The Construction of Utility Boxes in Pavements

A Best Practice by the National Guide to Sustainable Municipal Infrastructure

National Guide to Sustainable Municipal Infrastructure

Guide national pour des infrastructures municipales durables

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The Construction of Utility Boxes in Pavements
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FOREWORD

In spite of recent increases in public infrastructure investments, municipal infrastructure is decaying faster than it is being renewed. Factors such as low funding, population growth, tighter health and environmental requirements, poor quality control leading to inferior installation, inadequate inspection and maintenance, and lack of consistency and uniformity in design, construction and operation practices have impacted on municipal infrastructure. At the same time, an increased burden on infrastructure due to significant growth in some sectors tends to quicken the ageing process while increasing the social and monetary cost of service disruptions due to maintenance, repairs or replacement.

With the intention of facing these challenges and opportunities, the Federation of Canadian Municipalities (FCM) and the National Research Council (NRC) have joined forces to deliver the *National Guide to Sustainable Municipal Infrastructure: Innovations and Best Practices*. The Guide project, funded by the Infrastructure Canada program, NRC, and through in-kind contributions from public and private municipal infrastructure stakeholders, aims to provide a decision-making and investment planning tool as well as a compendium of technical best practices. It provides a road map to the best available knowledge and solutions for addressing infrastructure issues. It is also a focal point for the Canadian network of practitioners, researchers and municipal governments focused on infrastructure operations and maintenance.

The *National Guide to Sustainable Municipal Infrastructure* offers the opportunity to consolidate the vast body of existing knowledge and shape it into best practices that can be used by decision makers and technical personnel in the public and private sectors. It provides instruments to help municipalities identify needs, evaluate solutions, and plan long term, sustainable strategies for improved infrastructure performance at the best available cost with the least environmental impact. The five initial target areas of the Guide are: potable water systems (production and distribution), storm and wastewater systems (collection, treatment, disposal), municipal roads and sidewalks, environmental protocols and decision making and investment planning.

Part A of the *National Guide to Sustainable Municipal Infrastructure* focuses on decision-making and investment planning issues related to municipal infrastructure. Part B is a compendium of technical best practices and is qualitatively distinct from Part A. Among the most significant of its distinctions is the group of practitioners for which it is intended. Part A, or the DMIP component of the Guide, is intended to support the practices and efforts of elected officials and senior administrative and management staff in municipalities throughout Canada.

It is expected that the Guide will expand and evolve over time. To focus on the most urgent knowledge needs of infrastructure planners and practitioners, the committees solicited and received recommendations, comments and suggestions from various stakeholder groups, which shaped the enclosed document. Although the best practices are adapted, wherever possible, to reflect varying municipal needs, they remain guidelines based on the collective judgements of peer experts. Discretion must be exercised in applying these guidelines to account for specific local conditions (e.g. geographic location, municipality size, climatic condition).

For additional information or to provide comments and feedback, please visit the Guide at www.infraguide.ca or contact the Guide team at infraguide@nrc.ca.

ACKNOWLEDGEMENTS

The dedication of individuals who volunteered their time and expertise in the interest of the *National Guide to Sustainable Municipal Infrastructure* is acknowledged and much appreciated.

This best practice was developed by stakeholders from Canadian municipalities and road specialists from across Canada, based on information from a scan of municipal practices and an extensive review. The following members of the National Guide's Municipal Roads and Sidewalks Technical Committee provided guidance and direction in the development of this best practice. They were assisted by the Guide Directorate staff and Groupe Qualitas Inc. and John Emery Geotechnical Engineering Limited (JEGEL).

Mike Sheflin, P.Eng.	Former CAO, Regional Municipality of Ottawa-Carleton, Ontario
Al Cepas, P.Eng.	City of Edmonton, Alberta
Don Brynildsen, P.Eng.	City of Vancouver, British Columbia
Brian Anderson	Ontario Good Roads Association
Vince Aurilio, P.Eng.	Ontario Hot Mix Producers Association
Brian E. Crist, P.Eng.	City of Whitehorse, Yukon
Michel Dion, Eng. M.Sc.	Axor Experts-Conseils, Quebec
Cluny Matchim, C.E.T.	Town of Gander, Newfoundland
Abe Mouaket, P.Eng.	IM Associates, Ontario
Tim J. Smith, P.Eng. M.Sc.Eng.	Cement Association of Canada, Ontario
Sylvain Boudreau, M.Eng, P.Eng	Technical Advisor, NRC

In addition, the Municipal Roads and Sidewalks Technical Committee would like to thank the following individual for his participation in working groups and peer review:

Bill Larkin, P.Eng.	City of Winnipeg, Manitoba

This and other best practices could not have been developed without the leadership and guidance of the Project Steering Committee and the Technical Steering Committee of *the National Guide to Sustainable Municipal Infrastructure*, whose memberships are as follows:

Project Steering Committee:

