

**APPENDIX R  
COST ESTIMATES**

**TABLE OF CONTENTS**

	<u>Page</u>
<b>Introduction</b>	R-1
<b>Costs for Conveyance Systems</b>	R-1
Determination of Pipe Size	R-3
Developing Costs for Conveyance Projects	R-4
Pump Stations	R-7
Other Initial Costs	R-7
Operation and Maintenance Costs	R-7
<b>Water Treatment Plants</b>	R-9
Conventional Water Treatment Plants	R-9
Reservoir Sites	R-10
Water Wells	R-10
<b>Annual and Life-Cycle Costs</b>	R-11
<b>Cost Estimates for Projects</b>	R-13

**LIST OF TABLES**

Table R-1	Example of Preferred Cost Estimate Format	R-2
Table R-2	Cost Items for Conveyance Projects	R-5
Table R-3	Costs for Pipe and ROW Width	R-6
Table R-4	Pump Station Costs	R-8
Table R-5	Ground Storage Tank Costs	R-8
Table R-6	Conventional Water Treatment Plant Costs	R-9
Table R-7	Cost Elements for Reservoir Sites	R-10
Table R-8	Cost Elements for Water Wells	R-11
Table R-9	Annual Cost Assumptions	R-12
Table R-10	Assumed Purchase Cost for Water	R-12
Table R-11	Factors for Interest During Construction	R-13
Table R-12	Cost of Marvin Nichols I Reservoir Site	
Table R-13	Dallas Water Utilities Additional Temporary Overdraft	
Table R-14	Dallas Water Utilities Extend Elm Fork Term Permit	
Table R-15	Lake Fork Connection (Including Pump Station and Connection to East Side WTP)	

## **List of Tables (cont'd)**

Table R-16	Lake Palestine Connection (Including Pump Station and Connection to Southeast WTP)
Table R-17	Dallas Water Utilities Reuse
Table R-18	Dallas Water Utilities Return Flows Above Lakes
Table R-19	Dallas Water Utilities Additional Reuse (After 2030)
Table R-20	Expand DWU Water Treatment Plants in Year 2010
Table R-21	Expand DWU Water Treatment Plants in Year 2020
Table R-22	Expand DWU Water Treatment Plants in Year 2030
Table R-23	Expand DWU Water Treatment Plants in Year 2040
Table R-24	Tarrant Regional Water District Cedar Creek, Richland-Chambers Expansion (Phase I)
Table R-25	Tarrant Regional Water District Cedar Creek, Richland-Chambers Expansion (Phase II)
Table R-26	Tarrant Regional Water District Reuse, Trinity River Diversion to Richland-Chambers Reservoir
Table R-27	Tarrant Regional Water District Reuse, Trinity River Diversion to Cedar Creek Reservoir
Table R-28	Tarrant Regional Water District Lake Texoma
Table R-29	Tarrant Regional Water District West Fork Connection
Table R-30	TRWD Oklahoma Water from Hugo to Eagle Mountain
Table R-31	Tarrant Regional Water District Lake Tehuacana
Table R-32	Tarrant Regional Water District Freestone County Groundwater Well Field
Table R-33	Expand Fort Worth Water Treatment Plants in Year 2000
Table R-34	Expand Fort Worth Water Treatment Plants in Year 2010
Table R-35	Expand Fort Worth Water Treatment Plants in Year 2030
Table R-36	Expand Fort Worth Water Treatment Plants in Year 2050
Table R-37	Fort Worth Reuse for Tarrant County Steam Electric
Table R-38	Trinity River Authority - Tarrant County Customers WTP Expansion for 2010
Table R-39	Trinity River Authority - Tarrant County Customers WTP Expansion for 2030
Table R-40	Trinity River Authority - Tarrant County Customers WTP Expansion for 2040
Table R-41	Trinity River Authority Las Colinas Reuse (Dallas County Other)
Table R-42	Trinity River Authority Joe Pool Reuse (Phase I)
Table R-43	Trinity River Authority Joe Pool Reuse (Phase II)
Table R-44	Trinity River Authority Mountain Creek Reuse
Table R-45	Trinity River Authority's Ellis County Reuse for Steam Electric Power
Table R-46	Trinity River Authority Denton Creek Plant Reuse
Table R-47	Trinity River Authority - Lake Grapevine Reuse (Phase I)
Table R-48	Trinity River Authority - Lake Grapevine Reuse (Phase II)
Table R-49	North Texas Municipal Water District Additional Reuse

