



September 29, 2009

Mr. John Diebold  
Niagara Frontier Transportation Authority  
181 Ellicott Street  
Buffalo, NY 14203

**Re: Port-Greenbelt Shoreline Improvement Project  
NFTA Project No. 12PL0202  
NYSDEC SAC #C302569 / NYSDOT PIN 5757.71  
Bell Slip Design Analysis Report  
Phase I Corrective Action for Bank Stabilization**

Dear Mr. Diebold:

URS Corporation – New York (URS) is pleased to submit three copies of the report entitled, “Design Analysis Report - Bell Slip Phase I Corrective Action for Bank Stabilization.” This report has been prepared to present URS’s proposed corrective action design to address the exposed soil scarps along the shoreline of the Bell Slip.

The report has been prepared in accordance with discussions held during the August 11, 2009 meeting between NFTA, NYSDEC, USACE, Man O’Trees, E&E, and URS, and subsequent discussions between NFTA, NYSDEC and URS.

Should you have any comments or wish to discuss any aspect of this report, please do not hesitate to call.

Sincerely,

**URS Corporation-New York**

Robert R. Henschel, P.G.  
Project Manager

Enclosure

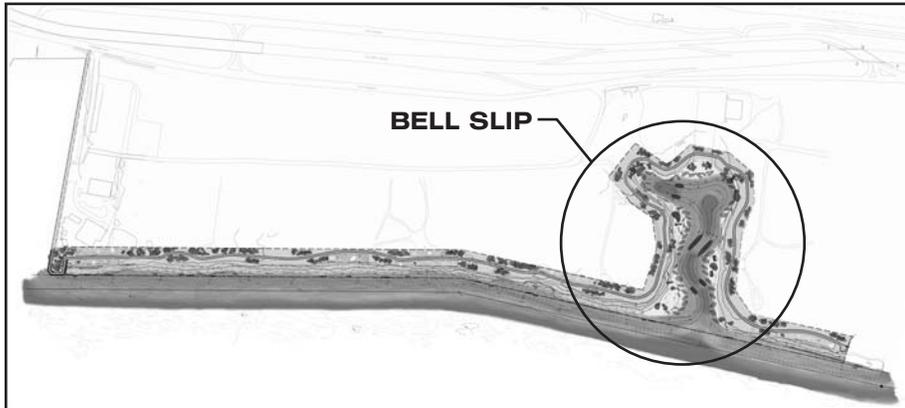
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# TRANSPORTATION



Niagara Frontier Transportation Authority  
*Serving the Niagara Region*



# PROJECT REPORT

## DESIGN ANALYSIS REPORT BELL SLIP PHASE I - CORRECTIVE ACTION FOR BANK STABILIZATION

PIN 5757.71  
PORT-GREENBELT SHORELINE  
IMPROVEMENT PROJECT  
NEW YORK STATE DEPARTMENT  
OF ENVIRONMENTAL CONSERVATION  
STATE ASSISTANCE CONTRACT NO. C302569  
SITE NO. B-00149-9  
CITY OF BUFFALO, ERIE COUNTY

September 2009

Prepared by:  
URS Corporation - New York

U.S. Department of Transportation  
Federal Highway Administration

NEW YORK STATE DEPARTMENT OF TRANSPORTATION  
DAVID A. PATERSON, Governor  
STANLEY GEE, Acting Commissioner



**NIAGARA FRONTIER TRANSPORTATION AUTHORITY  
PORT - GREENBELT SHORELINE IMPROVEMENT PROJECT**

**NFTA Project No. 12PL0202  
NYSDEC SAC #C302569 / NYSDOT PIN 5757.71**

**BELL SLIP  
DESIGN ANALYSIS REPORT**

**CORRECTIVE ACTION FOR BANK STABILIZATION  
PHASE I**

**Prepared for:  
Niagara Frontier Transportation Authority  
181 Ellicott Street  
Buffalo, NY 14203**

**Prepared by:  
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**SEPTEMBER 2009**

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## LIST OF DRAWINGS (Following Text)

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ES-101	Phase I – Corrective Action Limits
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Attachment A	Site Photographs (September 10, 2009)
Attachment B	Meeting Attendance List (August 11, 2009)
Attachment C	Product Information

## **1.0 INTRODUCTION**

URS Corporation (URS) is under contract to the Niagara Frontier Transportation Authority (NFTA) to provide engineering services for the Port - Greenbelt Shoreline Improvement Project. NFTA has requested that URS provide such services relative to design of a corrective action for soil sloughing/erosion that occurred over the winter of 2008 - 2009 in the Bell Slip area. Based on discussions with the NFTA, New York State Department of Environmental Conservation (NYSDEC) and URS, it was agreed that design and construction of the initial corrective action (i.e. stabilizing the exposed soil scarps) should be undertaken and completed before the winter of 2009. Consequently, this Design Analysis Report (DAR) focuses on the Phase I Corrective Action only. The design of any other alternatives (i.e., Phase II) would be performed over the winter months with construction in the spring of 2010.

## **2.0 PROJECT BACKGROUND**

In 2007 NFTA completed construction of approximately 4,000 feet of shoreline improvement along Buffalo's Outer Harbor. As part of this project, habitat in the Bell Slip was enhanced by construction of aquatic shelves, placement of soil to support vegetative growth and new plantings of upland, emergent and aquatic species. The Bell Slip provides an important Muskellunge spawning habitat for the area of Lake Erie near Buffalo. As such, it is important that the shoreline/slopes around the Bell Slip be protected from erosion so that the resulting siltation does not impact the spawning areas.

By October 2007, the contractor had completed placement of soils in the Bell Slip but not the plantings. The subsequent winter weather caused soil located near the water's edge to slough and/or erode into the waters. The most notable event occurred during January 2008 when a very heavy wind event (i.e. 60+ mph winds) and a strong storm surge occurred that raised the lake water levels in the vicinity of the Bell Slip by as much as 11 feet.

URS was tasked with developing a corrective action design to address the sloughing/erosion problem. URS was instructed to comply with the original design intent, which was to establish as natural a habitat as possible, by avoiding unnatural structural elements, to the extent practicable, while meeting the other project objectives.

During the design phase NYSDEC stressed that their preference was to avoid the use of stone revetments within the limits of the Bell Slip and maximize the usage of plantings both as erosion control and to provide natural habitat. It was frankly discussed, and understood by all parties that given the severe conditions of Lake Erie, some future scouring/erosion could re-occur, in spite of everyone's best efforts to meet the stated design intent of avoiding stone revetment.

The selected approach incorporated a plantable, compost-filled synthetic woven sock placed and anchored on the existing grade at the water's edge, with 2-inch minus gravel backfill placed behind. The slope over the stone was covered with a layer of compost and fiber erosion-control mats anchored into the underlying soil materials. The compost contained a seed mix with numerous fast-growing grasses and wild flowers. Live plantings of various tree species also were placed in selected locations along the slopes. Construction of the repair was completed by August 2008.

Subsequently, during the winter of 2008 – 2009 (i.e. December and January), several heavy windstorms again resulted in storm surges of several feet and strong wave action in the Bell Slip. Several areas of the slopes within the Slip were eroded. In some areas it was evident that the plantings, fiber mat, anchors and gravel backfill were damaged or completely destroyed. A preliminary assessment performed by NFTA personnel identified four areas totaling approximately 800 lineal feet, where the erosion extended down to the underlying stone/rubble with an exposed soil scarp at the top of the exposed slope. The remaining areas totaling approximately 1,200 lineal feet, were essentially intact as constructed, with a developing vegetative cover, and only showed some localized erosion, mainly within the first few feet adjacent to the shoreline. Photographs of current conditions (i.e. September 2009) are contained in Attachment A.