Mike Badham, Chair	City Councillor, Regina, Saskatchewan
Bill Crowther	City of Toronto, Ontario
Jim D'Orazio	Greater Toronto Sewer and Watermain Contractors Association, Ontario
Glen Everitt	Mayor, Dawson City, Yukon
Derm Flynn	Mayor, Appleton, Newfoundland
David General	Cambridge Bay, Nunavut
Ralph Haas	University of Waterloo, Ontario
Barb Harris	Whitehorse, Yukon
Robert Hilton	Office of Infrastructure, Ottawa, Ontario
Dwayne Kalynchuk	City of St.Albert, Alberta
René Morency	Régie des installations olympiques Montréal, Quebec
Saeed Mirza	McGill University, Montréal, Quebec
Lee Nauss	City Councillor, Lunenburg, Nova Scotia
Ric Robertshaw	Region of Halton, Ontario
Dave Rudberg	City of Vancouver, British Columbia
Van Simonson	City of Saskatoon, Saskatchewan
Basil Stewart	Mayor, Summerside, Prince Edward Island
Serge Thériault	Department of Environment and Local Government, Fredericton, New Brunswick
Alec Waters	Alberta Transportation, Edmonton, Alberta
Wally Wells	Dillon Consulting Ltd., Toronto, Ontario

Stakeholder Liaison:

Joan Lougheed	City Councillor, Burlington, Ontario

Technical Steering Committee:

Don Brynildsen	City of Vancouver, British Columbia
Al Cepas	City of Edmonton, Alberta
Andrew Cowan	City of Winnipeg, Manitoba
Tim Dennis	City of Toronto, Ontario
Kulvinder Dhillon	Province of Nova Scotia, Halifax, Nova Scotia
Wayne Green	City of Toronto, Ontario
John Hodgson	City of Edmonton, Alberta
Bob Lorimer	Lorimer & Associates, Whitehorse, Yukon
Betty Matthews-Malone	City of Hamilton, Ontario
Umendra Mital	City of Surrey, British Columbia
Anne-Marie Parent	City Councillor, City of Montréal, Quebec
Piero Salvo	WSA Trenchless Consultants Inc., Ottawa, Ontario
Mike Sheflin	Former CAO, Regional Municipality of Ottawa-Carleton, Ontario
Konrad Siu	City of Edmonton, Alberta
Carl Yates	Halifax Regional Water Commission, Nova Scotia

EXECUTIVE SUMMARY

This best practice forms part of the *National Guide to Sustainable Municipal Infrastructure.* The overall objective of the Guide is to assist municipalities in the management of all components of the municipal infrastructure, including transportation and water distribution systems, and all activities involved with infrastructure management, including planning, design, financing and maintenance. This document has been prepared to address the construction of utility access boxes in pavements.

The *National Guide to Sustainable Municipal Infrastructure* conducted a scan across Canada to establish the best practices for construction and restoration/repair of utility access boxes. This best practice scan established that replacement, repair and restoration of utility boxes should be considered separately from initial construction procedures of utility access boxes in roadways. **Hence, two best practices, one for new construction and one for restoration and repair, have been developed based on the results of the best practice scan.**

Utility access box construction has a profound influence on pavement performance where improper construction procedures are used. The purpose of this best practice is to provide the municipal community with the best practices and state-of-the-art technologies on the construction of utility boxes in pavements so their influence on pavement performance will be minimized. The main differences between the two best practices can be seen in the work description where the procedures for initial construction are slightly different than for a restoration/repair project in existing pavements.

The most significant initial observation resulting from the scan was that there is no single standard specification for the construction and repair of utility access boxes, and all the organizations polled had developed their procedures empirically through trial and error. It was also established that the performance of pavement near utility access boxes decreased rapidly when less emphasis was given to appropriate design or construction specifications. Consequently, this best practice focussed on providing specification guidance to the level appropriate to ensure a high level of performance for the surrounding pavement near utility access boxes.

This best practice addresses the need for standardized procedures and identifies deficiencies that can occur when poor construction and repair practices/techniques are used. This best practice also identifies step-by-step construction procedures that should be implemented to minimize the impact of utility access boxes on the surrounding pavement and on long-term performance. The influence of quality assurance/control procedures on the performance of adjacent pavement is also discussed.

This best practice is considered to be applicable for all Canadian regions, noting that the resulting specifications will need to be adapted to reflect specific local climatic conditions and agency requirements. For example, the City of Vancouver does not use frost tapers because of the low freezing index in that city; conversely, the City of Québec and many municipalities in northern Ontario specify frost tapers extending to depths of about 2 m or greater.

The anticipated outcome of adoption of this best practice will be improved pavement performance near utility access boxes. However, changes in performance may not be immediately obvious and long-term evaluations will likely be necessary for the performance improvements to become fully apparent.

