# NEORSD
# Heights Hilltop Interceptor
# Local Sewer System Evaluation Study
# (HHI-LSSES)

## Project Cost Opinion Development for LSSES Improvement Alternatives Analysis

**Technical Memorandum**

**Revision 2**

**Prepared For**

Northeast Ohio Regional Sewer District

**September 2018**

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# Project Cost Opinion Development for LSSES Improvement Alternatives Analysis (Revision No. 2)

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| | |
|---|---|
| AFP | Advanced Facilities Plan |
| CCI | Construction Cost Index |
| CCTV | Closed Circuit Television |
| CIPPL | Cured-In-Place-Pipe Lining |
| CSO | Combined Sewer Overflow |
| CT | Common Trench |
| DWO | Dry Weather Outlet |
| EI | Easterly Interceptor |
| ENR | Engineering News Record |
| EWWTP | Easterly Wastewater Treatment Plant |
| ft | feet or foot |
| I/I | Infiltration and Inflow |
| LF | Linear Feet |
| LSSES | Local Sewer System Evaluation Study |
| ROW | Right of Way |
| SSO | Sanitary Sewer Overflow |
| SW | Stormwater |

# 1.0 Introduction

This report summarizes AACE[1] Class 5 planning level capital cost information for sewer system improvement alternatives developed for the Heights Hilltop Interceptor Local Sewer System Evaluation Study (HHI-LSSES) project. The cost opinions are developed to compare alternatives and provide preliminary costs for proposed improvements during Task 4 of the project, which may include the following:

- New sewers to control sanitary sewer overflows (SSOs) and/or provide adequate capacity for peak wet weather flow rates
- Sewer separation/replacement in common trench over-under (invert plate) areas
- Sewer system rehabilitation in common trench standard and dividing wall manhole areas using cured-in-place-pipe lining (CIPPL)
- Alternative stormwater separation within the public ROW and on private property
- Illicit discharge remediation
- Correction of failing septic tanks

## 1.1 Project Benefits

Quantification of project benefits, including reduced pollutant loading to streams and Lake Erie and reduced frequency of sanitary sewer basement backups, will be summarized in a subsequent HHI-LSSES report.

# 2.0 Development of Unit Construction Costs and Project Costs

Class 5 unit construction costs were developed using previous NEORSD and local municipality construction project bid tabs and costing reports. Per AACE, Class 5 estimates are prepared based on very limited information and subsequently have wide accuracy ranges. Typical purpose of the estimate is for concept screening and typical accuracy ranges for Class 5 estimates are -20% to -50% on the low side, and +30% to +100% on the high side. Development of the

[1] AACE – From AACE website: *The legal name since 1992 is AACE International. In 1956 the organization was established as the American Association of Cost Engineers. While you may have seen that "AACE" stands for the Association for the Advancement of Cost Engineering, this is only a statement that encompasses the work of the Association, not a legal name.*

estimated unit construction and project costs is summarized in the following sections of this report for each alternative.

Unit construction costs were extracted from the project bid tabs and costing reports from 2011 to 2017, and an average unit price was calculated and escalated to 2018 costs. Escalation of the cost basis for the unit prices from the communities was updated to May 2018 using an Engineering News Record (ENR) Construction Cost Index (CCI) of 12,325 for Cleveland. Summary of recent ENR CCI values is included in **Appendix A**. The AACE Recommended Practice No. 18R-97, Cost Estimate Classification System summary is included in **Appendix B**.

## 2.1 Project Costs

The unit construction cost tables provided in this report do not include construction contingencies, design engineering, construction engineering and administration costs. This section identifies the additional markups to be added based on construction costs to obtain planning level project costs.

Engineering and administration costs for capital projects of similar complexity typically decrease as a percentage of construction cost with increasing project size and cost. **Table 2-1** summarizes standard assumptions for NEORSD design and construction engineering and administration updated during the 2013 Advanced Facilities Plan (AFP) Project.

Table 2-1. Revised Professional Services Cost Estimates by Project Size

| Project Size (Construction Costs, $ Million) | Design, % of Construction Cost | CA/RE, % of Construction Cost |
|---|---|---|
| Up to 10 | 15 | 10 |
| 10 to 20 | 10 | 7 |
| 20 to 80 | 7 | 7 |
| Greater than 80 | 6 | 4 |

Individual project construction costs for the LSSES project improvements are expected to average less than $10 million. Based on this assumption, and on the planning level information developed for the LSSES projects, project costs for the LSSES improvements are being developed from construction costs using the following percentages:

- Construction contingency: 30% of construction cost
- Design engineering: 15% of construction cost including the contingency
- Construction resident engineering and administration: 10% of construction cost including the contingency

This results in a project cost multiplier of 1.625 times the construction cost, e.g.

Project Cost = Construction cost*1.3*(1.0+0.15+0.10) = 1.625*Construction cost

## 2.2 Project Definition Investigation Cost

NEORSD LSSES projects are planning level studies, and prioritized field investigations are completed in up to 10% of the project area on average. In addition to standard construction, engineering and administrative activities/costs discussed in the previous paragraphs, many of the potential improvements proposed in the HHI area may benefit significantly from additional investigations to refine the proposed work areas and preferred improvements. For example, even though dyed water testing in one portion of a subcatchment may identify pipe reaches with high infiltration in the public ROW, private property I/I may actually be a significant, if not greater source of wet weather flows, particularly in areas with pre-WWII vintage homes. As another example, even though elevated wet weather flows may be a partial cause of some basement backup problem or SSO, a system bottleneck, structural or recurrent debris or other O&M problems may also be a significant cause of the problem.

Improved definition of these types of potential unknown system characteristics will help to further optimize cost-effectiveness and resulting performance. The *HHI-LSSES Project Summary Report, Final, [month] 2018* and individual community reports discuss implementation activities such as CCTV, micromonitoring and dyed water testing that may be beneficial in many potential improvement areas to better define the specific extents and causes of problems to be addressed.

These investigation activities will add up front cost to planning and implementing the projects but will also help reduce overall project costs and improve cost-effectiveness by properly defining the work areas and specific system improvements to be implemented, particularly in common trench project areas. Based on HHI-LSSES investigation costs, an allowance of $10,000 per acre is suggested as a planning level allowance for project definition investigations in common trench remediation areas and will be included as a separate line item for these work areas.

## 2.3 Available Cost Data Reviewed

Many bid tabs, invoices and costing references from existing construction projects performed by NEORSD and municipalities in the HHI-LSSES area were compiled and evaluated to estimate the unit construction costs for the collection system improvement alternatives. Costs used from recent projects were escalated using appropriate ENR CCI values.