## **List of Tables (cont'd)**

Table R-50	NTMWD Oklahoma Water from Hugo to Cooper Lake
Table R-51	Additional Lake Texoma Supply
Table R-52	Cost of Lower Bois d' Arc Creek Reservoir Site
Table R-53	Substantial Additional Lake Texoma Supply
Table R-54	Extend North Texas MWD Pipeline from Current Drop-Off Point to Lake Lavon
Table R-55	NTMWD Water Treatment Plants and Transmission by Year 2010
Table R-56	NTMWD Water Treatment Plants and Transmission by Year 2020
Table R-57	NTMWD Water Treatment Plants and Transmission by Year 2030
Table R-58	NTMWD Water Treatment Plants and Transmission by Year 2040
Table R-59	NTMWD Water Treatment Plants and Transmission by Year 2050
Table R-60	Upper Trinity Regional Water District Reuse
Table R-61	Expand Upper Trinity Regional Water District's Water Treatment Plants by Year 2010
Table R-62	Expand Upper Trinity Regional Water District's Water Treatment Plants by Year 2020
Table R-63	Expand Upper Trinity Regional Water District's Water Treatment Plants by Year 2030
Table R-64	Expand Upper Trinity Regional Water District's Water Treatment Plants by Year 2040
Table R-65	Expand Upper Trinity Regional Water District's Water Treatment Plants by Year 2050
Table R-66	New Groundwater Well for the City of Blue Ridge
Table R-67	Prosper - Overdraft Woodbine Aquifer with Existing Wells in 2000
Table R-68	Wastewater Reuse from North Texas Municipal Water District Wastewater Treatment Plant to Steam Electric Power in Collin County
Table R-69	Gainesville Water Supply Project
Table R-70	Cooke County Water Supply Project
Table R-71	Gainesville - Cost of Using Existing Pumps
Table R-72	Lindsay - Cost of Using Existing Pumps
Table R-73	Muenster - Cost of Using Existing Pumps
Table R-74	Muenster Lake
Table R-75	Valley View - Cost of Using Existing Pumps
Table R-76	Valley View - New Well in Trinity Aquifer
Table R-77	Cooke County Other - Cost of Using Existing Pumps
Table R-78	Cooke County Other - New Wells in Trinity Aquifer
Table R-79	Cooke County Other - New Wells in Woodbine Aquifer
Table R-80	Cooke County Manufacturing - Cost of Using Existing Pumps
Table R-81	Cooke County Mining - Cost of Using Existing Pumps
Table R-82	Cooke County Irrigation - Cost of Using Existing Pumps
Table R-83	Cooke County Livestock - Cost of Using Existing Pumps
Table R-84	Cooke County Livestock - New Well in Trinity Aquifer
Table R-85	Irving Connection to Chapman

## **List of Tables (cont'd)**

Table R-86	Irving Oklahoma Water from Hugo to Lake Lewisville
Table R-87	Irving Reuse
Table R-88	Wilmer - Cost of Overdrafting with Existing Wells
Table R-89	Dallas County Other Facilities for Joe Pool Lake Supply - Phase I
Table R-90	Dallas County Other Facilities for Joe Pool Lake Supply - Phase II
Table R-91	Dallas County Other Facilities for Lake Grapevine Supply - Phase I
Table R-92	Dallas County Other Facilities for Lake Grapevine Supply - Phase II
Table R-93	Dallas County Other Water Treatment Plant by 2030 (for Marvin Nichols Supply)
Table R-94	Dallas County Other Water Treatment Plant by 2050 (for Marvin Nichols Supply)
Table R-95	Dallas County Mining - New Well in Trinity Aquifer
Table R-96	Dallas County Steam Electric Power Reuse
Table R-97	Expand City of Denton's Water Treatment Plants in Year 2000
Table R-98	Expand City of Denton's Water Treatment Plants in Year 2020
Table R-99	Expand City of Denton's Water Treatment Plants in Year 2040
Table R-100	Justin - Cost of Overdrafting Trinity Aquifer with Existing Wells in 2000
Table R-101	Krugerville - New Wells in Trinity Aquifer
Table R-102	Krum - Cost of Overdrafting Trinity Aquifer with Existing Wells in 2000
Table R-103	Little Elm - New Wells in Trinity Aquifer
Table R-104	Pilot Point - Cost of Overdrafting Trinity Aquifer with Existing Wells
Table R-105	Denton County Reuse
Table R-106	Ellis County Water Supply Project
Table R-107	TRA to Ennis
Table R-108	Italy - Cost of Using Existing Pumps
Table R-109	Maypearl - New Well in Woodbine Aquifer
Table R-110	Midlothian Water Supply Project
Table R-111	Milford - New Well in Woodbine Aquifer
Table R-112	Palmer - Cost of Using Existing Pumps
Table R-113	Red Oak - Cost of Using Existing Pumps
Table R-114	Fannin County Other - New Well in Trinity Aquifer
Table R-115	Fannin County Other - New Well in Woodbine Aquifer
Table R-116	Fannin County Water Supply Project
Table R-117	Cost of Upper Bois d'Arc Reservoir Site
Table R-118	Ralph Hall Reservoir Site
Table R-119	Fairfield - New Well in Carrizo-Wilcox Aquifer
Table R-120	TRWD Freestone County Steam Electric Power (Calpine)
Table R-121	Freestone County Steam Electric Power (Plant 1)
Table R-122	Freestone County Steam Electric Power (Plant 2)
Table R-123	Grayson County Water Supply Project
Table R-124	Bells - Cost of Using Existing Pumps (Grayson County, Trinity Aquifer)
Table R-125	Bells - Cost of Using Existing Pumps (Grayson County, Woodbine Aquifer)