Several areas of additional research were identified during the course of this project:

- the use and most appropriate configuration for frost tapers in relation to differential heave (under different climatic and soils conditions) to determine more fully the parameters that should be used;

- the influence of the difference in elevation on the ride comfort index, such as the IRI, in relation to drainage requirements;

- the use of geotextile (or geosynthetic membranes or equivalent products) to mitigate frost heave;

- the use of radiator bags (under investigation by NRC) to mitigate differential and frost heave around maintenance access holes (manholes) (which can be found at www.nrc.ca/irc/uir/ur/manholes/index.html);

- the short- and long-term performance of the adjustable frame and cover systems to establish the performance and cost benefits in comparison with conventional systems; and

- the asphalt concrete parameters and design methods for congested areas to establish criteria and properties most appropriate for placement and use around utility access boxes.

It is recommended that this best practice be reviewed every three to five years to reflect any new research findings or technology developments. As the specific requirements for utility access boxes themselves can vary substantially based on the technical requirements of the individual utility/service provider, this best practice does not address the utility access boxes themselves. Consideration should be given to developing a separate best practice document that provides such guidance for utilities and agencies.

1. GENERAL

The *National Guide to Sustainable Municipal Infrastructure* conducted a scan throughout Canada to establish the best practices for construction and repair of utility access boxes. This best practice scan established that the replacement, repair and restoration of utility boxes should be considered separately from initial construction procedures. Hence, two best practices, one for construction and one for restoration and repair, have been developed based on the results of the best practice scan.

The purpose of this best practice is to provide the municipal community with the best practices and state-of-the-art technologies on the construction of utility boxes in pavement so their influence on pavement performance will be negligible. As the specific requirements for utility access boxes can vary substantially based on the technical requirements of the individual utility/service provider, this best practice does not address the utility access boxes.

This best practice addresses the need for standardized procedures and identifies deficiencies that can occur when poor construction practices/techniques are used. This best practice also identifies step-by-step construction procedures that should be implemented to minimize the impact of utility access boxes on the surrounding pavement and on its long-term performance.

2. RATIONALE

The most significant initial observation resulting from the scan was that there is no single standard specification for the construction of utility access boxes. All the organizations polled had developed their procedures empirically through trial and error. It was also established that the performance of pavement near utility access boxes decreased rapidly when less emphasis was given to appropriate design or construction specifications.

Consequently, this best practice focussed on providing specification guidance to the level appropriate to ensure a high level of performance for the surrounding pavement near the utility access boxes.

As demonstrated in the following section, utility access box construction has a profound influence on pavement performance where improper construction procedures are used. The influence of quality assurance/control (QA/QC) procedures on the performance of adjacent pavement is also discussed.

2.1 BOXES INFLUENCE PAVEMENT PERFORMANCE

The four most frequent distresses observed in the pavements adjacent to utility access boxes established from the best practice scan are listed in Table 2–1.

Table 2–1: Frequency of Distress (Construction)

Type of Distress	Photograph Number	Distress Frequency %	Most Probable Cause(s)
Settlement	1	55	Compressible soils Deficient workmanship
Concentric cracking	2 and 4	27	Frost-susceptible soils Heavy traffic
Differential heave	3	23	Frost-susceptible soils
Transverse cracking	4	23	Thermal properties of asphalt concrete

The following photographs and figures illustrate these significant distress types.

Photograph 2–1: Slight Settlement Around Catch Basin

Photograph 2–2: Concentric Cracking

Photograph 2–3: Differential Heave

Photograph 2–4: Concentric and Transverse Cracking

As shown in Table 2–1, the most significant cause of pavement distress is the lack of adequate support, due to the presence of compressible soils or frost-susceptible soils, or deficient workmanship.

A review of the technical literature has shown that, on average, about 25 percent of catch basins and maintenance access holes (manholes) and 10 percent of valve boxes exhibit the distress types identified in Table 2–1 (Charpentier, 1999). It is important to note that, while widely recognized to be key indicators of poor pavement performance, no specific quantitative data were found concerning the performance reduction attributed to increased roughness or inadequate structural capacity adjacent to utility access boxes.

The types of distresses shown in Table 2–1 have been demonstrated to have a substantial negative impact on the performance of the adjacent pavement, with pavement service life reductions approaching two to five years reported. A study of the urban pavements in the Montréal region showed that these distresses will appear, on average, only on four percent of utility access boxes where adjustable frames are used, with a negligible loss of pavement service life.

2.2 The Benefits of QA/QC Procedures

The best practices scan also established that the performance of pavements decreases where there is reduced emphasis on quality assurance/control during utility access box construction. Recommended QA/QC procedures and guidelines have been developed for this best practice.

Respondents to the information scan indicated that city forces occasionally perform some utility access box construction projects. It was recommended that a training program for municipal staff involved in utility access box design and construction be established. This program could be based on this best practice.

3. WORK DESCRIPTION

3.1 DESIGN CONSIDERATIONS

3.1.1 LOCATION

The most appropriate location for utility access boxes should be guided by their fundamental function and recognition that it is most desirable to minimize the number of utility access boxes in the roadway to mitigate their impact on pavement performance and maintain a smooth pavement surface. In cities where substantial numbers of utilities are present, the siting of utility access boxes can be particularly challenging.