The following NEORSD projects provided bid tabs and costing references that were evaluated for applicability:

- Combined Sewer Overflow Advanced Facilities Plan and Integrated Planning (2013 CSO AFP)
- CSO Relining and Replacement Contract (CSORARC - 2012)
- CSO Rehabilitation Contract (CSORC - 2010)
- Dugway West Interceptor Relief Sewer (DWIRS - 2013)
- Easterly District Interceptor Relining/Replacement Contract (EDIRARC - 2007)
- Mill Creek Interceptor Relief (MCIR - 2009)
- NEORSD Professional Services for the Asset Management Implementation Phase I Project, Report for Task Order 8 Calculate Cost of Lining District Sewers (April 26, 2012)
- Southerly & Westerly Interceptors Service Agreement Contract (SWDISAC - 2010)
- Southerly & Westerly Interceptors Replacement and Rehabilitation Contract (SWDIRARC - 2008)

The following municipalities provided project bid tabs and applicable costing references that were assessed for applicability:

- Beachwood
- Highland Heights
- Lakewood, City of; Integrated Wet Weather Improvement Plan (September 2016)
- Lyndhurst
- Mayfield Heights
- Shaker Heights
- South Euclid

The bid tabs and costing references provided by NEORSD and municipalities were used to estimate the cost of the components in each alternative. These components are listed under the assumptions sections for each alternative in the following section.

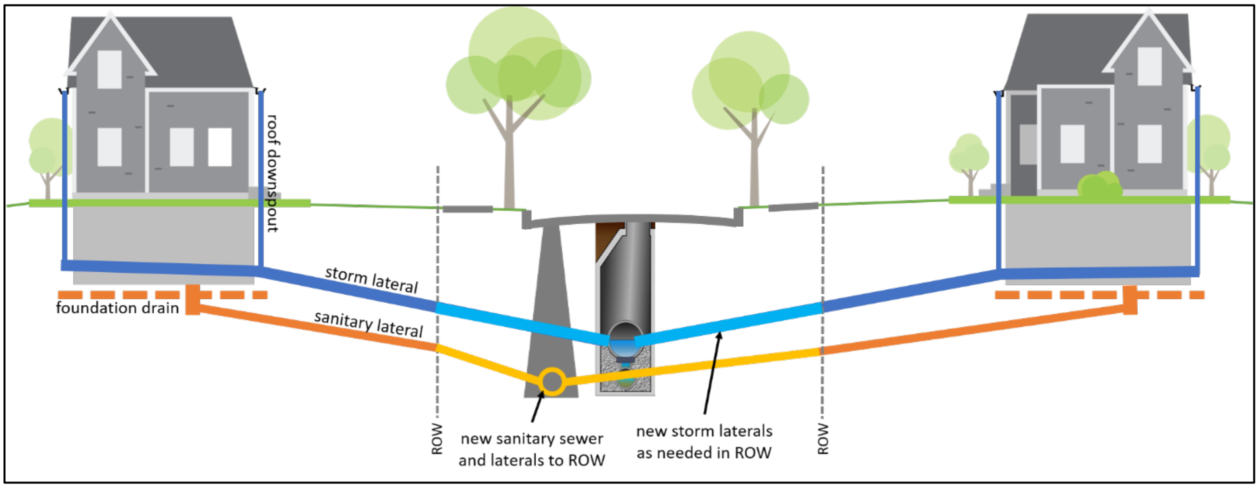
# 3.0 Sewer System Improvement Alternatives and Construction Costs

The following sections describe the typical sewer system improvements that were considered for control of SSOs, sanitary sewer basement backups, illicit discharges and failing septic tanks in the HHI-LSSES area. Stormwater control measures such as swales and rain gardens may also be considered in selected areas using available District guidance but are not considered in this technical memorandum. The improvement alternatives are developed at a planning level for comparison and to summarize the potential scope of work for each community. Implementation of individual projects will require further field investigation, problem definition and updated cost information to confirm the extents and types of improvements to be constructed. Implementation considerations are provided in subsequent HHI-LSSES reports.

## 3.1 New Sanitary Sewers for SSO Control and/or Capacity Increase

This improvement assumes construction of a new sanitary sewer to route SSO flow to a District sewer or other local sanitary sewer with adequate capacity, or to increase capacity in a sewer reach with insufficient capacity. A new sewer in this alternative may be constructed in parallel with a separate or common trench system and would allow for abandonment of the existing sanitary sewer if desirable. This would be determined based on specific site conditions during preliminary design. This improvement could also be used to improve separation of sanitary and stormwater flows in common trench reaches where the sanitary sewer is in poor condition and storm sewer can be allowed to remain. This improvement assumes the existing storm sewer remains in good condition. **Figure 3-1** shows a sketch of the concept for a new sanitary sewer. Additional assumptions for this improvement are summarized after the figure.

Figure 3-1. New Sanitary Sewer for Added Capacity or Flow Rerouting




*Assumptions*

- Construction is within the 40-ft wide ROW and assumes a typical 24-ft wide residential roadway.
- Excavations are constructed using standard trench boxes. Sheeting is not included.
- New sanitary sewers of acceptable material under Uniform Standards are provided in standard diameters at up to 15 feet deep and 16-20 feet deep.
- New manholes are included at 48-inch diameter for sewers 8-30 inches in diameter, and 84-inch diameter for sewers 36-48 inch in diameter. Manholes are assumed at every 300 feet along the sanitary sewer line.
- Sanitary manholes are included at 15 feet deep, or deeper to match the sewer.
- Two 25-foot-long residential sanitary sewer laterals and stormwater service laterals are included every 50 feet along the sanitary sewer line.
- Restoration assumes a 40-foot-wide ROW with a 24-foot-wide roadway and 5-foot-wide sidewalks.

- Asphalt pavement includes removal and replacement of 24-foot-wide roadway (6-inch bituminous base, 1.5-inch intermediate asphalt layer, 1.5-inch asphalt road surface (top layer)).
- Includes removal and replacement of 6-inch-high concrete curb.
- Concrete sidewalks are replaced - five feet wide, 4.5 inches thick.
- Concrete residential drive aprons include removal and replacement of two 12-ft wide concrete aprons every 50 feet along the street at six inches thick.
- Grass seeded tree lawns include four inches of topsoil, seeding, fertilizing and mulch.
- Assumes protection of existing utilities. New utilities may increase cost.

*Construction Costs*

**Table 3-1** summarizes the unit costs used to estimate construction costs (without contingencies and engineering) to install sanitary sewer pipe per linear foot of right of way. The unit costs are categorized by sewer pipe diameter. Diameters assumed to have the same excavated trench width have the same unit construction cost because the material cost of the pipe is considered insignificant to the overall unit construction cost per linear foot of ROW.

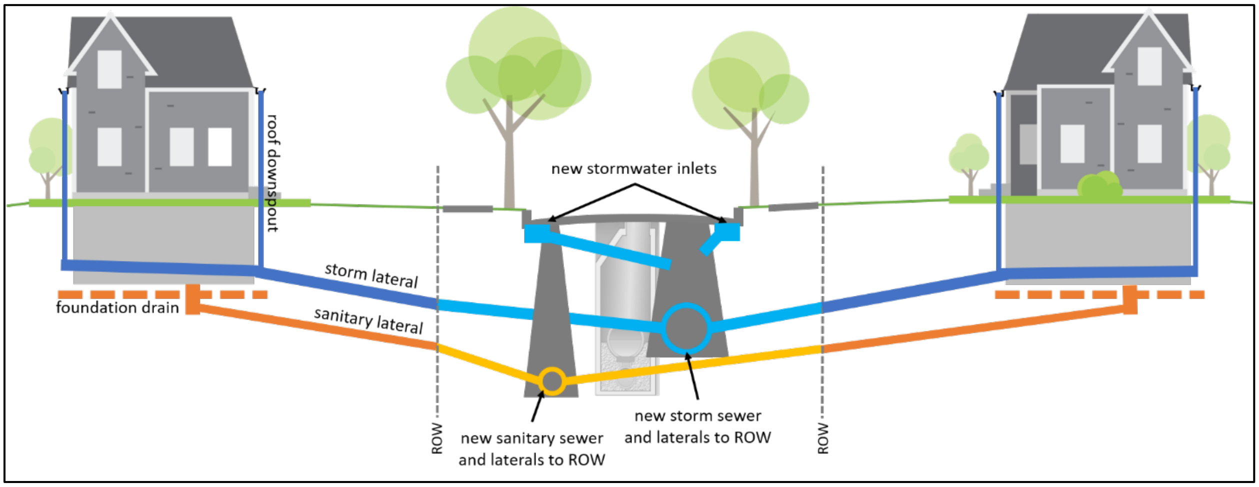
Table 3-1. Sanitary Sewer Construction Unit Costs

