

**APPENDIX F:  
Identified Structural Stormwater  
Strategies for Entire Study Area**

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## 1.0 INTRODUCTION

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The Permit-defined objective of watershed-scale stormwater planning is to identify a stormwater management strategy or strategies that would result in hydrologic and water quality conditions that fully support “existing uses,” and “designated uses,” as those terms are defined in WAC 173-201A-020, throughout the stream system. Poor water quality (temperature, dissolved oxygen, fecal coliform bacteria, turbidity, and toxicants) and altered hydrology in the Bear Creek study area are significant factors in causing the stream and its tributaries to not meet their designated uses (King County, 2017).<sup>1</sup> With the exception of temperature and dissolved oxygen, overall water quality in the Bear Creek watershed appears to be improving since the 1970s. Current fecal coliform concentrations indicate a potential risk to human health, but the concentrations have decreased over the past three decades. Temperature and dissolved oxygen levels are not conducive for salmonids (as represented by violations of the state water quality standards), and long-term trends have indicated that conditions have worsened over the past four decades. The average qualitative Benthic Index of Biotic Integrity (B-IBI) score in the study area is considered “fair.” The “flashiness” of a stream has been linked to poor macroinvertebrate health as measured by B-IBI. Both water quality and quantity concerns may be improved through stormwater management and treatment.

Stormwater best management practices (BMPs) include both low impact development (LID) type facilities, such as pervious pavement or bioretention systems, and more traditional facilities, such as stormwater detention and treatment. LID BMPs generally address stormwater impacts near the source, and traditional facilities are more regional in nature, serving larger areas further away from the source. The impacts of stormwater BMPs are most readily modeled and comprised the primary component of the SUSTAIN optimization model scenarios.

SUSTAIN optimization modeling was used to determine the number and type of structural strategies required to achieve instream targets (Table 7 in Section 2.2 of the main document) for water quality and flow metrics for all catchments (see King County [2018]<sup>2</sup> for a description of how the structural strategies were modeled). The structural stormwater strategies identified for the prioritized catchments and for the entirety of the study area are presented below.

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<sup>1</sup> King County. 2017. Bear Creek Watershed-scale Stormwater Plan: Existing Water Quality Conditions. Prepared by Timothy Clark and Eric Ferguson, Water and Land Resources Division. Seattle, WA.

<sup>2</sup> King County. 2018. Watershed Model Development for Bear Creek Stormwater Retrofit Planning Project. Prepared by Scott Miller and Jeff Burkey, Water and Land Resources Division. Seattle, WA.

## **2.0 IDENTIFIED STRUCTURAL STRATEGIES FOR THE ENTIRE STUDY AREA**

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The modeled stormwater solution to meet Permit-defined objectives in the entire study area is estimated to cost about \$1.11 billion dollars or an average of \$43 million per square mile (dollar amounts are non-discounted 2017 dollars). This includes all costs incurred by public institutions and private firms and individuals. Tables 1 through 4 summarize the identified number of BMPs by jurisdiction and individual catchment. Table 5 summarizes a more detailed cost for each jurisdiction by categorizing types of expenditures into capital dollars, operation and maintenance dollars, and replacement dollars accounting for end-of-life in terms of both publicly-incurred and privately-incurred.

The total estimated costs (non-discounted 2017 dollars) for all catchments by expenditure are:

- Capital - \$710 million
- O&M - \$248 million (\$5.4 million per year when all facilities are in-place)
- Replacement - \$173 million over the course of 100 years

The stormwater costs are further differentiated between assumed burdens between public (dollars collected via taxes and fees) and private (expenses paid for by development and property owner LID maintenance).

