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Streams and Rivers Use Support Assessment



Dolan Falls on the Devils River north of Del Rio



Streams and Rivers Use Support Assessment

For the 2000 report, 348 streams and rivers (222 classified, 126 unclassified) encompassing approximately 17,342 miles were surveyed and at least one designated beneficial use was assessed in each water body. The surveyed miles represent 43.3 percent of the State's 40,194 miles of perennial streams and rivers or about 9.1 percent of the estimated 191,228 miles of all streams and rivers, including intermittent streams that flow only during wet periods (Figure 12). Most of the surveyed streams and rivers are perennial water bodies that flow year round. Approximately 2,994 more stream and river miles were surveyed in 2000 than in 1996, the last year a full statewide assessment was conducted by the TNRCC. The increase in surveyed miles is due to additions of new monitoring sites within existing water bodies to improve spatial coverage and increase in new monitoring of small unclassified streams. Included in the 2000 mileage are 124 streams and rivers that were not monitored in 1996.

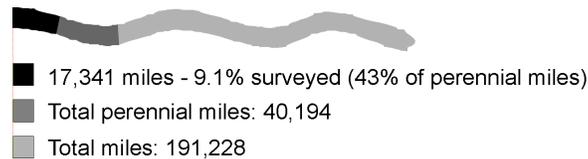


Figure 12. Streams and River Miles Surveyed

About 70 percent of the 15,082 assessed stream and river miles fully support all of their designated beneficial uses (Figure 13). Of these waters, 69.2 percent fully support designated uses and 0.7 percent have good water quality that fully supports all uses but is threatened for one use (public water supply). These threatened waters may deteriorate if potential sources of pollution are not properly managed. Some form of pollution impairs the remaining 30.1 percent of assessed stream and river miles. The framework, indicators, and criteria used to assess support of designated uses are discussed in the “Surface Water Assessment Methodology” section and shown in Tables 18-28.

Figure 14 identifies the causes and sources of pollutants that impair stream and river miles (i.e., prevent them from fully supporting designated uses). Causes and sources are rated as major, moderate, or minor contributors to impairment. A major cause or source is solely responsible for an impact or

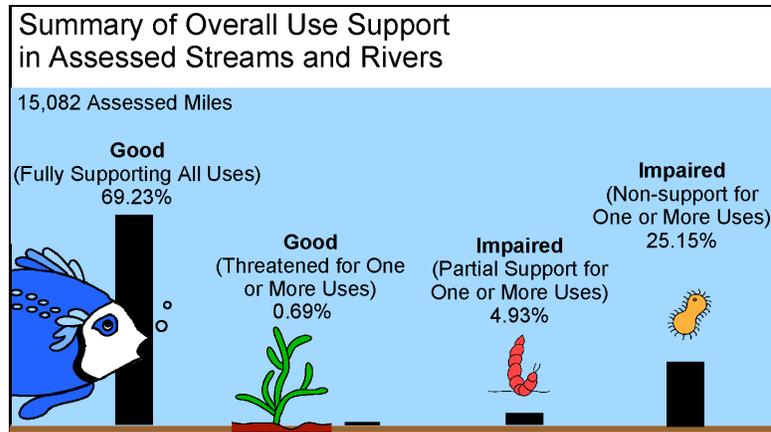
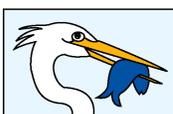


Figure 13. Summary of Use Support in Assessed Streams and Rivers

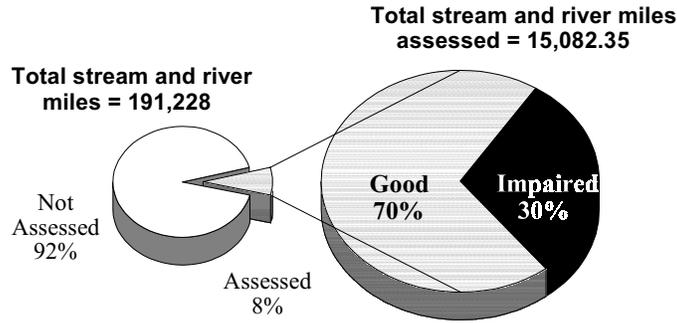
predominates over other causes and sources. A moderate or minor cause or source is one of multiple pollutants and processes that degrade aquatic life or interfere with other uses.

Causes that contribute most to overall impairment of designated uses in streams and rivers include elevated fecal coliform densities (contact recreation), depressed dissolved oxygen concentrations (aquatic life uses), elevated dissolved mineral concentrations (general uses), and low or high pH values (general uses)(Figure 14). The sources of pollution for most streams and rivers are presently unknown (Figure 14). Municipal sewage treatment plants account for the largest category of known pollution sources, polluting approximately 22 percent of impaired stream and river miles. Urban runoff, sources from outside the state, agricultural sources (irrigated crop production and confined animal feeding operations) are also identified as known sources of pollution.

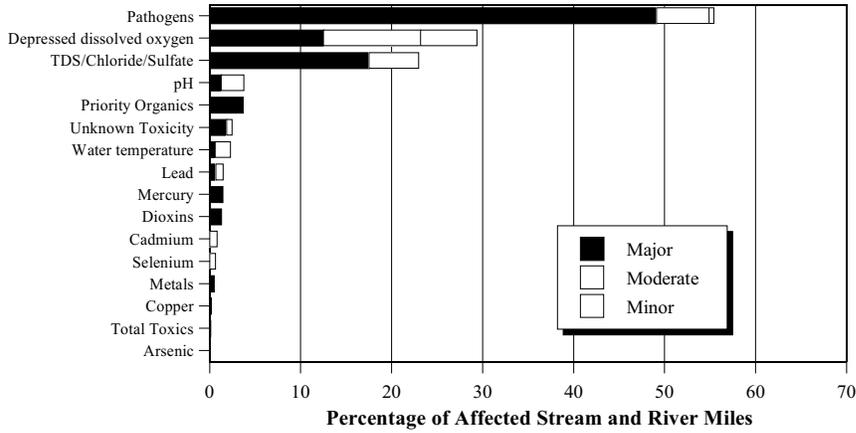


Aquatic Life Use Support

Individual use support information provides additional detail about water quality problems in streams and rivers. Approximately 17,342 stream and river miles were surveyed to determine support of the aquatic life use. Sufficient data were available to provide assessment of 11,565 miles (67% of surveyed miles) (Table 34). Of these assessed miles, 87 percent fully supported the aquatic life use, while 7 percent partially supported the use, and six percent failed to support the use. Impairment of the aquatic life use was identified as the second leading cause of overall use impairment in streams and rivers (Figure 14).



