Review of SUE Return on Investment Studies

2022-02-08

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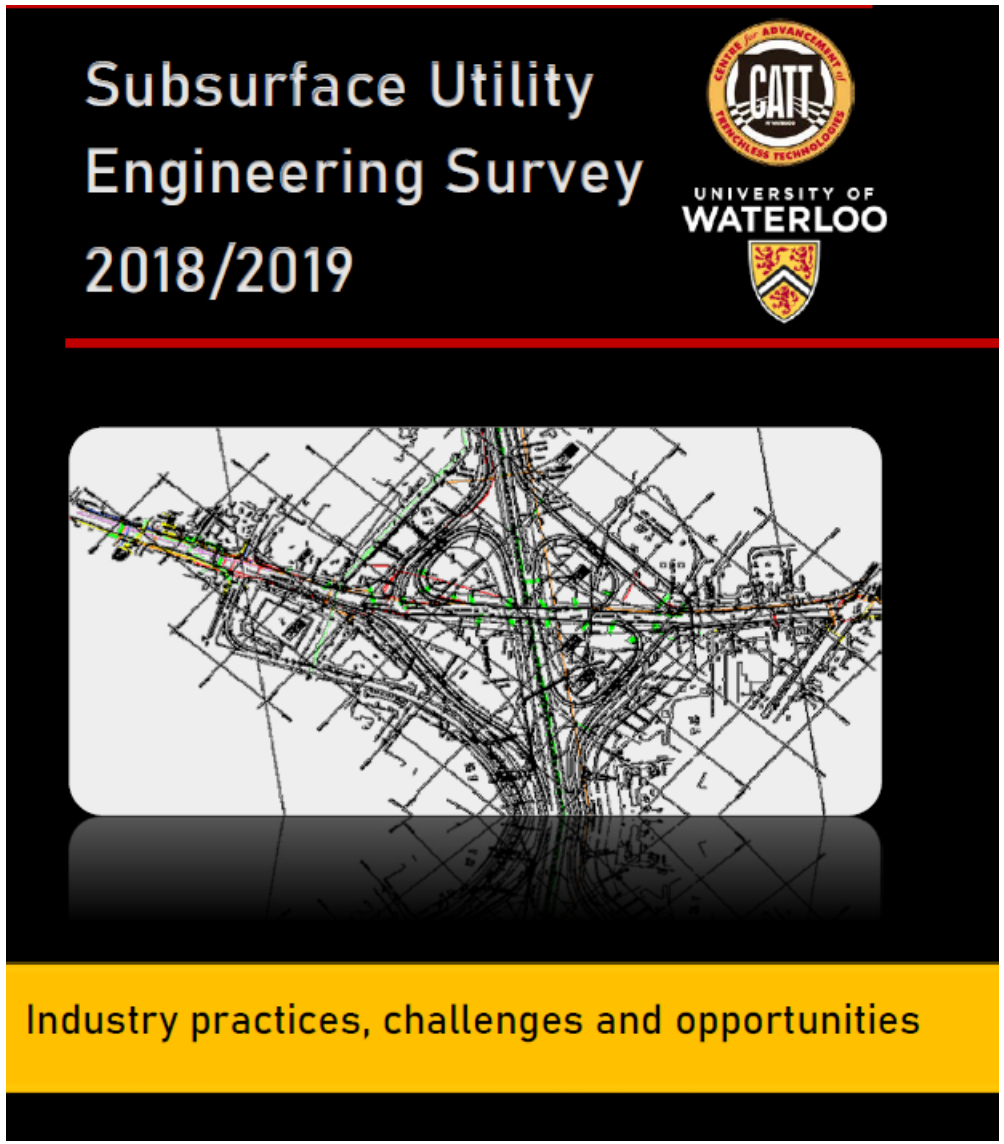
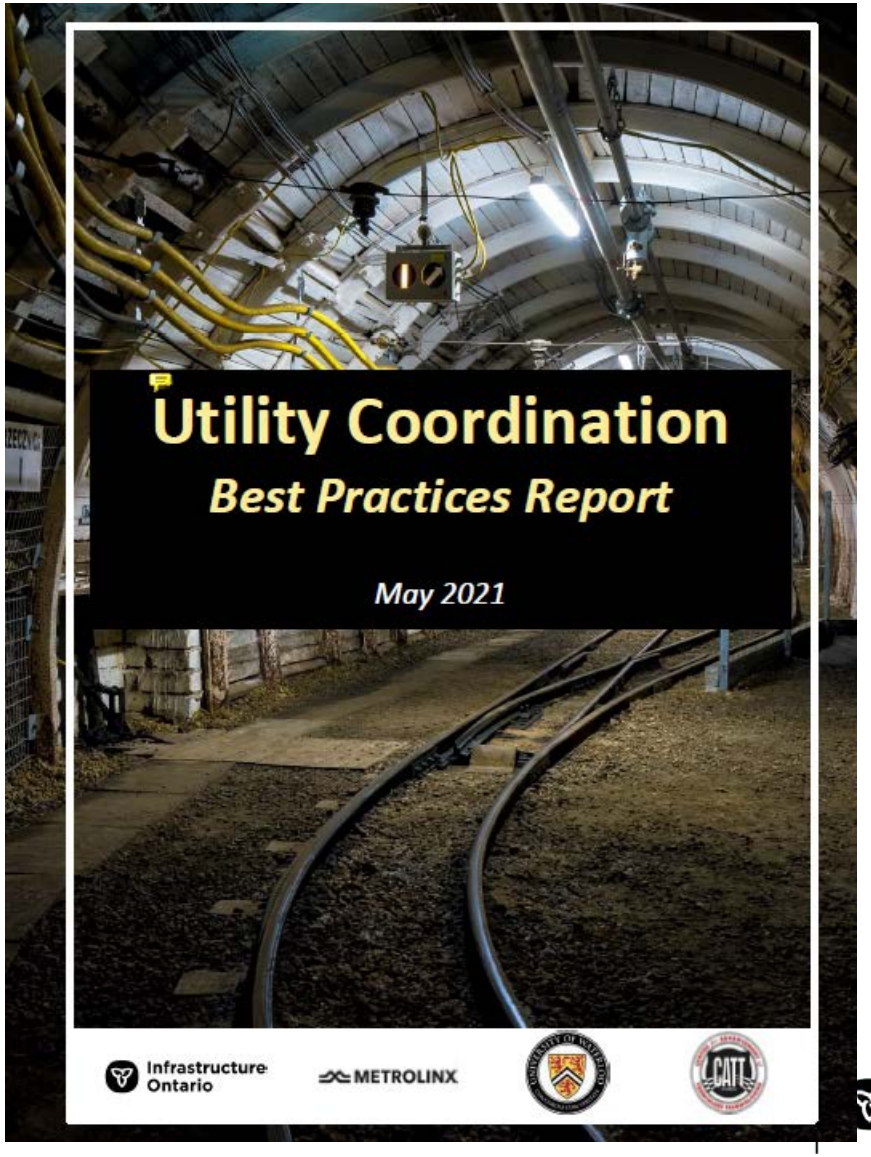
CATT SUE Research