| Inside Diameter (inches) | 0-15 feet deep ($/LF) | 16-20 feet deep ($/LF) |
|---|---|---|
| 10 | 923 | 1,546 |
| 12 | 943 | 1,556 |
| 15 | 943 | 1,556 |
| 18 | 1,018 | 1,629 |
| 21 | 1,018 | 1,629 |
| 24 | 1,018 | 1,629 |
| 30 | 1,018 | 1,629 |
| 36 | 1,073 | 1,690 |
| 42 | 1,073 | 1,690 |
| 48 | 1,153 | 1,787 |

## 3.2 Sewer System Replacement in Common Trench Over-Under (invert plate) Areas

New sanitary and storm sewers will be constructed in urban residential streets by removing the existing sewers, service laterals and catch basins, and reconstructing new separate sanitary and storm sewer systems in the ROW. The costs estimated are costs per linear foot of ROW and include flow maintenance, as well as removal and replacement of entire roadway, curb, sidewalks, and landscaping. The sanitary sewer would typically be constructed in approximately the same location as the existing sanitary sewer and a new storm sewer would be constructed in a parallel separate trench in the roadway. **Figure 3-2** summarizes the proposed sewer system replacement/separation concept. Additional assumptions for this improvement are summarized following the figure.

Figure 3-2. Sewer System Replacement in Common Trench Over/Under Areas




*Assumptions*

- Construction is within the 40-ft wide ROW and assumes a typical 24-ft wide residential roadway.
- Excavations are constructed using standard trench boxes. Sheeting is not included.
- New sanitary sewers of acceptable material under Uniform Standards are provided in standard diameters up to 15 feet deep and 16-20 feet deep.
- New storm sewers of acceptable material under Uniform Standards are included using existing piping sizes provided and adjusted to standard diameters at eight feet deep.
- New manholes are included as 48-inch diameter and assumed at every 300 feet along sanitary and storm lines.
- Sanitary manholes are included at 15 feet deep, or deeper to match the sewer. Storm manholes are included at eight feet deep.
- Two new catch basins with 12-inch storm pipe from the catch basins to the new storm sewer are included every 300 feet.
- Two residential storm service laterals are included at 25 feet long each, every 50 feet along the storm sewer.
- Two residential sanitary service laterals are included at 25 feet long each, every 50 feet along the sanitary sewer.
- Restoration assumes a 40-foot-wide ROW with a 24-foot-wide roadway and 5-foot-wide sidewalks.

- Asphalt pavement includes removal and replacement of 24-foot-wide roadway (6-inch bituminous base, 1.5-inch intermediate asphalt layer, 1.5-inch asphalt road surface (top layer))
- Six-inch concrete curb is removed and replaced.
- Concrete sidewalk is removed and replaced at five feet wide, 4.5 inches thick.
- Concrete residential drive aprons include removal and replacement of two 12-ft wide concrete aprons every 50 feet along the street at six inches thick.
- Grass seeded tree lawns include four inches of topsoil and seeding, fertilizing and mulch.
- Assumes protection of existing utilities. New utilities may increase cost.

### *Construction Costs*

**Table 3-2** summarizes the unit costs to install sanitary sewer pipe per linear foot of right of way, and **Table 3-3** summarizes the unit costs to install a storm sewer of the same size as existing in a parallel separate trench. The unit costs in **Table 3-2** are categorized by sewer pipe diameter. Diameters assumed to have the same excavated trench width have the same unit construction cost because the material cost of the pipe is considered insignificant to the overall unit construction cost per linear foot of ROW. Restoration costs covering the entire ROW are included with the sanitary sewer replacement unit costs. The storm sewer replacement unit costs include excavation, bedding, storm pipe, backfill, two storm laterals every 50 feet, and two catch basins every 300 feet; no restoration is included.

Table 3-1. Sanitary Sewer Replacement Unit Costs

| Inside Diameter (inches) | 0-15 feet deep ($/LF) | 16-20 feet deep ($/LF) |
|---|---|---|
| 10 | 1,022 | 1,712 |
| 12 | 1,042 | 1,719 |
| 15 | 1,042 | 1,719 |
| 18 | 1,117 | 1,787 |
| 21 | 1,117 | 1,787 |
| 24 | 1,117 | 1,787 |
| 30 | 1,117 | 1,787 |
| 36 | 1,172 | 1,846 |
| 42 | 1,172 | 1,846 |
| 48 | 1,252 | 1,941 |

Table 3-3. Storm Sewer Replacement Unit Costs When Replaced with Sanitary Sewer

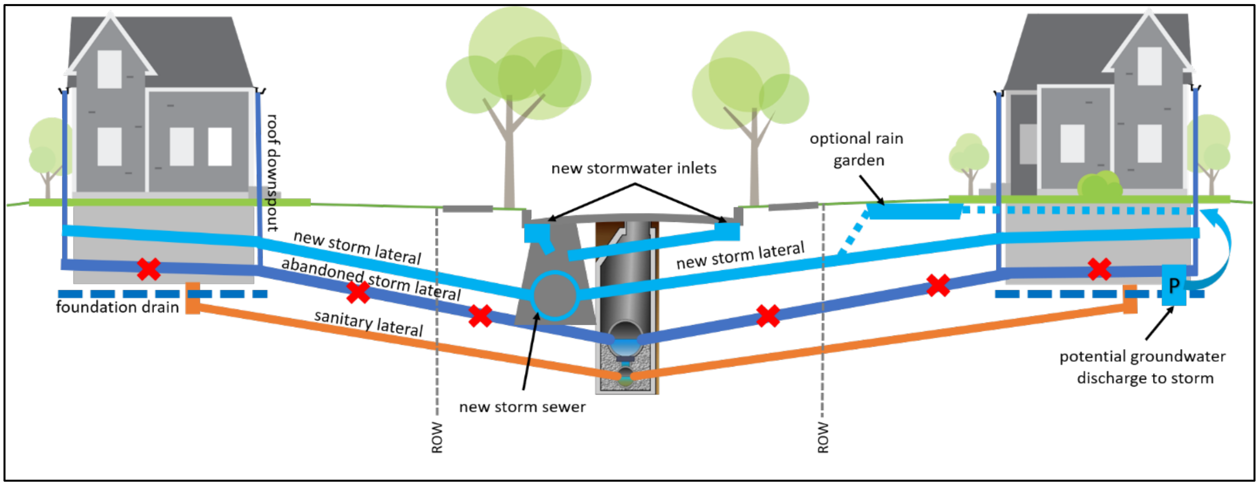
| Inside Diameter (inches) | eight feet deep ($/LF) |
|---|---|
| 15 | 234 |
| 18 | 251 |
| 21 | 269 |
| 24 | 290 |
| 30 | 312 |
| 36 | 337 |
| 42 | 364 |
| 48 | 393 |

