Coastal Hydrology for the Lavaca-Colorado Estuary

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Bays & Estuaries Program
Surface Water Resources Division
Texas Water Development Board
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Purpose

This technical memo documents the procedure for estimating combined freshwater inflow data and the freshwater inflow balance for the Lavaca-Colorado Estuary and the specifics related to producing hydrology dataset versions #TWDB201001 and #TWDB201004 for this estuary.

Introduction

The goal of the Texas Water Development Board (TWDB) Coastal Hydrology program is to provide estimates of historical freshwater inflows into Texas bays and estuaries to support environmental and water planning studies. The earliest freshwater inflow estimates were compiled in a series of reports published by the Texas Department of Water Resources between 1980 and 1983. Monthly inflows to the seven major estuaries in Texas for the period 1941-1976 were estimated in those studies, with estimates for the Lavaca-Colorado Estuary published in Chapter 4 of LP-106, *Lavaca-Tres Palacios Estuary: A Study of the Influence of Freshwater Inflows* (TDWR 1980, available on the TWDB website or upon request).

Inflow records for each estuary have been updated periodically since then in support of ongoing research and planning studies both within and external to TWDB. Additionally, subsequent updates are provided in daily as well as monthly formats. This report covers the most recent update of freshwater inflow estimates for the Lavaca-Colorado Estuary which extends the hydrology through 2009. Therefore, complete hydrology is available for this estuary for 1941-2009, with daily estimates of inflows available only after 1977.

Estimates of Combined Freshwater Inflows

Detailed studies of hydrology of the areas draining to the Lavaca-Colorado Estuary include gaged and ungaged portions of the Lavaca and Colorado River basins, as well as other small coastal basins. The combination of Gaged Inflows + Ungaged Inflows + Return Flows - Diversions below the last gaging

stations provide for estimates of ***Combined Freshwater Inflow*** to the estuary. The ***Freshwater Inflow Balance*** consists of Combined Inflows + Precipitation on the estuary – Evaporation from the estuary. Although inflow estimates are updated on an ongoing basis, there are two distinct periods of estimation. Before 1977, inflow estimates are available only in monthly intervals. Starting in 1977 and thereafter, inflow estimates became available on a daily basis.

1941 - 1976 Period of Record

This dataset uses measurements from U.S. Geological Survey (USGS) stream gages along with rainfall-runoff estimates from a water yield model to determine flows in both gaged and ungaged watersheds, respectively (TDWR 1980). In most estimates of coastal hydrology, flows in ungaged areas are adjusted for known agricultural, municipal, and industrial return flows obtained from the Texas Department of Water Resources (or equivalent agency; *e.g.*, TDWR 1980). However, LP-106 does not explicitly address the use of diversions in estimating combined inflows to the estuary. Data on inflows to the Lavaca-Colorado Estuary for 1941 - 1976 are available as monthly or annual estimates.

1977 - 2009 Period of Record

This dataset uses measurements from USGS stream gages along with rainfall-runoff estimates from the Texas Rainfall-Runoff (TxRR) model, adjusted for known diversion and return flows obtained from the TCEQ (or equivalent agency, such as the Texas Natural Resource Conservation Commission (TNRCC)), the South Texas Water Master (STWM), and the TWDB Irrigation Water Use estimates. Data on inflows to the Lavaca-Colorado Estuary for 1977 - 2009 are available as daily, monthly, or annual estimates.

Gaged Watersheds

Daily flow recorded at nine USGS stream gages and from one reservoir release site is used to develop the gaged inflow component of combined inflows to the Lavaca-Colorado Estuary. Table 1 lists the USGS stream gages and corresponding period of record utilized in estimating combined freshwater inflows to the bay system.

Table 1. USGS stream gage number, location, and period of record used to develop the gaged inflow component of combined inflows to the Lavaca-Colorado Estuary.

Estuary	Gage Station Number	Gage Location	Utilized Period of Record
Lavaca-Colorado	8164525*	Lake Texana near Edna	1980 - Present
	08162500	Colorado River near Bay City	1948 - Present
	08162600	Tres Palacios River near Midfield	1970 - Present
	08163500	Lavaca River above Hallettsville	1939-1992
	08164000	Lavaca River near Edna	1938 - Present
	08164300	Navidad River near Hallettsville	1961 - 1980
	08164500	Navidad River above Ganado	1939 - 1980
	08164503	West Mustang Creek near Ganado	1977 - 1980
	08164600	Garcitas Creek near Inez	1970 - Present
	08164800	Placedo Creek near Placedo	1970 - Present

*USGS gage #08164525 provides lake level; however, TWDB uses release data from Lake Texana provided by the Lavaca-Navidad River Authority to estimate inflows.

Ungaged Watersheds

The number of ungaged watersheds for which ungaged inflows are estimated has changed through time as USGS gages became available or unavailable. Initial estimates were determined using 15 ungaged watersheds; current estimates are based on 12 ungaged watersheds. Figures 1 - 5 show the delineation of watershed boundaries and their changes over five periods from 1941 to 2009.

The ungaged inflow component of combined inflows is estimated using a rainfall-runoff model. Before 1977, stream flows in ungaged watersheds were obtained using a *water yield model* which required daily precipitation, Soil Conservation Service average curve numbers, and soil depletion index (TDWR 1980). This water yield model provided for monthly estimates of ungaged inflows – not daily. TWDB does not have daily estimates of ungaged inflows for the period prior to 1977.

Since 1977, however, TWDB has used the Texas Rainfall-Runoff (TxRR) model to estimate daily stream flows in ungaged watersheds. This model is conceptually similar to the Agricultural Research Service (ARS) rainfall-runoff model which is based on the Soil Conservation Service's curve number method to estimate direct runoff from a precipitation event. TxRR, however, has three key differences: (1) use of a simpler and more straightforward mathematics, (2) introduction of 12 monthly depletion factors, instead of the single depletion factor used in the ARS Model, and (3) introduction of a base flow component into the model. TxRR has been used to estimate daily stream flows from over 50 coastal ungaged watersheds as a part of the Bays & Estuaries Coastal Hydrology Program to study freshwater inflows to Texas bays and estuaries.