Causes Found in Impaired Streams and Rivers



Sources Found in Impaired Streams and Rivers

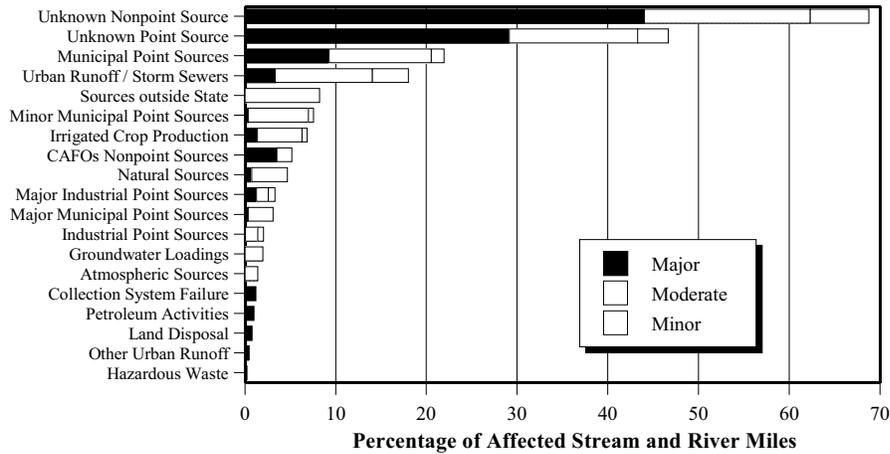
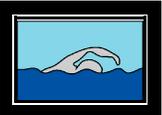


Figure 14. Causes and Sources in Streams and Rivers

Table 34. Overall Use Support in Streams and Rivers

Designated Use	Miles Surveyed	Miles Assessed	Percent of Miles Assessed	Percent of Assessed Miles			
				Good (Fully Supporting)	Good (Threatened)	Fair (Partially Supporting)	Poor (Not Supporting)
 Aquatic Life Support	17,341.55	11,564.85	66.69	87	0	7	6
 Fish Consumption	17,341.55	3,354.25	19.34	91	0	2	8
 Contact Recreation	17,285.55	9,600.45	55.54	74	0	X*	26
 Noncontact Recreation	27.00	27.00	100.00	100	0	X*	0
 Public Water Supply	8,881.00	8,881.00	100.00	99	1	0	0
 General Uses	14,321.00	10,217.50	71.35	87	0	2	11

X* - Category not applicable

The number of surveyed miles and miles assessed are not equal for most indicators. This disparity may be due to insufficient spatial coverage by monitoring sites or too few samples that prevents comprehensive assessment over entire stream and river reaches. For example, if one monitoring site is located on a stream that is 100 miles long, only a 25-mile portion is reported as assessed, provided sample numbers exceed required minimum requirements at the site. In the above example, the remaining 75-mile portion of the stream is reported as not assessed. In another example, if four sites are generally equally spaced along a stream that is 100 miles long and more than the minimum number of samples are available at all sites, then the entire length is reported as assessed. However, if only five dissolved oxygen measurements were made at each of the two lower sites and 15 measurements were made at each of the upper two sites, then only the upper 50 miles of the stream would be considered assessed. The lower 50 miles is reported as not assessed, due to data limitations (a minimum of nine measurements is required for assessment purposes). Determination of overall use support for streams and rivers and for individual designated uses (aquatic life, fish consumption, and general uses) where multiple indicators are involved requires aggregation of assessment data. Due to inconsistent overlap of the assessed miles for each indicator, the total reported assessment mileage may be more or less than the largest amount of any one indicator. This relationship between surveyed and assessed stream and river miles is similar for subsequent sections of the report dealing with reservoirs and lakes, bays and estuaries, and oceans.

Depressed instantaneous (grab sample) dissolved oxygen concentrations was the most common indicator used to assess support of the aquatic life use (11,331 miles; 65% of surveyed miles) (Table 35). Of the miles assessed by instantaneous dissolved oxygen measurements, 88 % fully supported aquatic life uses, seven percent partially supported the use, and five percent failed to support the use. The aquatic life use in streams and rivers was assessed in 3,123 miles (18% of surveyed miles) by evaluation of metals in water data (acute and chronic exposures to aquatic life) and most (96%) fully supported the use. For each of the remaining six indicators (24-hour dissolved oxygen concentrations, organic substances in water, water toxicity tests, sediment toxicity tests, macrobenthos and fish), data were so insufficient that less than five percent of stream and river miles were assessed by each indicator for aquatic life use support. Despite limited data availability, support of the aquatic life use was 85 percent or greater in assessed miles for most indicators. Of the 71 miles assessed by 24-hour dissolved oxygen measurements, 64 percent fully supported the aquatic life use, 30 percent partially supported the use, and four percent failed to support the use.

The most common causes of impaired aquatic life use in freshwater and tidal streams is depressed dissolved oxygen concentrations (Figure 14).

Table 35. Individual Indicators for Assessment of Aquatic Life, Fish Consumption, and General Uses

Designated Use	Miles Surveyed	Miles Assessed	Percent of Miles Assessed	Percent of Assessed Miles			
				Good (Fully Supporting)	Good (Threatened)	Fair (Partially Supporting)	Poor (Not Supporting)
 Aquatic Life Support							
Instantaneous Dissolved Oxygen	17,341.55	11,330.65	65.34	88	0	7	5
24-hour Dissolved Oxygen	17,341.55	70.70	0.41	66	0	30	4
Metals in Water	17,341.55	3,123.25	18.01	96	0	0	4
Organic Substances in Water	17,341.55	786.25	4.53	100	0	0	0
Water Toxicity	17,341.55	549.75	3.17	85	0	10	5
Sediment Toxicity	17,341.55	419.75	2.42	91	0	2	7
Macrobenthos Community	17,341.55	76.00	0.44	100	0	0	0
Fish Community	17,341.55	126.00	0.73	100	0	0	0

Table 35. Individual Indicators for Assessment of Aquatic Life, Fish Consumption, and General Uses (Continued)

Designated Use	Miles Surveyed	Miles Assessed	Percent of Miles Assessed	Percent of Assessed Miles			
				Good (Fully Supporting)	Good (Threatened)	Fair (Partially Supporting)	Poor (Not Supporting)
 Fish Consumption							
Advisories / Closures	17,341.55	692.00	3.99	59	0	9	32
Human Health Criteria	17,341.55	2,632.25	15.18	99	0	0	1
 General Uses							
Water Temperature	14,321.00	9,220.50	64.38	99		< 1	< 1
pH	14,321.00	9,115.50	63.65	98	0	1	<1
Chloride	13,668.00	9,503.50	69.53	96	0	X*	4
Sulfate	13,668.00	9,503.50	69.53	95	0	X	5

Table 35. Individual Indicators for Assessment of Aquatic Life, Fish Consumption, and General Uses (Continued)

Designated Use	Miles Surveyed	Miles Assessed	Percent of Miles Assessed	Percent of Assessed Miles			
				Good (Fully Supporting)	Good (Threatened)	Fair (Partially Supporting)	Poor (Not Supporting)
Total Dissolved Solids	13,668.00	9,564.50	69.98	89	0	X	11

X* - Category not applicable

Table 36. Streams and Rivers with Partially Supported or Nonsupported Aquatic Life Uses Due to Depressed Dissolved Oxygen Concentrations