## 3.3 Stormwater Separation Alternative for Common Trench Areas

The stormwater separation improvement alternative assumes construction of a new storm sewer in the street ROW to collect stormwater from the ROW, and replacement of the stormwater service lateral piping on private property where feasible to reduce sanitary system I/I. This alternative would construct a new storm sewer the same size as existing in the street, and may be applicable in over/under separation, or in other common trench areas where the storm sewer may be in poor condition. Providing increased storm sewer capacity may also be feasible, contingent on available downstream capacity. Stormwater service lateral rehabilitation may also be feasible but may require the new storm sewer to be constructed deeper to collect water from existing stormwater laterals. The proposed work would include removal and replacement of the entire roadway, curb, and sidewalks within the ROW. **Figure 3-3** shows a conceptual cross section of the alternative. Additional cost assumptions for this improvement are summarized following the figure. Additional considerations regarding this improvement concept include the following:

- May not be applicable if the existing storm and/or sanitary sewers are in poor structural condition.
- May allow shallower construction compared to common trench separation concept.
- May allow both pipes of existing common trench system to remain as a wet sanitary system that collects and treats runoff from small rainfalls.
- Could include private property raingardens with overflow to new storm sewer lateral.
- Could allow sump pump discharge of groundwater to new stormwater lateral or rain garden.

Figure 3-3. Stormwater Separation Concept for Common Trench Areas




*Assumptions*

<u>Work in Public ROW:</u>

- All storm sewer mainline construction is within residential road ROWs.
- New storm sewers of acceptable material under Uniform Standards are included using existing piping sizes provided and adjusted to standard diameters at approximately eight feet deep.
- New manholes are included as 48-inch diameter and assumed at every 300 feet along the new storm sewer at eight feet deep.
- Two new catch basins with 12-inch storm leads to the new storm sewer are included every 300 feet.
- Two residential service stormwater service laterals are included at 25 feet long each (from storm sewer to ROW), every 50 feet along the storm sewer.
- All excavations use standard trench boxes. Sheeting is not included.
- Restoration within the ROW assumes a 40-foot-wide ROW with a 24-foot-wide roadway and 5-foot-wide sidewalks.
- Asphalt pavement includes removal and replacement of roadway (6-inch bituminous base, 1.5-inch intermediate asphalt layer, 1.5-inch asphalt road surface (top layer))
- Includes removal and replacement of 6-inch-high concrete curb.
- Concrete sidewalk removal and replacement - 5-foot-wide, 4.5-inchesthick.

- Remove and replace two 12-ft wide concrete residential drive aprons every 50 feet along the street at six inches thick.
- Restore tree lawns with four inches of topsoil, seeding, fertilizing and mulch.
- Assumes protection of existing utilities. New utilities may increase cost.

Work on Private Property:

- Private property work assumes two parcels every 50 feet requiring separation.
- Replace/construct 50 LF of 6-inch stormwater lateral from ROW to house, and 80 LF of 6-inch lateral around three sides of house connecting downspouts. Restoration is assumed to be topsoil and grass. Re-pitching gutters and/or trenchless construction may be cost-effective to limit disruption of existing landscaping and reduce cost.

*Construction Costs*

**Table 3-4** summarizes the unit costs to construct new storm sewer pipe per linear foot of ROW and includes the private property stormwater lateral improvements at a cost of $10,000 per parcel. This parcel cost is based on recent experience in the City of Lakewood, and separate discussion with a local plumbing contractor active in the HHI-LSSES area. The unit costs are categorized by sewer pipe diameter. Diameters assumed to have the same excavated trench width have the same unit construction cost because the material cost of the pipe is considered insignificant to the overall unit construction cost per linear foot of ROW.

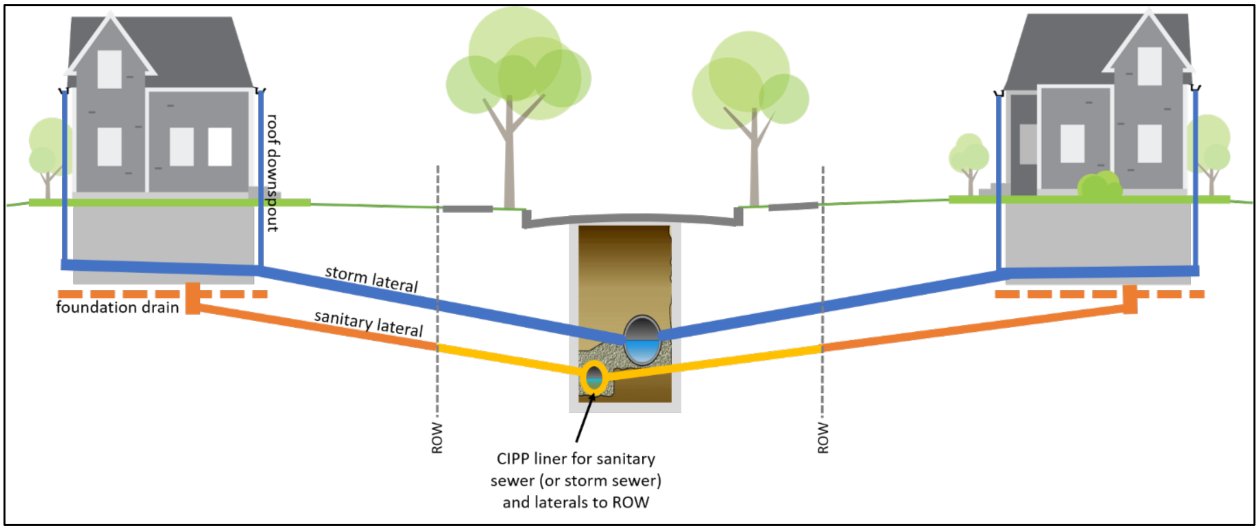
Table 3-4. Storm Sewer Separation Unit Costs

| Inside Diameter (inches) | Eight feet deep ($/LF) |
|---|---|
| 15 | 1,249 |
| 18 | 1,316 |
| 21 | 1,316 |
| 24 | 1,316 |
| 30 | 1,316 |
| 36 | 1,366 |
| 42 | 1,366 |
| 48 | 1,438 |

## 3.4 Sewer Rehabilitation in Common Standard and Dividing Wall Manhole Areas

The sewer rehabilitation improvement includes installing a cured-in-place pipe liner (CIPPL) inside the sanitary sewer in a residential street within the ROW. The cost estimated is per linear foot of ROW and includes CCTV and light cleaning of the existing sanitary sewer, flow control, installation of CIPPL in sewer pipe, installation of CIPPL in sanitary sewer laterals to the ROW, and CCTV of final lining. For dividing wall systems, the dividing wall manholes are reconstructed to eliminate the hydraulic connectivity and provide separate access to both storm and sanitary sewers. Common standard manholes are not expected to require significant rehabilitation. This improvement would also be applicable in separate trench areas. **Figure 3-4** shows the concept. Additional assumptions for this improvement are summarized after the figure.