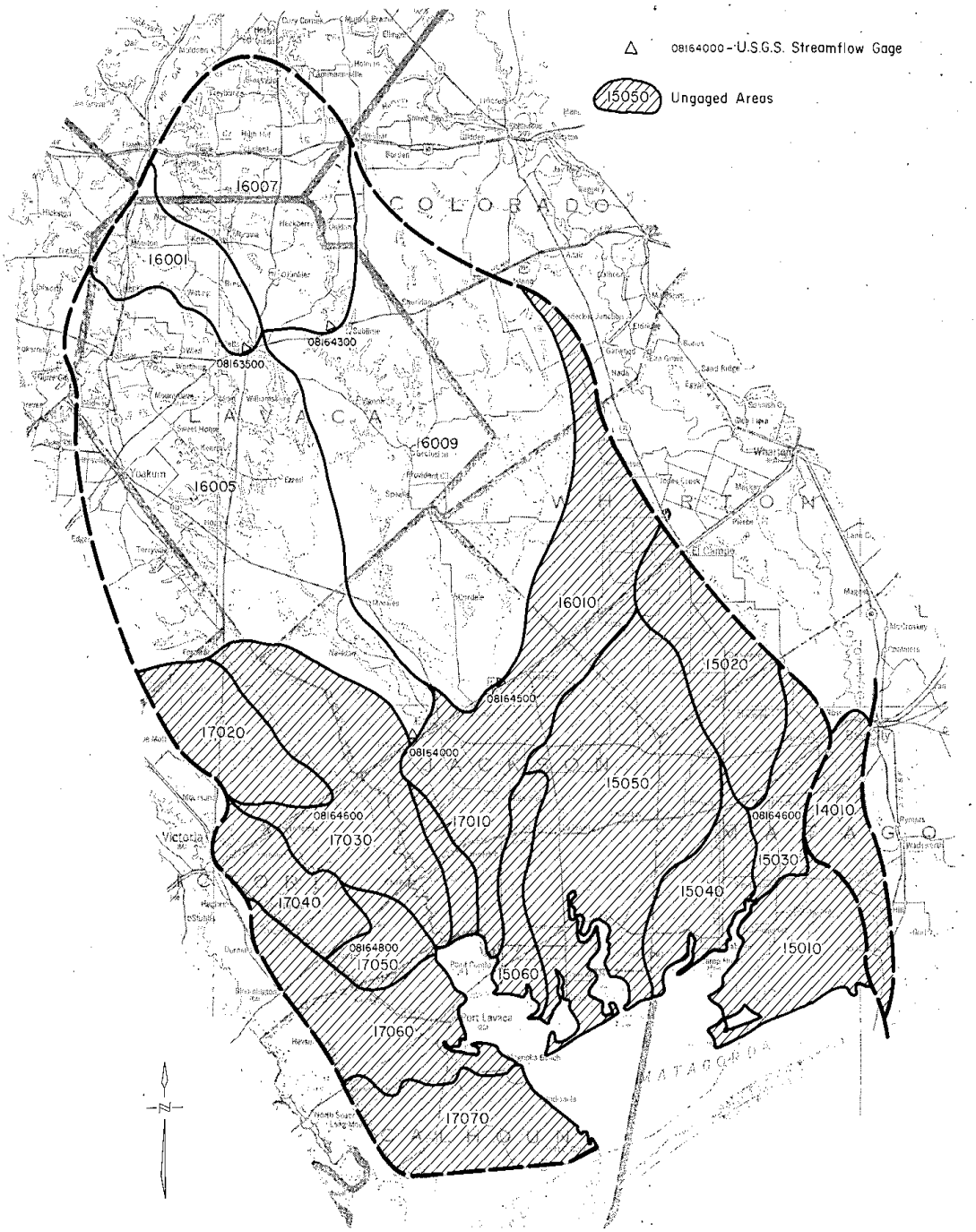

Figure 1. Ungaged watershed delineation used to determine ungaged inflows in the Lavaca-Colorado Estuary from 1941 to 1976. Ungaged watersheds are shown with cross-hatching.

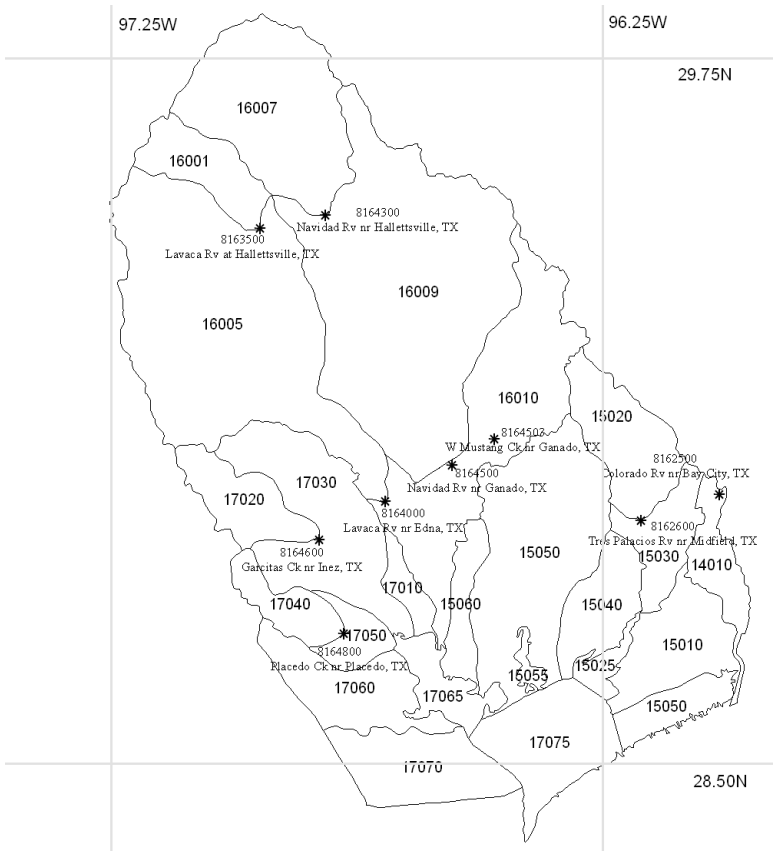

Figure 2. Gaged and ungaged watershed delineation used to determine combined inflows to the Lavaca-Colorado Estuary in 1977. Gage locations are indicated by (*).

