CHAPTER SIX
COMPARISON OF CSO CONTROL ALTERNATIVES

This chapter presents a comparison of the CSO control alternatives for Alewife Brook that were developed and described in Chapter Five. The alternatives are compared on the basis of cost per unit of pollutant load removed, cost/performance curves, and non-monetary factors.

COST PER POLLUTANT LOAD REMOVED

Table 6-1 presents cost data, net present value per pollutant load removed for CSO pollutant loads only, net present value per pollutant load removed for total pollutant loads, and annual performance data for the alternatives presented in Chapter Five. For CSO loads only, the alternative with the least cost per pollutant load removed for all three pollutants considered (fecal coliform bacteria, TSS and BOD) was Targeted Sewer Separation Alternative A, which included separation of CAM004 and CAM400, relieving the Rindge Avenue siphon, providing a hydraulic relief gate at outfall MWR003, and enlarging the interceptor connections at CAM002, CAM401B and SOM01A. The alternative with the next-lowest cost per load removed for all three parameters was Targeted Sewer Separation Alternative B, which was similar to Alternative A, but included separation of the Massachusetts Avenue combined sewer upstream of Cedar Street. Following these two alternatives, the third-lowest cost per load removed was an expansion of Alternative B to include complete separation upstream of outfall CAM002.

In terms of cost per total load reduction, Targeted Sewer Separation Alternative A had the lowest cost per load removed for fecal coliform bacteria and TSS. Targeted Sewer Separation Alternative B had the next-lowest cost per total fecal coliform bacteria load removed, followed again by the expansion of Alternative B to include complete separation upstream of CAM002.

The consolidation/storage conduit sized for two over-flows per year had the next-lowest cost per total load removed for TSS, followed by consolidation to a storage tank sized for four overflows per year. The consolidation/storage conduit sized for two overflows per year had the lowest unit

cost for total BOD load removed, followed by the consolidation to a storage tank sized for two and four overflows per year, respectively.

In summary, Targeted Sewer Separation Alternative A had the lowest cost per CSO pollutant load removed for fecal coliform bacteria, TSS and BOD, followed by Targeted Sewer Separation Alternative B. Targeted Sewer Separation Alternative A also had the lowest cost per total pollutant load removed for fecal coliform bacteria and TSS. The cost-effectiveness of the targeted sewer separation alternatives in terms of total pollutant load removal was enhanced based on the expected performance of the CAM004 detention basin in reducing bacteria and TSS loads discharged to the Little River following separation of the CAM004 area. The cost-effectiveness of the targeted sewer separation alternatives with regard to control of bacteria, TSS and BOD may continue to improve, as the quality of stormwater runoff improves through implementation of BMPs and control of dry weather flow connections. Thus, on a cost-per-unit load removed basis, Targeted Sewer Separation Alternative A was determined to be the most cost-effective, especially for the pollutants of most concern (bacteria and TSS), followed by Targeted Sewer Separation Alternative B.

COST/PERFORMANCE CURVES

Figures 6-1 to 6-3 present plots of net present value versus CSO load reduction as a percent of baseline CSO load for fecal coliform bacteria (FC), TSS and BOD, respectively. For each figure, the "knee-of-the-curve" appears to be at Targeted Sewer Separation Alternative A. For most alternatives, performance ranged between approximately 80 and 100 percent removal. Targeted Sewer Separation Alternative A would achieve 85 percent annual fecal coliform load removal. The net present value of the lowest-cost alternative that achieves approximately 100 percent fecal coliform bacteria removal (consolidation conduit with screening and disinfection; 99.98 percent fecal coliform bacteria removal) would be almost 50 percent greater than the net present value of Targeted Sewer Separation Alternative A. For BOD and TSS, moving from the 85 percent removal achieved by Targeted Sewer Separation Alternative A to 100 percent removal would require nearly doubling the net present value. For fecal coliform bacteria, TSS and BOD,