Figure 3-4. CIPP Sewer and Lateral Rehabilitation Concept




### *Assumptions*

- Condition of existing sewer to be lined is acceptable for CIPPL with no major repairs or preparation work required.
- CIPPL unit prices for sewer internal diameters less than 36 inches assume the lining can be performed from manhole to manhole without manhole reconstruction.
- For sewers 36 inches and greater in diameter, the top sections of existing manholes will be removed to perform the work and replaced once lining is completed.
- Includes reinstatement of two residential sanitary service laterals every 50 feet.
- Includes CIPP lining of two residential service laterals for a length of 25 LF every 50 feet along the sewer from the main sewer to the ROW.
- Unit costs include light sewer cleaning and pre- and post-construction CCTV. Sewers requiring heavy cleaning would add cost.

### *Construction Costs*

**Table 3-5** summarizes the unit cost to install CIPPL inside an existing sanitary or storm sewer and associated service laterals per linear foot of right of way.

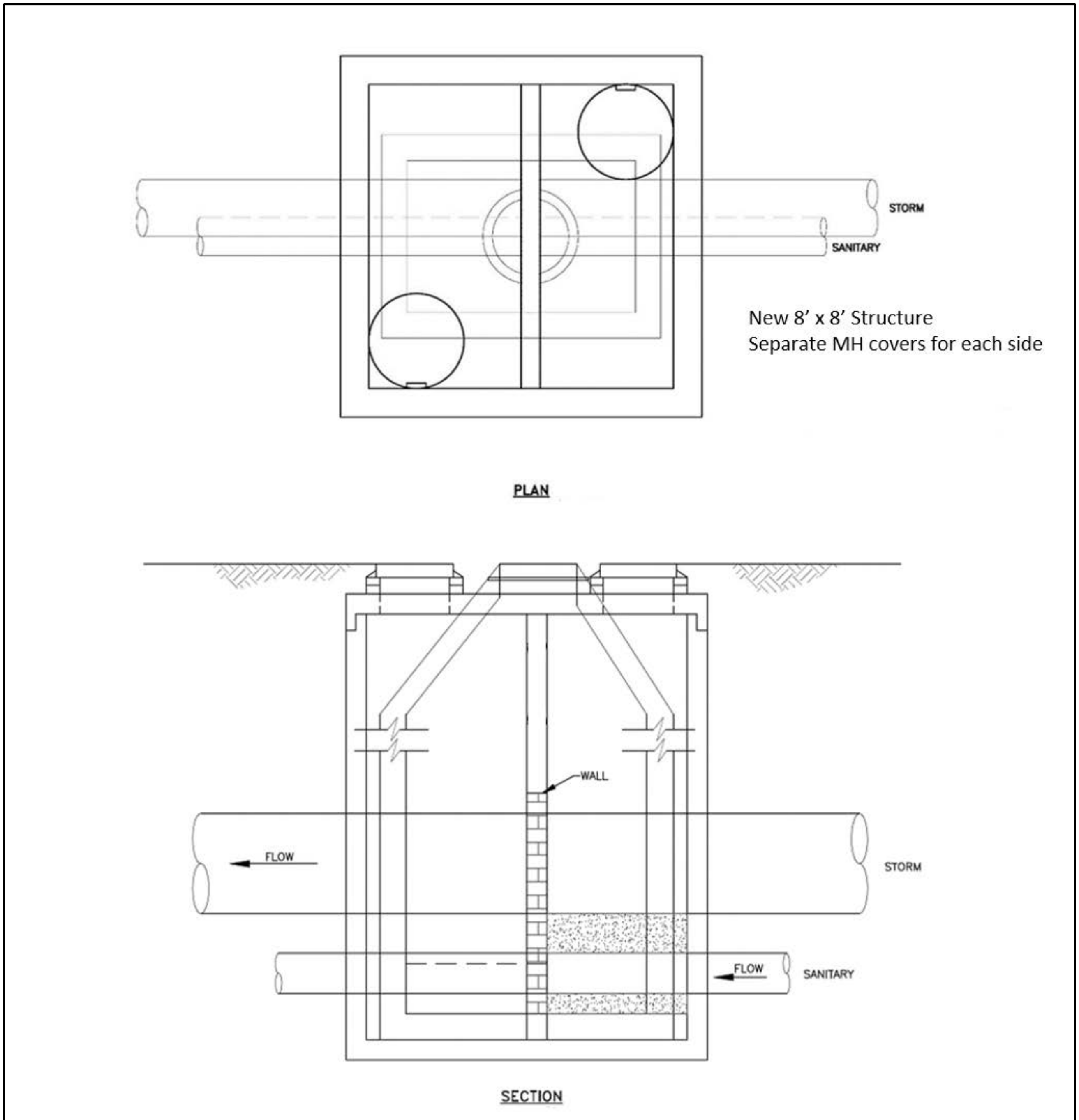
Table 3-5. Mainline CIPPL Rehabilitation with Lateral Lining in ROW Unit Costs

| Inside Diameter (inches) | Unit Price ($/LF) |
|---|---|
| 10 | 344 |
| 12 | 355 |
| 15 | 375 |
| 18 | 398 |
| 21 | 428 |
| 24 | 458 |
| 30 | 534 |
| 36 | 627 |
| 42 | 737 |
| 48 | 864 |

Dividing Wall Manhole Reconstruction

For dividing wall manhole systems, the dividing wall manholes are recommended to be reconstructed to eliminate hydraulic connectivity between the storm and sanitary sewers, and to provide separate maintenance access to both sewers. Concepts were developed in 2014 as part of the AFP Integrated Planning study and cost estimates were prepared. The proposed work would remove and reconstruct the manhole with an 8 x 8-foot rectangular structure that includes separate chambers and access manhole covers for each sewer. **Figure 3-5** shows conceptual plan and section views.

Figure 3-5. Dividing Wall Manhole Reconstruction Concept Plan and Section Views




The following assumptions were used to develop the unit cost for replacing existing dividing wall manholes with new structures to separate the existing storm and sanitary sewers.

- All work is below a residential 24-foot-wide roadway within the ROW. Neither curb or sidewalk will require replacement.

- Manhole structure is up to 15 feet deep.
- 8 x 8-foot structure constructed of cast-in-place concrete.
- Restoration assumes full depth asphalt pavement removal and replacement of 10 x 10-foot area of roadway (6-inch bituminous base, 1.5-inch intermediate asphalt layer, 1.5-inch asphalt road surface (top layer))

The unit construction cost to reconstruct the dividing wall manholes, as shown, is updated from the construction cost that was prepared for the AFP Integrated Planning project by Regency Construction in August 2014. The cost in 2014 was $50,000 (ENR CCI 11,860) and is escalated to $51,960 (May 2018 ENR CCI 12,325). A 2018 unit construction cost of $52,000 is suggested for HHI-LSSES alternatives cost opinion development.

## 3.5 Private Property I/I Remediation

Some PFL areas likely have significant I/I originating on private property. In these areas, the most cost-effective solution may involve reducing I/I on private property. Typical I/I control methods used on private property include pipe rehabilitation and infrastructure replacement.