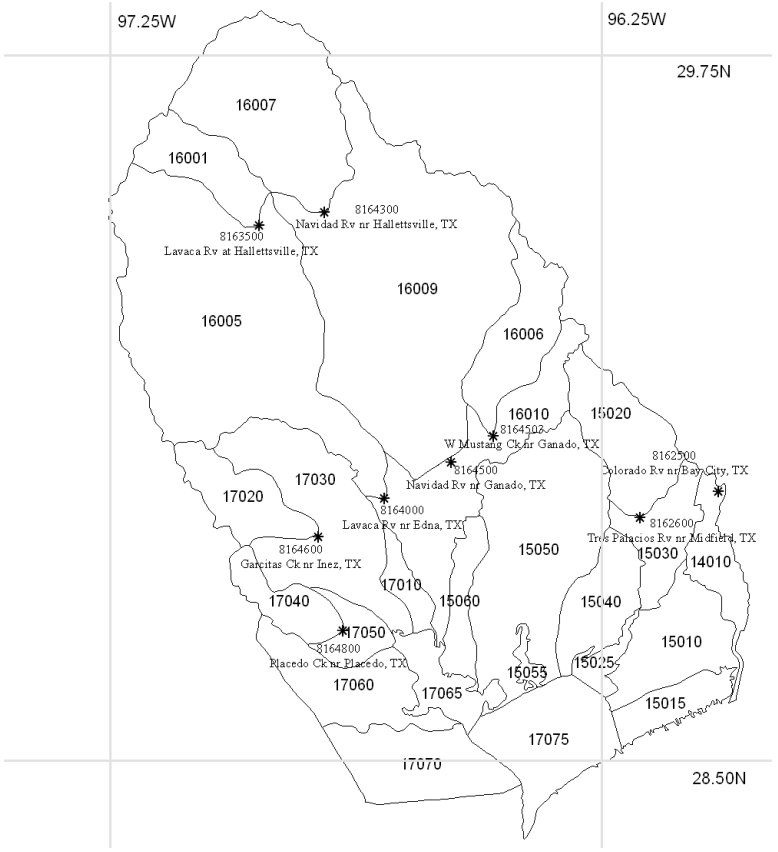

Figure 3. Gaged and ungaged watershed delineation used to determine combined inflows to the Lavaca-Colorado Estuary from 1977 to 1980. Gage locations are indicated by (*).

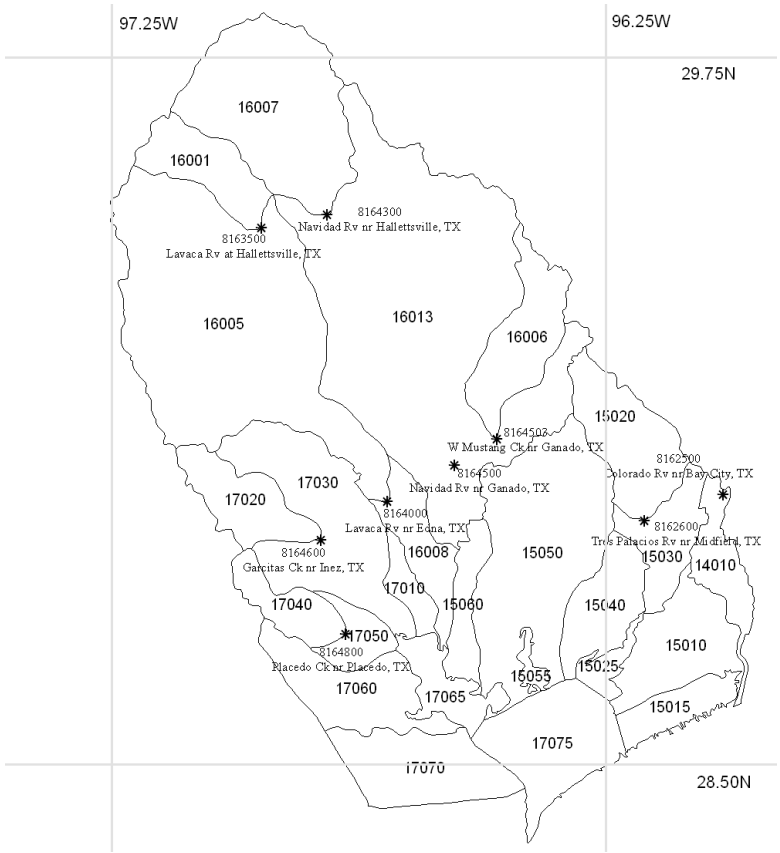

Figure 4. Gaged and ungaged watershed delineation used to determine combined inflows to the Lavaca-Colorado Estuary from 5/22/80 to 9/1/80. Gage locations are indicated by (*).

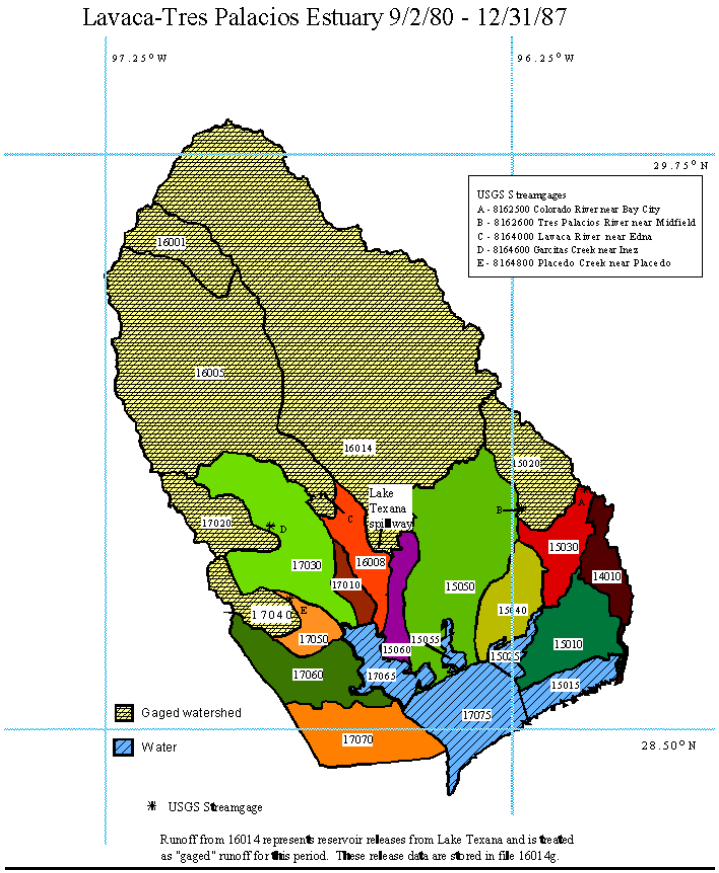

Figure 5. Gaged and ungaged watershed delineation used to determine combined inflows to the Lavaca-Colorado Estuary from 9/2/1980 to 12/31/1987 and through the present day. Gaged watersheds are indicated by cross-hatching and gage locations are indicated by (*).

Diversion and Return Points

The major water rights and holders and the major discharge permits and dischargers in the Lavaca-Colorado Estuary are listed in Table 2, with locations of these permits shown in Figure 6.