- Public expense - \$781 million
- Private expense - \$350 million

**Table 1. Summary of stormwater BMP type and storage identified by catchment for King County (Priority basins shown in bold).**

Catchment	Cost (\$M)		Area (acres)	Bioretention (inches of storage)	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well Units / acre	Infiltration Pond (inches of storage)	Dry+Wet Pond (inches of storage)	Wet pond
	Capital	O&M									
BEA020	\$0.43	\$0.01	10.6	0.042	0.050	0.020	0.104	0.094	0.232	0.000	0.175
BEA030	\$5.48	\$0.07	135.3	0.047	0.023	0.015	0.110	0.118	0.128	0.132	0.124
BEA040	\$3.96	\$0.04	106.0	0.036	0.027	0.020	0.057	0.132	0.163	0.168	0.018
BEA050	\$4.96	\$0.07	147.7	0.010	0.060	0.013	0.123	0.183	0.000	0.040	0.151
BEA060	\$8.01	\$0.14	172.1	0.060	0.055	0.018	0.311	0.046	0.143	0.034	0.249
BEA070	\$1.81	\$0.04	45.6	0.114	0.050	0.014	0.181	0.110	0.054	0.000	0.041
<b>BEA120</b>	<b>\$6.43</b>	<b>\$0.09</b>	<b>241.1</b>	<b>0.048</b>	<b>0.008</b>	<b>0.004</b>	<b>0.066</b>	<b>0.025</b>	<b>0.041</b>	<b>0.172</b>	<b>0.093</b>
BEA130	\$2.81	\$0.05	60.9	0.086	0.055	0.018	0.172	0.164	0.041	0.000	0.183
BEA140	\$5.30	\$0.06	136.3	0.050	0.012	0.007	0.065	0.081	0.072	0.218	0.164
BEA150	\$3.03	\$0.03	119.1	0.030	0.009	0.008	0.051	0.059	0.041	0.149	0.094
BEA160	\$0.75	\$0.01	30.3	0.035	0.042	0.011	0.055	0.033	0.000	0.196	0.061
BEA170	\$4.64	\$0.06	129.3	0.031	0.031	0.018	0.162	0.093	0.134	0.046	0.158
BEA180	\$2.06	\$0.02	138.3	0.016	0.003	0.012	0.040	0.036	0.054	0.043	0.067
<b>BEA200</b>	<b>\$13.88</b>	<b>\$0.18</b>	<b>321.0</b>	<b>0.033</b>	<b>0.025</b>	<b>0.018</b>	<b>0.256</b>	<b>0.022</b>	<b>0.100</b>	<b>0.314</b>	<b>0.133</b>
BEA210	\$2.59	\$0.02	59.3	0.022	0.018	0.026	0.121	0.152	0.042	0.000	0.439
BEA220	\$0.96	\$0.02	196.5	0.009	0.007	0.031	0.003	0.010	0.000	0.030	0.000
<b>BEA230</b>	<b>\$1.97</b>	<b>\$0.03</b>	<b>43.9</b>	<b>0.034</b>	<b>0.056</b>	<b>0.010</b>	<b>0.301</b>	<b>0.114</b>	<b>0.112</b>	<b>0.000</b>	<b>0.255</b>
<b>BEA240</b>	<b>\$5.68</b>	<b>\$0.11</b>	<b>99.8</b>	<b>0.061</b>	<b>0.096</b>	<b>0.023</b>	<b>0.309</b>	<b>0.040</b>	<b>0.025</b>	<b>0.416</b>	<b>0.149</b>
<b>BEA245</b>	<b>\$9.51</b>	<b>\$0.16</b>	<b>117.4</b>	<b>0.142</b>	<b>0.055</b>	<b>0.026</b>	<b>0.474</b>	<b>0.102</b>	<b>0.210</b>	<b>0.152</b>	<b>0.317</b>
<b>BEA250</b>	<b>\$43.42</b>	<b>\$0.59</b>	<b>493.3</b>	<b>0.011</b>	<b>0.096</b>	<b>0.017</b>	<b>0.768</b>	<b>0.187</b>	<b>0.000</b>	<b>0.505</b>	<b>0.336</b>
BEA260	\$3.67	\$0.03	68.3	0.039	0.004	0.019	0.242	0.132	0.325	0.000	0.273
BEA270	\$2.21	\$0.02	115.5	0.014	0.015	0.021	0.038	0.078	0.021	0.051	0.097
BEA275	\$6.52	\$0.07	225.3	0.033	0.006	0.028	0.056	0.058	0.000	0.079	0.273
BEA280	\$7.90	\$0.14	125.5	0.152	0.026	0.006	0.198	0.056	0.216	0.236	0.119
BEA290	\$5.14	\$0.09	163.1	0.044	0.040	0.017	0.128	0.043	0.045	0.218	0.034