Segment Number	Water Body	Water Body Type	Level of Aquatic Life Support	
			Partial	Non
0101A	Dixon Creek (unclassified)	Freshwater	✓	
0211	Little Wichita River	Freshwater	✓	
0214A	Beaver Creek (unclassified)	Freshwater	✓	
0229	Upper Prairie Dog Town Fork Red River	Freshwater		✓
0303B	White Oak Creek (unclassified)	Freshwater	✓	
0306	Upper South Sulphur River	Freshwater	✓	
0401A	Harrison Bayou (unclassified)	Freshwater	✓	
0402	Big Cypress Creek Below Lake O' Pines	Freshwater	✓	
0402A	Black Cypress Bayou (unclassified)	Freshwater		✓
0406	Black Bayou	Freshwater		✓
0407	James' Bayou	Freshwater	✓	
0409	Little Cypress Bayou	Freshwater		✓
0503A	Nichols Creek (unclassified)	Freshwater		✓
0505B	Grace Creek (unclassified)	Freshwater	✓	
0505D	Rabbit Creek (unclassified)	Freshwater	✓	✓
0505G	Wards Creek (unclassified)	Freshwater	✓	
0506A	Harris Creek (unclassified)	Freshwater		✓
0507A	Cowleech Fork Sabine River (unclassified)	Freshwater	✓	

Table 36. Streams and Rivers with Partially Supported or Nonsupported Aquatic Life Uses Due to Depressed Dissolved Oxygen Concentrations (Continued)

Segment Number	Water Body	Water Body Type	Level of Aquatic Life Support	
			Partial	Non
0508	Adams Bayou Tidal	Saltwater		✓
0508A	Adams Bayou above Tidal (unclassified)	Freshwater		✓
0508B	Gum Gully (unclassified)	Freshwater		✓
0511	Cow Bayou Tidal	Saltwater		✓
0511A	Cow Bayou above Tidal (unclassified)	Freshwater		✓
0511B	Coon Bayou (unclassified)	Saltwater		✓
0511C	Cole Creek (unclassified)	Saltwater	✓	
0601A	Star Lake Canal (unclassified)	Saltwater	✓	
0602A	Booger Branch (unclassified)	Freshwater	✓	
0607	Pine Island Bayou	Freshwater	✓	✓
0607A	Boggy Creek (unclassified)	Freshwater	✓	
0607B	Little Pine Island Bayou (unclassified)	Freshwater		✓
0607C	Willow Creek (unclassified)	Freshwater		✓
0608A	Beech Creek	Freshwater	✓	
0608C	Cypress Creek	Freshwater		✓
0701	Taylor Bayou above Tidal	Freshwater	✓	
0704	Hillebrandt Bayou	Freshwater	✓	
0812	West Fork Trinity River Above Bridgeport Reservoir	Freshwater		✓
0814	Chambers Creek	Freshwater	✓	
0831	Clear Fork Trinity River Below Lake Weatherford	Freshwater	✓	
0833	Clear Fork Trinity River Above Lake Weatherford	Freshwater	✓	
0902	Cedar Bayou Above Tidal	Freshwater	✓	
1008	Spring Creek	Freshwater		✓
1110	Oyster Creek Above Tidal	Freshwater		✓
1103	Dickinson Bayou Tidal	Saltwater	✓	
1113	Armand Bayou Tidal	Saltwater		✓
1113A	Armand Bayou Above Tidal (unclassified)	Freshwater		✓
1217A	Rocky Creek (unclassified)	Freshwater		✓
1222A	Duncan Creek (unclassified)	Freshwater		✓

Table 36. Streams and Rivers with Partially Supported or Nonsupported Aquatic Life Uses Due to Depressed Dissolved Oxygen Concentrations (Continued)

Segment Number	Water Body	Water Body Type	Level of Aquatic Life Support	
			Partial	Non
1243	Salado Creek	Freshwater	✓	
1245	Upper Oyster Creek	Freshwater	✓	
1305	Caney Creek Above Tidal	Freshwater		✓
1420	Pecan Bayou Above Lake Brownwood	Freshwater	✓	
1427	Onion Creek	Freshwater	✓	
1501	Tres Palacios Creek Tidal	Saltwater	✓	
1801	Guadalupe River Tidal	Saltwater	✓	
1803A	Elm Creek (unclassified)	Freshwater		✓
1803B	Sandies Creek (unclassified)	Freshwater		✓
1806A	Camp Creek (unclassified)	Freshwater	✓	
1815	Cypress Creek	Freshwater	✓	
1906	Lower Leon Creek	Freshwater	✓	
1908	Upper Cibolo Creek	Freshwater	✓	
1910	Salado Creek	Freshwater	✓	✓
1913	Mid Cibolo Creek	Freshwater	✓	
2104	Nueces River Above Frio River	Freshwater	✓	
2107	Atascosa River	Freshwater		✓
2113	Upper Frio River	Freshwater	✓	
2117	Frio River Above Choke Canyon Reservoir	Freshwater	✓	
2201	Arroyo Colorado River Tidal	Saltwater		✓
2453A	Garcitas Creek Tidal (unclassified)	Saltwater	✓	
Totals			41	30

Depressed dissolved oxygen concentrations contribute to partial support in one reach and nonsupport in a different reach in Rabbit Creek (Segment 0505D), Pine Island Bayou (Segment 0607), and Salado Creek (1910) (Table 36). Low dissolved oxygen concentrations contribute to partially supported aquatic life use in 41 stream and river water body segments (27 classified segments and 14 unclassified water bodies) (Table 36). Aquatic life use is not supported in 30 stream and river water body segments (15

classified segments and 15 unclassified water bodies) due to depressed dissolved oxygen concentrations.

Most of the water bodies affected by depressed dissolved oxygen concentrations are freshwater streams (57), but 11 tidally influenced water bodies also have depressed dissolved oxygen concentrations that contribute to impaired aquatic life use. A large portion of the impaired streams occur in East Texas where low stream velocity, dense tree canopy shading, low stream gradients (small changes in stream bed elevations), few riffle areas (limit replenishment of dissolved oxygen by physical reaeration), and high sediment oxygen demands are naturally occurring factors that contribute to low dissolved oxygen concentrations. In other areas of the state, low stream velocity associated with low stream flow, caused by drought, or sluggish tidal activity are thought to contribute heavily to depression of dissolved oxygen concentrations. Assimilation of even minor point and nonpoint source pollutant loads in streams already stressed by low flows and near stagnant velocities, contributes further to depression of dissolved oxygen concentrations.

Nearly all of the water bodies identified in Table 36 are placed on the 2000 303(d) List of Impaired Waters. A 2000 303(d) listing for Rabbit Creek, due to depressed dissolved oxygen concentrations was deferred pending approval of the 2000 TSWQS.