Table 2. Major water rights and discharge permits in the Lavaca-Colorado basin below the lowest USGS stream gages

	Water Right Number	Owner
DIVERSIONS	2097	Gebrueder Viehof Farms OHG
	2098	Harrison Stafford II *et al.*
	2099	Harrison Stafford *et al.*
	2100	Harrison Stafford II *et al.*
	2101	Francis Koop
	4782	Farmers Canal Company
	4787	Farmers Canal Company
	4788	Mrs. Glen Hutson *et al.*
	4789	Texas Parks & Wildlife Department
	4790	South Texas land LTD. Partner
	4791	Formosa Plastics Corporation
	4792	Point Comfort Water Company
	4793	Calhoun County Navigation District
	4794	Aluminum Co. of America
	5437	STP Nuclear Operating Company Agent
	5476	Lower Colorado River Authority
	5487	Brian M. Swenson *et al.*
	5584	Jackson County
RETURNS	NPDES Number	OWNER
	TX0004715	ALCOA World Alumina LLC and ALCOA, Inc.
	TX0006017	Oxea Corporation
	TX0023051	City of Palacios
	TX0023167	City of Point Comfort
	TX0024252	City of Edna
	TX0024601	Aquasource Utility, Inc.
	TX0027669	Jackson County WCID 2
	TX0047562	City of Port Lavaca
	TX0054038	Matagorda Waste Disposal & WSC
	TX0054470	Markham MUD
	TX0064998	Jackson County WCID 1
	TX0077291	Texas Department of Transportation

	NPDES Number	OWNER
RETURNS	TX0085570	Formosa Utility Venture, Ltd.
	TX0087173	Equistar Chemicals, LP
	TX0091260	Matagorda County WCID 5
	TX0092142	Jesse Carl Wood
	TX0093360	Victoria County WCID 2
	TX0098205	Midfield Water Supply Corporation
	TX0098248	TRI- County Point Property Owners Association
	TX0104205	South Central Calhoun County WCID 1
	TX0105104	City of La Ward
	TX0105937	Calhoun County Navigation District
	TX0105988	Beach Road MUD
	TX0108405	Interplast Group, Ltd.
	TX0113379	St. Martin's Seafood
	TX0113492	Ronald Allen Benner
	TX0118923	Guadalupe-Blanco River Authority
	TX0119016	Seaside Aquaculture
	TX0122246	Victoria County WCID 1
	TX0123803	Lonestar Aquafarms, Ltd.
	TX0127353	Bloomington ISD

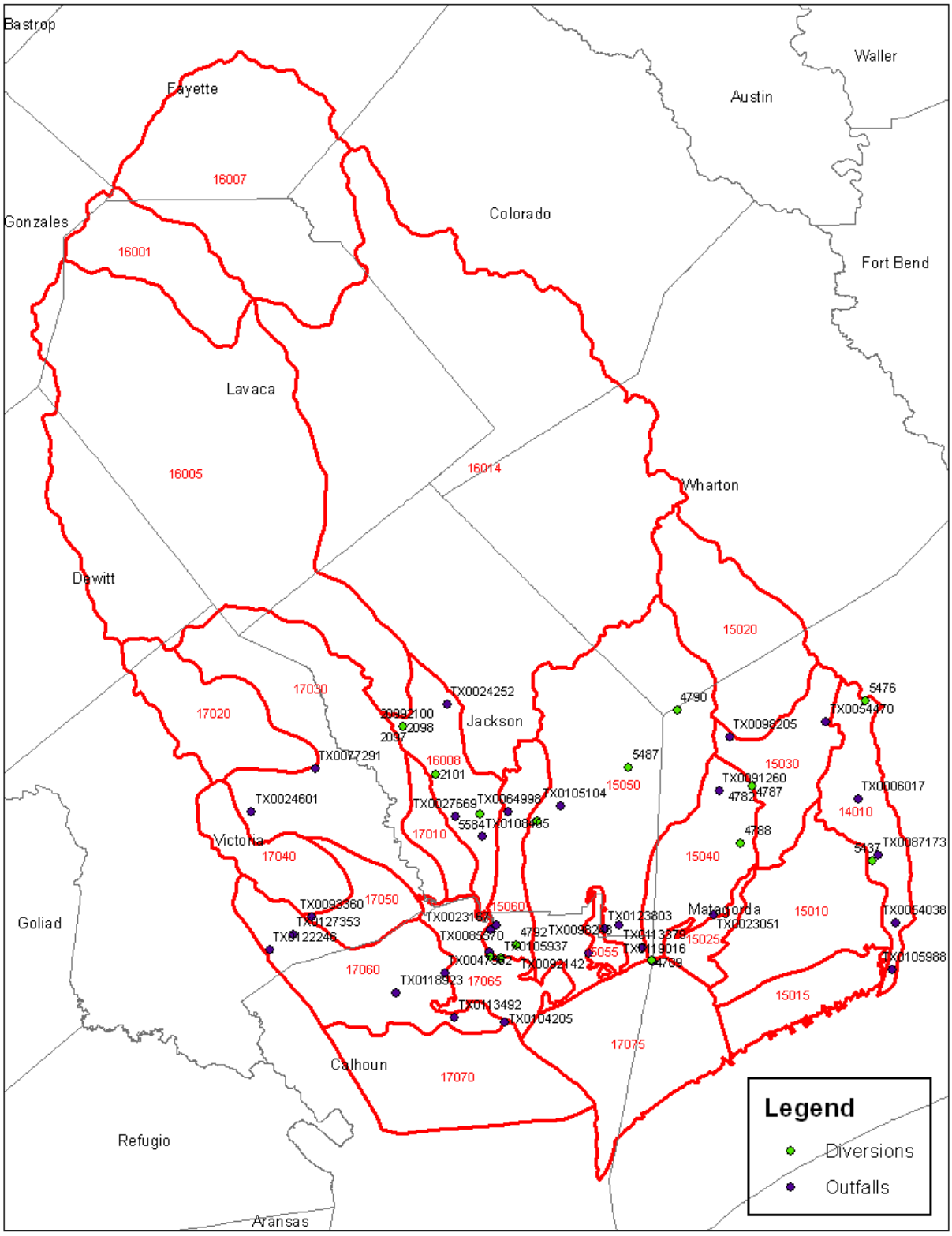

Figure 6. Location of permitted diversion points and wastewater outfalls in the Lavaca-Colorado river basins.

Estimates of Freshwater Inflow Balance

Total Freshwater Inflow to the estuary may include estimates of ***Combined Freshwater Inflow*** to the estuary + Precipitation on the Estuary. The ***Freshwater Inflow Balance***, then, considers the effect of evaporation from the estuary. Due to limitations on the ungaged inflows prior to 1977 and on estimates of evaporation throughout the period of record, estimates of the freshwater inflow balance are available only in monthly intervals.

Precipitation

Direct precipitation onto the surface of the Lavaca-Colorado Estuary is calculated using Thiessen-weighted precipitation techniques as described in LP-106 (TDWR 1980). Station based rainfall data are obtained from the National Weather Service (NWS) and processed using Arc/Info Macro Language. Figure 7 shows the Thiessen polygons that were drawn to be coincident with rainfall stations to calculate watershed rainfall. Bay watersheds (#15015, #15025, #15055, #17065, and #17075) then are used to calculate precipitation on the bay by summing the area-weighted rainfall of the Thiessen polygon fragments within the bay watershed.