Based on subsequent discussions between NFTA and the NYSDEC, it was agreed that a more “substantial” form of erosion control would be necessary to protect the Bell Slip from future storm events. The NYSDEC concurred that some type of stone revetment would most likely be required, as part of the solution.

### **3.0 DESIGN OBJECTIVES**

Project objectives are discussed below.

#### **3.1 Original Design and Status**

- Protect and enhance the Muskellunge spawning Area – has been accomplished
- Create additional aquatic and upland habitat – has been largely accomplished.
- Provide public access to waterfront – has been accomplished.
- Enhance the aesthetics of the waterfront – has been accomplished
- Stabilize shoreline/slopes to provide vegetative cover and habitat along the shoreline – only partially successful.

#### **3.2 Additional Corrective Action (Phase I)**

Based on discussions with the involved parties, the primary objectives of the Phase I Corrective Action will be to:

- Stabilize the exposed soil scarps in the four eroded areas to prevent further erosion and siltation of the Muskellunge spawning area/water in general. (This needs to be accomplished during the 2009 construction season.)
- Provide test areas of several alternative erosion control/stabilization designs to allow for an evaluation of options that could be implemented in the remaining areas of the Bell Slip at a future time (Phase II), under other funding mechanisms.
- Utilize natural materials (i.e. no synthetics or concrete) to maximum extent practicable.
- Maximize corrective action within existing funds remaining.
- Minimize detailed design activities so that a maximum amount of remaining funds will be available for construction

#### **4.0 POTENTIAL CORRECTIVE ACTION ELEMENTS**

In order to obtain input and ideas for potential corrective action approaches that might be applicable to the Bell Slip, a meeting was held on August 11, 2009 with all interested parties. A list of attendees and affiliation is provided in Attachment B. A summary of the key discussion points is presented below.

##### **4.1 Suggested Approaches**

During the onsite meeting, the following thoughts and ideas were discussed:

- Critical need for stabilizing existing scarp face (exposed soil) to prevent further erosion and/or siltation of waters in the Slip. Use large armor stone with smaller ‘chinking’ stone to provide weight and filter to retain soils. ‘Chinking’ stone mix could be enhanced with topsoil to allow vegetative plantings.
- Use ‘willow walls’ and/or ‘grids’ of willows and other tree species to create natural erosion barriers. These could be combined with use of armor/revetment stone. Orient perpendicular to primary wave direction.
- Develop ‘terraced’ slope using combination of armor/revetment stone and soil fill to create step-type slope. Can plant on terraces.
- Utilize combination of armor stone with interspersed filter socks (as currently used onsite) to provide erosion protection and filter to retain soil from washing through armor stone. Chinking with smaller stone and soil mix would be placed in areas upslope from the filter socks to allow plantings. Similar to existing slope area in east end of Slip (immediately in front of Parking Lot).

- Select the most promising approaches and do small ‘test areas’ for a select number of approaches. Monitor performance and then utilize the most successful approach for remaining areas of the Slip that require stabilization. This may require the project schedule to extend beyond the current limit of March 31, 2010.
- Allow for some width of exposed shoreline (e.g. 10 – 15’) wherein there is no constructed protective measures. May be able to plant a variety of emergent plant species in this area, and see which are most successful. Then replicate in other areas.
- Install removable Jersey Barriers, or equivalent, along the water’s edge to provide temporary protection (i.e. 2 – 3 years?) until plantings on slopes are developed sufficiently to protect slopes. Then remove barriers. Alternatively, large armor stone could be placed and left in place at water’s edge, with intent that soil/stone will gradually infill around them and vegetation grow in as well.
- Utilize timbers or natural logs (e.g. drift wood?) to create barrier along waters edge to retain soil. This could be enhanced by utilizing ‘interlocking’ timber/log designs extending some distance up the slope.
- Use Coir, or other natural fiber materials, for wrapping soils while allowing planting. These would most likely be incorporated with other design elements.
- Utilize trenches excavated through the loose surface debris, down to stable, dense rubble fill and backfilled with soil and closely spaced plantings. Deep-rooted types of plant/tree species would be used.
- Install some type of barrier (submerged island, jetty, jacks) in the water at the mouth of the Slip to reduce wave action, etc. within the Slip.

## **5.0 RECOMMENDED CORRECTIVE ACTION**

At the conclusion of the August 11, 2009 meeting, the potential corrective action measures, identified above, were evaluated by NFTA, NYSDEC, United States Army Corps of Engineers (USACE), URS and Ecology and Environment (E&E). Based on that evaluation, the following Corrective Action Approaches were retained for further development:

- 1) The first priority is to stabilize the existing exposed soil scarp areas to minimize soil erosion that results in siltation of the Muskellunge spawning beds. As previously indicated, there are presently four areas, totaling

approximately 800 lineal feet, with exposed soil scarps that need to be addressed.

The above-referenced parties agreed that these areas will be stabilized by use of heavy armor stone combined with a filter system/media to provide sufficient weight to stabilize the toe of the soil slope and minimize soil erosion and migration through the armor stone. A shallow 'bench' will be excavated adjacent to the scarp. A natural fiber erosion control mat will be installed on the back slope of the excavation. The fabric will extend from the top of the exposed scarp, down the slope and about 2 – 3 feet across the floor of the excavated bench. One or two rows of armor stone (size to be determined) will be placed on the bench, adjacent to the scarp. A 'chinking' mixture comprised of well graded cobbles, gravel, and sand will be installed in the void spaces between the larger armor stones.

Plantings consisting of a row of willow stakes installed at the back of the bench between the armor stone and excavated surface, will be incorporated to provide some additional habitat and erosion control.

- 2) Once the critical areas have been stabilized, then several test areas will be installed to evaluate other potential corrective actions that utilize various planting schemes combined with stone revetment materials for the remaining exposed slope areas. The number and size of the areas will be dependent on the construction budget remaining after addressing item 1, above. The alternatives to be tested and evaluated will be developed in consultation with the NFTA and NYSDEC. In general, these test sections will incorporate the following elements, either individually or in various combinations: willow walls and/or grids; terraced slopes; and, armor stone revetment with stone/topsoil chinking mixture.

## **6.0 PHASE I - CORRECTIVE ACTION DESIGN**

Based on discussions with the NFTA, NYSDEC and URS, it was agreed that design and construction of the initial corrective action (i.e. stabilizing the exposed soil scarps) will be undertaken and completed before winter of 2009. The design of any other alternatives will be performed over the winter months with construction in the spring of 2010.

A description of the proposed Phase I Corrective Action is presented below in a step-by-step format. The rationale for selecting each component also is included. The proposed design is presented graphically on Drawing ES-102.

Copies of relevant product information supplied by potential vendors are included in Appendix B.

