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File No. 14-0107-036

The City of Winnipeg
Planning Property and Development Division
Municipal Accommodations Division
3rd Floor, 65 Garry Street
Winnipeg, Manitoba
R3C 4K4

ATTENTION: Brent Novak, P. Eng.
Structural / Civil Engineer

RE: Alexander Dock
Inspection and Condition Assessment, Final – Rev 0

Dear Mr. Novak:

KGS Group is pleased to submit this Final Inspection and Condition Assessment Report of the Alexander Dock.

1.0 INTRODUCTION AND BACKGROUND

The Alexander Dock was constructed in 3 phases originating in 1929 with additions constructed in 1939 and 1953. The existing dock facility spans approximately 406 feet (124 meters) along the river with 44 feet (13.5m) width extending out from the bank. The dock structure consists mainly of a wooden plank decking supported on rough timber stringers and pile cap bulkhead beams. The beams are in turn supported on 5 rows of driven timber piles with the 3 waterside rows of exposed piles cross-braced with rough timber struts. The dock plan and typical sections are shown on Figure 1 and 2, respectively.

KGS Group was previously retained in 2001 to conduct a condition assessment and structural evaluation of the Alexander Dock. The findings of that assessment concluded that the dock structure was in varying degrees of condition ranging from very poor to good, with the North half generally in better condition than the South half of the structure. The South half was particularly impacted by both ongoing riverbank movement and ice floe damage in addition to the typical long term deterioration many timber elements along the entire structure. Replacing the entire dock structure was deemed cost prohibitive, given the limited usage. The recommended remediation consisted of extending the structure life by replacing the severely deteriorated areas with new timber members and offloading the upper bank area to reduce the ongoing slope movement.

The rehabilitation program commenced in 2001 with replacing the north half of surface deck with new timber while leaving the stringers, beams and piling in place. The south half substructure condition was significantly impacted by historical riverbank movement and as such not recommended for remediation unless riverbank stabilization measures were implemented.

In 2002 the City of Winnipeg proceeded with the riverbank stabilization program as part of the Waterfront Drive project.

Upon completion of the riverbank stabilization on both the water and land side of the dock structure, the City of Winnipeg continued with remedial work to extend the life of the south half dock structure. The work was more extensive than the previous north half remediation and consisted of the entire top layer deck replacement with 3”x12” Douglas Fir planks and localized 12”x12” timber pile cap beams were replaced with steel W200x27 beams. The work also included two rows of new timber piles and significant replacement of waterside skirting. The work was completed in 2004 and no further remediation other than surficial repairs have been implemented since that time.

In 2014, the City of Winnipeg expressed renewed concern regarding the condition of the dock, specifically based on the significant ice damage at the upstream South end and localized depressed sections of the deck. KGS Group was again retained to conduct an inspection and reassess the structural condition, integrity and safe use of the Alexander Dock. This letter report describes the inspection findings regarding the current condition of the deck, waterside skirting, and accessible portions of the substructure. It also discusses the suitability for use and remediation options, where appropriate.

2.0 INSPECTION

The visual inspection of the structure was performed by Mr. N. Kyriakopoulos, P.Eng. The inspection was planned in two stages with the top side assessment to be completed in late fall of 2014, before winter snow would cover the large deck surface and a second underside inspection to be conducted once river levels dropped to seasonal lows and riverbank ground freezing allowed safe access. The inspection of the top surface of the timber deck and waterside skirting of the Alexander Dock was performed on November 5, 2014. The inspection of the accessible areas of the underside of the timber deck and substructure was performed on February 6, 2015. Figure 1 summarizes the assessment observations for the underside inspection.

2.1 WATERSIDE SKIRTING

In general, the waterside skirting condition ranges from very poor, including sections of entirely missing sections, to relatively good condition. The sections in good condition that remain are part of the 2004 rehabilitation work. Approximately 90 m of the total dock skirting length of 130 m require portions or total replacement of damaged skirting timbers. Representative photos are attached in Appendix A and typical observations of the skirting inspection are described below:

- Photo 1 displays the extent of the ice damage on the upstream end of the dock. This portion of the structure is severely damaged.
- Photo 2 is an overview of the waterside skirting along the structure. It can be seen that large areas of the waterside skirting has been damaged due to river-ice impact and long term

deterioration in wet conditions. The approximate lengths of deterioration are provided in Figure 1.