Infrastructure Ontario

Project Objectives

- Review past ROI studies
  - Do not reinvent the wheel
  - Learn for strengths and limitations
- Complete an updated ROI study
  - Defensible SUE ROI…

Past SUE ROI Studies

- Purdue University Study (2000)
- University of Toronto Study (2005)
- Pennsylvania (PennState) Study (2007)
- Louisiana State University (2021)

Purdue University Study [1]

- Background
  - In 1996, FHWA commissioned Purdue University to determine SUE cost savings
  - Study duration: 3+ years (Sept. 1996 – Dec. 1999)
    - Final Report January. 2000
  - 71 projects were studied
  - Four States (Virginia, North Carolina, Texas, and Ohio)
  - Nine departments of transportation (DOTs)
  - Project include a mix of interstate, arterial, and collector roads in urban, suburban, and rural settings

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Purdue University Study [2]

Methodology

- Interviews and Questionnaire:
  - DOTs project managers, utility owners, constructors, and designers

- SUE Cost Savings Types
  - Quantifiable
  - indirect cost savings
    - non-measurable and were not included

Purdue University Study [3]

Methodology (cont'd)

List of benefits (21 categories of SUE cost savings)

1. Reduction in unforeseen utility conflicts and relocations;
2. Reduction in project delays due to utility relocates;
3. Reduction in claims and change orders;
4. Reduction in delays due to utility cuts;
5. Reduction in project contingency fees;
6. Lower project bids;
7. Reduction in costs caused by conflict redesign;
8. Reduction in the cost of project design;
9. Reduction in travel delays during construction to the motoring public;
10. Improvement in contractor productivity and quality;
11. Reduction in-utility companies' cost to repair damaged facilities;
12. Minimization of utility customers' loss of service;
13. Minimization of damage to existing pavements;
14. Minimization of traffic disruption, increasing DOT public credibility;
15. Improvement in working relationships between DOT and utilities;
16. Increased efficiency of surveying activities by elimination o duplicate surveys;
17. Facilitation of electronic mapping accuracy;
18. Minimization of the chance of environmental damage;
19. Inducement of savings in risk management and insurance;
20. Introduction of the concept of a comprehensive SUE process;
21. Reduction in Right-of-Way acquisition costs.

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Purdue University Study [5]

Data Example [2]

Table 4. Specific Projects Studied (Continued)

Specific Project - **#3**: R 2228: 6.049004T, 6.049005T, 6.049006T

Project's Title:NC 168 from US 158 A Barco to VA State Line Year SUE Program Began: 1991
Project's Location: __Currituck CO._____ State: _____
Name of Person Completing Questionnaire: _Greg Stevens _____Phone:_(919) 250-4128
Cost of the Project: __$34,282,892.00 Const Bid Price _____
Cost of Engineering: _____
Cost of Right-of-Way: _____
Cost of Designating: _____ Locating: _____ Total SUE ___$5,995__
Description (Summary) of the Project: __Project consisted of 18.5 miles of highway widening. The project was divided into three sections: BB, A, and BA. Project involved widening from 2 lanes to 5 lanes, with the center lane being the turning lane. There were paved shoulders along the length of the project except for curb and gutter sections through Moyock and Sligo _____
Resident Engineer _____T. E. Bright_____ Phone _____
Project Manager (SHAs): __Design Services Ron Wilkins _____Phone: (919) 250-4128
Designer/ Consultant: _____Phone: _____
SUE Consultant: _____SoDeep # NCM 3718_____Phone: _____
Contractor: _Barnhill Contracting Corp. _____Phone: _____
Utility Co.: _____Phone: _____

Cost Items and Factors	Time Savings	Cost Savings	User Savings	Risk Mgmt.
1. Reduced the number of utility line relocations		$135,000 (1) $638,400 (1)		
2. Reduced project delays due to utility relocates	Yes, no $			
3. Reduced construction delay due to utility cuts	Yes, no $			
4. Reduced contractor's claims & change orders				
5. Reduced delays caused by conflict redesign				
6. Reduced accidents & injuries due to line cuts				
7. Reduced travel delays to the motoring public				
8. Reduced loss of service to utility customers				
9. Improved contractor productivity & methods				
10. Increased the possibility of reduced bids				
11. Reduced contingency fees from all parties				
12. Reduced the cost of project design				
13. Reduced the damage to existing pavements				
14. Reduced damage to existing site facilities				
15. Reduced the cost of needed utility locates				
16. Minimized disruption to traffic & emergency				
17. Facilitated electronic map accuracy, as- built				
18. Minimized chance of environmental damage				
19. Induced savings in risk Mgmt., & insurance				
20. Introduced concept of comprehensive SUE				
21.Right-of-Way acquisition, costs				

Savings Analysis: $773,400/$5995 = $129.00

On section BB SUE was used to designate the existing water line on the entire length of the section BB part of the project, 3.0 miles. SUE indicated that the majority of line was not in conflict and could remain as is in the shoulder of the road. The result was that the county utility decided to upgrade anyway. This was the result of a wait and see attitude, since state did not require relocation. So the water line was relocated by the utility. Since the State was in conflict, the line had to be moved and upgraded to SDR 21, quantifiable SUE savings were not realized. Some time savings due to reducing utility relocate delays and utility cuts were probably realized.