The aquatic life use is partially supported or not supported in seven stream and river water bodies due to elevated concentrations of toxic substances in water. The aquatic life use in Attoyac Bayou (Segment 0612) is not supported due to chronic exposure to cadmium and lead concentrations in water. Similar chronic exposures cause nonsupport of aquatic life uses in the East Fork Angelina River (Segment 0611A; lead), Wichita/North Fork Wichita River (Segment 0218; selenium), Neches River above Lake Palestine (Segment 0606; zinc), Houston Ship Channel (Segment 1006; copper), and Buffalo Bayou Tidal (Segment 1013; copper). Chronic exposure to elevated zinc in water concentrations cause nonsupport of the aquatic life use in Prairie Creek (Segment 0606A), acute exposures cause partial support in the Neches River above Lake Palestine (Segment 0606).

Significant effects in ambient water toxicity test results contribute to partial support of the aquatic life use in Alligator Bayou (Segment 0702A), the Rio Grande below Amistad Reservoir (Segment 2304) near Eagle Pass, and the Rio Grande Above Amistad Reservoir (Segment 2306) near Presidio. Nonsupport of the aquatic life use due to ambient water toxicity occurs in the Rio Grande below Amistad Reservoir (Segment 2304) near Del Rio and the Houston Ship Channel (Segment 1006). Significant effects in ambient sediment toxicity test results cause partial support of the aquatic life use in the Houston Ship Channel (Segment 1006 and 1007)

and nonsupport in Alligator Bayou (Segment 0702A) and the Arroyo Colorado Tidal (Segment 2201).



Contact Recreation Use Support

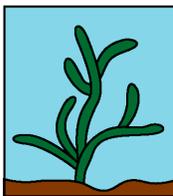
Bacterial indicators provide evidence of possible fecal contamination that may cause illness if the water is ingested. Fecal coliform is a bacterial indicator that is used to determine if streams and rivers are safe for swimming and drinking. Bacteria commonly enter streams in inadequately treated sewage, through wildlife contributions, and runoff from pastures, feedlots, and urban areas.

Elevated fecal coliform densities (indicating potential for pathogens) is the leading cause that contributes to impairment of overall uses in streams and rivers (Figure 14). Fecal coliform data were sufficient to provide assessment of the contact recreation use in 9,601 of 17,286 stream and river miles surveyed (56%) (Table 34). Of the 9,601 miles assessed, approximately 74 percent fully supported the contact recreation use. Partial support is not evaluated for the contact recreation use. Elevated fecal coliform densities caused nonsupport of the contact recreation use in 26 percent of assessed stream and river miles. Contact recreation is not supported in 107 streams and rivers (59 classified and 48 unclassified) (Table 37).



Noncontact Recreation Use Support

Fecal coliform densities are also used to evaluate support of the noncontact recreation use in streams and rivers. Fecal coliform data were sufficient to provide assessment of the noncontact recreation use in all 27 miles surveyed (Table 34). The contact recreation use was fully supported in all stream and river miles assessed.



General Use Support

Water quality criteria for several constituents are established in the TSWQS to safeguard general water quality, rather than for protection of specific uses. Water temperature, pH, chloride, sulfate, and total dissolved solids (TDS) indicators, which are assigned specifically to only classified segments, are included this grouping. General use support is not assessed for unclassified streams. Together these constituents comprise the third major category which causes nonsupport of overall uses in streams and rivers (Figure 14). Not all classified streams and rivers (those that are tidally influenced) are assigned criteria for chloride, sulfate, and TDS. Since unclassified streams are not assessed for general use support, the

Table 37. Streams and Rivers with Nonsupported Contact Recreation Uses

Segment Number	Water Body	Segment Number	Water Body
0101A	Dixon Creek (unclassified)	0608C	Cypress Creek (unclassified)
0202D	Pine Creek (unclassified)	0608D	Hickory Creek (unclassified)
0203A	Big Mineral Creek (unclassified)	0608F	Turkey Creek (unclassified)
0204	Red River Above Lake Texoma	0610A	Ayish Bayou (unclassified)
0205	Red River Below Pease River	0611	Angelina River Above Sam Rayburn R.
0207A	Buck Creek (unclassified)	0611B	LaNana Bayou (unclassified)
0306	Upper South Sulphur River	0611C	Mud Creek (unclassified)
0404B	Tankersley Creek (unclassified)	0612B	Waffelow Creek (unclassified)
0503A	Nichols Creek (unclassified)	0804	Trinity River Above Lake Livingston
0505B	Grace Creek (unclassified)	0805	Upper Trinity River
0505D	Rabbit Creek (unclassified)	0806	West Fork Trinity Below L. Worth
0507A	Cowleech Fork Sabine River (unclassified)	0810	W.F. Trinity River Below Bridgeport R.
0507B	Long Branch (unclassified)	0819	East Fork Trinity River
0508	Adams Bayou Tidal	0841	Lower West Fork Trinity River
0508A	Adams Bayou Above Tidal (unclassified)	0901	Cedar Bayou Tidal
0508B	Gum Gully (unclassified)	0902	Cedar Bayou Above Tidal
0511	Cow Bayou Tidal	1001	San Jacinto River Tidal
0511A	Cow Bayou Above Tidal (unclassified)	1008	Spring Creek
0511B	Coon Bayou (unclassified)	1009	Cypress Creek
0511C	Cole Creek (unclassified)	1013	Buffalo Bayou Tidal
0513	Big Cow Creek	1014	Buffalo Bayou Above Tidal
0603A	Sandy Creek (unclassified)	1016	Greens Bayou Above Tidal
0604	Neches River Below Lake Palestine	1017	Whiteoak Bayou Above Tidal
0604A	Cedar Creek (unclassified)	1101	Clear Creek Tidal
0604B	Hurricane Creek (unclassified)	1304A	Linville Bayou (unclassified)
0604C	Jack Creek (unclassified)	1403A	Bull Creek (unclassified)
0605A	Kickapoo Creek (unclassified)	1414	Pedernales River
0607	Pine Island Bayou	1427	Onion Creek
0607C	Willow Creek (unclassified)	1427A	Slaughter Creek (unclassified)
0608B	Big Sandy Creek (unclassified)	1427B	Williamson Creek (unclassified)
1102	Clear Creek Above Tidal	1427C	Bear Creek (unclassified)

Table 37. Streams and Rivers with Nonsupported Contact Recreation Uses (Continued)