- Photo 3 shows the general deflection (or bulging) near the middle of Section 1, likely the result of historical riverbank movement. This movement was noted in previous reports and does not appear to have visibly advanced since the dock structure was last rehabilitated. However, due to the tolerance of the wood structure construction and damage to localized areas, meaningful survey of the structure alignment to compare with the previous assessment was not possible.
- Photo 4 displays the extent of the ice damage along the South half of the skirting.
- Photo 5 shows the North face of Section 2 with damage in the upper left corner, likely the result of long term rot and disintegration.

2.2 TOP SURFACE OF DECK

In general, with the exception of localized areas, the top surface of the deck appeared to be in good condition with general observations as follows:

- Photo 6 shows the South end of the deck where several planks have been recently removed for remedial works. The exposed area shows that nearly half of the deck width is resting directly on the embankment material while the other half-width is supported by the deck stringer beams. In the upper riverbank areas it is not possible to determine the condition of beams and piles encased in the riverbank.
- Photo 7 identifies two planks adjacent to the Southern-most slipway that require replacement. The boards have developed notches that present trip hazards.
- Photo 8 presents an overall view of the deck just North of the Southern-most slipway. This overall view displays the generally good condition of the deck timbers and the recently replaced perimeter timber curb.
- Photo 9 identifies a depressed area, of approximately 4 m in diameter, where the deck planks, or their supporting structure, have deteriorated (softened) and settled. This deck area is likely no longer supported on structurally sound stringers, beam and/or piles.
- Photo 10 displays a localized example of planks that have deteriorated and developed notches that present trip hazards. There are approximately a dozen instances of similarly-deteriorated planks throughout the structure.
- Photo 11 displays a non-structural side-plank of the Southern Section 2 slipway that may present a trip hazard.

2.3 UNDERSIDE OF DECK AND STRINGERS

In general, the deck and the stringers (that were visible) were all in fair to good condition. No visible deterioration or warping was noticed. Photo 12 shows a typical view of the underside of the deck with stringers. Nearly half (the West side) of the dock supporting structure including stringers, beams and piles is encased in the riverbank and not visible for inspection.

2.4 PILECAP BEAMS

In general, the majority of the visible pile cap beams were in fair to good condition, given the age of the structure. The major deficiency of the pile cap beams is not the condition of the timber members, except for isolated locations; rather, in many locations the beams' ability to support load is compromised or nonexistent due to damaged, split and or misaligned piles.

- Photo 13 displays the typical condition of a timber pile cap beam.
- The timber beams along lines 16 and 17 were noted to be in a deteriorated state. Photo 14 shows the beam along line 17.
- With the exception of the damaged and deformed steel W200x27 sections on the upstream (South) end of the dock (where the decking is currently removed), the remainder of the W200x27 sections were in good condition, as shown in Photo 15.
- Many of the steel bearing seats that were installed as part of the original construction phases, prior to the 2001 KGS Group report, were severely deteriorated, as shown in Photo 16. Several of these seats were observed to have deteriorated since the previous assessment.
- Several timber pile cap beams spanning between lines C and E were observed to have insufficient bearing support on the pile at line C, where movement prior to the riverbank stabilization or ongoing creep of the inclined pile had caused the steel seat to tilt towards the river (Photo 17).
- There were several locations observed where beams embedded in the riverbank had insufficient bearing contact on the steel bearing seats (Photo 18). These beams still had appreciable bearing seat lengths when observed during the 2001 inspection.
- There were also several locations with beams cantilevering out of the riverbank that had no bearing contact on the steel seats (Photo 19).
- There were several locations where the intermediate support piers of the original timber pile cap beams were tilted or shifted out of place (Photo 20).