- All exposed soil scarps will be protected by installation of a limited armor stone revetment. Preliminary inspection has identified four primary areas of exposed soil scarps totaling about 775 lineal feet. (Estimated lengths: AREA I - 350'; AREA II – 130'; AREA III – 120'; AREA IV – 175'. Total Length – 775'). The actual limits of work will be determined by NFTA personnel in the field by visual inspection.
- The contractor will select and construct access to the work areas. The number and locations of the access routes will be kept to the absolute minimum required for the work. The contractor will 'cut' access roads from the top of slope down to the beach areas, and then move the equipment along the existing beach to the individual work areas. In order to reduce future construction costs, these routes will be left in-place for use during future phase 2 construction (i.e. 2010). They will be protected from erosion during phase 1 construction and will be constructed to preclude erosion over the winter. Following completion of the Phase II work, the access routes will be restored to their original condition. The contractor will submit for review the locations, proposed construction methods and proposed erosion control methods.
- The existing vegetated soil slope areas upslope of the exposed soil scarps and existing paved walkway will be protected from damage during construction. Contractor will select routes for equipment and materials delivery to the site that minimize travel on, or across, the existing pedestrian walkway and/or the vegetated areas of the project. Where necessary, mats, plates, or other approved methods will be used to protect these areas during construction. Any areas damaged during construction will be repaired to their original condition.
- A bench will be excavated immediately adjacent to the exposed soil scarp wide enough to accommodate two to three rows of armor stone (approximately 4 – 6 feet). The width of the bench will be adjusted based on the height of the exposed soil scarp. The higher the scarp, the more armor stone that will be required to cover the scarp face and accordingly, the wider the bench to provide support for the armor stone. The bench will be sloped slightly toward the rear of the excavation to prevent rolling or rotational movement of the armor stones toward the water. The Contractor will remove debris, including large rocks (> 6-inch size), roots, clods, and sticks as necessary to create a reasonably smooth surface for placement of the armor stones. The scarp face will be trimmed only as necessary to create a relatively smooth, near vertical face for placement of the willow stakes. Any excavated material will be used, to the extent practicable, in constructing the bench. No fine grained material will be left exposed on the slopes where it can be eroded and washed into the waters of the Slip. Any excess stone rubble will be placed at the downslope toe of the armor stone. This will help to minimize any erosion, washout or undercutting of the armor stone.

- The contractor will place a ‘natural’ fiber erosion control fabric (Rolanka BioD-Mat (90) or equivalent) at back of excavation on the prepared surface. The contractor will pin the fabric (temporarily) at the top of the rear excavation surface and drape it down the slope and about two feet onto the floor of the excavated bench. (This product was selected based on its use of natural coconut fiber, expected life of 4 – 7 years and a mesh opening of about 0.3 by 0.4 inches.) (Attachment C).
- The contractor will install armor stone consistent with the original contract specification Section 02487, on the bench. (This will simplify the construction as the armor stone is a standard contract item and is readily available in sufficient quantity from a local quarry in Lockport, NY. Additionally, the armor stone has performed satisfactorily over the past two years in the stone revetment installed on the Outer Harbor slopes. The contractor will position the stones a few inches from the back excavated surface to allow installation of willow stakes. The contractor will closely space and interlock the stones to the extent practicable during installation. In areas where the scarp exceeds 3 feet in height, the contractor will install additional layer(s) of armor stone such that they extend to, or slightly above, the top surface of the vegetated slope. In these areas, overlapping vertical and horizontal joints will be staggered. Additionally, the top of the armor stone will be matched to the top of scarp. Bedding stone will be used to fill in areas where the top of the armor stone is slightly lower than the top of the scarp. The actual amount of stone will be determined in the field based on site conditions.
- After placing the first row of armor stone adjacent to the scarp, the contractor will pull the erosion control fabric away from the rear soil slope and install willow stakes between the fabric and the soil slope at back of excavation. The contractor will select stake lengths such that they extend from the bench to about one to two feet above the slope. The stakes will consist of upland willow for drier areas (i.e. >3’ above lake level) and sandbar willows for wetter areas (i.e. < 3’ above lake level). URS will provide a qualified Landscape Architect, and/or Wetland Biologist to guide the selection process. The willow stakes will be placed at a spacing of two per lineal foot, to enhance the potential for surviving the winter, to increase habitat and to provide erosion control. The stakes will be treated with rooting hormone prior to installation to trigger some root growth this fall, if possible. The contractor will backfill the remaining annular space between the armor stones and excavated surface with moist topsoil. This will provide a better growing media for the Willow stakes, and enhance root growth.

- The contractor will ‘chink’ the voids in each layer of armor stone with 6-inch minus run-of-crush limestone immediately after each layer of armor stone is placed, and prior to placement of subsequent layers. This well-graded stone mixture (Attachment C) will act as a graded filter, thereby restricting the flushing of soil from upslope areas through the voids in the armor stone and ultimately into the waters of the Slip. This stone is durable, readily available, relatively low cost, and well-graded right from the quarry. (It was suggested that topsoil be added to the ‘chinking’ mixture and that individual willow stakes be installed in the open spaces between the armor stones in an effort to increase vegetative growth and habitat. However, the NYSDEC indicated that only the willow stakes at the scarp/armor stone interface need to be installed at this time. This was based on concerns of the topsoil washing out and resulting in siltation of the Muskellunge spawning areas, increased difficulty/cost of construction, and the fact that the next phase of the corrective action would focus on additional plantings/habitat issues.)
- The contractor will create transition zones tying the existing stone revetment on the Outer Harbor slopes into the Phase I corrective action on both the north and south sides of the Bell Slip. These zones will extend from the edge of the existing stone revetment for about 60 – 70 feet inland. The intent of these zones is to smooth out the wave action at the end of the existing revetment, and reduce the erosive forces on the slope. In these transition zones, the contractor will leave in place the existing stone rubble (typ. 4 – 12 inches in size) on the slope. The contractor will remove any non-stone debris (e.g. driftwood, plastic, etc.) and grade the stone rubble to create a smooth surface for placement of armor stone. The contractor will place additional bedding stone, as necessary, to ensure a minimum of one foot of bedding stone-size rock exists beneath the armor stone.
- The contractor will place the armor stone in the transition zones to an average 3-foot thickness in accordance with existing specifications. The contractor will use the existing stone rubble as sub-base to the extent practicable (see note above). The new armor stones will be integrated into existing stone revetment to create a continuous revetment.

## **7.0 SCHEDULE**

The corrective action for stabilizing the existing exposed soil scarp areas needs to be completed this fall, prior to the onset of winter weather conditions. This effort will be critical to minimizing further erosion and siltation of the Muskellunge spawning areas.

URS recommends that design of the alternative corrective action measures be completed this winter with construction of the test areas (Phase II) as early as practicable

in the spring of 2010. This will avoid potential damage that may occur this winter prior to vegetative establishment. The actual schedule will be dependent on weather conditions next spring and the available budget. Ideally, the test areas will be constructed, to allow for a full growing season for plant establishment.

The NYSDEC has indicated that it should be possible to obtain an additional extension of the State Assistance Contract (SAC) so that work can be performed beyond the current project completion date of March 31, 2010. They also indicated that while this is a likely case, there was no guarantee that such an extension would be approved by Albany.