APPENDIX F: Identified Structural Stormwater Strategies for Entire Study Area  
Bear Creek Watershed Management Study

Catchment	Cost (\$M)		Area (acres)	Bioretention (inches of storage)	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well Units / acre	Infiltration Pond (inches of storage)	Dry+Wet Pond	Wet pond
	Capital	O&M									
BEA300	\$2.04	\$0.03	62.7	0.049	0.013	0.007	0.105	0.048	0.315	0.000	0.030
BEA310	\$2.11	\$0.03	131.0	0.022	0.011	0.017	0.029	0.069	0.038	0.000	0.071
BEA315	\$1.34	\$0.01	175.6	0.002	0.004	0.003	0.013	0.034	0.042	0.034	0.000
BEA320	\$0.62	\$0.01	212.0	0.006	0.001	0.001	0.023	0.005	0.000	0.000	0.018
BEA325	\$0.66	\$0.01	195.4	0.005	0.002	0.001	0.011	0.005	0.025	0.000	0.010
BEA330	\$1.57	\$0.01	99.7	0.002	0.005	0.007	0.111	0.040	0.000	0.060	0.112
BEA335	\$2.07	\$0.02	127.3	0.008	0.010	0.006	0.065	0.047	0.000	0.047	0.132
BEA350	\$22.39	\$0.21	543.1	0.022	0.028	0.008	0.056	0.096	0.127	0.262	0.158
BEA360	\$4.52	\$0.08	184.1	0.035	0.041	0.060	0.081	0.033	0.013	0.064	0.142
BEA370	\$6.81	\$0.05	213.9	0.019	0.007	0.015	0.095	0.192	0.035	0.111	0.044
BEA380	\$7.22	\$0.07	99.9	0.075	0.010	0.014	0.094	0.030	0.049	0.773	0.317
BEA390	\$9.22	\$0.08	140.8	0.057	0.013	0.018	0.145	0.206	0.105	0.253	0.357
BEA400	\$2.60	\$0.04	86.1	0.069	0.021	0.018	0.058	0.070	0.086	0.069	0.065
BEA410	\$0.41	\$0.01	21.7	0.074	0.002	0.020	0.101	0.000	0.000	0.000	0.086
BEA420	\$3.76	\$0.04	155.0	0.019	0.020	0.007	0.032	0.039	0.080	0.153	0.096
BEA430	\$3.59	\$0.11	653.5	0.009	0.023	0.012	0.013	0.005	0.008	0.027	0.000
BEA450	\$3.42	\$0.04	363.6	0.016	0.003	0.011	0.017	0.014	0.000	0.098	0.005
BEA460	\$4.63	\$0.06	232.2	0.010	0.013	0.030	0.107	0.017	0.000	0.128	0.128
BEA480	\$2.34	\$0.02	130.5	0.010	0.006	0.006	0.025	0.000	0.038	0.136	0.143
BEA490	\$3.55	\$0.06	355.7	0.022	0.006	0.015	0.022	0.031	0.021	0.000	0.037
BEA500	\$15.35	\$0.12	251.2	0.071	0.005	0.012	0.033	0.287	0.177	0.024	0.326
BEA510	\$7.31	\$0.05	145.1	0.050	0.005	0.015	0.027	0.276	0.051	0.082	0.257
BEA525	\$9.87	\$0.07	132.8	0.038	0.013	0.011	0.058	0.121	0.186	0.849	0.112
BEA530	\$14.25	\$0.18	366.1	0.045	0.026	0.003	0.075	0.022	0.088	0.324	0.137
BEA540	\$7.14	\$0.08	124.1	0.052	0.025	0.019	0.098	0.048	0.139	0.144	0.585
BEA550	\$5.57	\$0.10	178.9	0.088	0.011	0.024	0.062	0.017	0.055	0.133	0.094