2.5 TIMBER PILES

In general, the original timber piles were in poor to severely deteriorated condition while the timber piles installed during the 2004 rehabilitation were still in good condition. The dock structure is supported on 451 timber driven piles as shown on Figure 1. Of these, only 164 are visible for inspection. 287 of the 451 are mostly or entirely encased in the riverbank and not accessible for a condition assessment. Of the 164 piles inspected, approximately 55% are no longer supporting the structure as intended with a summary of compromised condition as follows:

- 15 piles (9% of total inspected) have been damaged by ice.
- 20 locations (12% of inspected) have insufficient bearing area to fully support the timber pile cap beam described in the previous section.
- 40 piles (24% of inspected) are vertically split resulting in reduced capacity that is not quantifiable.
- 17 piles (10% of inspected) are no longer in contact with timber beams.

Representative photos are attached in Appendix A and typical observations of the pile inspection observations are described below:

- Photo 21 displays the typical condition of the piles installed after the 2001 KGS Group report and the 2004 rehabilitation work.
- Several piles were found to be significantly inclined (Photo 22). These piles are marked with a “T” on Figure 1.
- Several piles were also found to be split, to varying degree. Photo 23 displays a typical split pile. These piles are marked with a “S” on Figure 1.

- Several diagonal bracing members were found to be damaged and no longer attached to the timber piles (Photo 24). Of the 82 bracing locations inspected, 15 members (18%) require replacement.

2.6 UPSTREAM DAMAGED AREA

The upstream area of the dock, which has been damaged due to ice impact, appears to be unsalvageable. This area is currently exposed, due to the removal of the decking in this area. The underlying structure is severely damaged and deformed, as shown in Photo 25.

3.0 DISCUSSION

The deck and stringers appeared generally in good condition between lines C and E. The deck area between lines A and C appears in generally good condition with the exception of localized areas, mainly located in the North half of the structure. The underside of decking, stringers, pile cap beams and piles between lines A and C are embedded in the riverbank and not accessible so they could not be inspected. It is likely that the locally depressed areas are either significantly deteriorated or more likely no longer supported on sound stringers and beams.

The condition of several beam bearing seats along line C including those with less than 75 mm of contact and beams cantilevering out of the riverbank (not bearing on the support at all) present significant concerns to the loading capacity of these areas. Also of concern are several beams between line C and E that have spilt piles or displaced piles that no longer support or sufficiently support the beams above. A typical pile cap beam was evaluated considering a split or removed intermediate support along line D, as in Photo 9. The beam analysis resulted in a uniform live load capacity of 3.1 kPa (65 psf). This live load capacity 3.1 kPa is appreciably less than the design live load of 4.8 kPa required by the National Building Code of Canada (2010) for assembly areas. Sections of the dock where beams are cantilevering out of the riverbank, resting on split piles for their end support or supported with insufficient bearing lengths will have even further reduction in safe load carrying capacity.

The columns marked with an “S” on Figure 1 were split to varying degrees, with Photo 12 representing an example. The axial compressive capacity of some of the split piles may be only slightly reduced from the design strength of the pile but the current load carrying capacity of these piles is difficult to quantify. While load sharing from the decking/stringer system may spread the load to more capable piles, the load carrying capacity of the split piles should be considered to be reduced, and in some cases negligible.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Following the inspection of the dock structure, we have concluded that:

- The dock structure has experienced enough deterioration to the supporting elements, specifically the piles, pile cap beams and stringers that it cannot safely support the deck for its current intended use, i.e., riverboat operation and assembly area for the public. As described in Section 2, approximately 50% of the piling is no longer supporting the dock structure as intended. While a portion of the deteriorated piles still have some capacity, the remaining load carrying capability is not quantifiable. Further underside dock access for monitoring is difficult and only available during winter when water levels have receded.