(1)
ON A, the length of the section was 8.9 miles. Using SUE, it was determined that 4500 feet of 8" PVC water line could remain in place, otherwise it would have been removed and relocated.
The cost would have been:

14,000' of 8" moved, 29.200" of 10" moved, no savings
Savings = 4,500 feet x $30.00/ feet = $135,000.

(1)
On BA, the length of the section was 6.7 miles. 21,280 feet of 8" could remain in place, otherwise it would have been removed.
The cost would have been:

Savings = 21,280 feet x $30/ feet = $638,400.

Subtotal SUE savings $773,400.

Purdue University Study [6]

Results

- 68 of the 71 projects had a positive return on investment
- Total savings of $4.62 for every dollar spent on SUE

State	Total SUE Savings	Total SUE Costs	Savings/Costs
Virginia	$2,293,852	$557,259	$4.12
North Carolina	$4,183,432	$631,368	$6.63
Texas	$17,574,000	$4,115,241	$4.27
Ohio	$4,230,240	$812,170	$5.21
Total	**$28,281,524**	**$6,116,040**	**$4.62**

Purdue University Study [7]

- Limitations
  - Difficulty in obtaining historical data
  - How to quantify benefits and reductions in risk for projects utilizing SUE?
    - Mostly subjective or speculative in nature

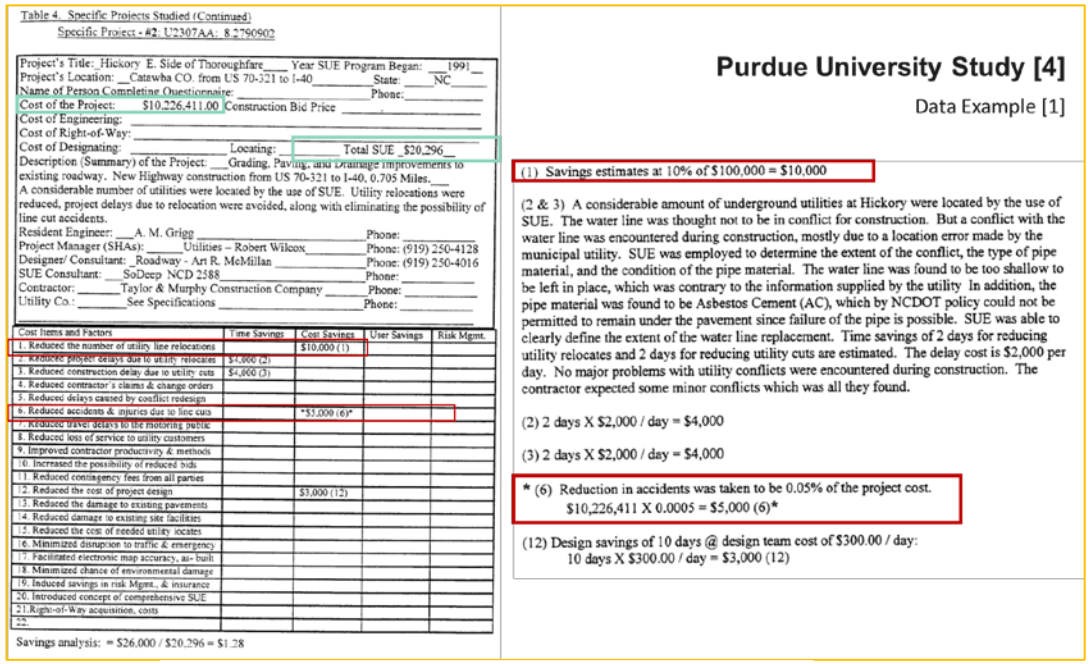

Table 4. Specific Projects Studied (Continued)

Specific Project - #2: U2307AA: 8.2790902

Project's Title: Hickory E. Side of Thoroughfare Year SUE Program Began: 1991
Project's Location: Catawba CO. from US 70-321 to I-40 State: NC
Name of Person Completing Questionnaire: Phone:
Cost of the Project: $10,226,411.00 Construction Bid Price
Cost of Engineering:
Cost of Right-of-Way:
Cost of Designating: Locating: Total SUE $20,296
Description (Summary) of the Project: Grading, Paving, and Drainage Improvements to existing roadway. New Highway construction from US 70-321 to I-40, 0.705 Miles.
A considerable number of utilities were located by the use of SUE. Utility relocations were reduced, project delays due to relocation were avoided, along with eliminating the possibility of line cut accidents.
Resident Engineer: A. M. Grigg Phone:
Project Manager (SHAs): Utilities – Robert Wilcox Phone: (919) 250-4128
Designer/ Consultant: Roadway - Art R. McMillan Phone: (919) 250-4016
SUE Consultant: SoDeep NCD 2588 Phone:
Contractor: Taylor & Murphy Construction Company Phone:
Utility Co.: See Specifications Phone:

Cost Items and Factors	Time Savings	Cost Savings	User Savings	Risk Mgmt.
1. Reduced the number of utility line relocations		$10,000 (1)		
2. Reduced project delays due to utility relocates	$4,000 (2)			
3. Reduced construction delay due to utility cuts	$4,000 (3)			
4. Reduced contractor's claims & change orders				
5. Reduced delays caused by conflict redesign				
6. Reduced accidents & injuries due to line cuts		*$5,000 (6)*		
7. Reduced travel delays to the motoring public				
8. Reduced loss of service to utility customers				
9. Improved contractor productivity & methods				
10. Increased the possibility of reduced bids				
11. Reduced contingency fees from all parties				
12. Reduced the cost of project design		$3,000 (12)		
13. Reduced the damage to existing pavements				
14. Reduced damage to existing site facilities				
15. Reduced the cost of needed utility locates				
16. Minimized disruption to traffic & emergency				
17. Facilitated electronic map accuracy, as- built				
18. Minimized chance of environmental damage				
19. Induced savings in risk Mgmt., & insurance				
20. Introduced concept of comprehensive SUE				
21.Right-of-Way acquisition, costs				
22.				

