

SETTLEMENT ANALYSIS ON NEW HIGHWAY INTERCHANGE

Location: Winnipeg, Manitoba

The construction of a new interchange was recently finalized in the northeastern end of Winnipeg, Manitoba, Canada. Overseen by Manitoba Infrastructure (MI), this new Provincial Trunk Highway (PTH) interchange was built to alleviate increased traffic congestion on Winnipeg's highways and to also help with the goal of renewing aging existing transport infrastructure.

Throughout the construction of the interchange, it was fully instrumented, but these installations did not all occur concurrently. Upon completion in 2018, the on-site instruments include 60 settlement plates, over 40 vibrating wire piezometers, over 15 Inclinoimeters, and nine ShapeArrays.

As a completed project, this Winnipeg interchange features seven bridge structures at four locations. Their embankments measure up to ten metres above the original prairie elevation and were built on 8 to 15 m of compressible clay. To accelerate settlement and meet the design requirements, wick drains were also installed into the clay.

During the mid-2010s, MI confirmed their intent to build this full free-flow interchange and forged a partnership with the KGS Group, who became the design-build team that created the geotechnical design. Construction began in 2015 and was finished approximately three years later.



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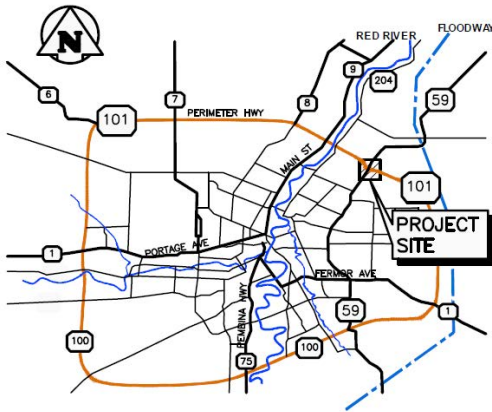


FIGURE 1

SITE LOCATION

Largely completed during the autumn of 2018, the interchange is located between the Red River (to the west) and the Winnipeg Floodway (to the east), at the intersection of Provincial Trunk Highway (PTH) 59N (also called Lagimodiere Boulevard) and PTH 101 (otherwise known as the north perimeter highway).