Suburban communities with larger lots may find low-cost options such as discharging downspouts to grade to be effective and acceptable. Other more densely situated parcels in urban neighborhoods may not allow for this due to resulting surface drainage problems. In these areas, I/I mitigation may likely involve replacement or trenchless rehabilitation of stormwater and/or sanitary service laterals to eliminate I/I. This work may need to be completed from the downspouts to the sewers in the street to be effective, and dyed water testing at each parcel under consideration is recommended. Typical methods include the following:

- New sanitary and or stormwater service laterals
  - New shallower stormwater piping may help reduce cost and disruption
  - Trenchless construction methods such as pilot tube microtunneling may be effective
  - Re-pitching eaves troughs may help redirect roof water to minimize trenching in heavily landscaped areas
- CIPP lining of laterals if in acceptable condition

While actual costs may vary widely for I/I remediation on private property an average allowance of $10,000 per parcel is assumed for this study. This cost is based on recent experience in the City of Lakewood, and separate discussion with a local plumbing contractor active in the HHI-LSSES area.

## 3.6 Illicit Discharge Remediation

Correction of illicit discharges is discussed in the May 2017 Integrated Planning report, which used information from the Cuyahoga County Board of Health, Illicit Discharge Detection and Elimination Manual, 2006, to estimate an average cost for illicit discharge, detection and elimination of $15,000. Elimination construction assumes disconnection from the existing discharge location and reconnection to the sanitary sewer, which is assumed to be in the same street ROW. Escalation from 2014 (CCI-ENR 11,860) results in a 2018 construction cost of $15,600. This includes investigation and construction but no other soft costs for administration and enforcement, and so is considered as an average construction cost, to which will be added the contingency, engineering and administrative percentages for a project cost of $25,300 per site.

## 3.7 Correction of Failing Septic Systems

Individual failing septic tanks in the HHI service area may be repaired or replaced to bring them into compliance, or new sewerage improvements may be constructed to discharge the flows to the HHI sewer system. The Integrated Planning report developed a planning level project cost of $20,300 per unit to abandon the existing septic system, construct new local mainline sewers and connect the home service lateral to the new sewer system. Specific projects may result in costs higher or lower than this. Escalation of this cost to 2018 results in a project cost of $21,100 per property. Locations where costs may be higher than this would likely be candidates for a new septic system.

Based on internet searches, replacement of an individual drain field septic system can range from approximately $3,000 to $15,000, with a national average of $5,500. For this study, an average project cost of $10,000 is assumed to replace a single failing septic system.

# Appendix A.
# ENR Construction Cost Index (CCI) for Cleveland through May 2018

# Appendix A
# ENR Construction Cost Index (CCI) for Cleveland through May 2018

| Cleveland CCI - updated May 2018 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **YEAR** | **MONTH** | **BCI** | **%CHG** | **CCI** | **%CHG** | | |
| | **2018** | May | 5782 | 0 | 12325 | 0 | | |
| | **2018** | Apr | 5789 | 0 | 12331 | 0 | | |
| | **2018** | Mar | 5745 | 8 | 12287 | 17 | | |
| | **2018** | Feb | 5745 | 0 | 12287 | 0 | | |
| | **2018** | Jan | 5756 | 1 | 12299 | 0 | | |
| | **2017** | Dec | 5745 | 1 | 12287 | 0 | | |
| | **2017** | Nov | 5735 | 1 | 12277 | 2 | | |
| | **2017** | Oct | 5715 | 0 | 12258 | 2 | | |
| | **2017** | Sept | 5797 | 2 | 12339 | 3 | | |
| | **2017** | Aug | 5799 | 2 | 12341 | 3 | | |
| | **2017** | Jul | 5795 | −1.8 | 12338 | −2.4 | | |
| | **2017** | Jun | 5788 | 2 | 12331 | 3 | | |
| | **2017** | May | 5779 | 1 | 12322 | 2 | | |
| | **2017** | Apr | 5776 | 1 | 12319 | 2 | | |
| | **2017** | Mar | 5339 | −3.9 | 10494 | −11.9 | | |
| | **2017** | Feb | 5339 | −3.9 | 10494 | −11.9 | | |
| | **2017** | Jan | 5725 | 4 | 12268 | 3 | | |
| | **2016** | Dec | 5697 | 4 | 12240 | 3 | | |
| | **2016** | Nov | 5699 | 4 | 12052 | 1 | | |
| | **2016** | Oct | 5698 | 4 | 12051 | 1 | | |
| | **2016** | Sep | 5680 | 3 | 12032 | 1 | | |
| | **2016** | Aug | 5694 | 4 | 12046 | 2 | | |
| | **2016** | Jul | 5694 | 4 | 12047 | 2 | | |
| | **2016** | Jun | 5683 | 4 | 12035 | 1 | | |
| | **2016** | May | 5699 | 4 | 12051 | 2 | | |
| | **2016** | Apr | 5707 | 4 | 12060 | 2 | | |
| | **2016** | Mar | 5556 | 2 | 11908 | 0 | | |
| | **2016** | Feb | 5555 | 2 | 11907 | 0 | | |
| | **2016** | Jan | 5503 | 1 | 11896 | 0 | | |
| | **2015** | Dec | 5494 | 0 | 11887 | 0 | | |
| | **2015** | Nov | 5496 | 0 | 11887 | −0.10 | | |
| | **2015** | Oct | 5487 | 0 | 11877 | 0 | | |
| | **2015** | Sep | 5493 | 1 | 11884 | 0 | | |
| | **2015** | Aug | 5480 | 1 | 11870 | 0 | | |
| | **2015** | Jul | 5480 | 0 | 11870 | 0 | | |
| | **2015** | Jun | 5475 | −0.15 | 11865 | −0.07 | | |
| | **2015** | May | 5483 | 0 | 11873 | 0 | | |
| | **2015** | Apr | 5471 | 1 | 11861 | 1 | | |
| | **2015** | Mar | 5467 | 6 | 11857 | 6 | | |
| | **2015** | Feb | 5464 | 6 | 11870 | 6 | | |
| | **2015** | Jan | 5476 | 6 | 11882 | 6 | | |
| | **2014** | Dec | 5473 | 6 | 11879 | 6 | | |
| | **2014** | Nov | 5488 | 6 | 11894 | 6 | | |
| | **2014** | Oct | 5465 | 6 | 11871 | 6 | | |
| | **2014** | Sep | 5443 | 7 | 11861 | 6 | | |
| | **2014** | Aug | 5443 | 7 | 11860 | 6 | | |
| | **2014** | Jul | 5443 | 6 | 11860 | 6 | | |
| | **2014** | Jun | 5445 | 6 | 11862 | 6 | | |
| | **2014** | May | 5441 | 6 | 11859 | 6 | | |
| | **2014** | Apr | 5440 | 7 | 11757 | 5 | | |
| | **2014** | Mar | 5161 | 2 | 11234 | 4 | | |
| | **2014** | Feb | 5152 | 1 | 11225 | 4 | | |
| | **2014** | Jan | 5154 | 3 | 11227 | 5 | | |
| | **2013** | Dec | 5146 | 3 | 11218 | 5 | | |
| | **2013** | Nov | 5148 | 3 | 11220 | 5 | | |
| | **2013** | Oct | 5134 | 2 | 11207 | 5 | | |
| | **2013** | Sep | 5108 | 2 | 11180 | 4 | | |
| | **2013** | Aug | 5107 | 2 | 11179 | 4 | | |
| | **2013** | Jul | 5131 | 3 | 11204 | 4 | | |
| | **2013** | Jun | 5125 | 3 | 11197 | 5 | | |
| | **2013** | May | 5118 | 3 | 11191 | 4 | | |
| | **2013** | Apr | 5098 | 2 | 11170 | 4 | | |
| | **2013** | Mar | 5082 | 2 | 10760 | 1 | | |
| | **2013** | Feb | 5083 | 3 | 10761 | 6 | | |
| | **2013** | Jan | 5029 | 2 | 10742 | 6 | | |