Savings analysis: = $26,000 / $20,296 = $1.28

Purdue University Study [4]

Data Example [1]

(1) Savings estimates at 10% of $100,000 = $10,000

(2 & 3) A considerable amount of underground utilities at Hickory were located by the use of SUE. The water line was thought not to be in conflict for construction. But a conflict with the water line was encountered during construction, mostly due to a location error made by the municipal utility. SUE was employed to determine the extent of the conflict, the type of pipe material, and the condition of the pipe material. The water line was found to be too shallow to be left in place, which was contrary to the information supplied by the utility In addition, the pipe material was found to be Asbestos Cement (AC), which by NCDOT policy could not be permitted to remain under the pavement since failure of the pipe is possible. SUE was able to clearly define the extent of the water line replacement. Time savings of 2 days for reducing utility relocates and 2 days for reducing utility cuts are estimated. The delay cost is $2,000 per day. No major problems with utility conflicts were encountered during construction. The contractor expected some minor conflicts which was all they found.

(2) 2 days X $2,000 / day = $4,000

(3) 2 days X $2,000 / day = $4,000

* (6) Reduction in accidents was taken to be 0.05% of the project cost.
$10,226,411 X 0.0005 = $5,000 (6)*

(12) Design savings of 10 days @ design team cost of $300.00 / day:
10 days X $300.00 / day = $3,000 (12)

Potential Savings ~ $26,000

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Bad intel on water main leads to $4.5M court award for condo developer, city prepares to appeal

Jon Willing
Aug 01, 2019 • August 1, 2019 • 1 minute read • Join the conversation

Possible Savings ~ $4.5 million

Source: https://bit.ly/33TzIaa

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University of Toronto Study [1]

- Background
  - Client: Ontario Sewer and Watermain Construction Association
  - Published in Oct. 2005 (study duration: 12 months)
  - Considered nine projects
    - Eight in urban and one in rural settings
    - All but one were municipal projects

Site feature	Ritson Road	Downtown Hamilton	Dunlop Street water main	Weston-Walsh water main	Major Mackenzie feeder main	Homer Watson interchange	King Street water main	Hall-Rearnan Streets reconstruction	Weldrick Road bypass sewer
Setting	Urban	Urban	Urban	Urban	Urban	Rural	Urban	Urban	Urban
Project	Municipal	Municipal	Municipal	Municipal	Municipal	Highway	Municipal	Municipal	Municipal
Age of records	Very old	Very old	Old	Old	Mixed	Old	Very old	Old	Fairly recent
Land use	Residential	Commercial	Residential	Mixed	Mixed	Open, rural	Commercial	Residential	Residential
No. of service connections	Very large	Very large	Large	Large	Medium	Few	Very large	Large	Medium
Utility congestion	High	Very high	High	High	Medium	Medium	Very high	High	High
Unknown utilities found	No	Yes	No	Yes	Yes	Yes	No	No	No
Misidentified utilities found	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SUE performed at percentage of design completed	30	60	90	60	30	30	30	90	30
Project cost (CAN$M)	4.1	N/A	0.5	N/A	8–10	20	1.5	0.9	1.7
SUE percentage of total	2.3	N/A	1.8	N/A	0.2–0.25	0.125	2.6	1.2	3.5

Note: N/A, not available.

University of Toronto Study [2]

- Methodology
  - Survey or interviews with project managers, utility owners, constructors, and designers
  - Proposed cost model incorporating costs that could be incurred as a result of not performing SUE

What-if-scenarios were created to predict the costs that could have been incurred if the SUE investigation had not been carried out.

$$\text{Cost of not performing SUE} = \text{IGC} + \text{IVC} + \text{DSC} + \text{URC} + \text{OCC} + \text{CCC} + \text{CCO} + \text{CIC} + \text{PIC} + \text{UDC} + \text{TDC} + \text{BIC} + \text{SIC} + \text{LRC}$$

$$\text{ROI} = \frac{\text{Cost of not performing SUE}}{\text{Cost of SUE investigation}}$$

3 categories of SUE cost savings:

Category	Cost saving item
Cost of Information	Information Gathering cost
	Information verification cost
Savings to Project Costs	Design cost
	Utility relocation cost
	Savings to overall construction cost
	Contractor contingency costs
	Contractor claims & change order costs
	Construction personnel injury cost
	Public injury cost
	Utility damage cost
User Costs	Travel delay cost
	Business impact cost
	Service interruption cost

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University of Toronto Study [3]