Table 3–1: Recommended Location of Utility Access Boxes

<table>
<tr><th colspan="2">Type of Boxes</th><th>Preferred Locations</th></tr>
<tr><td rowspan="2">Catch basins</td><td>Horizontal</td><td>As close as possible to sidewalk
or curb</td></tr>
<tr><td>Side inlet</td><td>In sidewalk or curb face</td></tr>
<tr><td colspan="2">Valve boxes</td><td>Behind sidewalk or curb
In sidewalk
In middle of roadway (Center of the driving lane)</td></tr>
<tr><td colspan="2">Manholes or other boxes</td><td>In middle of roadway (Center of the driving lane)
In middle of street
Behind sidewalk or curb in right-of-way
In sidewalk</td></tr>
</table>

3.1.2 ELEVATION

The difference in elevation between the covers of utility access boxes and adjacent pavements should be guided principally by ride comfort/roughness considerations, except for catch basins where surface drainage must also be satisfied. Another factor influencing this parameter is the use of adjustable frames that have a tapered side frame which provides a more monolithic bond with the asphalt concrete.

The recommended elevation differences are shown in Table 3–2.

Table 3–2: Recommended Difference in Elevation Between Utility Access Boxes and Adjacent Pavement (flexible or rigid pavement)

Type of Box	Type of Frame	Difference in Elevation (Below Pavement Grade) mm	Remarks
Catch basins	Conventional	10 to 25	This difference in elevation should be implemented in a 1 m taper around the catch basin.
	Adjustable	5 to 15	This difference in elevation should be implemented in a 1 m taper around the catch basin.
Maintenance access holes (manholes) and other boxes	Conventional	0 to 15	This difference in elevation should be implemented in a 1 m taper around boxes.
	Adjustable	0	

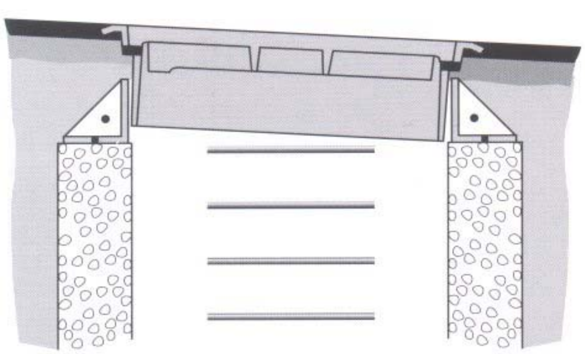
3.1.3 Types of Frames and Covers

Conventional frames and covers consist usually of a metal frame, which rests on a concrete riser, and a cover, which is fitted to match the size of the frame.

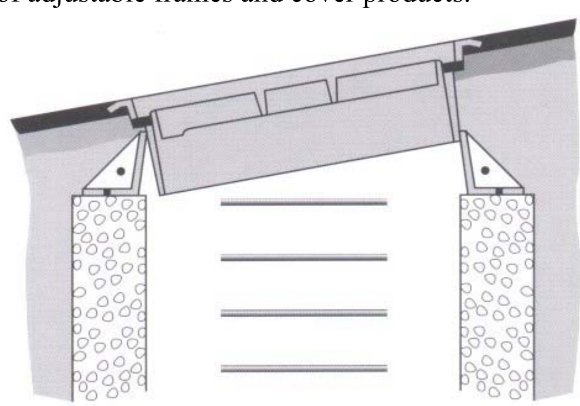
In the last decade, new types of frames and covers have been developed and have become widely available commercially. Most adjustable frames, for instance, have two or more independent parts: a frame base that is fixed to the concrete riser and an upper section that can be adjusted to compensate for any movement of the pavement surface, resulting in less vibration and pavement deterioration.

Where the cost of a conventional frame and cover would be about $300 per unit, the adjustable frame and cover is about $700 (October 2002 prices).

Figure 3–1 illustrates various types of adjustable frames and cover products.



Straight guiding frames
for surface inclined from 0 to 7 %



Tapered guiding frames
for surface inclined from 0 to 17 %

Figure 3–1: Adjustable covers with guiding frames (tapered or straight)

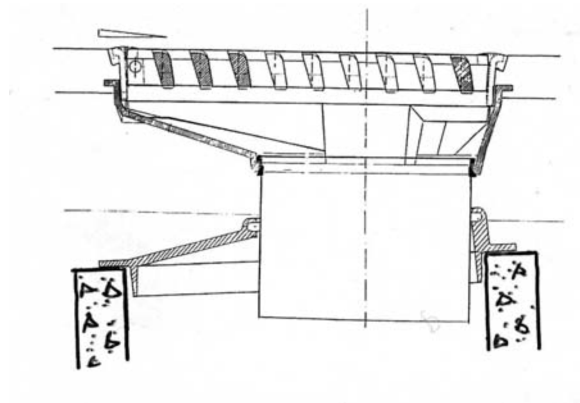


Figure 3–2: Other type of adjustable frame and cover

3.2 SPECIFICATIONS

All construction procedures should be completed in such a manner as to mitigate the distresses and respective causes identified in Table 2–1. Construction must be carried out to eliminate the settlement problems caused by the use of compressible soils as backfill and the differential frost-heaving problems attributed to the use of frost-susceptible soils.