# Appendix B.

# AACE Recommended Practice No. 18R-97, Cost Estimate Classification System

AACE INTERNATIONAL RECOMMENDED PRACTICE

18R-97

# COST ESTIMATE CLASSIFICATION SYSTEM - AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PROCESS INDUSTRIES

AACE INTERNATIONAL

AACE International Recommended Practice No. 18R-97

# COST ESTIMATE CLASSIFICATION SYSTEM – AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PROCESS INDUSTRIES

TCM Framework: 7.3 – Cost Estimating and Budgeting

Rev. March 1, 2016

Note: As AACE International Recommended Practices evolve over time, please refer to www.aacei.org for the latest revisions.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*Disclaimer: The opinions expressed by the authors and contributors to this recommended practice are their own and do not necessarily reflect those of their employers, unless otherwise stated.*

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# COST ESTIMATE CLASSIFICATION SYSTEM – AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PROCESS INDUSTRIES

TCM Framework: 7.3 – Cost Estimating and Budgeting

March 1, 2016

## PURPOSE

As a recommended practice of AACE International, the *Cost Estimate Classification System* provides guidelines for applying the general principles of estimate classification to project cost estimates (i.e., cost estimates that are used to evaluate, approve, and/or fund projects). The *Cost Estimate Classification System* maps the phases and stages of project cost estimating together with a generic project scope definition maturity and quality matrix, which can be applied across a wide variety of process industries.

This addendum to the generic recommended practice (17R-97) provides guidelines for applying the principles of estimate classification specifically to project estimates for engineering, procurement, and construction (EPC) work for the process industries. This addendum supplements the generic recommended practice by providing:

- A section that further defines classification concepts as they apply to the process industries.
- A chart that maps the extent and maturity of estimate input information (project definition deliverables) against the class of estimate.

As with the generic recommended practice, the intent of this addendum is to improve communications among all of the stakeholders involved with preparing, evaluating, and using project cost estimates specifically for the process industries.

The overall purpose of this recommended practice is to provide the process industry with a project definition deliverable maturity matrix that is not provided in 17R-97. It also provides an approximate representation of the relationship of specific design input data and design deliverable maturity to the estimate accuracy and methodology used to produce the cost estimate. The estimate accuracy range is driven by many other variables and risks, so the maturity and quality of the scope definition available at the time of the estimate is not the sole determinate of accuracy; risk analysis is required for that purpose.

This document is intended to provide a guideline, not a standard. It is understood that each enterprise may have its own project and estimating processes and terminology and may classify estimates in particular ways. This guideline provides a generic and generally acceptable classification system for process industries that can be used as a basis to compare against. This addendum should allow each user to better assess, define, and communicate their own processes and standards in the light of generally-accepted cost engineering practice.

## INTRODUCTION

For the purposes of this addendum, the term “process industries” is assumed to include firms involved with the manufacturing and production of chemicals, petrochemicals, and hydrocarbon processing. The common thread among these industries (for the purpose of estimate classification) is their reliance on process flow diagrams (PFDs) and piping and instrument diagrams (P&IDs) as primary scope defining documents. These documents are key deliverables in determining the degree of project definition, and thus the extent and maturity of estimate input information.

Estimates for process facilities center on mechanical and chemical process equipment, and they have significant amounts of piping, instrumentation, and process controls involved. As such, this addendum may apply to portions of other industries, such as pharmaceutical, utility, water treatment, metallurgical, converting, and similar industries.

This addendum specifically does not address cost estimate classification in non-process industries such as commercial building construction, environmental remediation, transportation infrastructure, hydropower, “dry” processes such as assembly and manufacturing, “soft asset” production such as software development, and similar industries. It also does not specifically address estimates for the exploration, production, or transportation of mining or hydrocarbon materials, although it may apply to some of the intermediate processing steps in these systems.

The cost estimates covered by this addendum are for engineering, procurement, and construction (EPC) work only. It does not cover estimates for the products manufactured by the process facilities, or for research and development work in support of the process industries. This guideline does not cover the significant building construction that may be a part of process plants.

This guideline reflects generally-accepted cost engineering practices. This RP was based upon the practices of a wide range of companies in the process industries from around the world, as well as published references and standards. Company and public standards were solicited and reviewed, and the practices were found to have significant commonalities. These classifications are also supported by empirical process industry research of systemic risks and their correlation with cost growth and schedule slip[8].

## COST ESTIMATE CLASSIFICATION MATRIX FOR THE PROCESS INDUSTRIES

A purpose of cost estimate classification is to align the estimating process with project stage-gate scope development and decision-making processes.

Table 1 provides a summary of the characteristics of the five estimate classes. The maturity level of project definition is the sole determining (i.e., primary) characteristic of class. In Table 1, the maturity is roughly indicated by a percentage of complete definition; however, it is the maturity of the defining deliverables that is the determinant, not the percent. The specific deliverables, and their maturity or status are provided in Table 3. The other characteristics are secondary and are generally correlated with the maturity level of project definition deliverables, as discussed in the generic RP [2]. The post sanction classes (Class 1 and 2) are only indirectly covered where new funding is indicated. Again, the characteristics are typical and may vary depending on the circumstances.

| | ***Primary Characteristic*** | ***Secondary Characteristic*** | | |
|---|---|---|---|---|
| **ESTIMATE CLASS** | **MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition | **END USAGE** Typical purpose of estimate | **METHODOLOGY** Typical estimating method | **EXPECTED ACCURACY RANGE** Typical variation in low and high ranges |
| **Class 5** | 0% to 2% | Concept screening | Capacity factored, parametric models, judgment, or analogy | L: -20% to -50%<br>H: +30% to +100% |
| **Class 4** | 1% to 15% | Study or feasibility | Equipment factored or parametric models | L: -15% to -30%<br>H: +20% to +50% |
| **Class 3** | 10% to 40% | Budget authorization or control | Semi-detailed unit costs with assembly level line items | L: -10% to -20%<br>H: +10% to +30% |
| **Class 2** | 30% to 75% | Control or bid/tender | Detailed unit cost with forced detailed take-off | L: -5% to -15%<br>H: +5% to +20% |
| **Class 1** | 65% to 100% | Check estimate or bid/tender | Detailed unit cost with detailed take-off | L: -3% to -10%<br>H: +3% to +15% |

**Table 1 – Cost Estimate Classification Matrix for Process Industries**

This matrix and guideline outline an estimate classification system that is specific to the process industries. Refer to the generic estimate classification RP[1] for a general matrix that is non-industry specific, or to other addendums for guidelines that will provide more detailed information for application in other specific industries. These will provide additional information, particularly the project definition deliverable maturity matrix which determines the class in those particular industries.