Data and Results

Cost saving item	Ritson Road	Downtown Hamilton	Dunlop Street water main	Weston-Walsh water main	Major Mackenzie feeder main	Homer Watson interchange	King Street water main	Hall-Reaman Streets reconstruction	Weldrick Road by-pass sewer	Total
Utility relocation cost (URC)	150 000	—	50 000	—	10 000	—	—	—	100 000	310 000
Design cost (DSC)	9 000	52 000	—	—	NAE	2 000	4 000	2 000	8 000	77 000
Contractor contingency cost (CCC)	20 000	—	—	—	—	—	—	—	—	20 000
Overall construction cost (OCC)	—	—	—	48 800	8 000	—	—	1 000	—	57 800
Contractor claims and change order costs (CCO)	10 000	230 000	—	52 000	60 000	60 000	75 000	30 000	—	517 000
Construction personnel injury cost (CIC)	—	—	—	—	—	—	—	—	—	—
Utility damage cost (UDC)	—	NAE‡	—	—	—	—	NAE	—	15 000	15 000
Public injury cost (PIC)	—	—	—	—	—	—	—	—	—	—
Travel delay cost (TDC)	—	50 000†	—	NAE	—	NAE	NAE	—	—	—
Business impact cost (BIC)	—	NAE	—	NAE	—	—	NAE	—	—	—
Service interruption cost (SIC)	—	—	—	NAE	—	—	NAE	—	—	—
Total savings	189 000	282 000	50 000	100 800	78 000	62 000	79 000	33 000	123 000	996 800
SUE cost	90 100*	42 785	9 340	31 000	20 000	25 000	40 000	11 000	60 000	329 225
ROI	2.1	6.59	5.35	3.25	3.9	2.48	1.98	3.0	2.05	3.41

University of Toronto Study [4]

Results (cont'd)

- All 9 projects had a positive return on investment
  - Average ROI is $3.41 for every dollar spent on SUE
  - Total savings ranged from $2.05 to $6.59 for every dollar spent on SUE
- 51% of cost savings attained through reduction of contractor claim costs
- 31% of cost savings attained through reduction in utility relocation costs
- 18% of cost savings attained through all other cost items

University of Toronto Study [4]

- Limitations
  - Subjective methodology
  - Included factors for which no data or limited data was available
  - Difficult to compare different projects

PennState Study [1]

- **Background**
  - **Study of**
    1. **utility impact rating for pre-screening of projects for SUE investigations, and**
    2. **benefit-cost analysis of SUE for highway projects**
  - **2006/07 (over 12 months) for PennDOT**
  - **In-depth analysis of SUE projects executed by PennDOT districts**
  - **Detailed benefit-cost analysis performed on 22 SUE projects and 8 non-SUE projects**

PennState Study [2]

- Methodology [1]
- Utility Impact Rating Methodology
  - Questionnaire and Utility Impact Form
    - Step 1 & 2: Screening processes for possible SUE projects
    - Step 3: Utility impact evaluation on projects that passed Steps 1 & 2 to select appropriate quality levels of SUE

1

No.	QUESTIONS	Column 1		Column 2	
1	Is there evidence of underground utilities in the project area? (based on information from quality levels D&C)	☐	NO	☐	YES or Unknown
2	Does the project require any excavation "regardless of depth"? Note: This includes any TCE or other easements.	☐	NO	☐	YES or Unknown

2

No.	QUESTIONS	Column 1		Column 2	
1	Depth of project excavation.	☐	≤ 18"	☐	> 18"
2	Do you feel that the utility owners in the project area will be able to accommodate the project's schedule in regards to showing the location of their utility facilities?	☐	Confident	☐	Doubtful
3	What is the likelihood that project will have an impact on the existing utilities?	☐	No Impact	☐	Impact
4	How often have the utility owners in the project area provided accurate utility information?	☐	Always	☐	Seldom
5	Reliability of designer providing accurate design-construction related information.	☐	Good	☐	Poor

3

No.	Complexity Factors	Column 1 (Low)		Column 2 (Medium)		Column 3 (High)	
1	Density of Utilities	☐	1	☐	2 or 3	☐	> 3
2	Type of Utilities	☐	Less Critical	☐	Sub Critical	☐	Critical
3	Pattern of Utilities	☐	1 parallel or crossing	☐	2 parallel or crossing	☐	> 2 parallel or crossing
4	Material of Utilities	☐	Rigid	☐	Flexible	☐	Brittle
5	Access to Utilities	☐	Easy	☐	Medium	☐	Restricted
6	Age of Utilities	☐	≤ 10 years	☐	> 10 years, ≤ 25 years	☐	> 25 years
7	Estimated Utility Relocation Costs	☐	≤ 2%	☐	> 2, ≤ 5%	☐	> 5%
8	Estimated Project Traffic Volume (ADT per lane)	☐	≤ 1,500	☐	> 1,500, ≤ 6,000	☐	> 6,000
9	Project Time Sensitivity	☐	Low	☐	Medium	☐	High
10	Project Area Description	☐	Rural	☐	Suburban	☐	Urban
11	Type of Project/Section/Location	☐	Simple	☐	Moderate	☐	Complicated
12	Quality of Utility Record	☐	Good	☐	Fair	☐	Poor
13	Excavation Depth within Highway Right-of-Way, including Easement	☐	≤ 18"	☐	> 18", < 24"	☐	≥ 24"
14	Estimated Business Impact	☐	Low	☐	Moderate	☐	High
15	Estimated Environmental Impact	☐	Low	☐	Moderate	☐	High
16	Estimated Safety Impact	☐	Low	☐	Moderate	☐	High
17	Other Impact Factors (Specify):	☐	Low	☐	Moderate	☐	High

$$UIS = \{(1 \times \Sigma \text{ Column 1}) + (2 \times \Sigma \text{ Column 2}) + (3 \times \Sigma \text{ Column 3})\} / n$$

Where, UIS = Utility Impact Score

n = Number of the complexity factors considered/checked

PennState Study [3]

- Methodology (cont'd)
  - Benefits and costs estimated by conducting interviews with Penn DOT, using historical data, case studies and direct costs of projects

Benefit factors of SUE:

1. Utility relocation cost
2. Utility damage cost
3. Emergency restoration cost
4. Traffic delay cost
5. Business impact cost
6. User service cost
7. Environmental impact cost
8. Information gathering and verification cost
9. Legal and litigation cost
10. Efficient utility design and construction
11. Other utility related costs and benefits