Segment Number	Water Body	Segment Number	Water Body
1103	Dickinson Bayou Tidal	1428B	Walnut Creek (unclassified)
1104	Dickinson Bayou Above Tidal	1428C	Gilleland Creek (unclassified)
1108	Chocolate Bayou Above Tidal	1429A	Shoal Creek (unclassified)
1109	Oyster Creek Tidal	1429B	Eanes Creek (unclassified)
1110	Oyster Creek Above Tidal	1430	Barton Creek
1113	Armand Bayou Tidal	1502	Tres Palacios Creek Above Tidal
1113A	Armand Bayou Above Tidal (unclassified)	1803A	Elm Creek (unclassified)
1209C	Carters Creek (unclassified)	1804B	Peach Creek (unclassified)
1217A	Rocky Creek (unclassified)	1811A	Dry Comal Creek
1218	Nolan/South Nolan Creek	1901	Lower San Antonio River
1221	Leon River Below Proctor Lake	1903	Medina River Below Medina Diversion L
1222A	Duncan Creek (unclassified)	1906	Lower Leon Creek
1226	North Bosque River	1910	Salado Creek
1226A	Duffau Creek (unclassified)	1911	Upper San Antonio River
1226C	Meridian Creek (unclassified)	2107	Atascosa River
1226D	Neils Creek (unclassified)	2110	Lower Sabinal River
1242	Brazos River Below Whitney Lake	2117	Frio River Above Choke Canyon R.
1245	Upper Oyster Creek	2202	Arroyo Colorado Above Tidal
1255	Upper North Bosque River	2302	Rio Grande Below Falcon Reservoir
1304	Caney Creek Tidal	2304	Rio Grande Below Amistad Reservoir
1428	Colorado River Below Town Lake	2306	Rio Grande Above Amistad Reservoir
1428A	Boggy Creek (unclassified)		

total miles surveyed (14,321) is about 3,000 less than those surveyed for aquatic life, contact recreation, and fish consumption uses (Table 34). Water temperature, pH, and dissolved mineral data were sufficient to provide assessment of general uses in 10,218 of 14,321 miles surveyed (71%)(Table 34). Of the miles assessed, 87 percent fully support general uses, while two percent partially supports (due to elevated water temperature and low or high pH values), and 11 percent failed to support the use. Each of the five indicators used to assess general use support was monitored about equally, which each accounting for over 9,000 assessed miles

(>60%) (Table 35). General uses were supported in 99 percent of assessed miles for water temperature, 98 percent for pH, 96 percent for chloride, 95 percent for sulfate, and 89 percent for TDS.

Elevated average TDS concentrations contributed to nonsupport of general uses in 19 streams and rivers (Table 38). General uses were not supported due to elevated average chloride and sulfate concentrations in six and eight water bodies, respectively. A 2000 303(d) listing for the Neches River (Segment 0606), due to an elevated average sulfate concentration, was deferred pending approval of the 2000 TSWQS. Low pH values contributed to partial and nonsupported uses in five East Texas water bodies where water is naturally acidic. Elevated surface water temperature exceeded criteria in hot summer months causing partial or nonsupport of general uses in four streams and rivers.



Public Water Supply Use Support

The public water supply use is assigned to stream and rivers where water is withdrawn and treated for public consumption. Assessment of the use is based on evaluation of organic chemicals in water (after treatment at the entry to distribution systems) specified in the Public Drinking Water Standards.

All 8,881 stream and river miles assigned the public water supply use were assessed (Table 34). Due to the very low occurrence of organic chemicals in finished drinking water, 99 percent of all streams and rivers fully support the public water supply use. The Little River (Segment 1213) is the only river where use as a public supply is threatened by contaminated source water. All finished drinking water samples from the Little River currently indicate support use as a public water supply; however, some of the atrazine concentrations exceed 50 percent of the MCL. These elevated atrazine concentrations represent a threat to future use. Atrazine is a herbicide used extensively in Texas to control weeds in agricultural crops such as corn, sorghum, wheat, and soybeans. Atrazine enters streams and rivers from nonpoint source runoff following rainfall.



Fish Consumption Use Support

Fish consumption advisories are issued by the TDH to protect the public from consuming harmful quantities of toxic pollutants in contaminated noncommercial fish and wildlife. In general, the advisories recommend that the public limit the quantity and frequency of consumption of fish and other organisms (shrimp, crabs, and oysters) from contaminated water bodies. Individual advisories are issued following extensive sampling and completion of a risk assessment for each water body. The advisories are

Table 38. Streams and Rivers with Partially Supported or Nonsupported General Uses

Segment Number	Water Body	General Use Support Indicator					
		Temp	Low pH	High pH	Chloride	Sulfate	TDS
0211	Little Wichita River						N
0221	Middle Fork Pease River	P					
0306	Upper South Sulphur River		P	P/N			
0402	Big Cypress Creek Below Lake O' Pines		P				
0511	Cow Bayou Tidal		P				
0606	Neches River Above Lake Palestine					N**	N
0607	Pine Island Bayou		P				
0608	Village Creek		N				
0812	West Fork Trinity River Above Bridgeport Reservoir				N		N
0902	Cedar Bayou Above Tidal						N
1006	Houston Ship Channel Tidal	N					
1009	Cypress Bayou Above Tidal						N
1108	Chocolate Bayou Above Tidal						N
1214	San Gabriel River				N		
1221	Leon River Below Proctor Lake						N
1229	Paluxy River/North Paluxy River						N
1243	Salado Creek						N
1244	Brushy Creek						N
1255	Upper North Bosque River				N	N	N
1302	San Bernard River Above Tidal	P					
1426	Colorado River Below E.V. Spence Reservoir						N
1427	Onion Creek					N	N
1432	Upper Pecan Bayou						N
1502	Tres Palacios River Above Tidal						N
1602	Lavaca River Above Tidal	N					
1814	Upper San Marcos River					N	
2004	Aransas River Above Tidal					N	N
2104	Nueces River Above Frio River			P			
2204	Petronila Creek Above Tidal				N	N	N

Table 38. Streams and Rivers with Partially Supported or Nonsupported General Uses (Continued)

Segment Number	Water Body	General Use Support Indicator					
		Temp	Low pH	High pH	Chloride	Sulfate	TDS
2307	Rio Grande Below Riverside Diversion Dam				N	N	N
2310	Lower Pecos River				N	N	N
Totals		4	5	2	6	8	19

* P = Partially Supported Use; N = Nonsupported Use; In some streams, different reaches may have areas with differing levels of use support (P/N).

** Water bodies are deferred from placement on the 2000 303(d) List, since application of the 2000 TSWQS will change the criteria and negate justifications for listing.

then tailored to each water body to minimize health risks based on contaminant data collected in the fish tissue.

Advisories may completely prohibit consumption in severely polluted waters or limit consumption to several meals for a month or year in cases of less severe contamination. Advisories may target a subpopulation at risk (such as children, pregnant women, or nursing mothers), specific fish species that concentrate toxic pollutants in the flesh, or larger, older fish within a species that may have accumulated high concentrations of a pollutant over a longer lifetime than a smaller, younger fish. In severe cases of pollution, an aquatic life closure may be issued by the TDH, which prohibits the taking of all species from a water body.

Human health criteria for toxic substances in water are other indicators that are used to determine support of the fish consumption use. Human health criteria are back-calculated from fish tissue concentrations. Exceedance of the criteria by average toxic substances concentrations in water suggest that concentrations in fish tissue could also be elevated.