Table 1 illustrates typical ranges of accuracy ranges that are associated with the process industries. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically to achieve a 50% probability of project overrun versus underrun) for given scope. Depending on the technical and project deliverables (and other variables) and risks associated with each estimate, the accuracy range for any particular estimate is expected to fall into the ranges identified (although extreme risks can lead to wider ranges).

In addition to the degree of project definition, estimate accuracy is also driven by other systemic risks such as:

- Level of non-familiar technology in the project.
- Complexity of the project.
- Quality of reference cost estimating data.
- Quality of assumptions used in preparing the estimate.
- Experience and skill level of the estimator.
- Estimating techniques employed.
- Time and level of effort budgeted to prepare the estimate.
- Unique/remote nature of project locations and the lack of reference data for these locations.
- The accuracy of the composition of the input and output process streams.

Systemic risks such as these are often the primary driver of accuracy, especially during the early stages of project definition. As project definition progresses, project-specific risks (e.g. risk events) become more prevalent and also drive the accuracy range[3]. Another concern in estimates is potential pressure for a predetermined value that may result in a biased estimate. The goal should be to always have an unbiased and objective estimate. The stated estimate ranges are dependent on this premise and a realistic view of the project.

Failure to appropriately address systemic risks (e.g. technical complexity) during risk analysis impacts the resulting probability distribution of the estimate costs, and therefore the interpretation of estimate accuracy.

Another way to look at the variability associated with estimate accuracy ranges is shown in Figure 1. Depending upon the technical complexity of the project, the availability of appropriate cost reference information, the degree of project definition, and the inclusion of appropriate contingency determination, a typical Class 5 estimate for a process industry project may have an accuracy range as broad as -50% to +100%, or as narrow as -20% to +30%.

Figure 1 also illustrates that the estimating accuracy ranges overlap the estimate classes. There are cases where a Class 5 estimate for a particular project may be as accurate as a Class 3 estimate for a different project. For example, similar accuracy ranges may occur if the Class 5 estimate of one project that is based on a repeat project with good cost history and data and, whereas the Class 3 estimate for another is for a project involving new technology. It is for this reason that Table 1 provides ranges of accuracy range values. This allows application of the specific circumstances inherent in a project, and an industry sector, to provide realistic estimate class accuracy range percentages. While a target range may be expected of a particular estimate, the accuracy range is determined through risk analysis of the specific project and is never pre-determined. AACE has recommended practices that address contingency determination and risk analysis methods.

If contingency has been addressed appropriately, approximately 80% of projects should fall within the ranges shown in Figure 1. However, this does not preclude a specific actual project result from falling inside or outside of the bands shown in Figure 1 indicating the expected accuracy ranges.

 

March 1, 2016

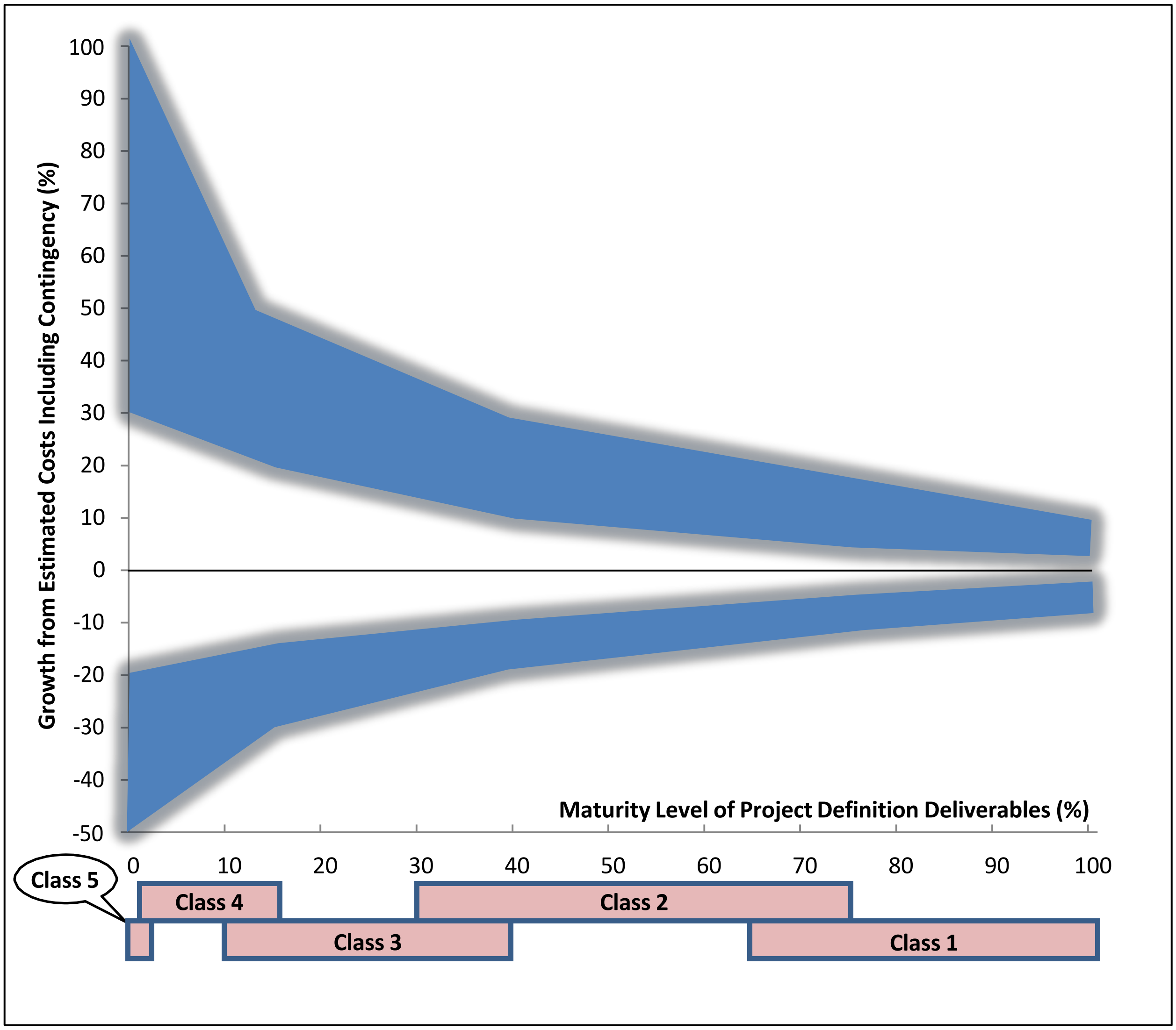


**Figure 1 – Example of the Variability in Accuracy Ranges for a Process Industry Estimate**

## DETERMINATION OF THE COST ESTIMATE CLASS

The cost estimator makes the determination of the estimate class based upon the maturity level of project definition based on the status of specific key planning and design deliverables. The percent design completion may be correlated with the status, but the percentage should not be used as the estimate class determinant. While the determination of the status (and hence the estimate class) is somewhat subjective, having standards for the design input data, completeness and quality of the design deliverables will serve to make the determination more objective.