## **List of Tables (cont'd)**

Table R-126	Collinsville - Cost of Using Existing Pumps
Table R-127	Gunter - Cost of Using Existing Pumps
Table R-128	Howe - Cost of Using Existing Pumps
Table R-129	Luella - Cost of Using Existing Pumps
Table R-130	Luella - New Well in Woodbine Aquifer
Table R-131	Pottsboro Water Supply Project
Table R-132	Southmayd - Cost of Using Existing Pumps
Table R-133	Southmayd - New Wells in Woodbine Aquifer
Table R-134	Tioga - Cost of Using Existing Pumps
Table R-135	Tom Bean - Cost of Using Existing Pumps
Table R-136	Van Alstyne - Cost of Using Existing Pumps (Grayson County, Trinity Aquifer)
Table R-137	Van Alstyne - Cost of Using Existing Pumps (Grayson County, Woodbine Aquifer)
Table R-138	Van Alstyne - New Well in Woodbine Aquifer
Table R-139	Whitesboro - Cost of Using Existing Pumps
Table R-140	Whitewright - Cost of Using Existing Pumps
Table R-141	Whitewright - New Well in Trinity Aquifer
Table R-142	Grayson County Other - Cost of Using Existing Pumps
Table R-143	Grayson County Other - New Well in Trinity Aquifer
Table R-144	Grayson County Other - Cost of Using Existing Pumps
Table R-145	Grayson County Mining Cost of Using Existing Pumps
Table R-146	Grayson County Mining - New Well in Trinity Aquifer (Grayson County, Trinity Aquifer (Red Basin))
Table R-147	Grayson County Mining - New Well in Trinity Aquifer (Grayson County, Trinity Aquifer (Trinity Basin))
Table R-148	Grayson County Mining - Cost of Using Existing Pumps
Table R-149	Grayson County Mining - New Well in Woodbine Aquifer
Table R-150	Grayson County Irrigation - Cost of Using Existing Pumps
Table R-151	Malakoff - New Well in Carrizo-Wilcox Aquifer
Table R-152	TRWD to Malakoff
Table R-153	Connecting Bryson to Jacksboro (Lost Creek/Jacksboro System)
Table R-154	Kemp Water Treatment Plant Expansion (2010)
Table R-155	Terrell Water Treatment Plant Expansion (2010)
Table R-156	Terrell Water Treatment Plant Expansion (2020)
Table R-157	Terrell Water Treatment Plant Expansion (2050)
Table R-158	Kaufman County Other (Lake Terrell)
Table R-159	Reuse from Garland Wastewater
Table R-160	Kaufman County Mining - New Well in Woodbine Aquifer
Table R-161	Irrigation Local Supply Kaufman County
Table R-162	Corsicana Connecting to Richland-Chambers
Table R-163	Corsicana Water Treatment Plant Expansion (2020)
Table R-164	Corsicana Water Treatment Plant Expansion (2040)