Equation for BCR of SUE projects:

$$(BCR)_{SUE} = \frac{B_{SUE}}{C_{SUE}}$$

Where, $(BCR)_{SUE}$ = Benefit-cost ratio of SUE projects

B_{SUE} = Estimated benefits of SUE projects

C_{SUE} = Actual SUE costs of SUE projects

Equation for BCR of non-SUE projects:

$$(BCR)_{NON\text{-}SUE} = \frac{B_{NON-SUE}}{C_{NON-SUE}}$$

Where, $(BCR)_{NON\text{-}SUE}$ = Benefit-cost ratio of non-SUE projects

$B_{NON\text{-}SUE}$ = Actual benefits of quality level A of non-SUE projects

$C_{NON\text{-}SUE}$ = Estimated SUE costs of non-SUE projects

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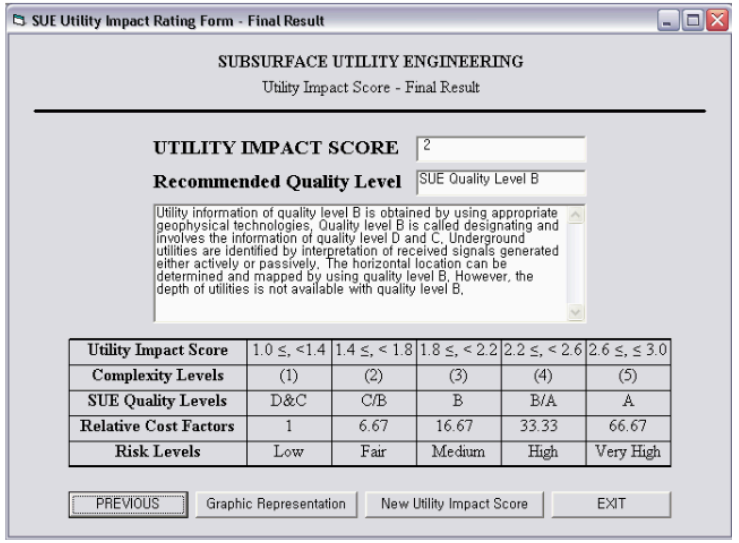
PennState Study [4]

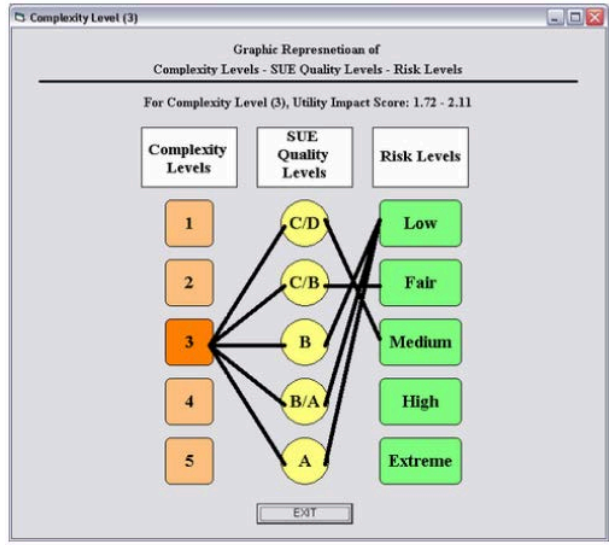
Results

- Based on the UIS (utility impact score), the appropriate SUE quality level is recommended
- The utility impact rating form was computerized and provides a final result of the UIS (as well as a graphical representation)

TABLE 5-1 Utility Impact Score, Complexity Levels, Recommended SUE Quality Levels, Relative Costs, and Project Risk Levels

Utility Impact Score	1.0 ≤, <1.4	1.4 ≤, < 1.8	1.8 ≤, < 2.2	2.2 ≤, < 2.6	2.6 ≤, ≤ 3.0
Complexity Levels	(1)	(2)	(3)	(4)	(5)
SUE Quality Levels	D&C	C/B	B	B/A	A
Relative Costs	1	6.67	16.67	33.33	66.67
Project Risk Levels	Low (L)	Fair (F)	Medium (M)	High (H)	Very High (V)





Project No.	Project Cost	SUE Cost (C)	Cost Saving (B)	B/C	SUE % of Total Project Cost	Saving % of Total Project Cost	Impact Score	Complexity Level
SUE PROJECT (22 Projects)								
District 9 – Hollidaysburg								
SR 0865-002	$3,100,000	$20,000	$65,000	3.25	0.65	2.10	1.80	3
SR 2014-04M	$2,400,000	$34,243	$165,050	4.82	1.43	6.88	2.37	4
SR 0022-024	$2,600,000	$50,000	$265,000	5.30	1.92	10.19	2.50	4
SR 4013-002	$11,600,000	$50,000	$1,515,000	30.30	0.43	13.06	2.69	5
SR 0036-25M	$1,600,000	$44,804	$1,515,000	33.81	2.80	94.69	2.81	5
District 3 - Montoursville								
SR 0061-079	$9,000,000	$66,000	$1,500,000	22.72	0.73	16.67	2.24	4
SR 6006-001/002	$13,000,000	$141,000	$4,210,000	29.86	1.08	32.38	2.44	4
SR 0054-014	$9,000,000	$101,000	$2,650,000	26.23	1.12	29.44	2.24	4
SR 0015-077	$63,000,000	$141,000	$4.500,000	31.91	0.22	7.14	2.94	5
SR 0049-50M	$5,200,000	$56,000	$1,900,000	33.93	1.08	36.54	2.94	5
District 6 – King of Prussia								
SR 0202-610	$63,500,000	$240,400	$975,000	4.06	0.38	1.54	2.38	4
SR 0202-400	$313,800,000	$35,952	$200,000	5.56	0.01	0.06	2.44	4
District 4 – Dunmore								
SR 1012-202	$600,000	$17,000	$77,000	4.53	2.83	12.83	2.24	4
SR 0247-291	$125,000	$24,000	$83,000	3.46	19.20	66.40	2.00	3
SR 0006-607	$1,100,000	$54,000	$275,000	5.09	4.91	25.00	2.24	4
District 2 – Clearfield								
SR 0026-C02	$84,100,000	$13,050	$60,000	4.60	0.02	0.07	2.38	4
SR 2027-A01	$1,900,000	$15,600	$50,000	3.21	0.82	2.63	1.63	2
District 5 – Allentown								
SR 0145-05S	$6,800,000	$24,000	$100,000	4.17	0.35	1.47	2.47	4
SR 0061-13S	$13,500,000	$38,144	$170,000	4.46	0.28	1.26	2.41	4
SR 0033-006	$19,700,000	$30,316	$130,000	4.29	0.15	0.66	2.24	4
SR 3012-02B/03B	$2,500,000	$34,716	$150,000	4.32	1.39	6.00	2.24	4
SR 0222-001/002	$216,800,000	$84,803	$2,600,000	30.66	0.04	1.20	2.65	5
SUE Total	$844,925,000	$1,316,028	$23,155,050					
NON-SUE PROJECT (8 Projects)								
District 9 – Hollidaysburg								
SR 3007-001	$2,000,000	$50,000	$117,500	2.35	2.50	5.88	2.50	4
SR 1002-HST	$1,500,000	$45,000	$195,000	4.33	3.00	13.00	2.56	5
SR 4013-001	$19,600,000	$85,000	$400,000	4.71	0.43	2.04	2.81	5
SR 1001-012	$27,000,000	$150,000	$1,290,000	8.60	0.56	4.78	2.71	5
District 5 – Allentown								
SR 4012-DLY	$9,600,000	$35,000	$235,000	6.71	0.36	2.45	2.53	5
SR 1004-01B	$1,600,000	$10,000	$40,000	4.00	0.63	2.50	2.53	5
SR 0078-17M	$69,700,000	$40,000	$130,000	3.25	0.06	0.19	2.29	4
SR 0222-002	$60,400,000	$40,000	$285,000	7.13	0.07	0.47	2.65	5
Non-SUE Total	$191,400,000	$455,000	$2,692,500					
TOTAL PROJECT (30 Projects)								
TOTAL	$1,036,325,000	$1,771,028	$25,847,550					