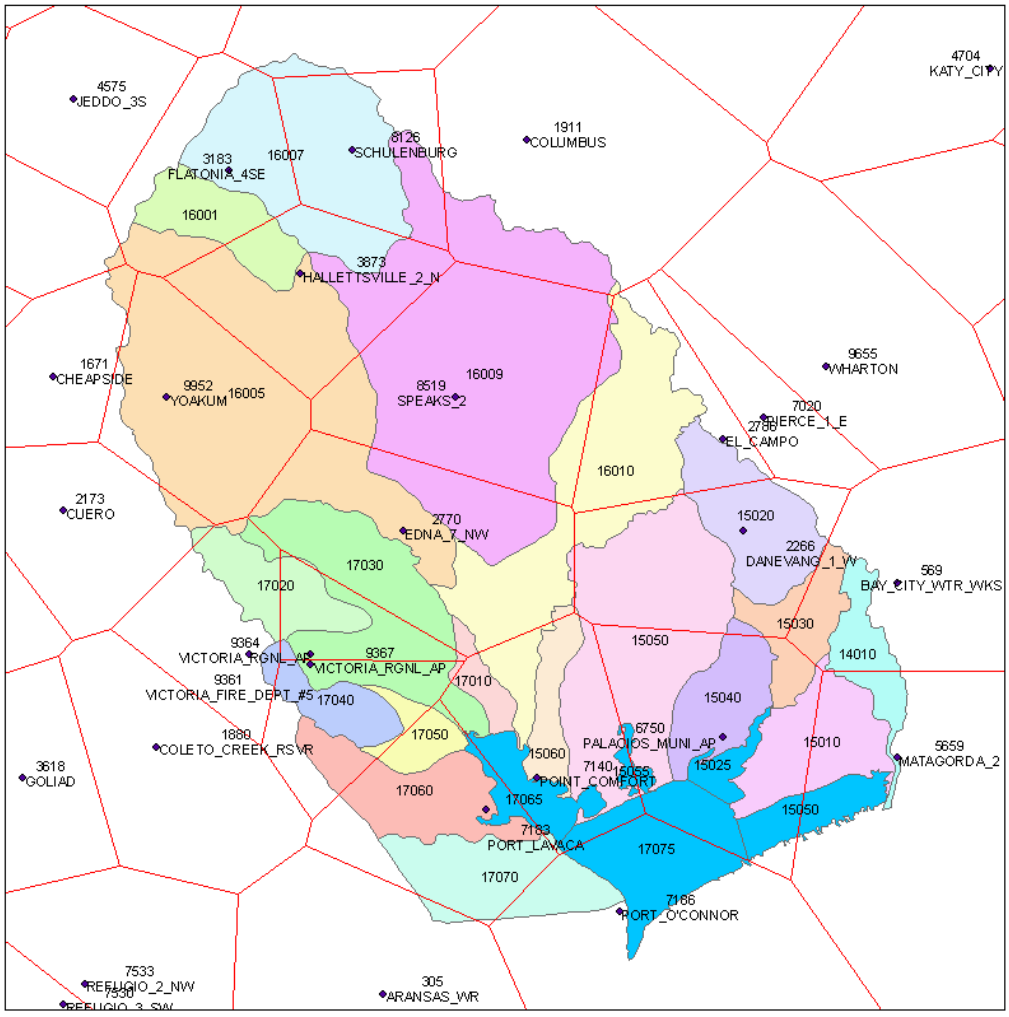

Figure 7. Rainfall stations (♦) and Thiessen polygons (red lines) used to estimate direct precipitation onto the Lavaca-Colorado Estuary.

Evaporation

Evaporation is calculated for the surface area of the bays using TWDB and NWS pan evaporation data to estimate evaporation rates. Bay watersheds used to calculate evaporation include watersheds #15015, #15025, #15055, #17065, and #17075, which are all located within quadrangle 911 (Figure 8). Total water evaporated from these watersheds is calculated by multiplying the watershed area by the evaporation rates obtained from the TWDB. Evaporation rates are determined with a GIS-based program, *ThEvap*, using TWDB and NWS pan evaporation data. The *ThEvap* program replaced an older program, *WD0300*, previously run by the Texas Department of Water Resources (http://midgewater.twdb.state.tx.us/Evaporation/evap.html).