## **List of Tables (cont'd)**

Table R-165	Navarro County Mining - New Well in Carrizo-Wilcox Aquifer
Table R-166	Navarro County Mining - New Well in Nacatoch Aquifer
Table R-167	Aledo - Cost of Overdrafting Trinity Aquifer Using Existing Pumps
Table R-168	Annetta - New Wells in Trinity Aquifer
Table R-169	Hudson Oaks - Cost of Overdrafting Trinity Aquifer Using Existing Pumps
Table R-170	Springtown Water Treatment Plant Expansion (2010)
Table R-171	Springtown Water Treatment Plant Expansion (2030)
Table R-172	Weatherford Pipeline from Benbrook
Table R-173	Parallel Weatherford Pipeline from Benbrook
Table R-174	Parker County Steam Electric Pipeline from Benbrook in 2010
Table R-175	Parker County Steam Electric Pipeline from Benbrook in 2030
Table R-176	Parker County Steam Electric Reuse in 2010
Table R-177	Parker County Steam Electric Reuse in 2030
Table R-178	Treated Water Transmission Lines in Southeast Parker County
Table R-179	Treated Water Transmission Lines to Southeast Parker County - Phase 2 - 2030
Table R-180	Weatherford WTP Expansion
Table R-181	Willow Park - Cost of Overdrafting Trinity Aquifer Using Existing Pumps
Table R-182	Parker County Other - New Wells in Trinity Aquifer (Parker County, Trinity Aquifer, Trinity Basin)
Table R-183	Parker County Other - New Well in Trinity Aquifer (Parker County, Trinity Aquifer, Brazos Basin)
Table R-184	Parker County Manufacturing - New Well in Trinity Aquifer
Table R-185	Parker County Mining - New Well in Trinity Aquifer
Table R-186	Rockwall County S.E. Power Reuse
Table R-187	Arlington Water Treatment Plant Expansions
Table R-188	Benbrook Water Treatment Plant Expansion (2020)
Table R-189	Benbrook Water Treatment Plant Expansion (2040)
Table R-190	Kennedale - New Wells in Trinity Aquifer
Table R-191	Mansfield Water Treatment Plant Expansions
Table R-192	Pantego - Cost of Overdrafting Trinity Aquifer Using Existing Wells
Table R-193	Pelican Bay - New Wells in Trinity Aquifer
Table R-194	Pelican Bay - Cost of Reallocating Trinity Aquifer with Existing Wells
Table R-195	Pipeline from Fort Worth to Northeast Tarrant County
Table R-196	Direct Reuse from Grapevine WWTP to 3 Golf Courses
Table R-197	Alvord - New Well in Trinity Aquifer
Table R-198	Aurora - New Well in Trinity Aquifer
Table R-199	Boyd - Cost of Reallocating Trinity Aquifer with Existing Wells
Table R-200	Bridgeport Water Treatment Plant Expansion (2000)
Table R-201	Bridgeport Water Treatment Plant Expansion (2030)
Table R-202	Decatur Water Treatment Plant Expansion (2010)
Table R-203	Decatur Water Treatment Plant Expansion (2050)

## **List of Tables (cont'd)**

Table R-204	Newark - New Well in Trinity Aquifer
Table R-205	Rhome - Cost of Reallocating Trinity Aquifer with Existing Wells
Table R-206	Community WSC Water Treatment Plant Expansion (2000)
Table R-207	Community WSC Water Treatment Plant Expansion (2020)
Table R-208	Walnut Creek SUD Water Treatment Plant Expansion in 2010
Table R-209	Walnut Creek SUD Water Treatment Plant Expansion in 2020
Table R-210	Walnut Creek SUD Water Treatment Plant Expansion in 2030
Table R-211	Walnut Creek SUD Water Treatment Plant Expansion in 2040
Table R-212	Walnut Creek SUD Water Treatment Plant Expansion in 2050
Table R-213	Wise County Tractebel Steam Electric Transmission System
Table R-214	Wise County Duke Steam Electric Transmission Systems
Table R-215	Wise County Steam Electric Transmission Systems

**APPENDIX R**  
**COST ESTIMATES**

## **APPENDIX R COST ESTIMATES**

### **Introduction**

The evaluation of water management strategies requires the development of cost estimates. The strategy evaluations contained in this regional plan represent preliminary overviews and should not be considered as detailed feasibility analyses. Due to the forward looking nature of these types of planning efforts, the cost estimates in this plan do not necessarily represent what actual costs may be to design, build, or operate water supply systems. Project specific analyses should be developed at the time a project is undertaken to establish a more accurate estimate.