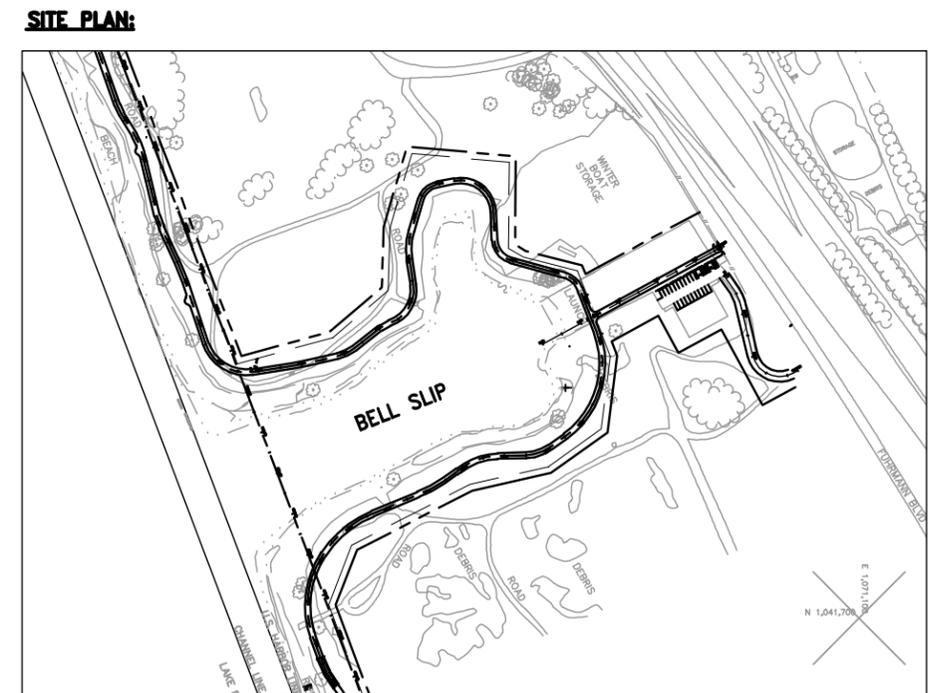
Niagara Frontier Transportation Authority  
Serving the Niagara Region

# PORT - GREENBELT SHORELINE IMPROVEMENT PROJECT

## BELL SLIP CORRECTIVE ACTIONS FOR BANK STABILIZATION PHASE I - SEPTEMBER 2009

**URS Corporation**  
New York  
77 Goodell Street, Buffalo, New York 14203  
(716)856-5636 - (716)856-2545 fax

NEW YORK STATE DEPARTMENT OF  
ENVIRONMENTAL CONSERVATION  
STATE ASSISTANCE CONTRACT NO. C302569  
SITE NO. B-00149-9  
BUFFALO, ERIE COUNTY



### DESCRIPTION OF WORK

THE SITE IS LOCATED IN AN AREA KNOWN AS THE OUTER HARBOR AND CONSISTS SOLELY OF THE BELL SLIP.

THIS PROJECT INCLUDES:  
PHASE I - CORRECTIVE ACTION CONSISTING OF HEAVY ARMOR STONE COMBINED WITH STONE FILTER MEDIA AND PLANTINGS TO STABILIZE EXISTING EXPOSED SOIL SCARPS.

### INDEX OF DRAWINGS:

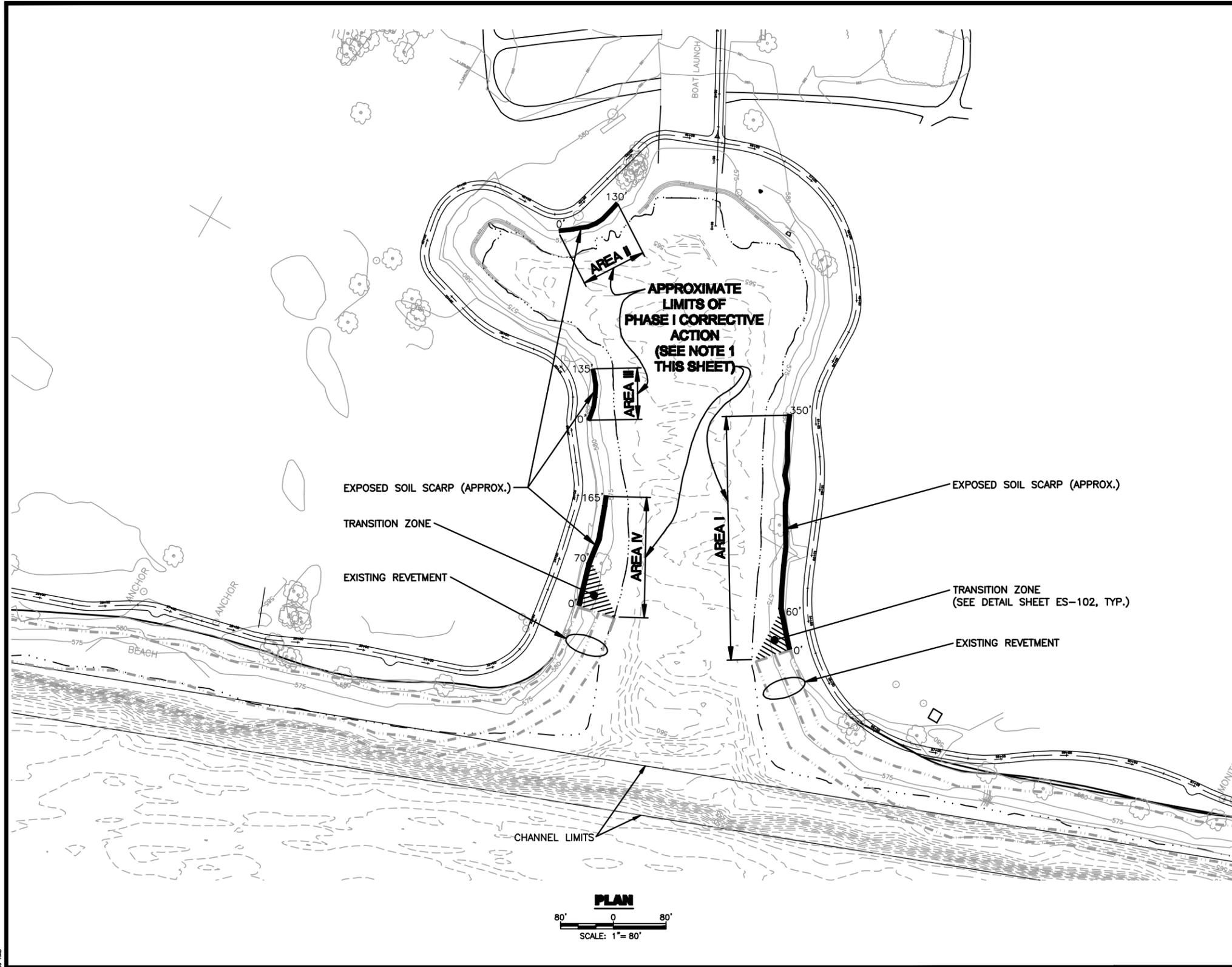
- G-100A COVER SHEET
- ES-101 PHASE I - CORRECTIVE ACTION LIMITS
- ES-102 PHASE I - CORRECTIVE ACTION DETAILS