Figure 3–3 describes the backfill specification requirements for proper construction.

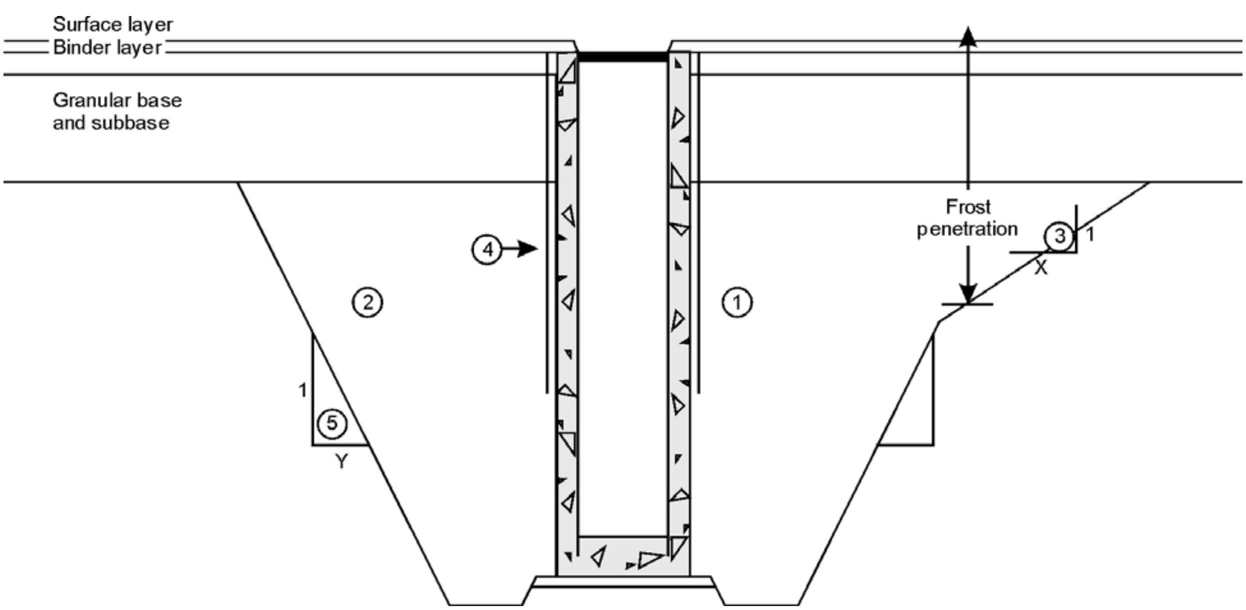


Figure 3–3: Construction specifications

1) Where imported backfill is to be used (different from the native/excavated soils), see section 3.2.1 for instructions for each material type.

2) Where backfilling is to be completed using native/excavated soils, see section 3.2.1.

3) Frost taper slope, see section 3.2.2.

4) Frost heave mitigation technique, see 3.2.3.

5) Excavation slope, see 3.2.5.

3.2.1 BACKFILL SPECIFICATIONS

The major materials used as backfill in utility access box excavations are summarized in Table 3–3, with anecdotal comments provided on their use.

Table 3–3: Type of Material for Backfill

Type Of Backfill	Comments	Remarks
Native/excavated material	Where suitable, reuse of the native/excavated material is usually cost effective and preferred to minimize excess material during construction. From an environmental viewpoint, reuse of the excavated material preserves and extends natural aggregate resources.	
	Some limitations on the type of native material should be established so compressible (clayey or organic) or frost-susceptible materials are not included as backfill.	Clay restriction: plasticity index <15.
Recycled material	From an environmental viewpoint, the use of recycled materials, such as processed reclaimed asphalt pavement (RAP) or recycled concrete, are encouraged in lieu of crushed stone, sand, or sand and gravel because it preserves and extends natural aggregate resources.	Recycled material containing more than 25% of RAP should not be used in the upper layers of backfill immediately below the granular sub-base, since its California Bearing Ratio (CBR) is usually lower. Crushed concrete could potentially contain chlorides and/or sulphates that could damage/corrode concrete structures or cast iron pipes.
Crushed stone, natural gravel, sand	Ensure reliable source/vendor for aggregate, and consider QA/QC checks to verify aggregate is not contaminated material.	A general standard for backfill could be: Sieve — % pass 150 mm — 100 5 mm — 30-100 80 µm — 0-15
Unshrinkable fill (UF)	Generally not practical in large continuous utility trench construction projects where conventional backfill construction methods and materials can be employed. Most effective in small excavations and around dense utility boxes where conventional compaction is not possible.	See National Guide's The Restoration and Repair of Utility Boxes in Pavements for specifications.