The fish consumption use was assessed in only 3,354 stream and river miles (19.3% of surveyed miles) due to high cost associated with laboratory preparation and analytical determination of toxic substances (approximately \$2,275 per sample for a full scan of toxic substances) (Table 34). Within the assessed miles, 91 percent fully support the fish consumption use, two percent partially supported the use, and eight percent failed to support the use. Evaluation of human health criteria with toxic substances in water data was more frequently used to assess support of the fish consumption use than issuance of consumption advisories or closures (Table 35). However, only about 15 percent of stream and river miles surveyed were assessed for the fish consumption use based on human

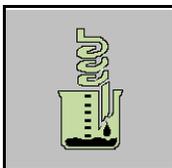
health criteria. Ninety-nine percent of the 2,632 miles assessed using the human health criteria fully supported the fish consumption use. The East Fork Angelina River (Segment 0611A; lead) and an unnamed tributary to Bryan Municipal Lake (Segment 1209A; arsenic) were the only two streams assessed where contaminants exceeded human health criteria. Due to existing consumption advisories and closures, 692 stream and river miles (4% of surveyed miles) were considered assessed for the fish consumption use (Table 35). Of these assessed miles, about 59 percent fully support the use, nine percent partially support the use, and 32 percent fail to support the use. The fish consumption use is not supported in several reaches of the upper Trinity River (Segments 0805, 0806, 0829, and 0841) within the Dallas-Fort Worth metroplex due to issuance in January 1990 of an aquatic life closure. The closure prohibits the taking of all fish species from the affected reaches due elevated concentrations of chlordane in fish tissue. Chlordane has been used historically for residential pest control and was probably carried into the river system by urban runoff.

Within the Houston Ship Channel (Segments 1005, 1006, and 1007), the tidal portion of the San Jacinto River (Segment 1001), and the tidal portions of unclassified streams that flow into the Houston Ship Channel, the fish consumption use is not supported due to issuance in September 1990 of a no-consumption advisory for children and women of child bearing age. The advisory recommends that this subpopulation not consume catfish and blue crabs due to elevated dioxin in their tissues. No-consumption advisories for the general population have issued by the TDH for Clear Creek (Segments 1101 and 1102) due to elevated organic substances (dichloroethane, trichloroethane, carbon disulfide, and chlordane) in fish and crab tissue and for the Arroyo Colorado due to elevated DDE, chlordane, and toxaphene concentrations in fish tissue.

The fish consumption use is partially supported in Big Cypress Creek (Segment 0402) upstream of Caddo Lake and Black Cypress Bayou (Segment 402A) due to issuance of restricted consumption advisories for the general population. Largemouth bass and freshwater drum from the streams contain elevated concentrations of mercury in their tissues. Mercury is a naturally occurring element that can be toxic if consumed in contaminated fish by humans and animals. Sources of mercury include weathering of the earth's crust, the burning of fossil fuels and garbage, and factories that use mercury. The specific source of mercury in fish from East Texas is atmospheric deposition. Bioaccumulation of mercury in east Texas fishes occurs primarily because of natural processes in streams and reservoirs related to low pH, elevated organic carbon, and low dissolved oxygen concentrations (Twidwell, 2000).

Streams and Rivers Concerns Assessment

Water quality criteria for nutrients and chlorophyll *a* in water have not been developed for Texas. The TNRCC is currently evaluating the feasibility of developing nutrient criteria with a goal for implementation in 2003. Sediment criteria have been developed by EPA for only a few parameters. Screening levels for some toxicants in fish tissue were developed from human health criteria in the TSWQS. The screening levels do not represent adopted state criteria. Secondary standards for dissolved mineral concentrations in finished drinking water are used to identify public water supply concerns. Dissolved mineral data collected from surface water is also screened against the secondary standards to identify public water supply concerns. Exceedances of screening levels for nutrients, chlorophyll *a*, toxic substances in sediment, and toxic substances in fish tissue do not cause direct impairment of designated uses. Instead, they are used to identify areas where elevated concentrations are cause for concern. The framework, indicators, and screening levels used to evaluate water quality concerns are discussed in the “Surface Water Assessment Methodology” section and are shown in Tables 29-33. Water bodies with identified concerns are targeted by the TNRCC and CRP for increased fixed station monitoring and/or special studies to identify possible causes and sources.



Nutrient Concerns

Approximately 17,342 stream and river miles were surveyed to identify areas of concern caused by elevated concentrations of ammonia nitrogen, nitrite plus nitrate nitrogen, orthophosphorus, and total phosphorus (Table 39). Sufficient data were available to provide assessment in about 50 percent of stream and river miles surveyed for each of the four nutrient indicators. Of the miles assessed in streams and rivers, water quality concerns were identified in only eight percent for ammonia nitrogen, 14 percent for nitrite plus nitrate nitrogen, six percent for orthophosphorus, and seven percent for total phosphorus. Forty-eight streams and rivers (37 classified; 11 unclassified) were identified with concerns for nitrite plus nitrate nitrogen; 33 (20 classified; 13 unclassified) with concerns for ammonia nitrogen; 23 (19 classified; 4 unclassified) for orthophosphorus; and 25 (16 classified; 9 unclassified) for total phosphorus (Table 40). Most of the streams and rivers identified with nutrient concerns receive heavy municipal point source and urban nonpoint source loadings. In Geronimo Creek (Segment 1804A) elevated nitrite plus nitrate nitrogen concentrations originate from groundwater (spring) sources.

Table 39. Individual Nutrient Concerns in Streams and Rivers

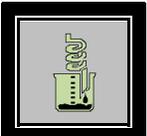
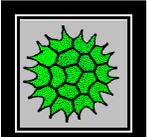
Concern Parameter	Miles Surveyed	Miles Assessed	Percent of Miles Assessed	Percent of Assessed Miles	
				No Concern	Concern
 Ammonia	17,341.55	9,718.35	56.04	92	8
 Nitrate + Nitrite	17,341.55	9,482.90	54.68	86	14
 Orthophosphorus	17,341.55	8,956.15	51.65	94	6
 Total Phosphorus	17,341.55	9,160.05	52.82	93	7
 Chlorophyll a	17,341.55	7,296.60	42.08	82	18

Table 40. Streams and Rivers with Nutrient and Chlorophyll *a* Concerns

Segment Number	Stream or River	Nutrient				Chl <i>a</i>
		NH ₃ -N	NO ₂ + NO ₃ -N	OPhos	TPhos	
0101	Canadian River Below Lake Meredith	✓				
0103A	East Amarillo Creek (unclassified)		✓			
0204	Red River Above Lake Texoma					✓
0205	Red River Below Pease River					✓
0211	Little Wichita River					✓
0214	Wichita River Below Diversion Lake					✓
0216	Wichita River Below Lake Kemp	✓				
0218	Wichita/North Wichita River	✓				
0218A	Middle Fork Wichita River (unclassified)	✓				
0220	Pease/North Fork Pease River	✓				
0226	South Fork Wichita River	✓				
0229	Upper Prairie Dog Town Fork Red River	✓	✓	✓	✓	
0301	Sulphur River Below Wright Patman Lake					✓
0304	Days Creek		✓			
0304A	Swampoodle Creek (unclassified)	✓				
0306	Upper South Sulphur River		✓	✓		
0404	Big Cypress Creek Below Lake Bob Sandlin		✓	✓	✓	
0404B	Tankersley Creek (unclassified)	✓	✓	✓	✓	
0505	Sabine River Above Toledo Bend Reservoir					✓
0505B	Grace Creek (unclassified)	✓				
0505C	Hawkins Creek (unclassified)	✓				
0505D	Rabbit Creek (unclassified)	✓				
0506	Sabine River Below Lake Tawakoni					✓
0506A	Harris Creek (unclassified)				✓	
0507A	Cowleech Fork Sabine River (unclassified)		✓	✓	✓	
0507B	Long Branch (unclassified)		✓			
0508	Adams Bayou Tidal					✓
0601A	Star Lake Canal (unclassified)	✓	✓	✓	✓	
0604C	Jack Creek (unclassified)	✓				
0606	Neches River Above Lake Palestine		✓			