NFTA PROJECT NO. 12PL0202

NFTA BID NO. E-367

DRAWING FILE NAME: G-100A.DWG  
DRAWING # 1 OF 3

**G-100A**



- NOTES**
- LIMITS OF EXPOSED SOIL SCARPS ARE APPROXIMATE. ONLY AND WILL BE DETERMINED BY VISUAL INSPECTION IN THE FIELD. (ESTIMATED LENGTHS: AREA I - 350'; AREA II - 130'; AREA III - 120'; AREA IV - 175'. TOTAL LENGTH - 775').
  - ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH ORIGINAL CONTRACT DOCUMENTS, AS APPROPRIATE.
  - THE NUMBER AND LOCATIONS OF ACCESS ROUTES CONSTRUCTED SHALL BE KEPT TO THE ABSOLUTE MINIMUM REQUIRED FOR THE WORK. THESE ROUTES ARE TO BE PROTECTED FROM EROSION DURING PHASE I CONSTRUCTION. THEY ARE TO BE LEFT IN-PLACE FOR FUTURE PHASE 2 CONSTRUCTION; THEREFORE, THEY ARE TO BE CONSTRUCTED TO PRECLUDE EROSION OVER THE WINTER. THE CONTRACTOR SHALL SUBMIT FOR REVIEW THE LOCATIONS, PROPOSED CONSTRUCTION METHODS AND PROPOSED EROSION CONTROL METHODS.
  - THE EXISTING VEGETATED SOIL SLOPE AREAS UPSLOPE OF THE EXPOSED SOIL SCARPS AND EXISTING PAVED WALKWAY ARE TO BE PROTECTED FROM DAMAGE DURING CONSTRUCTION.
  - A BENCH IS TO BE EXCAVATED IMMEDIATELY ADJACENT TO THE EXPOSED SOIL SCARP WIDE ENOUGH TO ACCOMMODATE THE TWO TO THREE ROWS OF ARMOR STONE. THE BENCH SHOULD BE SLOPED SLIGHTLY TOWARD THE REAR OF THE EXCAVATION. REMOVE DEBRIS, INCLUDING LARGE ROCKS, ROOTS, CLODS, AND STICKS AS NECESSARY TO CREATE A SMOOTH SURFACE FOR PLACEMENT OF THE ARMOR STONES. THE SCARP FACE SHALL BE TRIMMED ONLY AS NECESSARY TO CREATE A RELATIVELY SMOOTH, NEAR VERTICAL FACE. ANY EXCAVATED MATERIAL SHALL BE USED, TO THE EXTENT PRACTICABLE, IN CONSTRUCTING THE BENCH. ANY EXCESS STONE RUBBLE SHALL BE PLACED AT THE DOWNSLOPE TOE OF THE ARMOR STONE.
  - INSTALL A 'NATURAL' FIBER EROSION CONTROL FABRIC (ROLANKA BioD-MAT (90) OR EQUIVALENT) AT BACK OF EXCAVATION. PIN THE FABRIC (TEMPORARILY) AT THE TOP OF THE REAR EXCAVATION SURFACE AND DRAPE IT DOWN THE SLOPE AND ABOUT TWO FEET ONTO THE FLOOR OF THE EXCAVATED BENCH.
  - INSTALL ARMOR STONE ON THE BENCH. THE STONES ARE TO BE POSITIONED A FEW INCHES FROM THE BACK EXCAVATED SURFACE TO ALLOW INSTALLATION OF WILLOW STAKES. THE STONES ARE TO BE CLOSELY SPACED WITH OVERLAPPING VERTICAL AND HORIZONTAL JOINTS. FOR AREAS WHERE THE SCARP EXCEEDS 3 FEET IN HEIGHT, INSTALL ADDITIONAL LAYER(S) OF ARMOR STONE SUCH THAT IT EXTENDS TO, OR SLIGHTLY ABOVE, THE TOP SURFACE OF THE VEGETATED SLOPE. THE ACTUAL AMOUNT OF STONE WILL BE DETERMINED IN THE FIELD BASED ON SITE CONDITIONS.
  - AFTER PLACING THE FIRST ROW OF ARMOR STONE ADJACENT TO THE SCARP, PULL THE EROSION CONTROL FABRIC AWAY FROM THE REAR SOIL SLOPE AND INSTALL WILLOW STAKES BETWEEN THE FABRIC AND THE SOIL SLOPE AT BACK OF EXCAVATION. SELECT LENGTHS SUCH THAT THEY EXTEND FROM THE BENCH TO ABOUT ONE TO TWO FEET ABOVE THE SLOPE. STAKES SHALL CONSIST OF UPLAND WILLOW FOR DRIER AREAS (I.E. >3' ABOVE LAKE LEVEL) AND SANDBAR WILLOWS FOR WETTER AREAS (I.E. <3' ABOVE LAKE LEVEL). PLACE AT SPACING OF TWO PER LINEAL FOOT. TREAT THE STAKES WITH ROOTING HORMONE PRIOR TO INSTALLATION. BACKFILL THE REMAINING ANNULAR SPACE BETWEEN THE ARMOR STONES AND EXCAVATED SURFACE WITH MOIST TOPSOIL.
  - CHINK VOIDS IN EACH LAYER OF ARMOR STONE WITH 6-INCH MINUS RUN-OF-CRUSH STONE IMMEDIATELY AFTER IT IS PLACED, AND PRIOR TO PLACEMENT OF SUBSEQUENT LAYERS.
  - PLACE LAYER OF BEDDING STONE ON TOP OF ARMOR STONE AND GRADE TO MATCH EXISTING SLOPE AT REAR OF WORK AREA.
  - IN TRANSITION ZONES, LEAVE EXISTING STONE RUBBLE IN-PLACE. REMOVE ANY DEBRIS (E.G. DRIFTWOOD, PLASTIC, ETC.) AND GRADE TO CREATE A SMOOTH SURFACE FOR PLACEMENT OF ARMOR STONE. ADDITIONAL BEDDING STONE SHALL BE PLACED, AS NECESSARY, TO ENSURE A MINIMUM OF ONE FOOT OF BEDDING STONE SIZE ROCK BENEATH THE ARMOR STONE.
  - ARMOR STONE IN TRANSITION ZONES IS TO BE PLACED TO AVERAGE 3-FOOT THICKNESS IN ACCORDANCE WITH EXISTING SPECIFICATIONS. USE EXISTING STONE RUBBLE AS SUB-BASE TO THE EXTENT PRACTICABLE (SEE NOTE 11). ARMOR STONES ARE TO BE INTEGRATED INTO EXISTING STONE REVETMENT TO CREATE A CONTINUOUS REVETMENT.

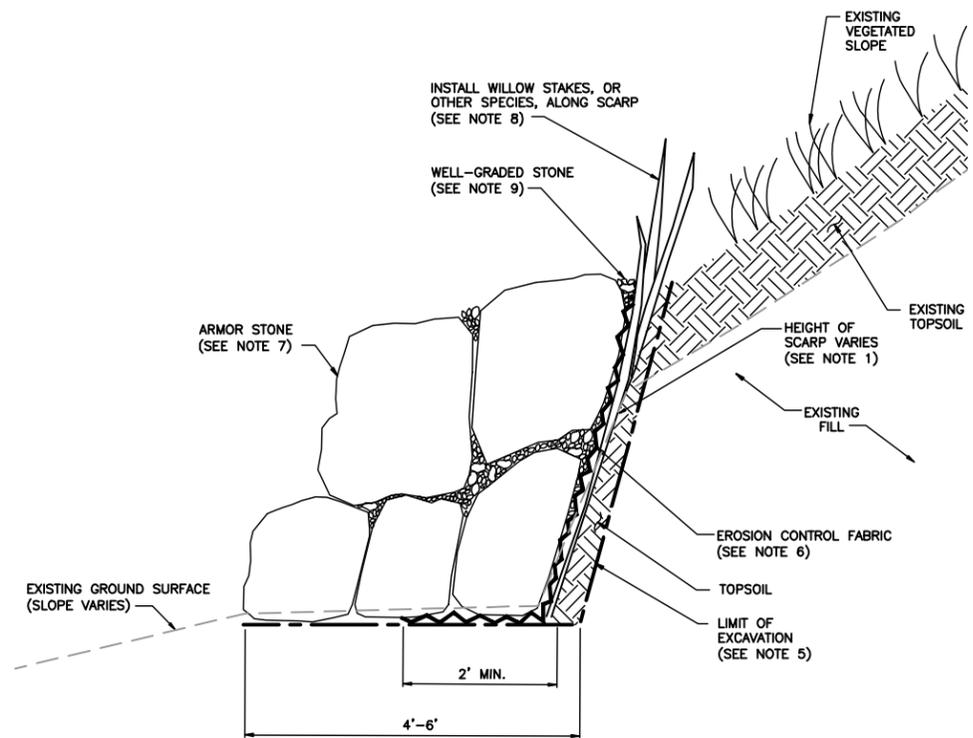
**PLAN**  
 80' 0 80'  
 SCALE: 1" = 80'