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	Capital	O&M									
BEA570	\$19.45	\$0.15	298.3	0.040	0.012	0.025	0.098	0.194	0.240	0.099	0.474
BEA580	\$7.58	\$0.07	175.3	0.010	0.031	0.016	0.031	0.046	0.225	0.135	0.372
BEA590	\$6.98	\$0.04	223.0	0.011	0.003	0.004	0.040	0.143	0.088	0.027	0.225
BEA600	\$7.70	\$0.05	202.9	0.029	0.006	0.005	0.008	0.138	0.000	0.205	0.248
BEA700	\$13.23	\$0.20	236.9	0.110	0.020	0.032	0.228	0.097	0.208	0.125	0.126
BEA710	\$12.90	\$0.22	187.3	0.139	0.048	0.027	0.294	0.096	0.026	0.317	0.229
BEA720	\$3.49	\$0.04	83.3	0.047	0.038	0.035	0.060	0.096	0.059	0.285	0.112
BEA725	\$4.47	\$0.07	62.3	0.166	0.035	0.028	0.186	0.177	0.040	0.190	0.269
BEA730	\$20.00	\$0.21	342.0	0.073	0.014	0.012	0.058	0.091	0.036	0.503	0.234
<b>BEA740</b>	<b>\$10.88</b>	<b>\$0.15</b>	<b>160.5</b>	<b>0.045</b>	<b>0.075</b>	<b>0.032</b>	<b>0.340</b>	<b>0.118</b>	<b>0.015</b>	<b>0.444</b>	<b>0.278</b>
BEA760	\$6.70	\$0.08	242.0	0.019	0.024	0.040	0.127	0.074	0.020	0.049	0.192
BEA770	\$10.79	\$0.16	217.8	0.064	0.050	0.043	0.132	0.069	0.170	0.245	0.128
BEA780	\$11.18	\$0.14	130.8	0.113	0.037	0.024	0.248	0.107	0.264	0.363	0.398
BEA800	\$5.08	\$0.03	352.5	0.008	0.001	0.002	0.020	0.057	0.042	0.101	0.016
BEA820	\$7.58	\$0.08	248.6	0.048	0.003	0.003	0.013	0.048	0.030	0.119	0.247
BEA830	\$1.74	\$0.02	253.0	0.010	0.004	0.005	0.015	0.012	0.059	0.000	0.015

All costs are in 2017 dollars, no discount or inflation rate applied.

**Table 2. Summary of stormwater BMP type and storage identified by catchment for Snohomish County (priority basins shown in bold).**

Catchment	Cost (\$M)		Area (acres)	Bioretention (inches of storage)	Roadside Bioretention Ditch (inches of storage)	Cistern (inches of storage)	Permeable Pavement (inches of storage)	Gravity Well Units / acre	Infiltration Pond (inches of storage)	Dry+Wet Pond (inches of storage)	Wet pond (inches of storage)
	Capital	O&M									
BEA610	\$4.17	\$0.02	212.9	0.013	0.005	0.003	0.021	0.160	0.023	0.028	0.017
<b>BEA620</b>	<b>\$3.83</b>	<b>\$0.03</b>	<b>46.1</b>	<b>0.038</b>	<b>0.003</b>	<b>0.005</b>	<b>0.072</b>	<b>0.043</b>	<b>0.748</b>	<b>0.514</b>	<b>0.202</b>
<b>BEA625</b>	<b>\$3.88</b>	<b>\$0.02</b>	<b>103.5</b>	<b>0.009</b>	<b>0.002</b>	<b>0.005</b>	<b>0.016</b>	<b>0.135</b>	<b>0.024</b>	<b>0.401</b>	<b>0.072</b>
<b>BEA630</b>	<b>\$4.94</b>	<b>\$0.04</b>	<b>168.3</b>	<b>0.021</b>	<b>0.004</b>	<b>0.001</b>	<b>0.013</b>	<b>0.006</b>	<b>0.015</b>	<b>0.458</b>	<b>0.044</b>
<b>BEA640</b>	<b>\$2.32</b>	<b>\$0.01</b>	<b>55.2</b>	<b>0.009</b>	<b>0.005</b>	<b>0.008</b>	<b>0.020</b>	<b>0.145</b>	<b>0.313</b>	<b>0.215</b>	<b>0.034</b>
BEA650	\$1.75	\$0.02	50.3	0.036	0.002	0.006	0.033	0.020	0.000	0.472	0.074
<b>BEA660</b>	<b>\$16.81</b>	<b>\$0.09</b>	<b>1168.3</b>	<b>0.006</b>	<b>0.003</b>	<b>0.004</b>	<b>0.025</b>	<b>0.111</b>	<b>0.002</b>	<b>0.020</b>	<b>0.041</b>
BEA665	\$3.03	\$0.03	184.8	0.027	0.001	0.003	0.009	0.016	0.000	0.161	0.060
<b>BEA670</b>	<b>\$5.60</b>	<b>\$0.04</b>	<b>185.1</b>	<b>0.009</b>	<b>0.010</b>	<b>0.007</b>	<b>0.018</b>	<b>0.049</b>	<b>0.000</b>	<b>0.417</b>	<b>0.070</b>
BEA690	\$4.18	\$0.02	175.6	0.005	0.007	0.001	0.047	0.159	0.042	0.068	0.053