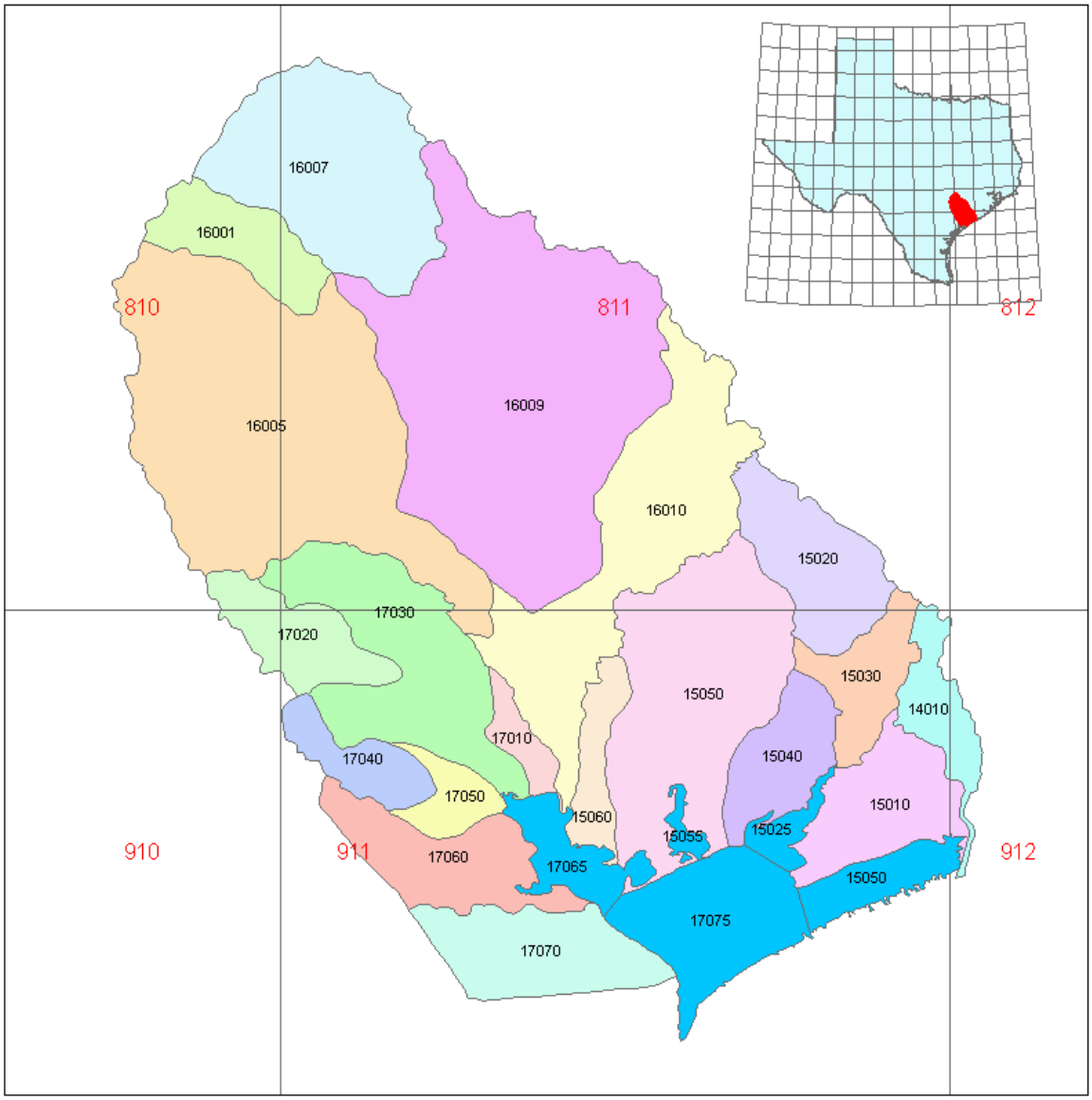

Figure 8. TWDB evaporation quadrangles used to estimate evaporation. Quadrangle 911 is used to estimate evaporation from the Lavaca-Colorado Estuary bay segments #15025, #15050, #15055, #17065, and #17075.

Hydrology: Version #TWDB201001

TWDB coastal hydrology version #TWDB201001 for the Lavaca-Colorado Estuary included gaged and ungaged inflows through December 2008, with all estimates prior to 1977 coming from those reported in LP-106 (TDWR 1980). Diversion and return data prior to 1977 also derives from LP-106, although the report does not specify diversion data for the period 1941 through 1976. After 1976, raw diversion data was obtained from TCEQ or an equivalent agency, *e.g.*, TNRCC, for the period from 1977 to 2005 and from the STWM for the period from 1989 through October 2005. Industrial and municipal return flow data was obtained from the TDWR self-reporting system from 1941 through 1976 and from TCEQ for the period from 1977 to 2007. Additional return flow data was obtained from TWDB's agricultural return flow estimates through December 2005. Note that while this version of hydrology extends estimates of freshwater inflow from 1941 through 2008, not all components were updated through 2008. Specifically, diversion and return flow estimates are not considered complete for the 2005-2008 period.

Hydrology: Version #TWDB201004

TWDB coastal hydrology version #TWDB201004 for the Lavaca-Colorado Estuary extended gaged inflow data through November 2009 and used provisional data for December 2009. Ungaged inflows were updated from coastal hydrology version #TWDB201001 using approved daily precipitation data from the NWS through November 2009, with provisional data for December 2009. Diversions from the STWM were the same as in version #TWDB201001, but additional data from TCEQ extended the dataset through 2009. Return flows were the same as in version #TWDB2010001, but additional data obtained from TCEQ extended the data through December 2009, and agricultural return flows data obtained from TWDB were extended to December 2007. Figure 9 shows the annual combined surface inflow to the Lavaca-Colorado Estuary as calculated by this version. Note that while this version of hydrology extends estimates of freshwater inflow from 1941 through 2009, not all components were updated through 2009. Gaged inflows and precipitation data were provisional for December 2009, and agricultural return flows were not available after 2007. Diversion flow data from the STWM were not available after October 2005.

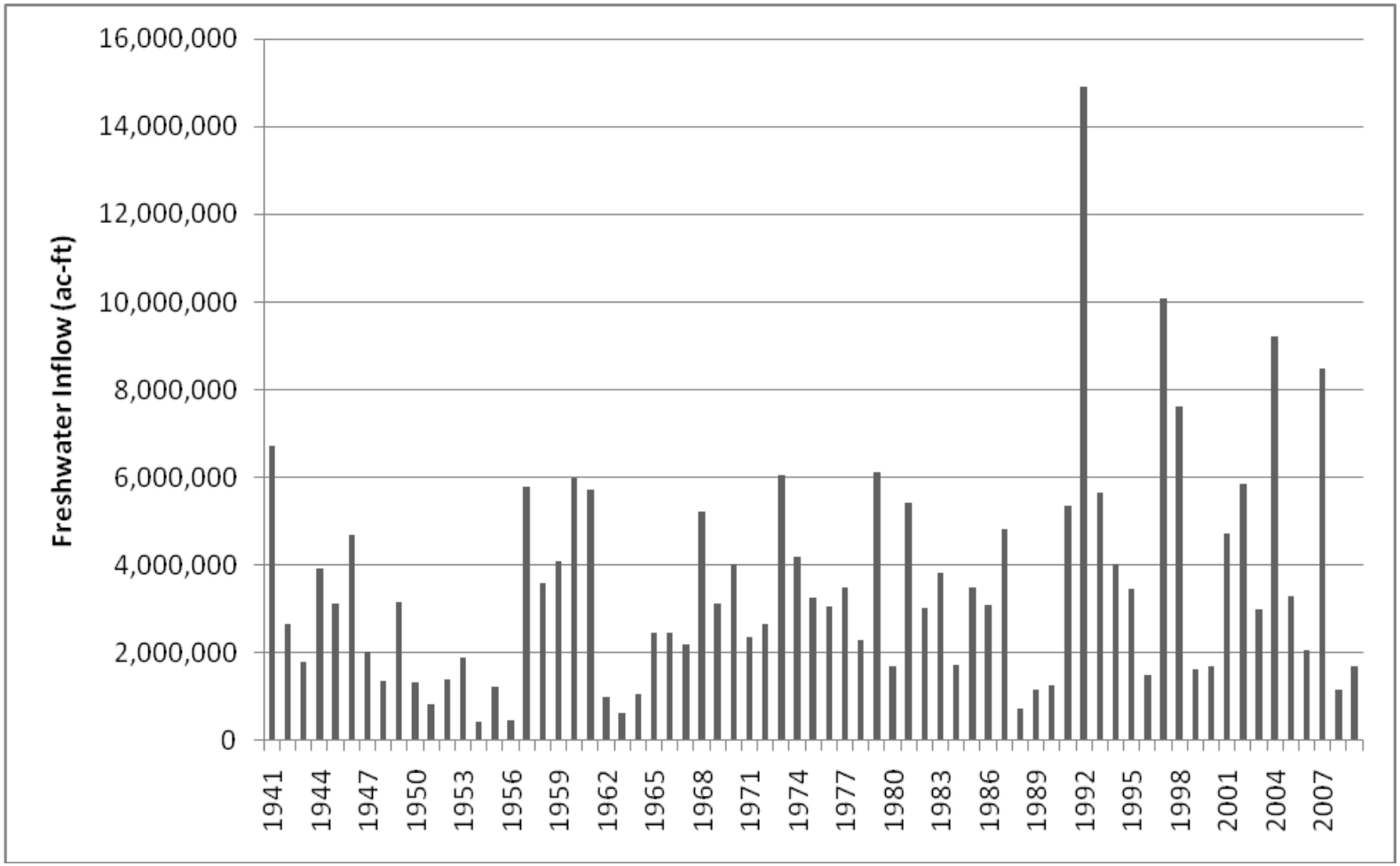

Figure 9. Annual estimates of combined freshwater inflow to the Lavaca-Colorado Estuary as calculated by version #TWDB201004 for the period 1941-2009.