**WARNING:**  
 IT IS A VIOLATION OF SECTION 7209, SUBDIVISION 2, OF THE NEW YORK STATE EDUCATION LAW FOR ANY PERSON OTHER THAN WHOSE SEAL APPEARS ON THIS DRAWING, TO ALTER IN ANY WAY AN ITEM ON THIS DRAWING. IF AN ITEM IS ALTERED, THE ALTERING ENGINEER SHALL AFFIX TO THE ITEM HIS SEAL AND THE NOTATION "ALTERED BY" FOLLOWED BY HIS SIGNATURE AND THE DATE OF SUCH ALTERATION, AND A SPECIFIC DESCRIPTION OF THE ALTERATION.

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 JOB NO. 11174825.00000

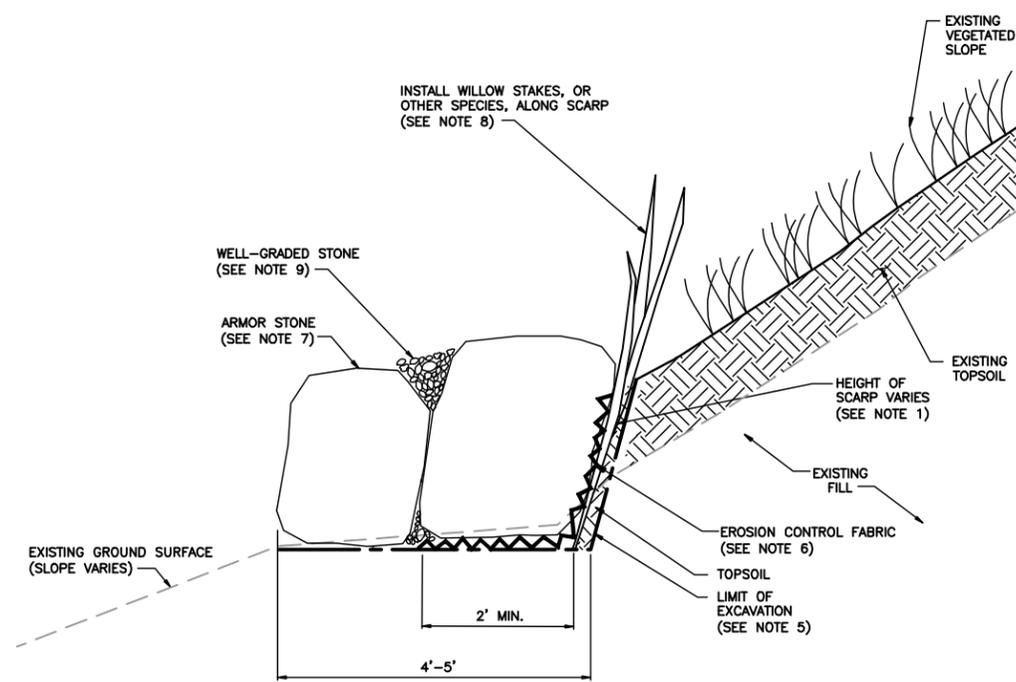
<b>Niagara Frontier Transportation Authority</b> Serving the Niagara Region				NFTA PROJECT NO. 12PL0202		
				SCALE - AS NOTED SEPT 2009		
<b>BELL SLIP</b> <b>CORRECTIVE ACTIONS FOR</b> <b>BANK STABILIZATION</b>				DESIGNED BY	MCD	SEPT. 2009
				DRAWN BY	ELB	SEPT. 2009
				CHECKED BY	JCW	SEPT. 2009
<b>PHASE I CORRECTIVE</b> <b>ACTION LIMITS</b>				DRAWING FILE NAME: ES-101.dwg		
				DRAWING # 2 OF 3		
				<b>ES-101</b>		