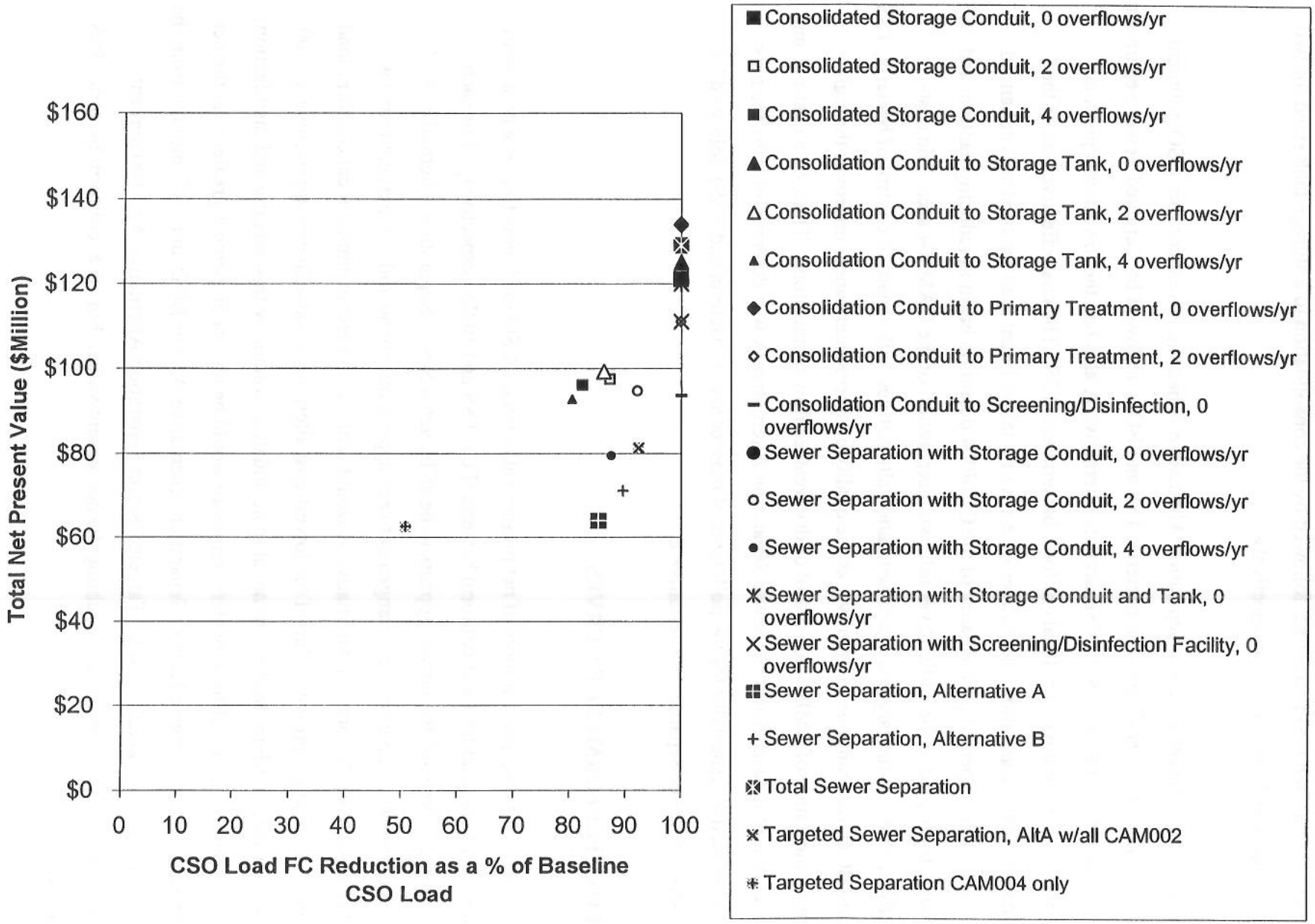

FIGURE 6-1. CSO FC REDUCTION AS A PERCENT OF CSO BASELINE LOAD

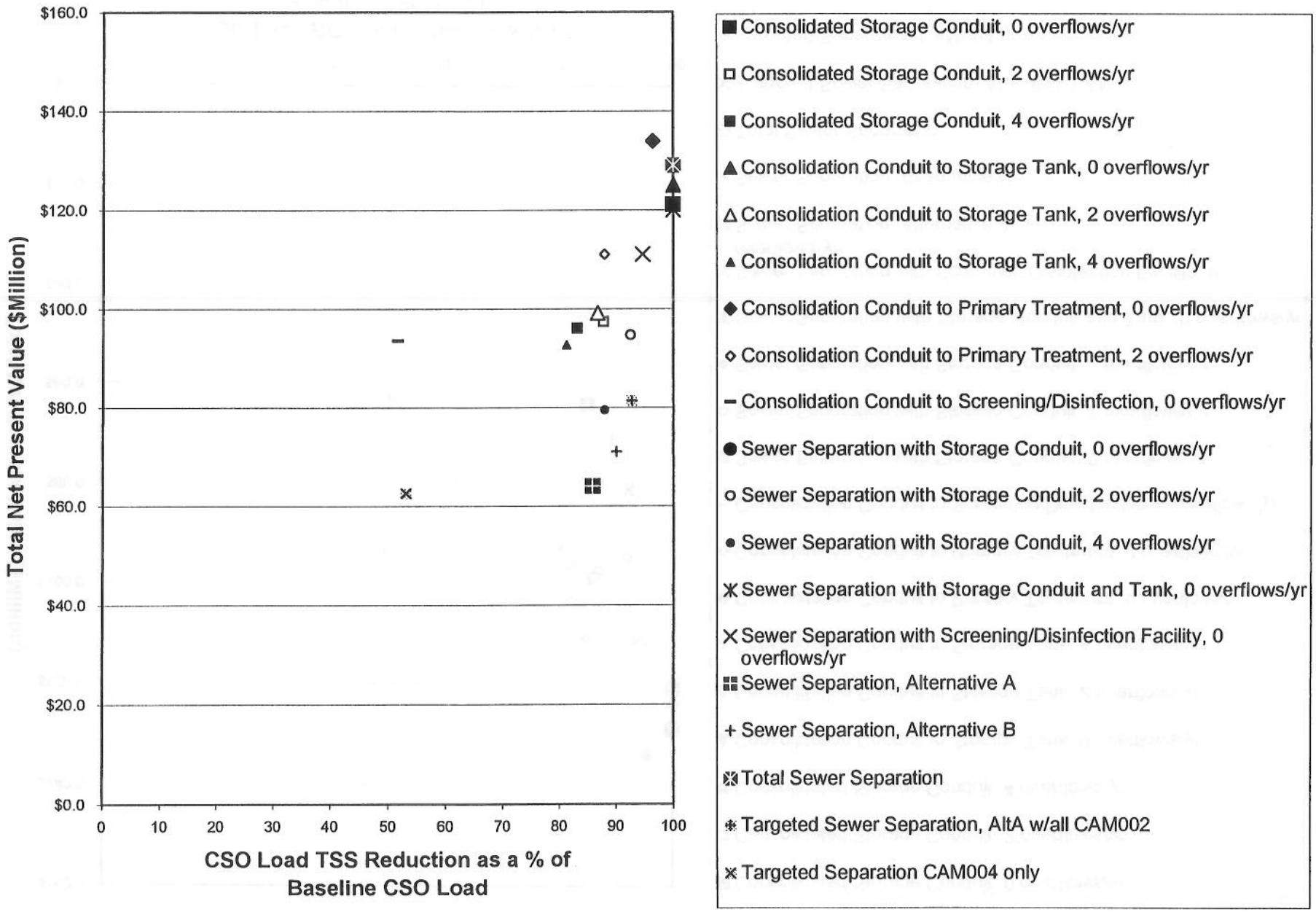

FIGURE 6-2. CSO TSS LOAD REDUCTION AS A PERCENT OF BASELINE CSO TSS LOAD

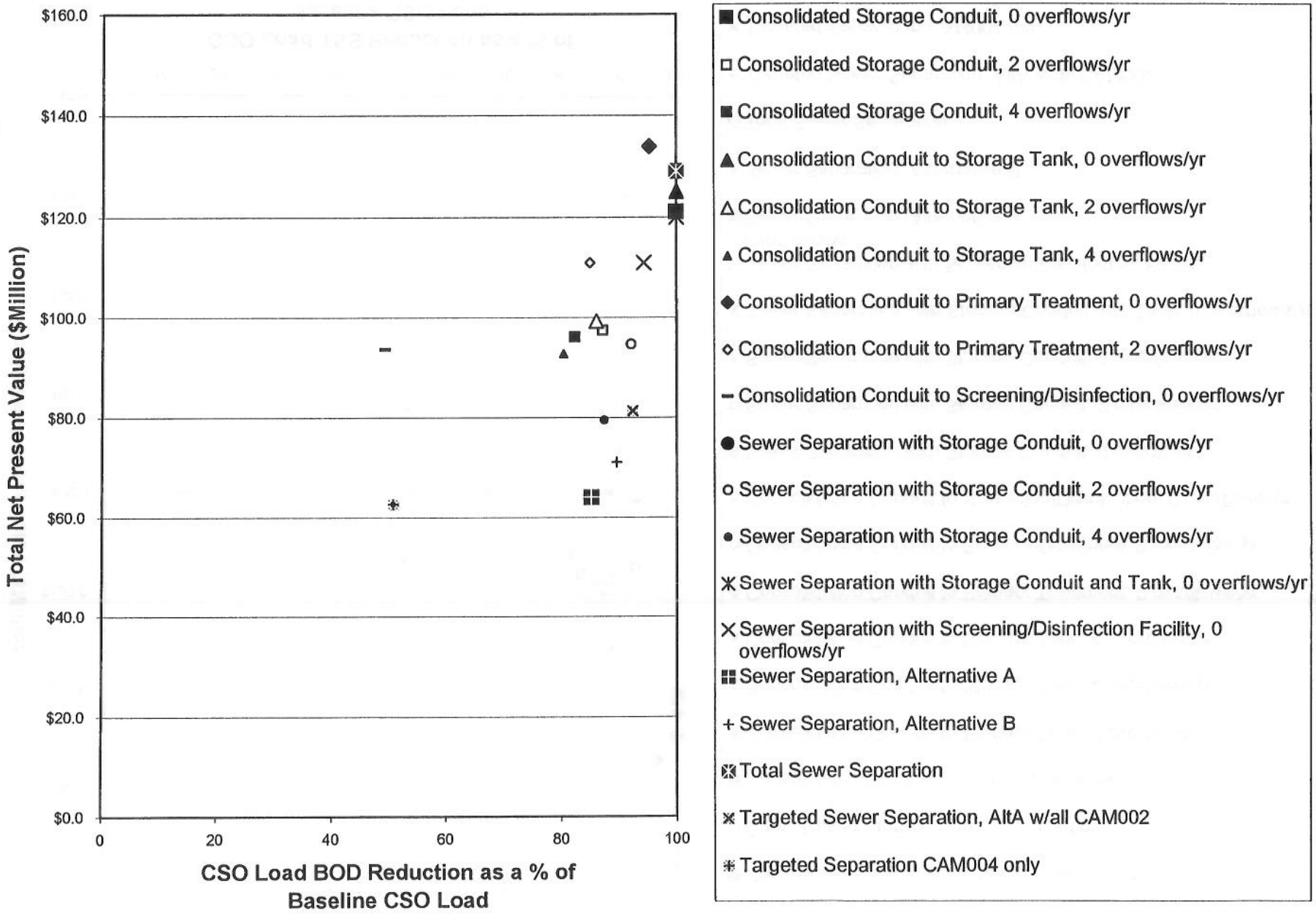

FIGURE 6-3. CSO BOD LOAD REDUCTION AS A PERCENT OF BASELINE CSO BOD LOAD

even a more modest improvement in performance (90 percent vs. 85 percent removal) over Targeted Sewer Separation Alternative A would require at least a $7 million increase in the net present value.