- A significant number of the timber piles (287) are encased in the riverbank and not visible for inspection. While these piles would not have deteriorated to the extent of the visible piles as they are encased and protected from ice and other damage, there are deck areas exhibiting settlement that are the result of deterioration in the supporting structure below.
- While much of the deck and visibly accessible stringers appear to remain in good condition, the supporting structure is now in varying condition ranging from poor to fair. Unfortunately the varying condition is not limited to localized areas but rather systemic throughout larger areas of the dock. The visible deterioration in accessible areas of the dock increases the uncertainty of the support structure condition and capacity in the areas that are encased in the riverbank.
- Localized repair or remediation does not appear practical given the widespread deterioration of the supporting structure. The deck planks and selected stringers are the main elements still in good condition but not likely be salvageable during rehabilitation work.

Based on the condition of the structure and conclusions regarding safe load carrying capacity and remedial work, the recommendations for next step are as follows:

- The City of Winnipeg should review its short term and long expectations, including operating requirements for the Alexander Dock with all stakeholders, as required.
- If no corrective actions are taken to rectify the deficient areas, the City of Winnipeg should consider closing off the dock structure. The City of Winnipeg may consider the implementation of "loading lanes" for riverboat operation that could be cordoned off on the dock, such that the deteriorated areas outlined on Figure 1 are not accessible. The location and details of access corridors would require further evaluation.
- If the City of Winnipeg determines that the entire dock or large sections of the dock are to be used for the long term, a cost analysis of upgrading the upstream damaged area with better ice-resisting capabilities and replacing the deteriorated substructure elements could be conducted. However, given the varying condition and age of much of the substructure, rehabilitation and partial replacement may not be practical or achieve a cost effective long asset. A long term solution would likely warrant demolition of the existing structure and construction of a new dock facility.

5.0 THIRD PARTY USE OF REPORT

This report has been prepared for the City of Winnipeg and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

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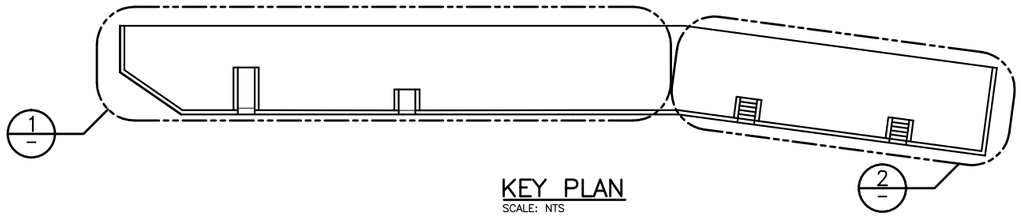
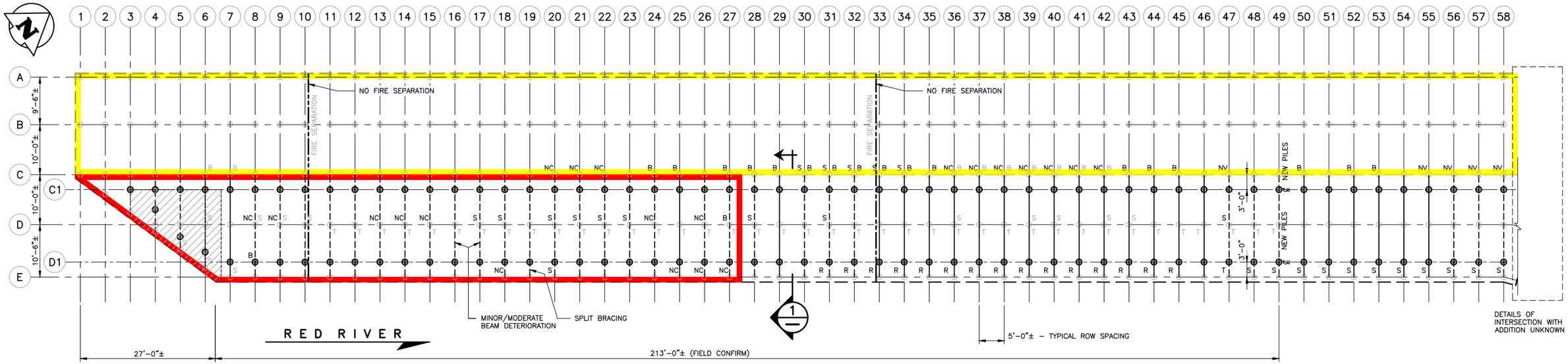
NK/nf
Enclosure