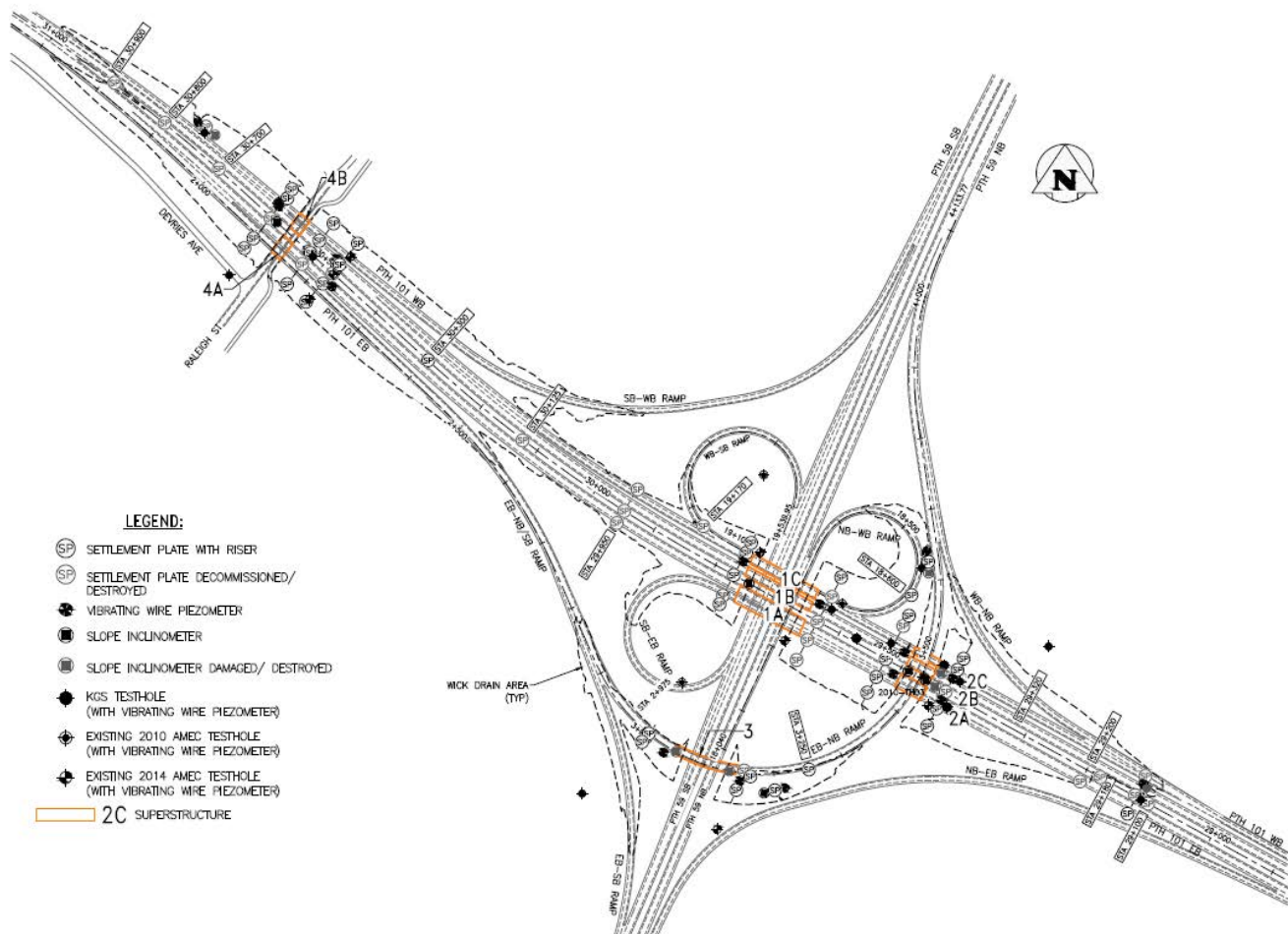


FIGURE 2

SITE DETAIL

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FIGURE 3

CROSS SECTION DETAIL

Providing around 770 linear metres of ShapeArray, the instruments were installed horizontally: one at a pipeline crossing and the other eight allocated individually to each of the eight abutments. The placements of these ShapeArrays also typically coincide with the settlement plates' locations. Together, along with the piezometers, they work to collect data to monitor the settlement and degree of consolidation within the embankments.

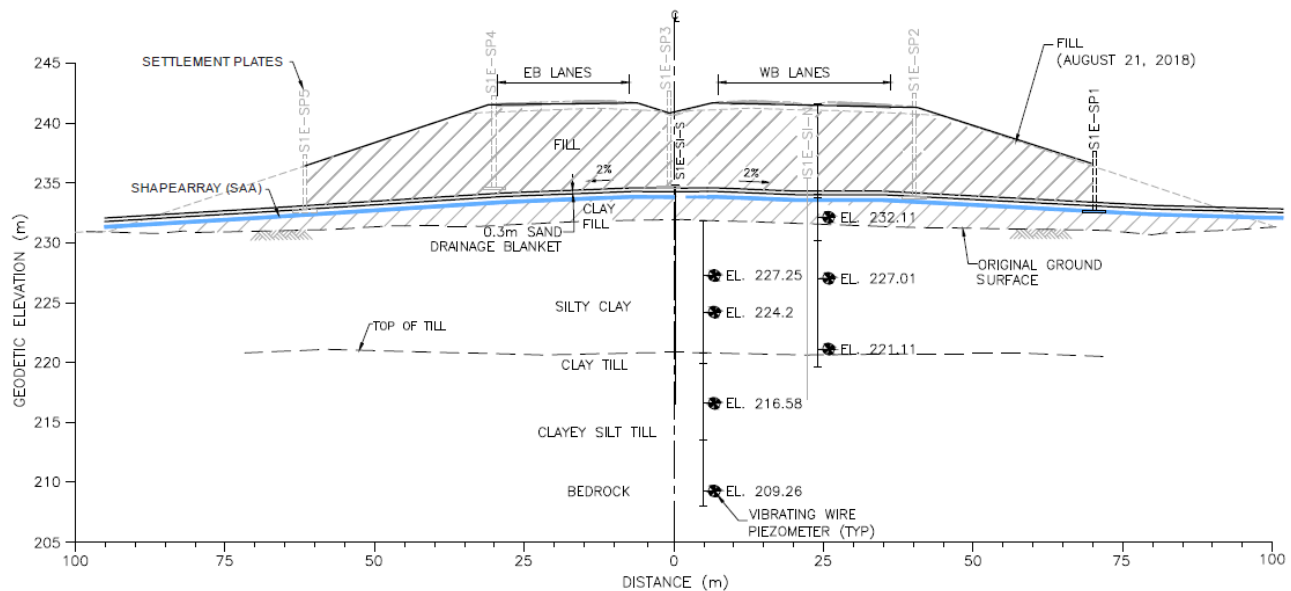
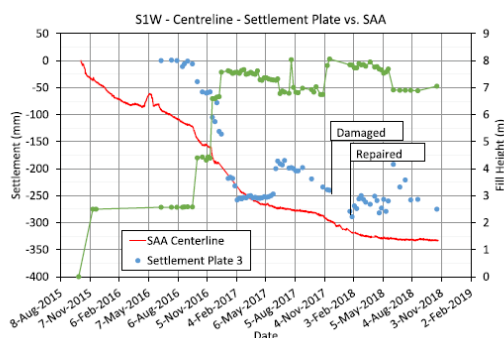