Costs for pipelines, pump stations and water treatment facilities are based on standard unit costs that include contractors' mobilization, overhead and profit. The unit costs do not include engineering, contingency, financial and legal services, costs for land and rights-of-way, permits, environmental and archeological studies, or mitigation, all of which are added separately. Previous cost estimates were used when available.

The cost estimates include two components:

- Initial capital costs, including engineering and construction costs, and
- Average annual costs, including annual operation and maintenance costs, water purchase costs, and debt service.

Table R-1 is an example of the preferred format for capital costs.

### **Costs for Conveyance Systems**

Conveyance systems include pipelines, pump stations, intake and outlet structures for delivering raw or treated water from one location to another.

**Table R-1  
Example of Preferred Cost Estimate Format**

<b>Construction Costs</b>					
<b>Well Field Facilities</b>	<b>Size</b>	<b>Quantity</b>	<b>Unit</b>	<b>Unit Price</b>	<b>Cost</b>
Water Wells		12	LS	\$50,000	\$600,000
Transmission to Pump Station	10 in.	120,000	LF	\$28	\$3,360,000
					\$3,960,000
Engineering and Contingencies (30%)					\$1,188,000
<b>Subtotal for Well Field Facilities</b>					<b>\$5,148,000</b>
<b>Transmission Facilities</b>	<b>Size</b>	<b>Quantity</b>	<b>Unit</b>	<b>Unit Price</b>	<b>Cost</b>
Pipeline	30 in.	368,860	LF	\$74	\$27,296,000
Right of way easements (ROW)		368,860	LF	\$1	\$369,000
Storage Tank at High Point	4 MG	1	LS	\$746,000	\$746,000
					\$28,411,000
Engineering and Contingencies (30%)					\$8,523,000
<b>Subtotal for Pipeline</b>					<b>\$36,934,000</b>
	<b>Size</b>	<b>Quantity</b>	<b>Unit</b>	<b>Unit Price</b>	<b>Cost</b>
Pump Station at Well Field	1100 HP	1	LS	\$2,510,000	\$2,510,000
Storage Tank at Well Field	4 MG	1	LS	\$746,000	\$746,000
Booster Station	1100 HP	1	LS	\$2,510,000	\$2,510,000
Storage Tank at Booster Station	4 MG	1	LS	\$746,000	\$746,000
					\$6,512,000
Engineering and Contingencies (35%)					\$2,279,200

<b>Table R-1, Continued</b>					
<b>Subtotal for Pump Stations</b>					
					<b>\$8,791,200</b>
<b>Environmental and Archeological Studies</b>		<b>Quantity</b>	<b>Unit</b>	<b>Unit Price</b>	<b>Cost</b>
		368,860	LF	\$0.60	\$221,000
<b>Construction Total</b>					
					<b>\$50,873,200</b>
Interest During Construction					
					\$3,978,000
<b>Total Cost</b>					
					<b>\$54,851,200</b>
<b>Annual Costs</b>					
Debt Service					
					\$3,984,880
Electricity					
					\$1,645,000
Operation and Maintenance					
					\$487,000
<b>Total Annual Costs</b>					
					<b>\$6,116,880</b>
<b>Unit Costs</b>					
Per Acre-Foot					
					<b>\$910</b>
Per 1000 gallons					
					<b>\$2.79</b>

### ***Determination of Pipe Size***

1. First, lay out the route of the pipeline on a topographic map. Considerations in selecting a route include:
  - The shortest route is usually the best route. Draw a line between the source and the point of use and follow that line as closely as possible.
  - Avoid urban areas if possible.
  - Follow highways, rail lines, power lines or other existing easements whenever possible. Avoid petroleum product pipelines because of interference from cathodic protection.
  - Avoid conflicts where possible. Conflicts include highway and rail line crossings, major rivers and reservoirs, and large oil fields.
  - Avoid high points above the hydraulic grade line if possible.