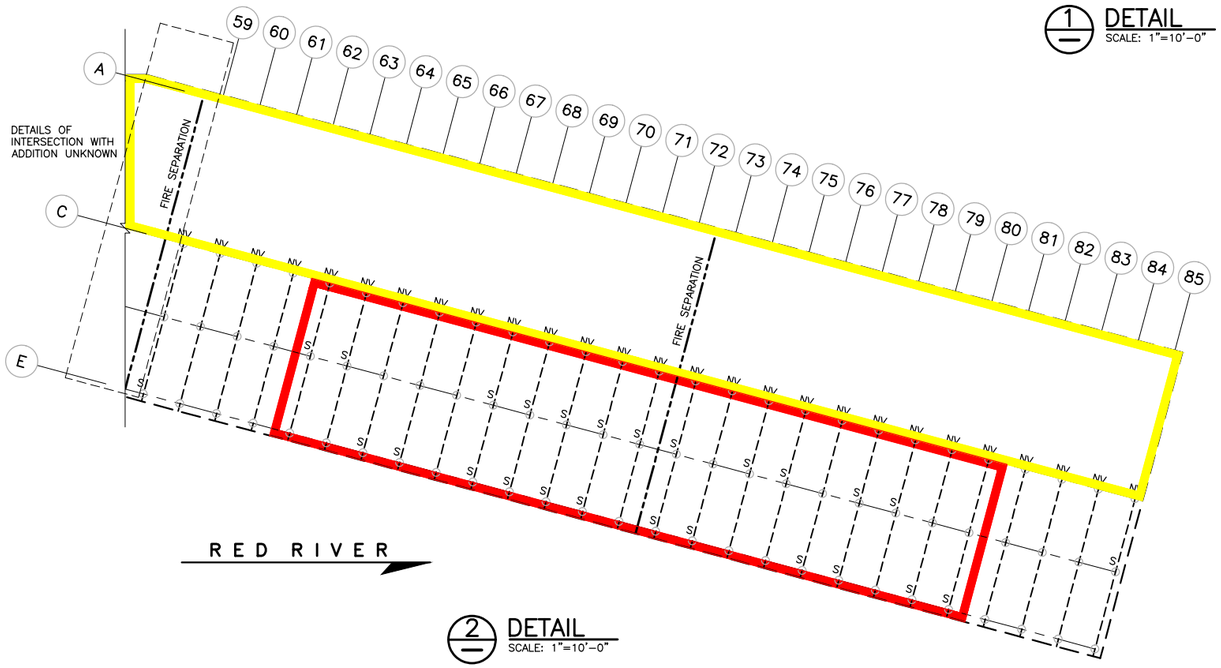
FIGURES



KEY PLAN
SCALE: NTS



1 DETAIL
SCALE: 1"=10'-0"



2 DETAIL
SCALE: 1"=10'-0"

LEGEND

EXISTING TIMBER PILE DESIGNATION CODES

- B DESIGNATES TIMBER PILECAP BEARING LESS THAN 3"
- S DESIGNATES SPLIT TIMBER PILE
- T DESIGNATES TILTED TIMBER PILE (8V:1H TO 6V:1H)

STEEL W200x27
12x12 TIMBER
UNDERSIDE NOT INSPECTED
REDUCED LOAD CAPACITY

NEW TIMBER PILE DESIGNATION CODES

- B DESIGNATES TIMBER PILECAP BEARING LESS THAN 3"
- S DESIGNATES SPLIT TIMBER PILE
- T DESIGNATES TILTED TIMBER PILE (8V:1H TO 6V:1H)
- NC DESIGNATES TIMBER PILE NOT IN CONTACT WITH BEAM
- NV DESIGNATES TIMBER PILE NOT VISIBLE DURING INSPECTION
- R DESIGNATES TIMBER PILE REMOVED