All costs are in 2017 dollars, no discount or inflation rate applied.

**Table 3. Summary of stormwater BMP type and storage identified by catchment for Redmond (priority basin shown in bold).**

Catchment	Cost (\$M)		Area (acres)	Bioretention (inches of storage)	Roadside Bioretention Ditch (inches of storage)	Cistern (inches of storage)	Permeable Pavement (inches of storage)	Gravity Well Units / acre	Infiltration Pond (inches of storage)	Dry+Wet Pond (inches of storage)	Wet pond (inches of storage)
	Capital	O&M									
<b>BEA010</b>	<b>\$25.06</b>	<b>\$0.07</b>	<b>44.2</b>	<b>0.198</b>	<b>0.068</b>	<b>0.154</b>	<b>0.212</b>	<b>0.158</b>	<b>0.167</b>	<b>0.000</b>	<b>0.463</b>
BEA080	\$26.80	\$0.08	69.0	0.018	0.077	0.094	0.663	0.188	0.215	0.602	0.135
<b>BEA100</b>	<b>\$21.88</b>	<b>\$0.07</b>	<b>62.9</b>	<b>0.129</b>	<b>0.034</b>	<b>0.029</b>	<b>0.324</b>	<b>0.048</b>	<b>0.000</b>	<b>0.283</b>	<b>0.237</b>
<b>BEA110</b>	<b>\$2.44</b>	<b>\$0.00</b>	<b>64.1</b>	<b>0.001</b>	<b>0.000</b>	<b>0.007</b>	<b>0.000</b>	<b>0.437</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>
<b>BEA190</b>	<b>\$47.53</b>	<b>\$0.20</b>	<b>169.5</b>	<b>0.148</b>	<b>0.026</b>	<b>0.075</b>	<b>0.397</b>	<b>0.147</b>	<b>0.000</b>	<b>0.350</b>	<b>0.132</b>
<b>MON</b>	<b>\$73.90</b>	<b>\$0.09</b>	<b>358.8</b>	<b>0.001</b>	<b>0.016</b>	<b>0.000</b>	<b>0.000</b>	<b>0.020</b>	<b>0.000</b>	<b>0.827</b>	<b>0.000</b>

All costs are in 2017 dollars, no discount or inflation rate applied.



**Table 4. Summary of stormwater BMP type and storage identified by catchment for Woodinville (priority basin shown in bold).**

Catchment	Cost (\$M)		Area (acres)	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
	Capital	O&M			(inches of storage)						
<b>BEA840</b>	<b>\$3.87</b>	<b>\$0.06</b>	<b>255.1</b>	<b>0.034</b>	<b>0.003</b>	<b>0.010</b>	<b>0.035</b>	<b>0.024</b>	<b>0.068</b>	<b>0.047</b>	<b>0.022</b>
<b>BEA850</b>	<b>\$5.04</b>	<b>\$0.03</b>	<b>246.7</b>	<b>0.012</b>	<b>0.003</b>	<b>0.002</b>	<b>0.016</b>	<b>0.049</b>	<b>0.210</b>	<b>0.024</b>	<b>0.053</b>
<b>BEA860</b>	<b>\$6.21</b>	<b>\$0.05</b>	<b>242.0</b>	<b>0.018</b>	<b>0.010</b>	<b>0.003</b>	<b>0.041</b>	<b>0.066</b>	<b>0.173</b>	<b>0.123</b>	<b>0.023</b>

All costs are in 2017 dollars, no discount or inflation rate applied.