Table 40. Streams and Rivers with Nutrient and Chlorophyll *a* Concerns (Continued)

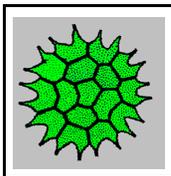
Segment Number	Stream or River	Nutrient				Chl <i>a</i>
		NH ₃ -N	NO ₂ + NO ₃ -N	OPhos	TPhos	
0606A	Prairie Creek (unclassified)		✓			
0610B	Papermill Creek (unclassified)	✓				
0611B	LaNana Bayou (unclassified)	✓				
0611D	West Mud Creek (unclassified)		✓			
0702A	Alligator Bayou (unclassified)					✓
0704	Hillebrandt Bayou	✓				✓
0803A	Harmon Creek (unclassified)			✓		
0804	Trinity River Above Lake Livingston		✓			
0805	Upper Trinity River		✓			
0806	West Fork Trinity River Below Lake Worth					✓
0819	East Fork Trinity River	✓	✓	✓	✓	
0824	Elm Fork Trinity River		✓	✓		
0841	Lower West Fork Trinity River		✓		✓	✓
1007	Houston Ship Channel/Buffalo Bayou Tidal	✓	✓			
1009	Cypress Creek		✓	✓	✓	
1013	Buffalo Bayou Tidal		✓			
1014	Buffalo Bayou Above Tidal		✓			
1016	Greens Bayou		✓	✓	✓	✓
1017	Whiteoak Bayou		✓			
1101	Clear Creek Tidal					✓
1102	Clear Creek Above Tidal		✓	✓		
1113	Armand Bayou Tidal					✓
1202	Brazos River Below Navasota River					✓
1208	Brazos River Above Possum Kingdom Lake					✓
1209D	Unnamed Tributary to Bryan Municipal Lake (unclassified)				✓	
1218	Nolan Creek/South Nolan Creek		✓	✓	✓	
1221	Leon River Below Proctor Lake		✓			
1221B	South Leon River (unclassified)		✓			
1222A	Duncan Creek (unclassified)		✓			

Table 40. Streams and Rivers with Nutrient and Chlorophyll *a* Concerns (Continued)

Segment Number	Stream or River	Nutrient				Chl <i>a</i>
		NH ₃ -N	NO ₂ + NO ₃ -N	OPhos	TPhos	
1226	North Bosque River					✓
1227	Nolan River			✓		
1232	Clear Fork Brazos River					✓
1232A	California Creek (unclassified)		✓			✓
1232B	Deadman Creek (unclassified)	✓			✓	
1244	Brushy Creek	✓	✓		✓	
1246	Middle/South Bosque River		✓			
1255	Upper North Bosque River	✓	✓	✓	✓	✓
1412	Colorado River Below Lake J.B. Thomas					✓
1412 B	Beals Creek (unclassified)					✓
1416A	Brady Creek (unclassified)				✓	✓
1421	Concho River		✓			✓
1428	Colorado River Below Town Lake		✓			
1431	Mid Pecan Bayou		✓	✓	✓	
1502	Tres Palacios Creek Above Tidal		✓			
1803A	Elm Creek (unclassified)	✓				
1804A	Geronimo Creek (unclassified)		✓			
1804B	Peach Creek (unclassified)	✓				
1810	Plum Creek		✓			
1901	Lower San Antonio River		✓	✓	✓	
1903	Medina River Below Medina Diversion Lake	✓	✓	✓		
1911	Upper San Antonio River		✓	✓	✓	
1912	Medio Creek			✓	✓	
1913	Mid Cibolo Creek	✓	✓	✓	✓	
2004	Aransas River Above Tidal				✓	
2101	Nueces River Tidal					✓
2107	Atascosa River	✓	✓	✓	✓	
2110	Lower Sabinal River		✓			
2117	Frio River Above Choke Canyon Reservoir		✓			

Table 40. Streams and Rivers with Nutrient and Chlorophyll *a* Concerns (Continued)

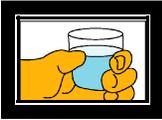
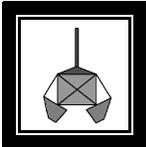
Segment Number	Stream or River	Nutrient				Chl <i>a</i>
		NH ₃ -N	NO ₂ + NO ₃ -N	OPhos	TPhos	
2201	Arroyo Colorado Tidal	✓	✓			✓
2202	Arroyo Colorado Above Tidal	✓	✓			✓
2203	Petronila Creek Tidal					✓
2204	Petronila Creek Above Tidal					✓
2301	Rio Grande Tidal					✓
2302	Rio Grande Below Falcon Reservoir	✓				✓
2304	Rio Grande Below Amistad Reservoir	✓				
2306	Rio Grande Above Amistad Reservoir					✓
2307	Rio Grande Below Riverside Diversion Dam	✓				✓
2308	Rio Grande Below International Dam	✓				
2314	Rio Grande Above International Dam					✓
2453A	Garcitas Creek Tidal (unclassified)				✓	
2456A	West Carancahua Creek (unclassified)		✓	✓	✓	
Totals		33	48	23	25	35

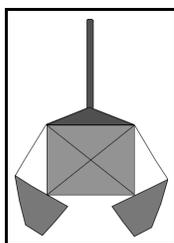


Chlorophyll a Concerns

Approximately 17,342 stream and river miles were surveyed to identify areas of concern caused by elevated concentrations of chlorophyll *a* (Table 39). Sufficient data were available to provide assessment of 7,296 stream and river miles (42% of surveyed miles). Concerns were identified in 18 percent of the assessed stream and river miles. Thirty-five (31 classified; 4 unclassified) streams and rivers were identified with elevated chlorophyll *a* concentrations (Table 40). Poor correlation is shown between stream and rivers with nutrient concerns and those with chlorophyll *a* concerns. Of the 35 streams and rivers identified with chlorophyll *a* concerns, only 11 also had concerns for at least one of the nutrient indicators. This demonstrates some of the difficulties that will be encountered in the development of water quality criteria for nutrients. In many cases, elevated nutrient concentrations do not produce responding elevated chlorophyll *a* concentrations. Other factors, such as turbidity, stream flow characteristics, and tree canopy shading influence the availability of nutrients and their assimilation by aquatic plants.