NO.	YY/MM/DD	DESCRIPTION	BY
A	15/02/27	ISSUED FOR INFORMATION	RM

REVISIONS / ISSUE

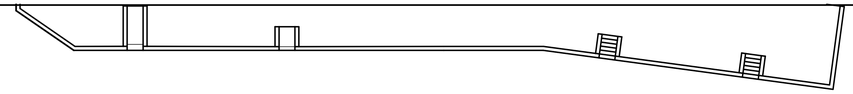
KGS GROUP CONSULTING ENGINEERS

THE CITY OF WINNIPEG
PLANNING AND PROPERTY
DEVELOPMENT DEPT.

ALEXANDER DOCK

CONDITION ASSESSMENT PLAN

FEBRUARY 2015 | FIGURE 1 | REV: A



KEY PLAN
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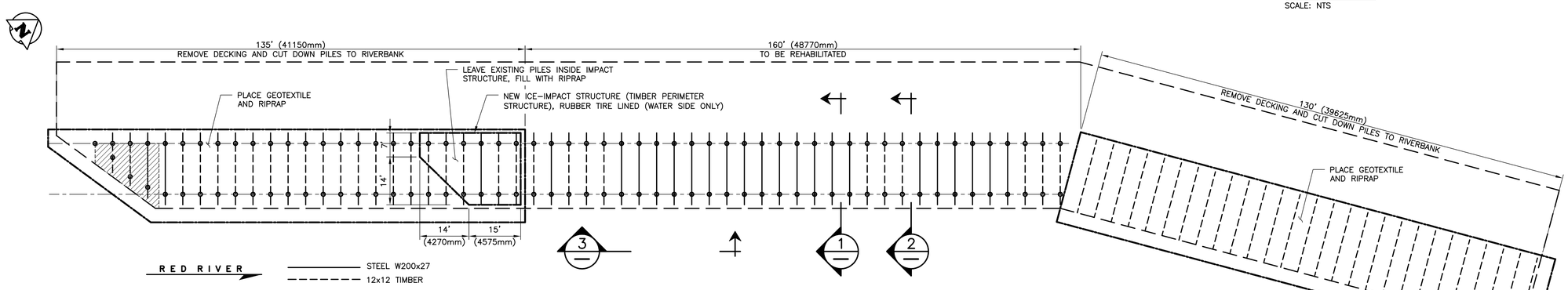

PLAN
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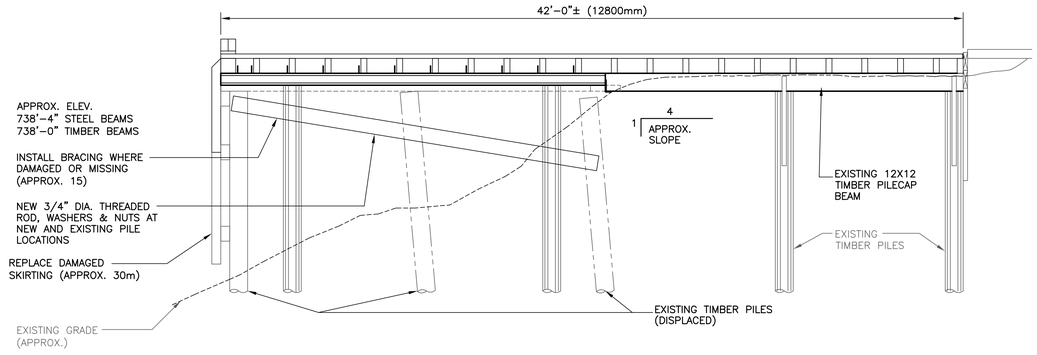
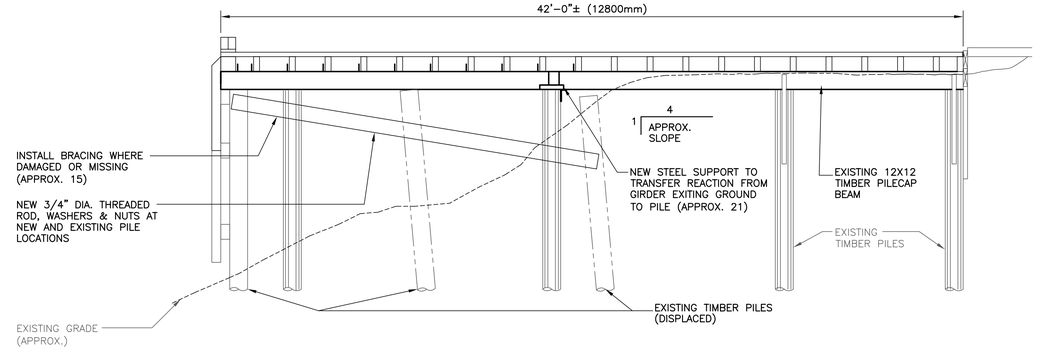
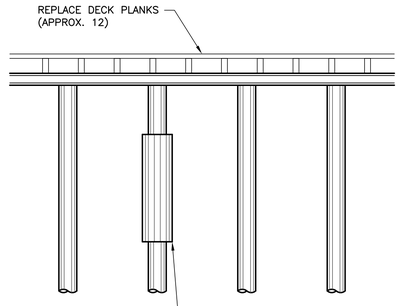