Figures 6-4 to 6-6 present plots of net present value versus total load reduction as a percent of baseline total load for fecal coliform bacteria, TSS and BOD, respectively. While the fecal coliform plot appears to show a knee-of-the-curve at Targeted Sewer Separation Alternative A, the TSS and BOD plots do not exhibit a distinct "knee". For most alternatives, fecal coliform bacteria removals ranged between approximately 50 and 70 percent, while TSS and BOD removals ranged from less than zero (net increase in load) to less than 20 percent. Targeted Sewer Separation Alternative A would achieve 60 percent annual fecal coliform load removal. Improving to approximately 70 percent removal would require nearly a 50-percent increase in the net present value.

Figures 6-1 to 6-6 indicate that while Targeted Sewer Separation Alternative A may be on the low end of performance in terms of percent removal, the spread between the lowest and highest performance is not that wide. Targeted Sewer Separation Alternative A appears to be located at the knee of the curve in each of the figures where a knee can be discerned. In effect, these figures indicate that compared with Targeted Sewer Separation Alternative A, higher-cost alternatives yield only marginal improvements in performance.

NON-MONETARY FACTORS

Table 6-2 presents a matrix of non-monetary factors associated with each alternative, along with a relative rating for each factor, and an overall relative rating, representing the sum of the individual ratings. The ratings (+, 0, and -) were assigned based on the descriptions of the non-monetary factors presented for each alternative. As applied, the ratings are relative, with + signifying that the alternative is better than others for the non-monetary factor rated, 0 signifying that the alternative is not as good as some but better than others, and – signifying that the alternative is less-suited than others for the factor rated. For example, while construction