2. Develop a profile of the route. A detailed profile is not required, but it is important to include high and low points.
3. Select a design capacity based upon the amount of water needed. If the pipeline is to be used to supply a treatment plant, the design capacity should be based upon the peak-day delivery rate. Assume a 2.0 peaking factor unless other information is available. If the pipeline is used to deliver water to terminal storage the design capacity should be from 1.25 to 1.5 times the average annual demand. If the water were used to supplement another source, the design capacity would be between 1.5 to 2.0 times the annual average demands.
4. Graph a hydraulic grade line using the Hazen-Williams equation at the design flow and a C factor of 120. Select the pipe size using the following criteria:
  - The velocity in the pipe at maximum flow should be between 4 and 6 ft/sec.
  - The head loss in the pipe should be between 1.5 and 2.5 feet/1000 feet.
  - Pipe sizes should be limited to standard diameters (i.e. the ones in the tables). However, if the pipeline is very long alternative diameters may be considered because the pipe supplier will be willing to manufacture non-standard sizes if the pipe is ordered in sufficient quantity.
5. In most cases assume that pump stations should add a maximum of 461 feet of head (200 PSI) to the HGL. Station losses of 10 feet should be assumed at each pump station. Booster pump stations should be added whenever the HGL is below 46 feet (20 PSI). If possible locate booster pump stations at topographic high points and near sources of power. Costs of pump stations are based upon number of pumps and the HP of each pump. The number of pumps is based upon the expected range of pumping. In general assume one additional pump as a backup. The amount of head required at a pump station may be converted into horsepower using the following formula:

$$HP = 0.17536 * Q_{mgd} * H_{ft} / \text{Efficiency}$$

**Developing Costs for Conveyance Projects**

1. Conveyance project capital and operational costs should include the items listed in Table R-2.
2. The costs of installed pipe and ROW width may be found in Table R-3. Costs are for 150-class pipe installed in rural areas. The cost with appurtenances includes items such as valves and fittings as well as a normal amount of boring under roadways. Increase costs if an unusual number of conflicts such as major highway or numerous railroad crossings are encountered. Add 20% for pipelines in urban areas. Costs might be even higher for small pipes in cities. Add 5% to 10% for shorter lengths. Additional costs should be added for obstacles such as rock excavation or forested areas. Cost should be reduced for easy pipeline conditions, such as soft soil in flat country.

**Table R-2  
Cost Items for Conveyance Projects**

<b>Capital Costs</b>	
<b>Pipelines</b>	<b>Pump Stations</b>
Installed pipe, including appurtenances	Pumps, building and appurtenances
ROW	Storage tanks
Conflicts	Intake structures
Outlet structures	
<b>Other Initial Costs</b>	
Engineering	Environmental and archeological studies
Contingencies	Interest during construction
Construction Management	Mitigation
<b>Operation and Maintenance Costs</b>	
General O&M	Estimated annual power costs
Debt service	

**Table R-3  
Costs for Pipe and ROW Width**

<b>Diameter (Inches)</b>	<b>Base Installed Cost (\$/Foot)</b>	<b>Cost with Appurtenances (\$/Foot)</b>	<b>Assumed ROW Width (Feet)</b>	<b>Assumed Temporary Easement Width (Feet)</b>
8	22	24	20	60
10	26	28	20	60
12	29	32	20	60
14	33	37	20	60
16	37	41	20	60
18	41	45	20	60
20	44	48	20	60
24	51	56	20	60
30	67	74	20	60
36	83	91	20	60
42	100	110	30	70
48	115	127	30	70
54	132	145	30	70
60	167	184	30	70
66	192	211	30	70
72	217	239	30	70
78	243	267	40	80
84	273	300	40	80
90	301	331	40	80
96	347	382	40	80
102	394	433	40	80
108	435	479	40	80
114	483	531	40	80
120	524	576	40	80

- Notes: a. Costs based on class 150 pipe for long, rural pipelines.  
b. Appurtenances assumed to be 10% of installed pipe costs.  
c. For urban pipelines, add 20% to base costs and 35% to cost with appurtenances for pipes 40" or larger. Add more for smaller pipelines.  
d. Adjust costs for obstacles (rock, forested areas) and easy conditions (soft soil in flat country).
3. The unit costs with appurtenances include an expected amount of conflicts such as highway and railroad crossings.

4. Pipeline easements are additional and consist of a permanent easement and a construction easement. Table R-3 gives the assumed ROW width for various sizes of pipe. It should be assumed that a permanent right-of-way is purchased for most projects.
5. Outlet structure cost is assumed to be \$100,000 for most sizes of pipe.

### ***Pump Stations***

1. Table R-4 presents the costs for individual pump stations. Each pump station includes a metal building with slab, pumps, miscellaneous valving and piping, electrical and instrumentation, a motor control center and land acquisitions including an access road.
2. It is assumed that a booster pump station will require ground storage tanks. The cost of ground storage includes slab, delivery of tank, and painting or coating of the tank. The tanks should be sized hold 8 hours of pumping at peak rates. Table R-5 presents assumed costs per storage volume.
3. Costs for intake structures are estimated on a case-by-case basis.