FIGURE 4

SETTLEMENT PLATE & SHAPEARRAY DATA

Settlement of a centreline settlement plate versus the closest ShapeArray with different installation times.



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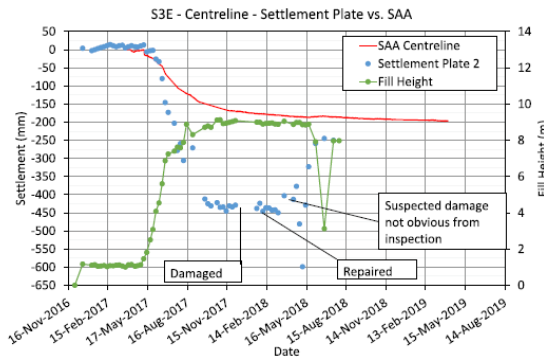


FIGURE 5

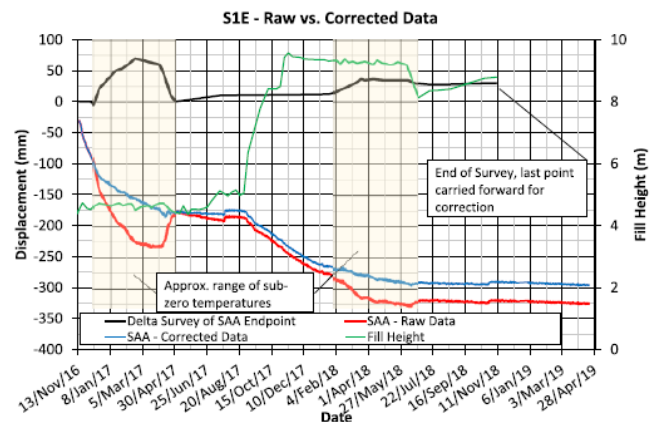
SETTLEMENT PLATE & SHAPEARRAY DATA

Settlement of a centreline settlement plate versus the closest ShapeArray with more similar installation times.

FIGURE 6

RAW AND ADJUSTED DATA

Manual adjustments were applied to the ShapeArray data to account for the heave and settlement of end points that occurred during winter.



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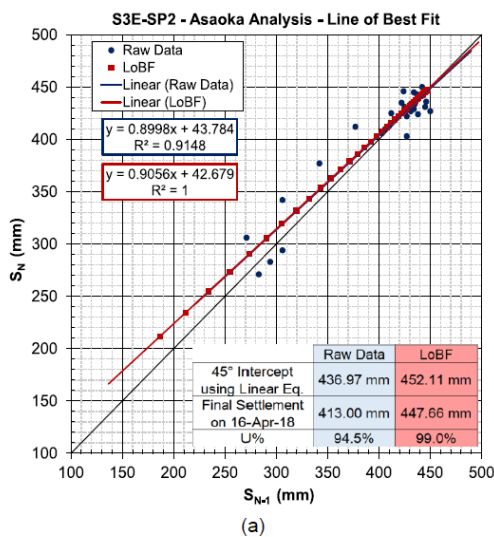