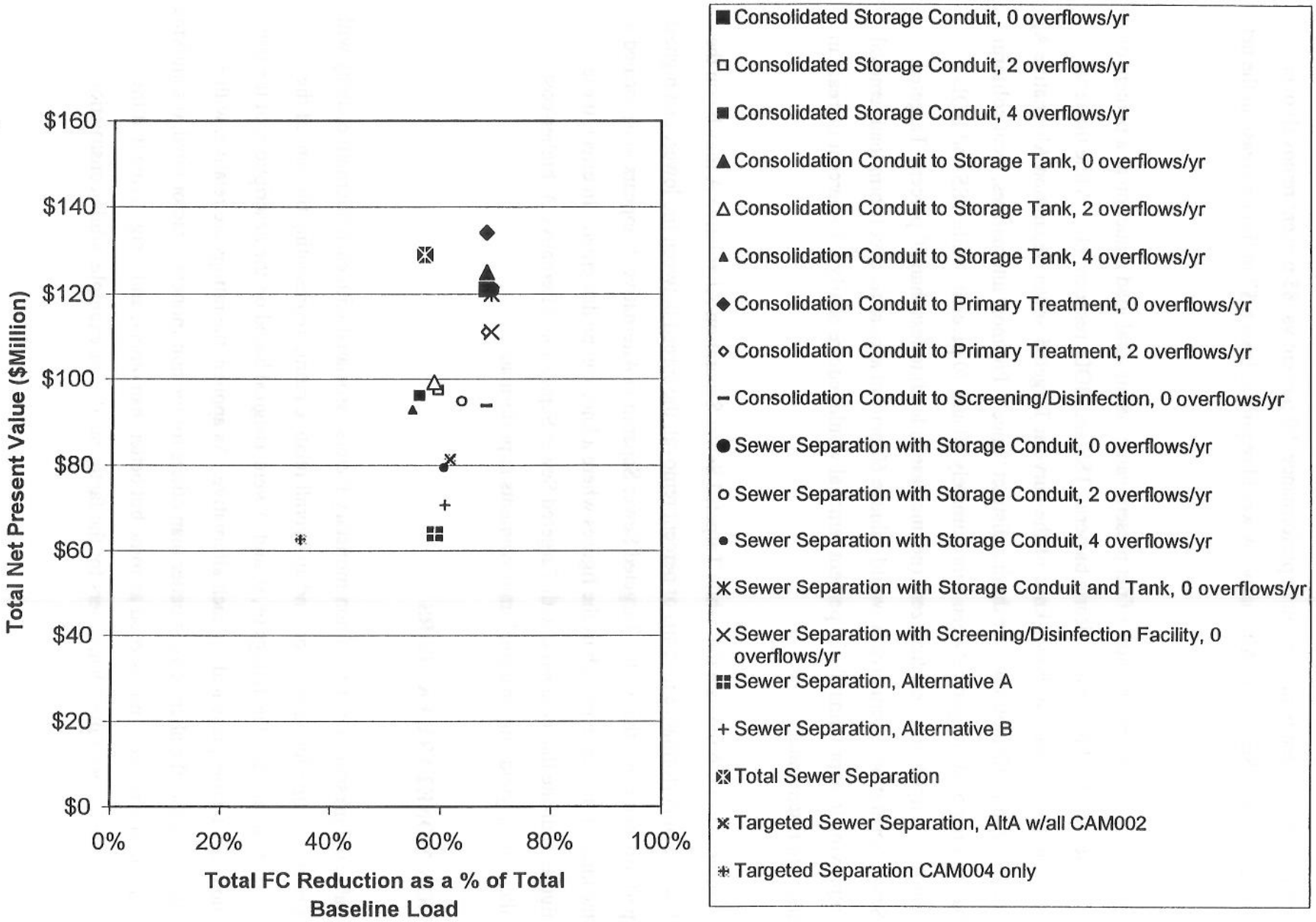

FIGURE 6-4. TOTAL FC REDUCTION AS A PERCENT OF TOTAL BASELINE LOAD

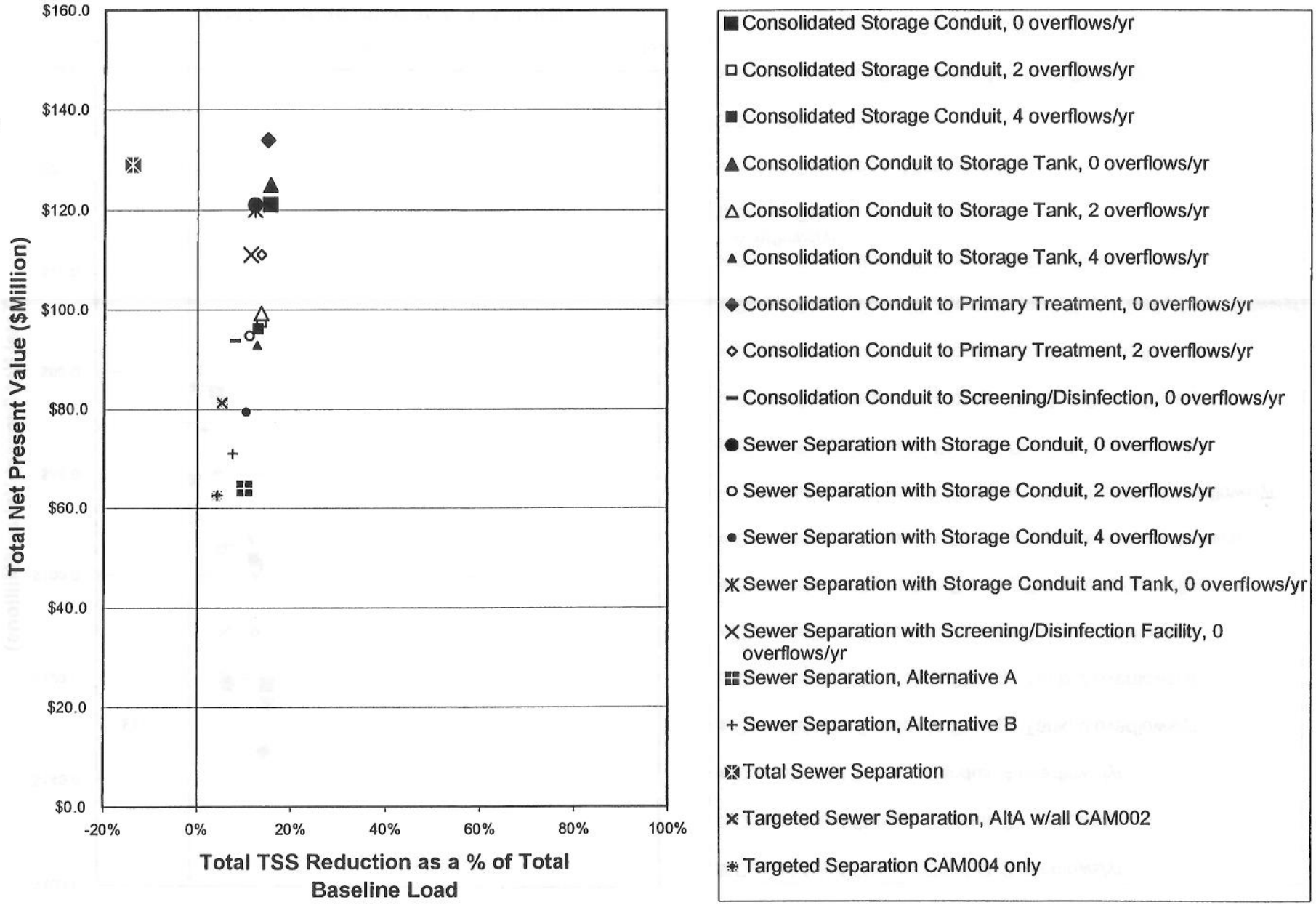

FIGURE 6-5. TOTAL TSS LOAD REDUCTION AS A % OF TOTAL BASELINE TSS LOAD

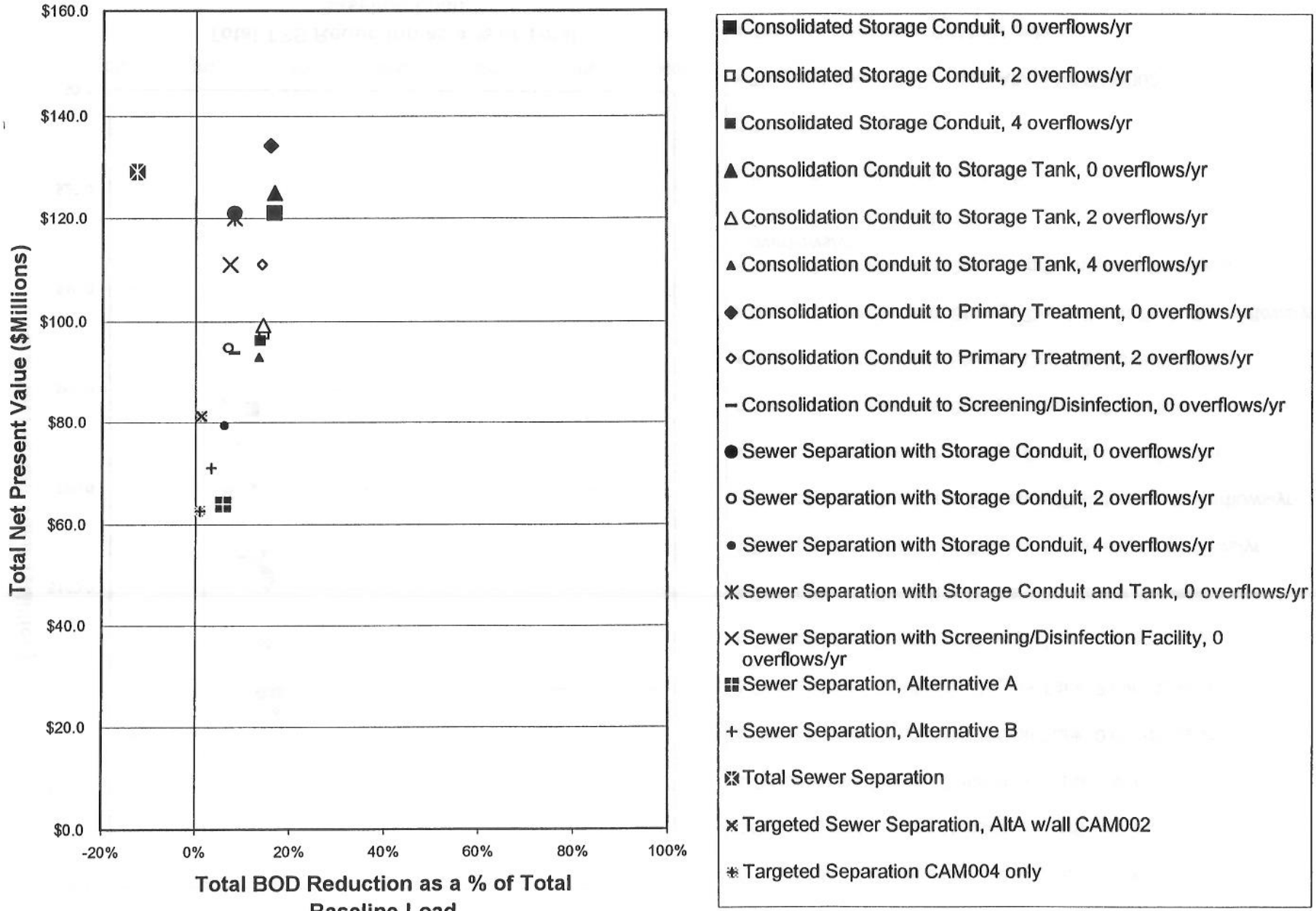

FIGURE 6-6. TOTAL BOD LOAD REDUCTION AS A % OF TOTAL BASELINE BOD LOAD

TABLE 6-2. RATING OF NON-MONETARY FACTORS FOR CSO CONTROL ALTERNATIVES

Alternative	Non-Monetary Factor	Description	Individual Rating	Overall Rating
Complete Sewer Separation	Short-Term Siting Impacts	Construction-related impacts along most streets in the tributary areas. Feasibility of siting facilities to mitigate high flow rates and volumes on Alewife Brook uncertain.	-	-1
	Long-Term Siting Impacts	Potential long-term impact of multiple detention/retention facilities to mitigate impacts of high flows on Alewife Brook.	-	
	O&M Considerations	Marginally reduced run time for pumps at Alewife Brook Pump Station and North Main Pump Station	+	
Consolidation/Storage Conduit	Short-Term Siting Impacts	Construction-related disruptions at main mining shaft near MBTA station for duration of construction, and periodic disruptions at equipment removal shaft, dropshaft and diversion structure locations along Alewife Brook	0	0
	Long-Term Siting Impacts	Relatively small pump-out facility at downstream end may fit below grade. Odor control facility at upstream end likely to be above grade. Public opposition to siting is likely, and identification of suitable sites will be difficult.	0	
	O&M Considerations	Routine maintenance required on equipment; periodic cleaning of accumulated grit in consolidation conduit likely required	0	
Consolidation to Storage Tank	Short-Term Siting Impacts	Construction-related disruptions at tank site near MBTA station, and at jacking and receiving shafts dropshafts and diversion structure locations along Alewife Brook	-	-3
	Long-Term Siting Impacts	Tank and pumping equipment would be below grade, but tank odor control facility likely to be above grade. Odor control facility at upstream end likely to be above grade. Public opposition to siting of tank and upstream odor control facility is likely, and identification of a suitable site will be difficult.	-	
	O&M Considerations	Cleanup of tank required after each activation. Routine maintenance required on equipment; periodic cleaning of accumulated grit in consolidation conduit likely required	-	