PennState Study [5]

Results (cont'd)

- Average B/C ratio of $11.36 estimated for total projects
- For SUE projects:
  - Cost savings ranged from $50,000 to $4.5 million
  - B/C ratio ranged from 3.21 to 33.93 (average 13.66)
- For non-SUE projects:
  - Cost savings ranged from $40,000 to $1.29 million
  - B/C ratio ranged from 2.35 to 8.60 (average 5.13)

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Louisiana University Study [1]

Background

- Considered 13 projects that were at least 90% complete
- However, only used three (3) projects that had completed SUE during construction

Louisiana University Study [2]

- Methodology
  - Projects that used QLA and QLB SUE services after encountering utility conflicts during construction were used to determine the ROI of SUE services in Louisiana
  - The ROI is a dollar amount of savings to show how much could have been saved if SUE was used correctly

$$\text{ROI} = \text{Utility related costs}/\text{Cost of performing SUE}$$

where,

Utility-related costs = Actual costs of encountering utilities during construction

Utility-related costs:

1. Utility conflicts and relocation cost
2. Project delay cost
3. Claims and change order costs
4. Project design costs
5. Travel delay costs
6. Damage costs
7. Information gathering and verification cost

Louisiana University Study [3]

- Methodology (cont'd)
  - Effectiveness of SUE services measured using Measures of Effectiveness (MOEs)
  - MOEs were used to compare projects cost and time/duration

Measure of Effectiveness	Data Item	Computation
Design cost	• Project design cost	Total project design cost
Construction cost	• Project construction cost	Total project construction cost
Construction cost increase	• Actual cost • Proposed cost	Actual cost – Proposed cost
Construction cost percent increase	• Actual cost • Proposed cost	(Actual cost – Proposed cost) * 100
Utility-related change order cost	• Utility-related change order cost	Total utility-related change order cost
Percent of utility related change order cost	• Utility-related change order cost • Construction cost	(Utility-related change order cost/Construction cost) * 100
Construction duration	• Actual construction days	Total actual construction days
Project delay	• Actual days • Proposed days	Actual days – Proposed days
Percent of project delay	• Actual days • Proposed days	(Actual days – Proposed days)/Proposed days * 100

Louisiana University Study [3]

- Methodology (cont'd)
  - Projects were classified into two general groups and four categories
    - Project groups
      - Projects that used SUE
      - Projects that did not use SUE
    - Project categories

Project Characteristics	Project Size ($ value)
Complex	C ≥ 3 million
Complex	C < 3 million
Simple	S ≥ 3 million
Simple	S < 3 million

Project Complexity Determination

Factor	Simple	Complex
Project Location	Rural	Urban
Average daily traffic (ADT)	< 6000	≥ 6000
Estimated utility relocation cost	< 3% of project costs	≥ 3% of project costs
Project improvement type	Shallow excavation	Deep excavation

Louisiana University Study [4]

Results

- $2.73 can be saved for every dollar spent on SUE if SUE is used correctly during early stages of project

Project No.	Construction amount	Year Let	SUE QL	SUE cost	SUE year	SUE % of construction amount
013-12-0032	$24,887,297	2006	A	$140,442.00	2007	0.56%
817-41-0008	$11,012,063	2009	A & B	$58,590.00	2009	0.53%
005-10-0037	$451,215,018.48	2008	A & B	$197,944.81	2010	0.04%

Project #	Utility conflicts and relocation cost	Project delay due to utilities	Total Utility Related Costs (URC)	SUE costs	ROI	URC % of construction cost
013-12-0032	$196,595.18	$102,000.00	$298,595.18	$140,442.00	2.13	1.20%
817-41-0008	$60,021.74	$93,000.00	$153,021.74	$58,590.00	2.61	1.39%
005-10-0037	$624,219.90	$8,527.20	$632,747.10	$197,944.81	3.2	0.14%
Total	**$880,836.82**	**$203,527.20**	**$1,084,364.02**	**$396,976.81**	**2.73**	**0.22%**