Layer Thickness
Backfilling should be carried out in uniform lifts not exceeding 300 mm loose thickness, subject to the placement method and types of compaction equipment employed. The layer thickness should be decreased to 150 mm around obstacles, such as conduits or utilities. The thickness of the first layer of backfill material placed directly above the utility may need to be increased to prevent damage to the utility during compaction. (In all cases, the utility bedding and requirements for backfilling in close proximity to the utility should be carried out in accordance with the specific requirements of the utility provider or agency.)

The backfill material should be simultaneously placed in equal lifts on all sides of the utility access box.

Degree of Compaction
To limit settlement problems around utility access boxes, the backfill material should be compacted to at least 95 percent of its modified Proctor Maximum Dry Density. Specifying 95 percent compaction will reduce the potential for settlement of properly placed, approved backfill material. A 95 percent compaction requirement will also limit the type(s) of native material that can be used as backfill. Note that it may be difficult to achieve this level of compaction using native/excavated materials, such as silt and clay materials.

3.2.2 FROST TAPERS

Frost tapers should be used when the type of backfill has a different frost susceptibility than the surrounding soils to avoid any differential frost heaving. The frost susceptibility of backfill or surrounding soils should be established by their "potential of segregation" as described in the research article *Frost Susceptibility Related to Soil Index Properties* (Konrad, 1999).

These frost tapers should begin at the lower limit of the sub-base to a depth equivalent to the frost depth penetration.

The frost penetration in pavements should be established with the freezing index and the formula in Chapter 20 of the *Geotechnical and Geo-Environmental Engineering Handbook* (Rowe, 2001).

When frost tapers are needed, they should be used to the depth of frost penetration and the slope should be varied (from 1H:1V to 5H:1V) depending on the type of trench (longitudinal or transversal) and the speed limit or classification of the road.

Table 3–4: Frost Tapers

Classification of Road	Longitudinal to the Direction of Traffic Slope "X"	Transversal to the Direction of Traffic Slope "X"
Residential	1H:1V	1.5H:1V
Collector	1.5H:1V	2H:1V
Arterial (<60 km/h)	3H:1V	3H:1V
High speed arterial (60 to 90 km/h)	3H:1V	5H:1V

3.2.3 Frost Heave Mitigation Techniques

Frost heave mitigation techniques should be used, especially if the backfill is a native material that might be frost susceptible. Frost heave mitigation techniques are shown in Figure 3–4.

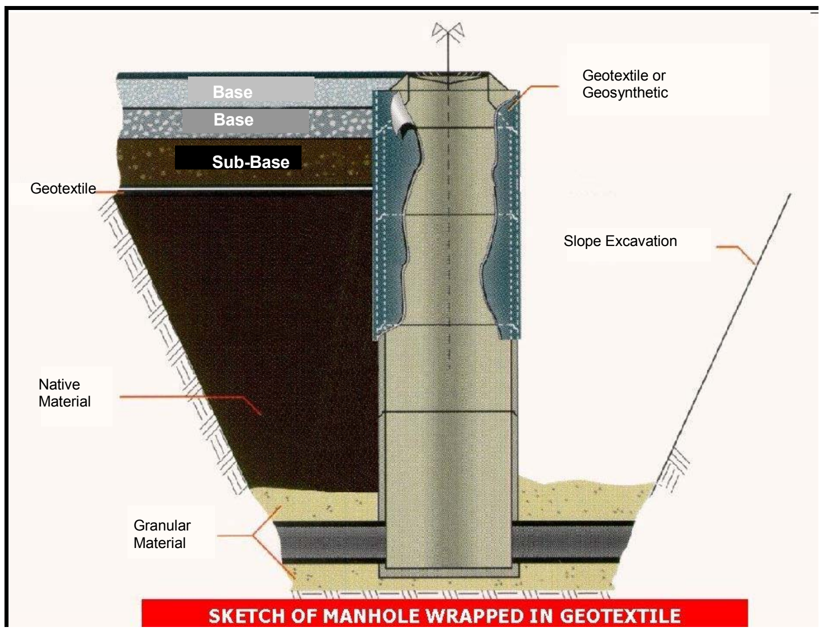


Figure 3–4: Frost heave mitigation

The purpose of the geotextile is to reduce the possibility of a bond developing between the utility access box and the backfill material, if frost susceptible, on freezing, causing heaving of the riser or chimney. Provision of a geotextile at the interface will prevent the riser from heaving and also prevent infiltration of fine material between the concrete rings (which can be a problem if a frost heave mitigation technique is not used).

Wrapping utility access boxes with a geotextile is not costly (typically about $150/box), and this technique should be considered for all utility access boxes installed where frost heave problems and fines infiltration into joints can occur.

This technique should be considered particularly for projects in areas where the freezing index is between 900 and 1000°C.-d or greater.

The geotextile should be attached in accordance with the manufacturer's recommendations. Typically, the geotextile is attached using 100 mm nails in a vertical joint in a stitching pattern. Horizontally, it is held in place until the backfill is placed, by lapping the geotextile over the top of the chimney and then placing the frame on top of it.