Conclusion

Version #TWDB201004 of coastal hydrology for the Lavaca-Colorado Estuary, presented herein, is the most up-to-date data set representing not only combined freshwater inflows but also the individual components of inflows (*i.e*., gaged flows, ungaged flows, diversions, return flows) for this estuary for the 1941 – 2009 period. Appendix A summarizes recent updates, by version, to the estimates of hydrology for the Lavaca-Colorado Estuary. Appendix B lists annual combined inflow along with the four components, as well as estimates for evaporation and precipitation on the estuary and the total freshwater inflow balance of the Lavaca-Colorado Estuary. Appendix C lists summary statistics for the inflow components over the 1941 – 2009 period.

During the period from 1941 – 2009, gaged inflow from the Lavaca, Colorado, and Navidad Rivers and Garcitas, Tres Palacios, and Placedo Creeks accounted for 69 percent of combined inflow, while ungaged flows accounted for 29 percent of combined inflow. In the Lavaca and Colorado River basins, average diversions totaled 0.16 percent of combined freshwater inflows, and average return flows totaled 1.63 percent of inflows. (Note: This estimate reflects the absence of diversion data prior to 1977.) The difference then between diversions and returns accounted for 1.47 percent of the total combined freshwater inflow to the estuary. Average combined surface inflow to the Lavaca-Colorado Estuary over the study period was approximately 3.5 million acre-feet per year, and ranged from a minimum of 441,162 acre-feet in 1954 to a maximum of 14.9 million acre-feet in 1992.

Finally, when considering total freshwater inflow balance, evaporation from and precipitation onto the surface of the estuary must also be considered. In only three out of 69 years, a negative freshwater inflow balance indicated that evaporation had exceeded precipitation and combined inflow to the estuary. During the 1941 through 2009 period, the freshwater inflow balance varied from a minimum of -445,265 acre-feet in 1956 to a maximum of 15.1 million acre-feet in 1992, and averaged 3.2 million acre feet per year.

Literature Cited

TDWR. 1980. *Lavaca-Tres Palacios Estuary: A study of the influence of freshwater inflows*. LP-106. Texas Department of Water Resources, Austin, Texas.

TWDB. 2010. Coastal Hydrology for the Guadalupe Estuary: Updated Hydrology with Emphasis on Diversion and Return Flow Data for 2000-2009. Texas Water Development Board, Austin, Texas.

Appendix A: Record of coastal hydrology versions developed by the TWDB Bays & Estuaries Program for the Lavaca-Colorado Estuary.

Estuary	Version	Date Range	Gaged Flows	Ungaged Flows	Diversions	Return Flows	Creation Date
Lavaca-Colorado	TWDB201001	1941-2008	1941-2008	1941-2008	1941-2005 TNRCC/TCEQ 1977-2005 STWM 1989-2005	1941-2007 TDWR 1941-1976 TNRCC/TCEQ 1977-2007 TDWR/TWDB 1977-2005 (Agricultural)	01/2010
	TWDB201002	Dataset does not exist.					
	TWDB201003	Dataset does not exist.					
	TWDB201004	1941-2009	1941-2009, provisional 12/09	1941-2009, Precipitation data provisional for 12/09	1941-2009 STWM 1989-2005 TNRCC/TCEQ 1977-2009	1941-2009 TDWR 1941-1976 TNRCC/TCEQ 1977-2009 TDWR/TWDB 1977-2007 (Agricultural)	09/2010

Appendix B: Annual Hydrology for the Lavaca-Colorado Estuary, version #TWDB201004. Included are estimates of gaged and ungaged (modeled) inflows, diversions, and return flows, combined surface inflow to the estuary, as well as evaporation and direct precipitation on the estuary and the total freshwater balance of the estuary. All values are in units of acre-feet.

Year	Gage	Model	Diversion	Return	Surface Inflow	Evaporation	Precipitation	Freshwater Balance
1941	4,701,850	1,955,491	0	69000	6,726,341	939,000	1,159,536	6,946,877
1942	1,779,000	826,430	0	69000	2,674,430	961,000	824,513	2,537,943
1943	1,397,350	331,222	0	69000	1,797,572	1,043,000	686,745	1,441,317
1944	2,310,160	1,558,025	0	69000	3,937,185	1,002,000	923,664	3,858,849
1945	2,132,080	931,623	0	69000	3,132,703	1,001,000	796,336	2,928,039
1946	2,953,160	1,659,794	0	69000	4,681,954	981,000	1,149,100	4,850,054
1947	1,553,614	415,969	0	69000	2,038,583	993,000	732,668	1,778,251
1948	941,601	353,879	0	69000	1,364,480	1,022,000	582,378	924,858
1949	1,612,760	1,474,939	0	69000	3,156,699	983,000	1,211,721	3,385,420
1950	1,021,722	226,091	0	69000	1,316,813	1,105,000	463,397	675,210
1951	559,795	209,633	0	69000	838,428	1,148,000	744,150	434,578
1952	860,870	451,014	0	69000	1,380,884	1,107,000	820,339	1,094,223
1953	1,028,650	789,423	0	69000	1,887,073	1,147,000	896,528	1,636,601
1954	327,010	45,152	0	69000	441,162	1,189,000	425,825	-322,013
1955	998,239	146,363	0	69000	1,213,602	1,399,000	620,994	435,596
1956	348,541	30,879	0	69,000	448,420	1,379,000	485,315	-445,265
1957	4,266,065	1,458,663	0	69,000	5,793,728	1,232,000	1,025,944	5,587,672
1958	2,574,609	937,894	0	69,000	3,581,503	1,252,000	887,132	3,216,635
1959	2,575,080	1,432,275	0	69,000	4,076,355	1,170,000	1,021,770	3,928,125
1960	3,265,730	2,655,000	0	69,000	5,989,730	1,149,000	1,254,511	6,095,241
1961	3,653,180	1,998,967	0	69,000	5,721,147	1,129,000	1,076,044	5,668,191
1962	794,744	143,076	0	69,000	1,006,820	1,252,000	613,689	368,509
1963	503,075	60,192	0	69,000	632,267	1,275,000	512,451	-130,282
1964	517,496	482,267	0	69,000	1,068,763	1,192,000	771,286	648,049
1965	2,034,640	345,356	0	80,000	2,459,996	1,272,000	741,018	1,929,014
1966	1,282,696	1,089,073	0	80,000	2,451,769	1,907,000	881,916	1,426,685
1967	948,891	1,164,460	0	80,000	2,193,351	1,252,000	1,029,075	1,970,426
1968	3,294,190	1,855,972	0	80,000	5,230,162	1,272,000	1,074,999	5,033,161
1969	2,034,330	1,005,074	0	80,000	3,119,404	1,376,000	827,646	2,571,050
1970	2,316,720	1,615,713	0	84,000	4,016,433	1,275,000	944,537	3,685,970
1971	1,403,753	874,242	0	84,000	2,361,995	1,374,000	943,495	1,931,490
1972	1,553,183	1,030,710	0	84,000	2,667,893	1,246,000	1,026,989	2,448,882
1973	4,049,239	1,894,304	0	96,000	6,039,543	1,222,000	1,148,056	5,965,599
1974	2,995,486	1,112,508	0	96,000	4,203,994	1,220,000	1,060,387	4,044,381
1975	2,706,335	453,070	0	96,000	3,255,405	1,183,000	702,401	2,774,806
1976	2,275,259	685,340	0	96,000	3,056,599	1,290,000	993,591	2,760,190
1977	2,230,684	1,227,494	16,928	41,489	3,482,739	1,245,086	916,153	3,153,806