FIGURE 7 (A)

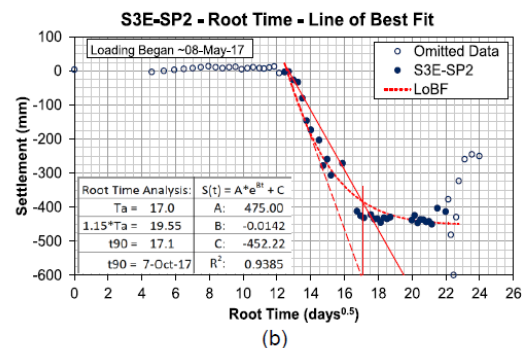
ASAOKA ANALYSIS USING RAW DATA AND LINE OF BEST FIT

Figure 7 (A) shows the Asaoka method completed for a fill height of 8.9 m on settlement plate 2 at S3E. See Figure 5 for raw survey values for the data presented here. It also illustrates the raw data and LoBF of the raw data using $S(t) = AeBt + C$, yielded estimated degrees of 94.5% and 99.0%, 11 months after the final embankment height was achieved.

FIGURE 7 (B)

ROOT TIME AND LINE OF BEST FIT

This figure shows the Root Time method using the LoBF and the estimated time of 90% consolidation. The LoBF projects an estimated final settlement of 452 mm. The settlement plate data is near that estimated value. The omitted data refers to the damaged settlement plate data noted in Figure 5.



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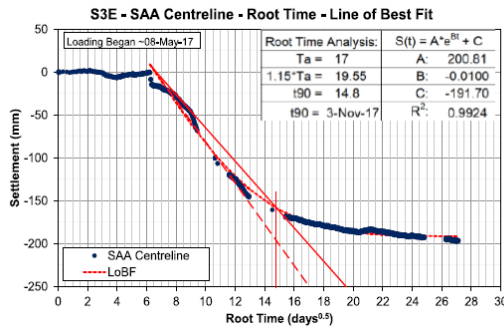


FIGURE 8

SHAPEARRAY CENTRELINE, ROOT TIME WITH LINE OF BEST FIT

The ShapeArray data with a line of best fit and root time analysis that confirms a greater than 90% consolidation.

FIGURE 9

SHAPEARRAY CENTRELINE, ROOT TIME WITH LINE OF BEST FIT

The figure illustrates the behaviour of the ShapeArray at the centreline of the S2E embankment.

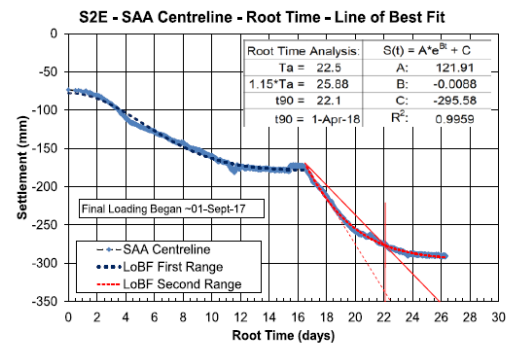
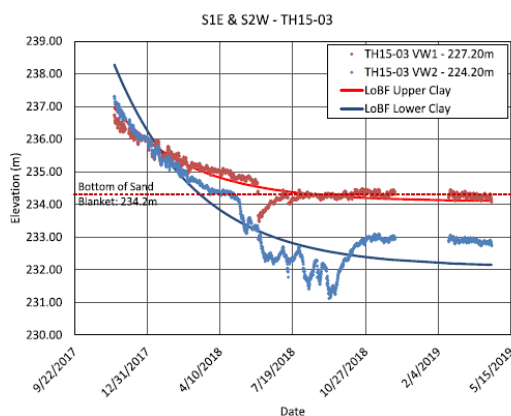


FIGURE 10

TOTAL HEAD DISSIPATION

The figure illustrates the dissipation of Total Head in the upper brown clay and lower grey clay between the final section of embankment raised to full height at the site.



CALL TO ACTION TEXT