**Table 5. Summary of stormwater structural costs for identified BMPs in the entire study area.**

Jurisdiction	Dollar Type	Source	Cost (\$M)			
			1-10 yrs	11-20 yrs	21-100 yrs	Total
King County	Capital	Private	\$0.5	\$3.5	\$27.8	\$31.8
		Public	\$7.9	\$45.3	\$362.2	\$415.4
	O & M	Private	\$0.2	\$1.8	\$135.5	\$137.5
		Public	\$0.1	\$0.7	\$69.7	\$70.4
	Replacement	Private	\$0.0	\$0.4	\$72.0	\$72.4
		Public	\$0.0	\$0.0	\$61.6	\$61.6
	<b>Total Private</b>		<b>\$0.8</b>	<b>\$5.6</b>	<b>\$235.3</b>	<b>\$241.7</b>
<b>Total Public</b>		<b>\$8.0</b>	<b>\$46.0</b>	<b>\$493.4</b>	<b>\$547.4</b>	
Snohomish County	Capital	Private	\$0.8	\$0.2	\$1.4	\$2.3
		Public	\$18.4	\$3.3	\$26.5	\$48.2
	O & M	Private	\$0.2	\$0.6	\$8.9	\$9.6
		Public	\$0.1	\$0.3	\$4.1	\$4.5
	Replacement	Private	\$0.0	\$0.5	\$3.7	\$4.2
		Public	\$0.0	\$0.0	\$17.1	\$17.1
	<b>Total Private</b>		<b>\$0.9</b>	<b>\$1.2</b>	<b>\$14.0</b>	<b>\$16.2</b>
<b>Total Public</b>		<b>\$18.4</b>	<b>\$3.6</b>	<b>\$47.8</b>	<b>\$69.8</b>	
Redmond	Capital	Private	\$54.5	\$1.0	\$7.7	\$63.2
		Public	\$19.4	\$12.8	\$102.2	\$134.4
	O & M	Private	\$0.0	\$0.2	\$13.4	\$13.7
		Public	\$0.1	\$0.3	\$5.6	\$6.0
	Replacement	Private	\$0.0	\$0.0	\$7.6	\$7.6
		Public	\$0.0	\$0.0	\$4.9	\$4.9
	<b>Total Private</b>		<b>\$54.5</b>	<b>\$1.2</b>	<b>\$28.8</b>	<b>\$84.5</b>
<b>Total Public</b>		<b>\$19.5</b>	<b>\$13.1</b>	<b>\$112.8</b>	<b>\$145.4</b>	
Woodinville	Capital	Private	\$0.3	\$0.0	\$0.3	\$0.6
		Public	\$4.8	\$1.1	\$8.7	\$14.5
	O & M	Private	\$0.0	\$0.2	\$4.3	\$4.6
		Public	\$0.0	\$0.1	\$1.6	\$1.7
	Replacement	Private	\$0.0	\$0.1	\$2.7	\$2.8
		Public	\$0.0	\$0.0	\$2.6	\$2.6
	<b>Total Private</b>		<b>\$0.3</b>	<b>\$0.3</b>	<b>\$7.4</b>	<b>\$7.9</b>
<b>Total Public</b>		<b>\$4.8</b>	<b>\$1.2</b>	<b>\$12.9</b>	<b>\$18.9</b>	
All Partners	Capital	Private	\$56.1	\$4.7	\$37.2	\$97.9
		Public	\$50.5	\$62.5	\$499.6	\$612.5
	O & M	Private	\$0.4	\$2.8	\$162.1	\$165.4
		Public	\$0.3	\$1.4	\$81.0	\$82.6
	Replacement	Private	\$0.0	\$1.0	\$86.0	\$87.0
		Public	\$0.0	\$0.0	\$86.2	\$86.2
	<b>Total Private</b>		<b>\$56.5</b>	<b>\$8.3</b>	<b>\$285.5</b>	<b>\$350.3</b>
<b>Total Public</b>		<b>\$50.7</b>	<b>\$63.8</b>	<b>\$666.9</b>	<b>\$781.4</b>	
<b>Total</b>		<b>\$107.2</b>	<b>\$72.1</b>	<b>\$952.4</b>	<b>\$1,131.7</b>	

All costs are in 2017 dollars, no discount or inflation rate applied.