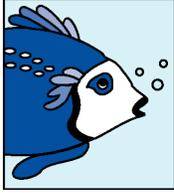
Table 41. Overall Concerns in Streams and Rivers

Concern parameter	Miles Surveyed	Miles Assessed	Percent of Miles Assessed	Percent of Assessed Miles	
				No Concern	Concern
 Public Water Supply	8,881.00	8,881.00	100.00	88	12
 Fish Tissue Contaminant	17,341.00	126.75	0.73	89	11
 Sediment Contaminant	17,341.55	767.25	4.42	54	46
 Narrative Criteria	17,341.55	17,341.55	100.00	100	< 1



Sediment Concerns

Due to high laboratory costs (approximately \$2,175 per sample) associated with analytical determination of metals and organic substances in combination with conventional parameters, sediment sampling is not widespread and is generally targeted to areas likely to be contaminated by point and nonpoint sources. Of the 17,341 stream and river miles surveyed, only 767 (4.4% of surveyed miles) were assessed for sediment concerns (Table 41). Of the assessed miles, 46 percent were identified with concerns for one or more metal or organic substance. Twenty-one (18 classified; 3 unclassified) streams and rivers were identified with sediment concerns (Table 42). Most of the identified sediment contaminants were metals. Only five stream and rivers were identified with elevated organic substances in sediment.



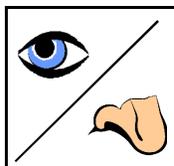
Fish Tissue Concerns

Due to high laboratory costs associated with tissue preparation and analytical determinations of metals and organic substances in tissue, fish tissue sampling in streams and rivers is very limited statewide. Of the 17,341 stream and river miles surveyed, only 127 (<1% of surveyed miles) were assessed for fish tissue concerns (Table 41). Of the 127 miles assessed, 11 percent were identified with fish tissue concerns. Fish from the Houston Ship Channel (Segment 1007) exceeded screening levels for chlordane and dieldrin. These two pesticides have historically been used to control residential insect pests and likely entered the ship channel through urban runoff. Separate sampling of the water body by the TDH determined that tissue concentrations have no appreciable risk to human consumers.



Public Water Supply Concerns

Concerns are identified in finished drinking water (after treatment at the point of entry to the distribution system) and surface samples from streams and rivers designated for public water supply if average concentrations exceed secondary standards for chloride (300 mg/L), sulfate (300 mg/L), and TDS (1,000 mg/L). Public water supply systems that experience increased costs for demineralization are also identified as concerns. All of the 8,881 stream and river miles designated for public water supply were assessed and 12 percent were identified with concerns (Table 41). Most of the streams and rivers identified with public water supply concerns for finished drinking water and surface water are located in the headwater regions of the Colorado and Brazos River basins. In these areas, natural conditions (brine seepage, groundwater seepage, rainfall runoff from salt bearing strata) or inadequate disposal of brine water produced by oil and gas operations influence dissolved mineral concentrations in surface waters. In the Rio Grande, surface water is used repeatedly for irrigation, thereby increasing dissolved mineral concentrations.



Narrative Criteria Concerns

All 17,342 stream and river miles were assessed to identify narrative criteria concerns. As examples, narrative criteria include floating debris and surface oil sheens, suspended solids and excessive foam, odor producing substances, dramatic changes in turbidity or color, and excessive algal growth. The Bosque River (Segments 1226 and 1255) and Papermill Creek (Segment 0610B) are the only stream and river segments with narrative criteria concerns. Their combined mileage is less than one percent of the total stream and rivers miles assessed for narrative concerns (Table 41). In both segments of the Bosque River, nutrient concentrations overstimulate the growth and proliferation of algae. In Papermill Creek, color and odor of water is influenced by effluent from a paper mill.

Table 42. Streams and Rivers with Sediment Concerns

Segment Number	Water Body	Pollutant
0304	Days Creek	Fluoranthene, phenanthrene, and pyrene
0402	Big Cypress Creek Below Lake O' the Pines	Arsenic, barium, chromium, manganese, mercury, and zinc
0402A	Black Cypress Bayou (unclassified)	Arsenic, barium, chromium, manganese, selenium, and oil and grease
0404	Big Cypress Creek Below Lake Bob Sandlin	Arsenic, cadmium, chromium, copper, lead, manganese, nickel, and oil and grease
0505	Sabine River Above Toledo Bend Reservoir	Chromium
0507A	Cowleech Fork Sabine River (unclassified)	Arsenic
0508	Adams Bayou Tidal	Chromium, copper, lead, nickel, and selenium
0601	Neches River Tidal	Arsenic, manganese, nickel, and oil and grease
0606	Neches River above Lake Palestine	Arsenic, manganese, mercury, and selenium
0702A	Alligator Bayou (unclassified)	Chromium, copper, lead, mercury, selenium, and zinc
1001	San Jacinto River Tidal	Manganese and mercury
1005	Houston Ship Channel/San Jacinto River Tidal	Nickel
1006	Houston Ship Channel	Arsenic, chromium, cooper, manganese, mercury, nickel, zinc, anthracene, arachlor 1248, bis (2-ethylhexyl) phthalate, flouranthene, and pyrene
1007	Houston Ship Channel/Buffalo Bayou	Arsenic, zinc, flouranthene, bis(2-ethylhexyl) phthalate, and benzo(b)flouranthene
1242	Brazos River below Whitney Lake	Arsenic and nickel
1910	Salado Creek	Cadmium
1911	Upper San Antonio River	Cadmium, chromium, copper, lead
2202	Arroyo Colorado above Tidal	Arsenic, barium, chromium, copper, manganese, mercury, nickel, selenium, zinc, DDE, and toluene
2203	Petronila Creek Tidal	Barium
2306	Rio Grande above Amistad Reservoir	Arsenic and barium
2308	Rio Grande below International Dam	Cadmium, copper, and cresols

Table 43. Streams and Rivers with Public Water Supply Concerns

Segment Number	Stream	Finished Drinking Water			Surface Water			Increased Costs for Demineralization
		Cl	SO ₄	TDS	Cl	SO ₄	TDS	
0902	Cedar Bayou Above Tidal						✓	
1242	Brazos River Below Lake Whitney							✓
1420	Pecan Bayou Above Lake Brownwood						✓	
1421	Concho River	✓	✓	✓	✓		✓	
1426	Colorado River Below E.V. Spence Reservoir				✓	✓	✓	
2107	Atascosa River						✓	
2302	Rio Grande Below Falcon Reservoir	✓	✓	✓				
2306	Rio Grande Above Amistad Reservoir	✓	✓	✓				
2307	Rio Grande Below Riverside Diversion Dam				✓	✓	✓	
2310	Lower Pecos River				✓	✓	✓	
Totals		3	3	3	4	3	7	1