A:\11174825\0000\020\09-08-09\ES-101.dwg 9/29/09 RAB



**TYPICAL CORRECTIVE ACTION DETAIL  
(SCARP > 3' HEIGHT)**

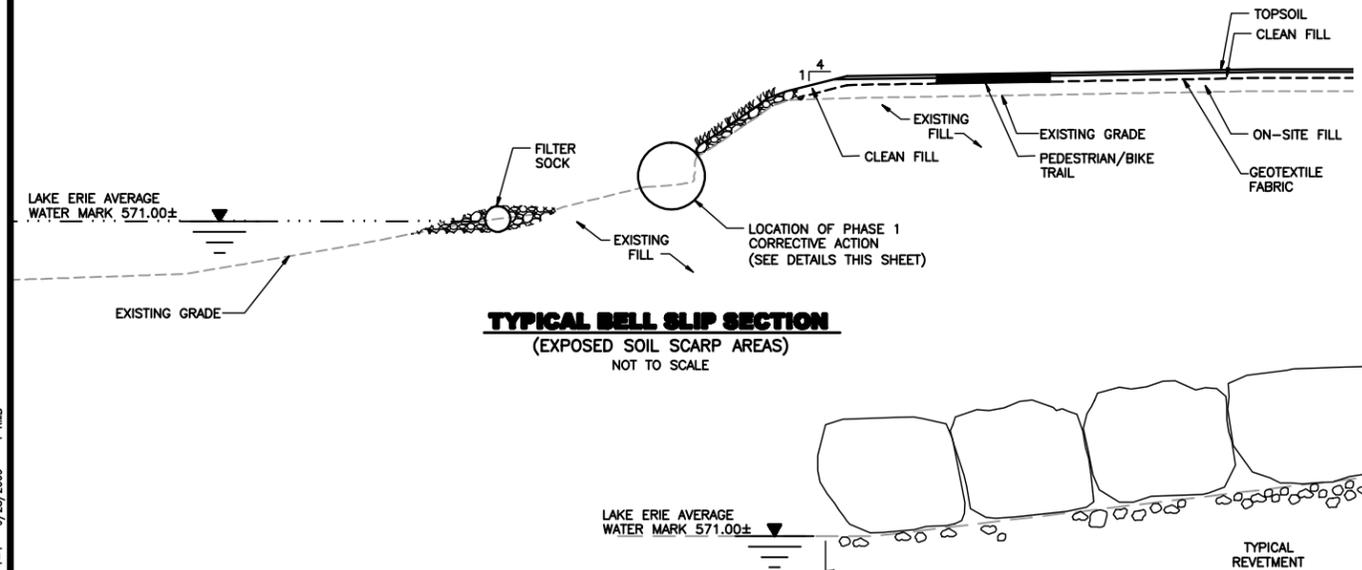
NOT TO SCALE



**TYPICAL CORRECTIVE ACTION DETAIL  
(SCARP < 3' HEIGHT)**

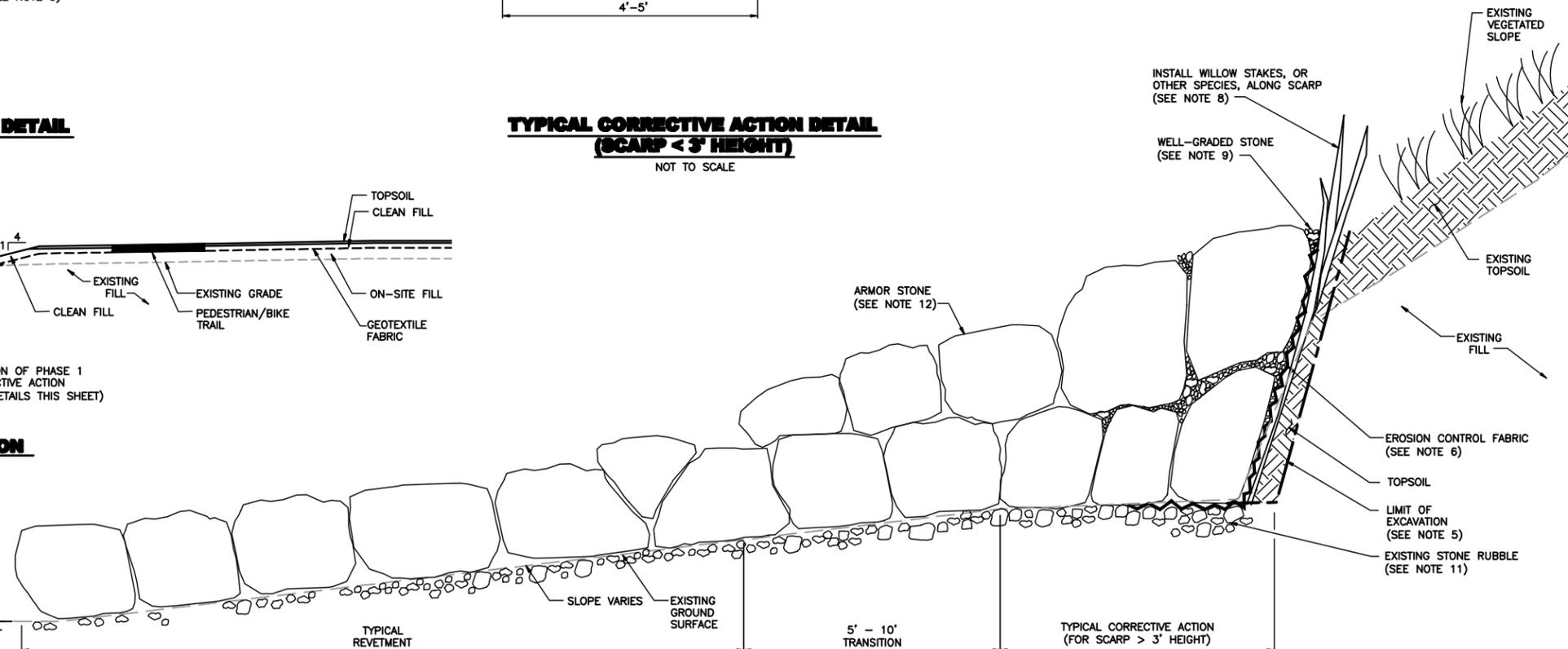
NOT TO SCALE

STONE SIZING TABLE							
ARMOR STONE				BEDDING STONE			
WEIGHT (lbs.)			LAYER THICKNESS (FT.)	WEIGHT (lbs.)			LAYER THICKNESS (FT.)
MAX.	MEDIAN	MIN.		MAX.	MEDIAN	MIN.	
1,900	1,400	1,100	3.0	20	5	1	1.0



**TYPICAL BELL SLIP SECTION  
(EXPOSED SOIL SCARP AREAS)**

NOT TO SCALE



**TYPICAL TRANSITION ZONE DETAIL**

NOT TO SCALE

WARNING:  
IT IS A VIOLATION OF SECTION 7209, SUBDIVISION 2, OF THE NEW YORK STATE EDUCATION LAW FOR ANY PERSON OTHER THAN WHOSE SEAL APPEARS ON THIS DRAWING, TO ALTER IN ANY WAY AN ITEM ON THIS DRAWING. IF AN ITEM IS ALTERED, THE ALTERING ENGINEER SHALL AFFIX TO THE ITEM HIS SEAL AND THE NOTATION "ALTERED BY" FOLLOWED BY HIS SIGNATURE AND THE DATE OF SUCH ALTERATION, AND A SPECIFIC DESCRIPTION OF THE ALTERATION.

1=1 9/28/2009 -1 RMB

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Consultant:  
**URS Corporation - New York**  
77 Gould Street, Buffalo, New York 14203  
(716)856-9036 phone (716)856-9545 fax  
JOB NO. 11174825.00000

Subconsultant:

**NFTA** Niagara Frontier Transportation Authority  
Serving the Niagara Region

NO.	REVISION	BY	DATE

NFTA PROJECT NO. 12PL0202  
**BELL SLIP  
CORRECTIVE ACTIONS FOR  
BANK STABILIZATION**  
PHASE 1 -  
CORRECTIVE ACTION DETAILS

SCALE - AS NOTED  
DESIGNED BY MCD SEPT. 2009  
DRAWN BY ELB SEPT. 2009  
CHECKED BY JCW SEPT. 2009  
DRAWING FILE NAME: ES-102.dwg  
DRAWING # 3 OF 3

**ES-102**

**ATTACHMENT A**

**SITE PHOTOGRAPHS  
(September 10, 2009)**

## Site Photographs



Photo 1: General view Area I (looking southwest).



Photo 2: General view Area II (looking southeast).

## Site Photographs



Photo 3: General view Area III (looking northwest).



Photo 4: General view Area IV (looking northwest).

## Site Photographs



Photo 5: Western portion of Area I, near outer stone revetment (looking west).



Photo 6: West-middle portion of Area I (looking west).

## Site Photographs



Photo 7: East-middle portion of Area I (looking west).



Photo 8: Eastern end of Area I (looking west).

## Site Photographs



Photo 9: Typical in-filled armor stone at eastern end of slip (looking south).



Photo 10: Typical in-filled armor stone at east end of slip (looking southeast).

## Site Photographs



Photo 11: Typical exposed soil scarp in Area II (looking north).



Photo 12: Typical exposed soil scarp in Area III (looking west).

## Site Photographs



Photo 13: Typical exposed soil scarp in Area IV (looking west).



Photo 14: Western end of Area IV near stone revetment (looking northwest).

**ATTACHMENT B**

**MEETING ATTENDANCE LIST  
(August 11, 2009)**

BELL SLIP MEETING

8/14/09

NAME	COMPANY	PHONE	E-MAIL
PAUL FUHRMANN	EXTE	684 8060	PFUHRMANN@ENE
BOB MURPHY	URS	923-1150	BOB.MURPHY@URS.COM
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JOHN N. DEBOLD	NFTA	855-7329	JOHN_DEBOLD@NFTA.COM
ANDREW ADAMS	NFTA	855-1360	ANDREW_ADAMS@NFTA.COM
Jim Looser	URS	216.622.2430	Jim_Looser@URS.COM
Martin DOSTER	NYSDEC	716.851.7220	
DAVID LOCEY	NYSDEC	" "	dplocey@gov.dec.state.ny.us
MIKE BYKOWSKI	NFTA	855-7389	michael_bykowski@NFTA.COM
DAVID DERRICK	CORPS	601-218-7717	DAVID.L.DERRICK@USACE.ARMY.MIL
TOM KRINS	E & E	684 8060	TKRINS@ENE.COM
DAVE PEPPER	MOT	807-8550	
JOHN STOCK	MOT	675-2365	
BOB HENSCHKE	URS	923-1225	bob_henschke@urscorp.com

# **ATTACHMENT C**

## **PRODUCT INFORMATION**

Home

Shop online

Erosion control mats

Sediment control products

Soil Bioengineering products

Wetland restoration products

Synthetic fabrics

Landscaping products

Hayracks & hanging baskets

Coir Liners & pots

Coir potting soil

Coir twine for hop

Coir doormats

Products installations

Directions

Product distribution

Supporting products

Raw coir fiber

Design tips

Current events

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## Soil Erosion Control Blankets and Mats

RoLanka offers a complete line of erosion mats for every application.

