGS, 1997) when stream flows were low and close to the 7Q2 values. These samples are a base of values that are appropriate to or representative of actual permit renewal conditions.

METHODOLOGY

For complete information on the project methodology, the reader is referred to the project report (City of Houston, 1998). The first step in the project was to select appropriate sampling stations. The H-GAC's Geographic Information System (GIS) was used to map existing active wastewater dischargers (i.e. those with recent self-reporting data), both domestic and industrial. Next, the locations of known USGS gages and points of flow regulation such as dams were superimposed. Dischargers in close proximity to gages or flow regulation points were removed from consideration and placed in a separate class, because the 7Q2 values for these dischargers would not require new monitoring. Dischargers with outfalls in tidal waters, where flow observation is generally more difficult and other dilution calculation methods are employed, were also removed. Finally, the most upstream dischargers on intermittent streams (where 7Q2 flow is clearly zero) were eliminated. What remained were dischargers where more accurate low-flow data would likely be beneficial in the permitting process. Figure 1 shows the locations of the monitoring sites and USGS gages.

Before any field measurements were performed, a QAPP was developed and approved by the TNRCC and H-GAC. This was produced in coordination with Mr. Jeffery East of the USGS, who sampled on the east side of the City.

At each station, a reach was selected for measurement with a relatively straight uniform channel and reasonable ease of access. The goal was to perform flow measurements at the same cross-section each time readings were collected. Water velocity measurements were made with a conventional Pygmy current meter. Since these were dry weather measurements and the stream depth was rarely more than one foot, a wading rod was used to hold the Pygmy meter, following USGS procedures. Velocity and depth was recorded at roughly 1-foot intervals along the stream cross-section, and converted to discharge values using a spreadsheet. To assure that only low-flow conditions were monitored, no field trip was begun until a check had been made with area USGS stream gages and rain gages to be sure that flow conditions were low and steady.

Water samples were collected in new, one-liter cubitainers. The samples were labeled indicating the stream, station, date, and time of the sampling, and kept in an ice chest. The City Public Works and Engineering Laboratory employed the following methods for water quality analysis: Hardness, EPA Method 130.2 (Titrimetric, EDTA); Chloride, EPA Method 300.0 (Ion Chromatography) or EPA Method 325.3 (Titrimetric, Mercuric Nitrate); TSS, EPA Method 160.2 (Gravimetric, Dried at 103-105°C).

ANALYSIS

The goal of the project was to characterize flows and quality conditions at the selected sites under near 7Q2 conditions. This goal was achieved because of reasonably dry conditions during the summer of 1997, and because of the efforts taken to verify conditions prior to data collection. The four to six samples collected at each site provided a substantial number of observations under similar conditions. These observations were conducted on a weekly basis during July, August and September of 1997.

Flows were measured with USGS procedures and the results were compared with nearby USGS long-term stream gages. The 7Q2 flows were calculated for each of the USGS gages, and it was confirmed that all of the USGS gages were close to their individual 7Q2 values during measurements. The flows measured at the 20 stations were related to the variations in flow observed at the USGS gages, and estimated 7Q2 values selected for each of the 20 stations.

The wastewater discharges upstream of each station for 1995 and 1996 were retrieved from discharge monitoring reports and compared to observed flows. Table 1 summarizes the results. It was found that for 12 of the 20 stations, the estimated wastewater flows essentially account for the measured 7Q2 flows. For the remaining stations the 1995-96 wastewater contribution does not account for the stream flows. In some cases it is likely that new dischargers started operating since 1996. Other possible explanations are potable water leaks, and unpermitted discharges.

The water quality parameters measured during low flow conditions representative of actual permit renewal are an important addition to the available data. It is rare that a significant body of data is collected under actual permit renewal conditions. In most cases, permit calculations are performed using values generated from data collected over the full range of flow conditions, with low flow data being only a small part of the observations. In some cases the values actually used are not the average or median of these data, but a value near the high flow end of the distribution, very different from low flow conditions.

For example, hardness is related to dissolved solids, and like dissolved solids, is an inverse function of flow. When flow is high, hardness levels tend to be low. Because of these differences, it is not surprising that the data obtained that are specific to permit renewal conditions are significantly different from the TNRCC values. Table 2 presents the TNRCC 15th percentile values for hardness, TSS and pH for freshwater segments in the H-GAC area, along with the values measured in this study. In the case of hardness, the TNRCC 15th percentile values range from 12 to 58 mg/L, except those near Galveston Bay, which appear to be very different, possibly because of salinity effects. The measured hardness values average 132.7 mg/L with a standard deviation of only 40 mg/L. These are substantially higher than the TNRCC values. In contrast, values for TSS and pH show little difference between the two data sources.

Hardness is significant because the criteria for a number of trace metals are defined as a function of hardness. If a low value of hardness is employed to calculate the chronic criterion for say, lead, an artificially low value is produced. This can be a serious concern resulting

in substantial regulatory cost burden because many chemical testing methods are unable to accurately measure trace levels at the extremely low levels that do not appear to be appropriate for permit renewal conditions in the Houston area.

Table 3 shows the freshwater chronic criteria for several trace metals at a range of hardness levels. Also included in the table are the Minimum Analytical Levels for the trace metals that the TNRCC specifies for permit applicants and for the Clean Rivers Program. In several cases, the ability to measure the trace metals with TNRCC specified MALs depends on which hardness data are employed. If a hardness of 20 or even 40 mg/L were employed for lead, the TNRCC specified data would be unable to measure the criterion. This can be a problem, particularly when analytical "noise" causes a laboratory to report detections at or near its ability to measure. Such artificial analytical problems tend to be reduced significantly when hardness values representative of permit renewal conditions are used.

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