Geosynthetic membranes consisting of a geotextile covered by a PVC membrane have been used successfully in arch frost heave conditions. In this case, the PVC layer should be installed on the outside, in accordance with the manufacturer's recommendations.

Another method to mitigate frost heaving is to use a cone-shaped top section on circular pre-cast maintenance access holes (manholes) and catch basins. The cone-shaped section should extend to below the frost penetration depth.

3.2.4 Utility Box Connection

Pre-cast concrete sections are assembled together with or without waterproofing butyl joints depending on utility/agency requirements. In some cases, the interior and exterior of the joint are mortared to improve waterproofing and to avoid infiltration of fine particles. Rubber sleeves are also available that can be installed on either the interior or exterior of the utility access box to stop water and soil infiltration.

For final unit levelling and frame installation, the use of concrete brick and mortar is not recommended, and the use of concrete or rubber rings should be adopted as the industry standard method. This conclusion was developed based on the consensus of comments from the scan indicating that the poor quality of the mortar (to resist freeze-thaw cycles) and poor workmanship has generally resulted in poor performance.

Flexible Pavement

To minimize water infiltration and promote a better connection between the frame and the pavement, a tack coat should be applied to the vertical surfaces of the asphalt and utility access box prior to asphalt paving.

Crack sealing should also be carried out two to five years following construction to prevent water infiltrating the road bed.

If adjustable frames are used, they may require thicker asphalt pavement near the box to permit the adjustment and reduce potential fines infiltration. Some adjustable frames consist of two cylinders of different diameters, which slide into one another. The gap between the two components could permit fines to infiltrate and cause the units to seize. This can be mitigated by increasing the thickness of the asphalt concrete to 200 mm. Regardless, utility access box systems, including adjustable frames, should *always* be installed in accordance with the manufacturer's recommendations.

Rigid Pavement

When utility access boxes are installed in rigid (concrete or composite) pavements, proper isolation joints are necessary where the concrete pavement abuts maintenance access holes (manholes), drainage fixtures or other utility access boxes. The isolation joints permit independent movement of the pavement and the utility access box structure, reducing the potential for damage to the rigid pavement. Details are presented in *Concrete Intersection, - A Guide for Design and Construction* prepared by the American Concrete Pavement Association, 1997. This reference also presents recommendations and standards for pre-formed compressive seals to be installed in the isolation joints.

3.2.5 Excavation Side Slopes

Excavation side slopes and construction methods must, at all times, be completed in conformance with provincial health and safety regulations and requirements, and other agency requirements as applicable, to ensure worker safety during utility installation. These regulations typically require that excavation side slopes be maintained for relatively short construction periods at an angle not exceeding 1H:1V. Additionally, excavations should at all times be properly sloped, or provided with appropriate continuous temporary support as needed to avoid any loss of support/undermining of the adjacent soils.

3.3 Guidelines for Quality Assurance and Control

The best practice scan revealed that the pavement's performance near boxes decreases as the effort of QA/QC procedures decreases. Hence, greater emphasis on QA/QC is needed to ensure that utility access box construction work is properly carried out in accordance with the project specifications. The following guidelines have been established.

3.3.1 Budgetary Considerations

Table 3–5 presents the typical fees (including expenses, at the date of publication) for QA/QC that should be anticipated for utility access box construction in the municipal context, and are based on the use of conventional granular backfill materials and placement/compaction in accordance with the previous recommendations.

Table 3–5: QA/QC Cost vs Construction Cost

Construction Cost $	Fees as a Percentage of Project Cost %
< 50 000	4 (min. $1 000)
50 000 to 99 999	2.75 to 4
100 000 to 199 999	2.5 to 3.5
200 000 to 499 999	2.25 to 3.0
500 000 to 999 999	2.0 to 3.0
≥ 1 000 000	1.75 to 2.75

3.3.2 Technical Considerations

The following minimum QA/QC testing requirements are recommended for relatively large utility access box installations backfilled using conventional granular materials and construction methods.

For each type of backfill material:

- one sieve analysis/500 t
- one Modified Proctor/each type of material or any change in sieve analysis.

Compaction for backfill around boxes:

- one density test (ASTM D-2922)/100 m^2/layer with a minimum of two density tests/layer.

Wherever practical, full-time inspection of projects should be encouraged to ensure the utility access box construction is carried out in accordance with the specifications, and the adjacent soils are not undermined during the operation. A training program is also recommended for inspectors to enhance their awareness of the consequences of poor workmanship and quality, and identify key areas of concern and their mitigation.

3.4 Monitoring

The monitoring of pavement near utility boxes should also be enhanced, perhaps in conjunction with crack-sealing operations recommended within two to five years of construction. The specifications for crack sealing and filling in asphalt pavements are being developed by the National Guide as this document is being published. Please refer to the Guide website at www.infraguide.ca or to the Urban Infrastructure Rehabilitation program of the Institute for Research in Construction at www.nrc.ca/irc/uir/.