TABLE 6-2. (Continued) RATING OF NON-MONETARY FACTORS FOR CSO CONTROL ALTERNATIVES

Alternative	Non-Monetary Factor	Description	Individual Rating	Overall Rating
Consolidation to Primary Treatment (similar to MWRA's Cottage Farm CSO Facility)	Short-Term Siting Impacts	Construction-related disruptions at tank site near MBTA station, and at jacking and receiving shafts, dropshafts and diversion structure locations along Alewife Brook	-	-3
	Long-Term Siting Impacts	Tank and pumping equipment would be below grade, but tank odor control equipment and chemical storage and feed equipment likely to be housed in an above-grade structure. Odor control facility at upstream end likely to be above grade. Periodic chemical deliveries required. Public opposition to siting of tank and upstream odor control facility is likely, and identification of a suitable site will be difficult.	-	
	O&M Considerations	Cleanup of tank required after each activation. Routine maintenance required on equipment; periodic cleaning of accumulated grit in consolidation conduit likely required.	-	
Consolidation to Screening and Disinfection (similar to MWRA's Somerville Marginal CSO Facility)	Short-Term Siting Impacts	Construction-related disruptions at screening/disinfection facility site near MBTA station, and at jacking and receiving shafts, dropshafts and diversion structure locations along Alewife Brook	-	-3
	Long-Term Siting Impacts	Screening and pumping equipment would be below grade, but odor control equipment and chemical storage and feed equipment likely to be housed in an above-grade structure. Odor control facility at upstream end likely to be above grade. Periodic chemical deliveries required. Public opposition to siting is likely, and identification of a suitable site will be difficult; may require detention/retention facilities to mitigate peak treated CSO flows.	-	
	O&M Considerations	Cleanup of screening facility required after each activation. Routine maintenance required on equipment; periodic cleaning of accumulated grit in consolidation conduit likely required.	-	

TABLE 6-2. (Continued) RATING OF NON-MONETARY FACTORS FOR CSO CONTROL ALTERNATIVES

Alternative	Non-Monetary Factor	Description	Individual Rating	Overall Rating
Consolidation/Storage Conduit with Targeted Sewer Separation	Short-Term Siting Impacts	For 0 OF/yr alternative, construction-related disruptions at main mining shaft site near MBTA station for the duration of the construction, and periodic disruption at the equipment removal shaft. For the 2 and 4 OF/yr alternatives, construction-related disruptions at the jacking and receiving shafts. For all alternatives, periodic disruptions at dropshafts and diversion structure locations along Alewife Brook, in most streets in the CAM004 and CAM400 tributary areas, and in the vicinity of the intersection of Massachusetts Avenue and Fresh Pond Parkway.	-	-1
	Long-Term Siting Impacts	Pumping equipment would be below grade, but odor control facility at upstream end of conduit likely to be above grade. Public opposition to siting of shafts and odor control facility is likely, and identification of suitable sites will be difficult. Detention basin/constructed wetland area required to attenuate peak stormwater flows	0	
	O&M Considerations	Routine maintenance required on equipment; periodic cleaning of accumulated grit in consolidation conduit likely required.	0	
Consolidation to Storage Tank with Targeted Sewer Separation	Short-Term Siting Impacts	Construction-related disruptions at tank site near MBTA station, at jacking and receiving shafts, dropshafts and diversion structure locations along Alewife Brook, in most streets in the CAM004 and CAM400 tributary areas, and in the vicinity of the intersection of Massachusetts Avenue and Fresh Pond Parkway.	-	-3
	Long-Term Siting Impacts	Tank and pumping equipment would be below grade, but tank odor control facility likely to be above grade. Odor control facility at upstream end likely to be above grade. Public opposition to siting of tank and upstream odor control facility is likely, and identification of a suitable site will be difficult. Detention basin/constructed wetland area required to attenuate peak stormwater flows.	-	
	O&M Considerations	Cleanup of tank required after each activation. Routine maintenance required on equipment; periodic cleaning of accumulated grit in consolidation conduit likely required	-	

TABLE 6-2. (Continued) RATING OF NON-MONETARY FACTORS FOR CSO CONTROL ALTERNATIVES

Alternative	Non-Monetary Factor	Description	Individual Rating	Overall Rating
Consolidation to Screening and Disinfection with Targeted Sewer Separation	Short-Term Siting Impacts	Construction-related disruptions at screening/disinfection facility site near MBTA station, at jacking and receiving shafts, dropshafts and diversion structure locations along Alewife Brook, in most streets in the CAM004 and CAM400 tributary areas, and in the vicinity of the intersection of Massachusetts Avenue and Fresh Pond Parkway.	-	-3
	Long-Term Siting Impacts	Screening and pumping equipment would be below grade, but odor control equipment and chemical storage and feed equipment likely to be housed in an above-grade structure. Odor control facility at upstream end likely to be above grade. Public opposition to siting is likely, and identification of a suitable site will be difficult; may require detention/retention facilities to mitigate peak treated CSO flows. Detention basin/constructed wetland area required to attenuate peak stormwater flows.	-	
	O&M Considerations	Cleanup of screening facility required after each activation. Routine maintenance required on equipment; periodic cleaning of accumulated grit in consolidation conduit likely required	-	
Targeted Sewer Separation	Short-Term Siting Impacts	Construction-related impacts along most streets in the tributary areas to be separated (CAM004, CAM400, CAM002 and/or SOM01A, depending on the alternative)	+	+3
	Long-Term Siting Impacts	Detention basin/constructed wetland area required to attenuate peak stormwater flows	+	
	O&M Considerations	Marginally reduced run time for pumps at Alewife Brook Pump Station and North Main Pump Station	+	