### ***Other Initial Costs***

1. Following SB1 guidelines, it will be assumed that engineering, contingency, construction management, financial and legal costs will be 30% of construction cost for pipelines and 35% of construction costs for pump stations.
2. It will be assumed that environmental and archeological studies will be \$0.57 per linear foot of pipeline for large transmission projects and \$0.28 for smaller transmission projects that follow existing easements. The minimum cost for environmental and archeological studies is \$25,000.

### ***Operation and Maintenance Costs***

According to SB1 guidelines operation and maintenance is assumed to be 1.0% of the construction cost of pipelines and 2.5% of the construction costs of pump stations.

**Table R-4  
Pump Station Costs**

<b>Horsepower</b>	<b>Costs</b>
100	\$ 620,000
200	\$ 930,000
300	\$ 1,200,000
400	\$ 1,500,000
500	\$ 1,700,000
600	\$ 1,800,000
700	\$ 1,900,000
800	\$ 2,100,000
900	\$ 2,200,000
1,000	\$ 2,400,000
2,000	\$ 3,500,000
3,000	\$ 4,200,000
4,000	\$ 5,100,000
5,000	\$ 5,800,000
6,000	\$ 6,600,000
7,000	\$ 7,200,000
8,000	\$ 7,800,000
9,000	\$ 8,500,000
10,000	\$ 9,000,000
20,000	\$14,000,000
30,000	\$17,000,000

**Table R-5  
Ground Storage Tank Costs**

<b>Size (Million Gallons)</b>	<b>With Roof</b>	<b>Without Roof</b>
0.10	\$ 75,000	
0.25	\$ 100,000	
0.50	\$ 156,000	
1.00	\$ 275,000	\$ 220,000
1.50	\$ 354,000	\$ 278,000
2.00	\$ 432,000	\$ 335,000
2.50	\$ 510,000	\$ 385,000
3.00	\$ 589,000	\$ 435,000
3.50	\$ 668,000	\$ 485,000
4.00	\$ 746,000	\$ 535,000
5.00	\$ 895,000	\$ 630,000
6.00	\$ 1,043,000	\$ 724,000

## Water Treatment Plants

Costs for treatment plants are given in terms of construction costs for building new plants or expansion of existing plants. Costs are presented for conventional plants. Engineering and contingency fees are 35% of the capital cost.

### ***Conventional Water Treatment Plants***

Conventional water treatment plants are plants that use standard flocculation, sand-filtration and chlorine or ozone disinfection or similar processes to produce potable water.

#### Capital Costs

Table R-6 presents approximate capital costs for construction of a new water treatment plant and expansion of an existing treatment plant. The cost includes the treatment facilities, piping, clearwell storage and administrative and other buildings. The cost does not include acquisition of property, high service pump stations, or treatment studies.

**Table R-6  
Conventional Water Treatment Plant Costs**

<b>Plant Capacity (mgd)</b>	<b>New Conventional Plants</b>	<b>Conventional Plant Expansions</b>
1	\$ 4,000,000	\$ 2,000,000
3	\$ 7,300,000	\$ 5,100,000
7	\$ 11,500,000	\$ 8,500,000
10	\$ 14,000,000	\$ 10,000,000
15	\$ 17,500,000	\$ 12,500,000
20	\$ 21,000,000	\$ 15,500,000
30	\$ 28,000,000	\$ 21,000,000
40	\$ 35,000,000	\$ 26,500,000
50	\$ 42,000,000	\$ 31,500,000
60	\$ 48,750,000	\$ 36,500,000
70	\$ 55,500,000	\$ 41,500,000
80	\$ 62,000,000	\$ 46,750,000
90	\$ 68,000,000	\$ 52,000,000
100	\$ 74,750,000	\$ 57,500,000

## Operation and Maintenance Costs

The operation and maintenance of a conventional water treatment plant is \$0.35 per 1,000 gallons for small systems (less than 6 mgd) and \$0.25 per 1,000 gallons for large systems (greater than 6 mgd). These costs include chemicals, labor and electricity.

## Reservoir Sites

1. Site-specific cost estimates are made for reservoir sites. The elements required for reservoir sites are included in Table R-7.