Trigger values that will bring action to repair or replace should be established (see Table 3–6).

Table 3–6: Trigger Values in Terms of Difference in Elevation Between Boxes and Adjacent Pavement

Speed Limit km/h	Boxes Higher Than Pavement	Boxes Lower Than Pavement	
	Manholes, Catch Basins or Other mm	Manholes or Other mm	Catch Basin mm
<60	+25	- 30	- 60
>60	+10	-15	-40

4. APPLICATIONS AND LIMITATIONS

This best practice is applicable in all Canadian regions, noting that the resulting specifications will need to be adapted to reflect specific local climatic conditions and agency requirements. For example, the City of Vancouver does not use frost tapers because of their low freezing index; conversely, the City of Québec and many municipalities in northern Ontario specify frost tapers extending to depths of about 2 m or greater.

It is recommended that this best practice be reviewed every three to five years to reflect any new research findings or technology developments.

The anticipated outcome of adoption of this best practice will be improved pavement performance near utility access boxes. Changes in performance may not be immediately obvious and long-term evaluation will likely be necessary before performance improvements become fully apparent.

5. OTHER CONSIDERATIONS

Certain areas have been identified for further research:

- the use and most appropriate configuration for frost tapers, in relation to differential heave (under different climatic conditions), to determine more fully the parameters that should be used;

- the influence of the difference in elevation on the ride comfort index, such as the IRI, in relation to drainage requirements;

- the use of geotextile (or geosynthetic membranes or equivalent products) to mitigate frost heave;

- the use of radiator bags (under investigation by NRC) to mitigate differential and frost heave around maintenance access holes (manholes) (which can be found at www.nrc.ca/irc/uir/ur/manholes/index.html);

- the short- and long-term performance of the adjustable frame and cover to establish the performance and cost benefits in comparison with conventional systems; and

- the asphalt concrete parameters and design methods for congested areas to establish criteria and properties most appropriate for placement and use around utility access boxes.

REFERENCES

ACPA (American Concrete Pavement Association), 1997. *Concrete Intersection, a guide for design and construction*.

Arudi, Rajagopal, Brian Pickering and Joseph Flading Joseph, 2000. *Planning and implementation of a management system for utility cuts.* Transportation Research Record, 1699.

Baker, T. Harry W., 1998. *Frost penetration in flowable fill used in pipe trench backfill.*

Charpentier, Stéphane, 1999. *Résultats de l'étude des types et des causes de dégradation du revêtement au voisinage des regards et des puisards* (Result of a study of types and causes of pavements degradation near manhole and catch basins). CERIU's Infra 99 International Congress, November 1999.

Chassé, Alain and Richard Foley, 1999. *Application d'une technologie spécifiquement adaptée à la prévention des dommages autour des regards* (A specific technology to prevent degradation around manholes). CERIU's Infra 99 International Congress, November 1999.

Chow, C.A. and V.B. Troyan, 1999. *Quantifying damage from utility cuts in asphalt pavement by using San Francisco's pavement management data.* Transportation Research Record, 1655.

Emery, John J., P.Eng. and David K. Hein, P. Eng., 1999. *Unshrinkable fill for utility cuts restorations.*CERIU'S Infra 99 International Congress.

Humphrey, Mewburn H. and Neville A. Parker Neville, 1998. *Mechanics of small utility cuts in urban street pavements - Implication for restoration.* Transportation Research Record, 1629.

Konrad, Jean-Marie, 1999. "Frost Susceptibility Related to Soil Index Properties," *Canadian Geotechnical Journal.* Vol. 36, No. 3, pp. 403-417.

Lee, Stephen Q.S. and Katherine A. Lauter, 2000. *Using pavement management system concepts to determine the cost and impact of utility trenching on an urban road network.* Transportation Research Record, 1699.

Lowery, Mark, IRC-NRC and Otto Svec, IRC-NRC, 2001. *Mitigation of heave around manholes: A proven innovation.* CERIU's Infra 2001 Congress, November 2001.

Martin, Yannick and Richard Gagné, 2001. *Remblai sans retrait : optimisation de la formulation et conditions d'utilisation* (Unshrinkable fill: formula optimization and limitation of utilization). University of Sherbrooke, March.

Nichols, Vallerga & Associates, 2000. *Impact of utility cuts on performance of Seattle streets.* January 31.

Rowe, R. Kerry (ed.), 2001. *Geotechnical and Geo-Environmental Engineering Handbook.* Kluwer Academic.

Shahin M.Y., J.A. Crovetti and J.L. Franco Jr., 1986. *Effects of utility cut patching on pavement performance and rehabilitation costs.* January.

Shahin M.Y., J.A.Crovetty, 1987. *Determining the effects of utility cut patching on the services life prediction of asphalt concrete pavement.*

Svec, O.J., 2001. *A new way to mitigate frost heave around manholes.* NRCC-44009, www.nrc.ca/irc.fulltext/nrcc44009.