impacts are inherently undesirable, the localized impacts of targeted sewer separation would be considered less severe than the impacts associated with construction of a consolidation conduit and CSO facility, or complete, area-wide sewer separation. For this reason, the short-term impacts associated with targeted sewer separation were rated as a +, relative to all of the other alternatives. For this level of analysis, the specific level of control for each alternative (0, 2, 4 or more overflows per year) was not considered to affect the relative ratings.

Table 6-3 ranks the alternatives by overall rating. As indicated in Table 6-3, the targeted sewer separation alternative was the highest ranked, followed by the consolidation/storage conduit, complete sewer separation, and the consolidation/storage conduit with targeted sewer separation. All of the alternatives that involved either a storage tank or treatment facility were tied for the lowest ranking.

The major benefits to the targeted sewer separation alternative were that construction impacts were limited to short-term disruptions to individual streets; no permanent above-grade structures would be required; and there would be no new facility to operate and maintain. Complete sewer separation would have the benefits of no above-grade structures and no additional O&M, but the construction impacts would be more wide-spread. The construction impacts of the consolidation/storage conduit would be more localized than for sewer separation, but would be for a longer duration in a specific location (the downstream mining shaft). Long term impacts of complete sewer separation would depend on the means determined for attenuating peak stormwater flows.

SUMMARY OF ANALYSIS

The cost/performance data presented above indicate that Targeted Sewer Separation Alternative A is the most cost-effective alternative in terms of fecal coliform bacteria, TSS and BOD load removal. To achieve marginally higher levels of removal of these pollutants would require significantly increased cost. The extent to which the marginally higher levels of pollutant removal would potentially benefit Alewife Brook is addressed as part of the water quality-based

TABLE 6-3. RANKING OF ALTERNATIVES BY NON-MONETARY FACTOR RELATIVE RATINGS

Alternative	Overall Rating from Table 6-2
Targeted Sewer Separation	+3
Consolidation/Storage Conduit	0
Complete Sewer Separation	-1
Consolidation/Storage Conduit with Targeted Sewer Separation	-1
Consolidation to Storage Tank	-3
Consolidation to Primary Treatment	-3
Consolidation to Screening and Disinfection	-3
Consolidation to Storage Tank with Targeted Separation	-3
Consolidation to Screening and Disinfection with Targeted Separation	-3

analysis presented in Chapter Seven. For example, despite the cost-effectiveness parameters presented above, if it could be demonstrated that increasing the percentage of bacteria load removed on a total load basis from 60 to 70 percent resulted in a significant improvement in the attainment of Class B criteria, then it could potentially be argued that increasing the cost by 50 percent to attain that improvement might be appropriate. If, however, the water quality modeling indicates that no significant improvement would be attained, then the additional costs would not be justified.

It should also be noted, however, that if a higher level of control were required, the next-most cost effective alternative that provided a higher level of control would be Targeted Sewer Separation Alternative B. This alternative essentially expands the scope of Targeted Sewer Separation Alternative A to include separation of the upstream reach of Massachusetts Avenue. The next most cost-effective alternative beyond Alternative B would be the expansion of Alternative B to include complete separation upstream of CAM002. Thus, Targeted Separation

Alternative A is consistent with the development of incrementally higher levels of CSO control for Alewife Brook, if in the future it is determined that additional expenditures for a higher level of control are appropriate.

In terms of non-monetary factors, the targeted sewer separation alternatives were the highest-ranked. While this ranking is subjective, it is an important consideration in the "implementability" of these projects. The strip of land between the Alewife interceptors and Alewife Brook is particularly narrow in the vicinity of Massachusetts Avenue, where a consolidation conduit would have to pick up outfalls CAM001, CAM002, CAM400 and SOM01A. It is generally an open grassed area, with a number of trees. It is expected that considerable public resistance would be encountered to major construction activities within this strip of land. Appropriating space for mining activities and/or a permanent CSO facility in the vicinity of the Alewife MBTA station would also likely be met with public resistance. If no other viable alternatives were presented, these obstacles could, eventually, be overcome. However, where a reasonable alternative does exist, it would likely make appropriating these sites that much more difficult.

From the technology-based cost-effective evaluations presented above, Targeted Sewer Separation Alternative A was established as the recommended plan, contingent upon receiving water modeling confirming that this alternative would be consistent with a BCSO designation for Alewife Brook and that higher levels of control would not yield significant water quality benefits. Chapter Seven presents the results of preliminary receiving water modeling that further supports the selection of Targeted Sewer Separation Alternative A as the appropriate plan for Alewife Brook, while subsequent chapters provide additional comments regarding the revised recommended plan, as well as impacts and mitigation.