**Table R-7  
Cost Elements for Reservoir Sites**

<b>Capital Costs</b>	<b>Studies and Permitting</b>
Embankment	Environmental and archeological studies
Spillway	Permitting
Outlet works	Engineering and contingencies
Site work	
Land	
Administrative facilities	
Supplemental pumping facilities	
Terrestrial mitigation tracts	

2. According to TWDB guidance, engineering and contingencies are 35% of construction cost, annual O&M are 1.5% of construction costs, and mitigation cost is based upon the number of acres inundated times the cost of land.
3. Archeological and environmental studies are determined based upon site-specific information.

## Water Wells

1. Costs for water wells are based on the relationship developed by LBG Guyton as shown in Table R-8.
2. Construction costs developed for municipal water providers included an additional \$100,000 per well for connection to the existing distribution system.

**Table R-8  
Cost Elements for Water Wells**

Well Diameter (inches)	Typical Production Range (gpm)	Estimated Cost a=production rate (gpm), b= well depth (feet) c=1 for PWS/Industrial or 0.55 for Irrigation
6	25-150	$4000 + 68a + 60bc$
8	150-300	$5000 + 65a + 130bc$
10	300-500	$6000 + 63a + 170bc$
12	500-800	$8000 + 60a + 210bc$
16	800-2000	$8000 + 60a + 300bc$

3. Engineering costs were estimated at 30% of the total construction costs. Mitigation and permitting were estimated at 1% of the total construction costs, with a minimum of \$10,000 per well.
4. The construction and engineering costs were annualized based on a 30 year pay-off on capital with 6% interest. Operation and maintenance costs were estimated annually and added to the debt service. The maintenance costs for the pipelines and connections with distribution systems were estimated at 1%, and the pump station maintenance was estimated at 2.5%.
5. Chemical usage for water treatment was estimated to cost \$0.10 per 1,000 gallons.
6. Pumping costs were developed on an annual basis using the average depth to water data from TWDB and the average amount pumped by the entity. The assumed cost per kilowatt hour is six cents.

### **Annual and Life-Cycle Costs**

The parameters for annual costs specified in TWDB guidance are summarized in Table R-9. Present value calculations or adjustments for inflation are not required by TWDB. Unit costs are to be presented in dollars per acre-foot. It is also recommended that values be presented in dollars per 1,000 gallons because readers may be more familiar with those units.

**Table R-9  
Annual Cost Assumptions**

<b>Annual Cost Element</b>	<b>Value</b>
Interest rate	6% per year simple interest
Length of debt service	30 years for most projects 35 year for state participation 40 years for reservoirs
Power costs	\$0.6 per kWh, may be adjusted for local conditions
O&M costs	Pipelines – 1.0% of construction Pump Stations – 2.5% of construction Dams – 1.5% of construction Water wells – see text Water treatment – \$0.25-\$0.35 per 1,000 gallons
Water Purchase Costs	See Table R-10

Some management strategies require the purchase of raw water, treated water, or treated wastewater. Because the Region C plan includes many hundreds of potential water purchases, it was not practical to determine an individual water purchase cost for each purchase. Instead, assumed purchase costs were based on values within current ranges. It should be emphasized that these assumed purchase costs in no way represent or are intended to limit the price to be set in future water purchases. The actual price of water will be negotiated between the buyer and the seller, depending on the details of the particular transaction. Table R-10 shows the purchase costs assumed in this study.

**Table R-10  
Assumed Purchase Cost for Water**

<b>Type of water</b>	<b>Cost Range (per 1,000 gallons)</b>	<b>Assumed Purchase Cost</b>	
		<b>(per 1,000 gallons)</b>	<b>(per acre-foot)</b>
Raw Water	0.25 to \$1.00	\$0.75	\$245
Treated Water	0.75 to \$3.50	\$1.50	\$490
Treated Wastewater	\$0.15 to \$1.00	\$0.50	\$163

Interest during construction is estimated assuming the total estimated project cost (excluding interest during construction) would be drawn down at a constant rate per month during the construction period. Interest during construction is the total of interest accrued at the end of the construction period using an 6 percent annual interest rate on total borrowed funds, less a 4 percent rate of return on investment of unspent funds. Factors for use in cost estimating are presented in Table R-10. These factors are multiplied by the cost to build the project, including engineering, contingencies, and environmental and ecological studies. The length of construction should be verified for individual projects.

**Table R-11**  
**Factors for Interest During Construction**

<b>Construction Period</b>	<b>Factor</b>
6 months	0.021667
12 months	0.041667
18 months	0.057593
24 months	0.078194
36 month construction	0.118796

### **Cost Estimates for Projects**

The following tables (R-12 through R-215) include cost estimates for the individual projects.