1 SECTION – TYPICAL STEEL BEAM LOCATION
SCALE: 1/4"=1'-0"



2 SECTION – TYPICAL TIMBER PILE CAP BEAM LOCATION
SCALE: 1/4"=1'-0"



3 ELEVATION – WITHOUT SKIRTING: SPLIT PILE REPAIR (APPROX. 13 LOCATIONS
SCALE: 1/4"=1'-0"

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THE CITY OF WINNIPEG
PLANNING AND PROPERTY DEVELOPMENT DEPT.

ALEXANDER DOCK

DOCK REHABILITATION AND DEMOLITION CONCEPT SKETCH

APRIL 2015 | FIGURE 2 | REV: A

APPENDIX A

PHOTOS

Photo 1 – South waterside skirting damage due to river ice

Photo 2 – East waterside skirting damage due to river ice erosion

Photo 3 – Longitudinal view of Section 1 skirting showing horizontal deflection

Photo 4 – View of deteriorated waterside skirting from the North end of Section 2

Photo 5 – North face of Section 2 with damage in upper left corner

Photo 6 – South end of deck with exposed area for remedial works

Photo 7 – Two planks adjacent to South slipway that require replacement

Photo 8 – Overall view of deck looking north; taken just north of South Slipway

Photo 9 – Area of depressed and deteriorated planks opposite bend marking transition between Section 1 and Section 2, approximately 4.5 m in diameter

Photo 10 – Plank deterioration resulting in a trip hazard near the Section 1 / Section 2 transition

Photo 11 – Deteriorated plank at southern Section 2 slipway

Photo 12 – Typical underside view of decking and stringers

Photo 13 – Typical condition of timber pilec ap beam

Photo 14 – Deteriorated pile cap beam at line 17

Photo 15 – Typical steel W200x27 girder

Photo 16 – Deteriorated steel pile cap beam support

Photo 17 – Pile cap beam between E and C; reduced bearing length at steel seat

Photo 18 – Insufficient bearing length for beam cantilevering out of riverbank at pile along line C

Photo 19 – Beam cantilevering out from riverbank and not bearing on pile, but supported on seat extension of steel beam. Beam has increased deterioration since the 2001 inspection.

Photo 20 – Intermediate pier support shifted away from original timber pile cap beam

Photo 21 – Typical condition of remedial piles installed in 2004

Photo 22 – Typical tilted pile support

Photo 23 – Split pile at line 85

Photo 24 – Diagonal bracing member no long attached to pile

Photo 25 – Damaged upstream side of Alexander Dock