**Do it right the first time. Save money, time, our environment and have a piece of mind ! Always remember failures not only require reconstruction, but also create extremely expensive and irreversible damage to our ecosystem.**

**Coir (coconut fiber) is an abundant natural resource. One hundred percent biodegradable coir products are strong, durable and provide the most environmentally friendly solutions for today's erosion control needs.**

### Specifications

### Tips for success

#### Permanent Mats

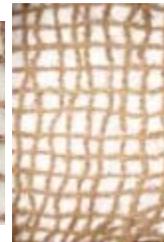
#### Semi-Permanent Mats Last 4-6 yrs Bristle coir woven mats



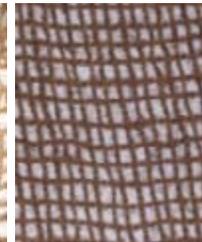
10 oz Synthetic TRM



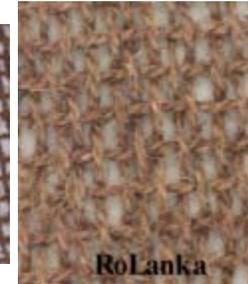
BioD-Mat 40



BioD-Mat 60



BioD-Mat 70



BioD-Mat 90

**Durable temporary mats**

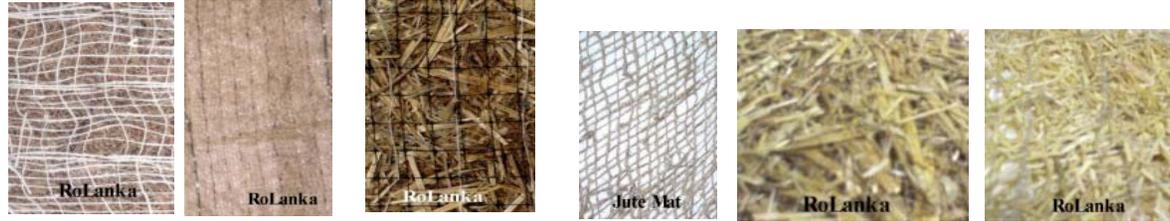
Last 9 - 18 months.

**Temporary mats**

Mattress coir stitched mats

Stitched straw/coir

----- Last only 6 - 9months -----



**BioD-OCF 30**

**BioD-SCF 30**

**StrawCocoMat**

**JuteMat**

**StrawMats**

**ExcelsiorMats**

### **Installation Instructions**

### **Applications**

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## BioD-Mat® 90

**Woven bristle coir erosion control blanket (weight 980 g/m<sup>2</sup>)**

**The most versatile, economical and effective erosion control mat for a variety of applications!**

[Print specification](#)

### Tips for success

**Perform better than most synthetic permanent mats as well as provide environmentally friendly erosion control. Strong, durable, yet 100% biodegradable.**



BioD-Mat 90 blanket is woven from machine-spun bristle coir twines. The 100% biodegradable, strong and durable bristle coir woven blankets provide higher resistance upon installation while supporting growth and development of vegetation. BioD-Mat 90 blanket has field functional longevity of 4-6 years. These blankets allow designers and specifiers to go beyond the design limits of other types of organic erosion control blankets. These strong, durable and biodegradable blankets play an important role in soil bioengineering. The open weave in the BioD-Mat 90 blanket allow seeding before and after installation. The 0.3" x 0.45" opening in the blanket allow planting plugs through the blanket without cutting the blanket. The 9.84 ft (3m) and 13 ft (4m) wide blankets have one seam.



### BioD-Mat 90 blanket is available in

- 3.28 ft. x83 ft = 30 SY/roll (1m x 25m =25 m<sup>2</sup>/roll)
- 6.56 ft x165 ft = 120 SY/roll (2m x 50m =100 m<sup>2</sup>/roll)
- 9.84 ft x165 ft = 180 SY/roll (3m x 50m =150 m<sup>2</sup>/roll)
- 13.1 ft x83 ft= 120 SY/roll (4m x 25m =100 m<sup>2</sup>/roll)

## General Specifications

### Advantages

- 100% biodegradable.
- Economical compared to synthetic mats.

The blankets shall be woven from coir twines. Coir twines shall be made of bristle coir obtained from freshwater cured coconut husks which shall be machine spun to a uniform diameter. The blanket shall also conform to the following properties.

Property	Test Method	BioD-Mat 90
Weight	ASTM D 3776	29 oz/SY ( 980 g / m <sup>2</sup> )
Tensile Strength <b>Dry</b>	ASTM D 4595	
Machine direction		2024 lbs/ft (29.6 kN/m)
Cross direction		1160 lbs/ft ( 17.0 kN/m)
Tensile Strength <b>Wet</b>	ASTM D 4595	
Machine direction		1776 lbs/ft (26 kN/m)
Cross direction		936 lbs/ft ( 13.7 kN/m)
Open area	Calculated	38%
Thickness	ASTM D1777	0.35 inch (9 mm)
Number of twines in the mat		
Machine direction		117 / yard (128 / m)
Cross direction		55 / yard (60 / m)
Recommended slope		>1:1
Recommended flow		16 fps (4.9 m/s)
Recommended shear stress		5 lbs /ft <sup>2</sup> (240 N/m <sup>2</sup> )
"C" factor		0.002

- Open weave allows re-seeding, when necessary.
- Easy to install and to walk on the mat.
- Wildlife will not feed on the mats.
- Higher resistance to UV light compared to synthetic mats.
- Open weave allows planting through the mat without cutting the mat.
- Coir twine move independently, create no threat to wildlife movement.
- Support establishing vegetation better than synthetic fiber.
- Woven from machine twisted bristle coir fiber twine; strong and durable.
- Hold moisture for seed germination and seedling growth.
- Higher tensile strength and provide initial support in bioengineering applications.
- Last 4 - 6 years and provide aesthetically pleasing applications.
- Made from freshwater cured bristle coir and dark brown in color.
- Higher wet tensile strength.



**Strong and durable BioD-Mat™ 90 blanket can be used in Wetland**

<b>Slopes</b> Can use on slopes up to 1:1	<b>Channels</b> Excellent mat for channel reformation.	<b>Soil Bioengineering</b> Variety of applications	<b>restoration</b> Excellent for planting through the mat
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[Manufacturer's Compliance](#)

[Design info](#)

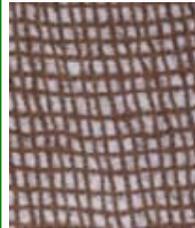
[Applications](#)

### [Installation Instructions](#)

## Open-weave semi-permanent erosion control mats

The best choice for effective and environmentally-friendly erosion control

Open weave bristle coir semi-permanent mat mats support vegetation establishment better than synthetic and composite TRMs.



BioD-Mat 70



BioD-Mat 90



Compare the difference in vegetation establishment.

Natural coir products, hold moisture and provide suitable medium for plant growth.

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