Year	Gage	Model	Diversion	Return	Surface Inflow	Evaporation	Precipitation	Freshwater Balance
1978	1,497,214	777,673	13,371	36,550	2,298,066	1,168,726	779,621	1,908,961
1979	3,478,977	2,608,897	11,261	35,998	6,112,611	1,017,556	1,220,210	6,315,265
1980	1,104,220	574,219	16,566	37,558	1,699,431	1,276,388	620,179	1,043,222
1981	3,619,379	1,780,854	15,539	35,857	5,420,551	1,163,001	1,129,908	5,387,458
1982	2,023,548	975,059	17,442	31,813	3,012,978	1,206,529	724,058	2,530,507
1983	2,360,319	1,452,223	9,535	23,067	3,826,074	1,136,668	941,103	3,630,509
1984	1,059,818	670,262	19,983	30,863	1,740,960	1,302,916	790,969	1,229,013
1985	2,338,308	1,132,792	18,720	26,438	3,478,818	1,184,951	763,529	3,057,396
1986	2,117,641	968,703	18,382	27,921	3,095,883	1,230,764	909,342	2,774,461
1987	3,978,367	824,175	15,240	26,531	4,813,833	1,240,887	671,183	4,244,129
1988	619,479	96,511	15,481	26,396	726,905	1,125,016	425,273	27,162
1989	807,940	331,217	15,936	23,682	1,146,903	971,742	619,922	795,083
1990	618,840	622,664	15,290	24,800	1,251,014	1,014,495	762,744	999,263
1991	3,760,496	1,583,114	21,614	24,814	5,346,810	1,002,472	1,171,676	5,516,014
1992	12,541,587	2,351,962	19,083	23,938	14,898,404	887,564	1,139,144	15,149,984
1993	4,126,306	1,540,200	20,292	19,229	5,665,443	1,068,329	780,298	5,377,412
1994	3,257,330	752,373	16,106	28,670	4,022,267	882,409	707,772	3,847,630
1995	2,391,798	1,027,932	16,549	42,134	3,445,315	924,404	667,144	3,188,055
1996	1,019,909	442,192	11,827	41,041	1,491,315	986,633	566,476	1,071,158
1997	7,982,542	2,067,367	14,514	48,660	10,084,055	983,220	1,073,160	10,173,995
1998	6,235,039	1,361,221	15,897	46,734	7,627,097	1,048,317	756,852	7,335,632
1999	1,220,848	368,617	15,776	40,310	1,613,999	977,755	388,083	1,024,327
2000	1,243,895	398,116	4,274	57,616	1,695,353	1,207,663	539,292	1,026,982
2001	3,431,350	1,221,854	707	64,628	4,717,125	947,535	807,043	4,576,633
2002	4,212,960	1,587,980	128	57,999	5,858,811	931,992	912,624	5,839,443
2003	2,243,489	704,463	156	55,719	3,003,515	827,824	687,632	2,863,323
2004	6,400,906	2,746,442	6	70,322	9,217,664	805,862	1,255,589	9,667,391
2005	2,423,470	805,568	877	59,943	3,288,104	993,326	770,501	3,065,279
2006	852,774	1,153,257	246	58,060	2,063,845	927,537	946,158	2,082,466
2007	6,056,765	2,367,164	912	49,677	8,472,694	934,416	1,189,646	8,727,924
2008	791,386	337,422	1,383	23,186	1,150,611	1,150,737	564,169	564,043
2009	1,300,219	367,469	1,254	25,102	1,691,536	950,256	688,805	1,430,085

Appendix C: Summary statistics for annual freshwater inflows (in acre-feet) over the 1941-2009 period for the Lavaca-Colorado Estuary, version #TWDB201004.

Year	Gaged	Ungaged (Model)	Diversion	Return	Combined Surface Inflow*	Evaporation	Precipitation	Freshwater Balance**
MIN	327,010	30,879	0	19,229	441,162	805,862	388,083	-445,265
5%ile	534,416	115,137	0	23,784	771,514	902,300	472,164	163,701
10%ile	757,005	222,799	0	25,044	1,131,275	933,931	559,194	538,354
25%ile	1,028,650	442,192	0	36,550	1,695,353	986,633	687,632	1,094,223
MEDIAN	2,117,641	937,894	0	69,000	3,095,883	1,147,000	807,043	2,774,461
MEAN	2,448,100	1,027,935	5,526	57,373	3,527,883	1,125,536	839,803	3,242,150
75%ile	3,265,730	1,474,939	15,240	69,000	4,717,125	1,240,887	1,025,944	4,576,633
90%ile	4,223,581	1,964,186	17,031	80,800	6,054,157	1,279,110	1,151,187	6,139,246
95%ile	6,163,729	2,361,083	18,938	91,200	8,134,455	1,375,200	1,202,891	8,171,007
MAX	12,541,587	2,746,442	21,614	96,000	14,898,404	1,907,000	1,255,589	15,149,984
TOTAL All Years	168,918,906	70,927,539	381,275	3,958,745	243,423,915	77,661,976	57,946,404	223,708,343
% of Total Combined Surface Inflow	69.39	29.14	0.16	1.63	100	-	-	-

*Combined Surface Inflow = Gage + Model - Diversion + Return

**Freshwater Balance = Surface Inflow – Evaporation + Precipitation