Louisiana University Study [5]

Effectiveness of SUE

Table 6. Summary of t-test results

Measures of Effectiveness	SUE		Control		t-test	
	Sample Size	Mean	Sample Size	Mean	p-value	Significance
Design cost	8	$305,250	457	$313,137	0.977	No
Construction cost	11	$57,210,616	203	$6,749,694	0.23	No
Construction cost increase	11	$2,175,084	203	$317,483	0.1806	No
Construction cost percent increase	11	0.0358	203	0.0243	0.734	No
Construction duration	11	837	203	214.4	0.0031	Yes
Project delay	11	10.5455	203	-9.3498	0.00028	Yes
Percent of project delay	11	0.0351	203	-0.096	<.0001	Yes
Utility related change order cost	11	$101,537	92	$30,541	0.2732	No
Percent of utility related change order cost	11	0.00279	92	0.005	0.5447	No

Example:

Figure 10. Mean construction duration (SUE vs. control projects)

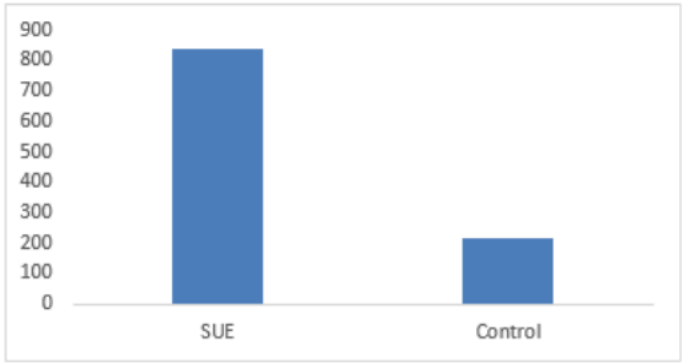
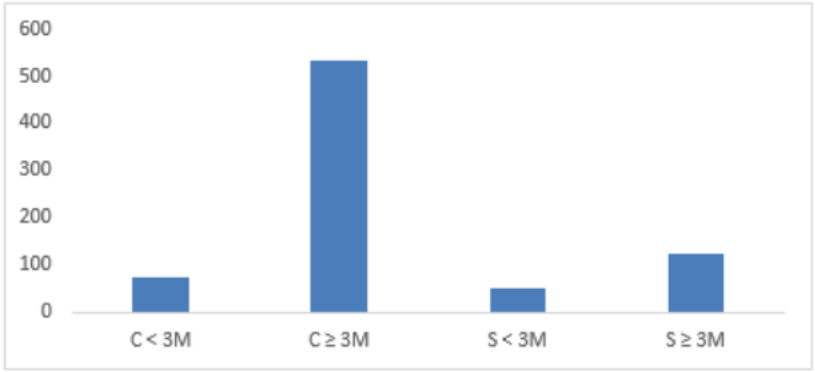


Figure 11. Mean construction duration by project category



- Mean construction duration of SUE projects higher than that of control projects
- t-test results showed significant difference between 2 means
- Mean construction duration of C ≥ 3M significantly different from that of other categories

Louisiana University Study [6]

- Limitations
  - Limited data (only 3 projects that used SUE were considered in the analysis)
    - Data availability – several data was missing or not tracked
  - Some SUE projects were missing data, so not all projects were correctly categorized
  - SUE data was obtained by reviewing SUE contracts which had incomplete/uncertain information
  - “SUE services were applied to larger projects. The construction duration, project delay and percent of project were significantly higher for SUE projects. All other MOEs showed no statistical significance. This may have been due to the very small sample size of SUE projects.”

Conclusions

Existing SUE ROI studies are subjective and speculative

Limited data

Unsubstantiated assumptions

Wide variation in ROI…..

A New Approach

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HOME IN YOUR REGION PROJECTS GET INVOLVED Français

Eglinton Crosstown LRT

Cross the City 60% Faster

A midtown connection between east and west Toronto will make the trip easier, thanks to


25
stations and stops
19
kilometres
Mount Dennis
Keelesdale
Caledonia
Fairbank
Oakwood
Cedarvale
Forest Hill
Chaplin
Avenue
Eglinton
Mount Pleasant
Leaside
Laird
Sunnybrook Park
Science Centre
Aga Khan Park & Museum
Wynford
Sloane
O'Connor
Pharmacy
Hakimi Lebovic
Golden Mile
Birchmount
Ionview
Kennedy
Barrie Line
Kitchener Line
UP Express
1 Yonge-University Line
1 Yonge-University Line
2 Bloor-Danforth Line
3 Scarborough Line
Stouffville Line
ABOVE GROUND
UNDERGROUND AND BELOW-GRADE
INTERMODAL LRT STOP
MAINTENANCE & STORAGE FACILITY
DVP
Enlarge

LRT Project Can be Divided into Distinct Components Types

25 Stations

Station Entrances and Exits

19 kms of Track

Transfer stations

LRT Project Cost Components with Potential Utility Conflicts

Main Categories	Subcategories		
Stations	Above Ground		
	Below Ground	Entrances	Existing Entrance
			New Entrance
Tracks	Above Ground		
	Below Ground		
Underground Entrance or Exit (UEE)			
Transfer Station			

Approach

Develop potential Utility conflicts for each component

Project total cost will be sum of component costs….

With and without conflicts

For Each Component

Establish potential utility conflicts

Cost for each utility conflict can be estimated

Using project data and/or expert judgement

Cost multiplier are applied for SUE known vs found during construction ($/m)

Cost per number of conflicts can be determined per unit Component

Data will is needed to validate unit costs…

- $/M for removal and cost over run

Return on Investment Analysis

Base cost = no conflicts and perfect SUE

What if Scenarios

No Sue

Percentage of conflicts per component…

Proposed Benefits of this ROI Method

- **Component costs can be used for new projects**
- **Range of ROI can be determined for the quality of SUE performed**
- **Cost of SUE can be included in ROI.**

Questions