I. Introduction:

Hurricane Sandy unexpectedly hit Northeast Ohio with great force on October 29, 2012. The storm caused significant damage to the Lake Erie shoreline. One area that suffered significant damage was Burke Lakefront Airport in downtown Cleveland, OH. Burke sits right on the lakeshore and was pounded by large waves which damaged the protective rock revetment along the shoreline.

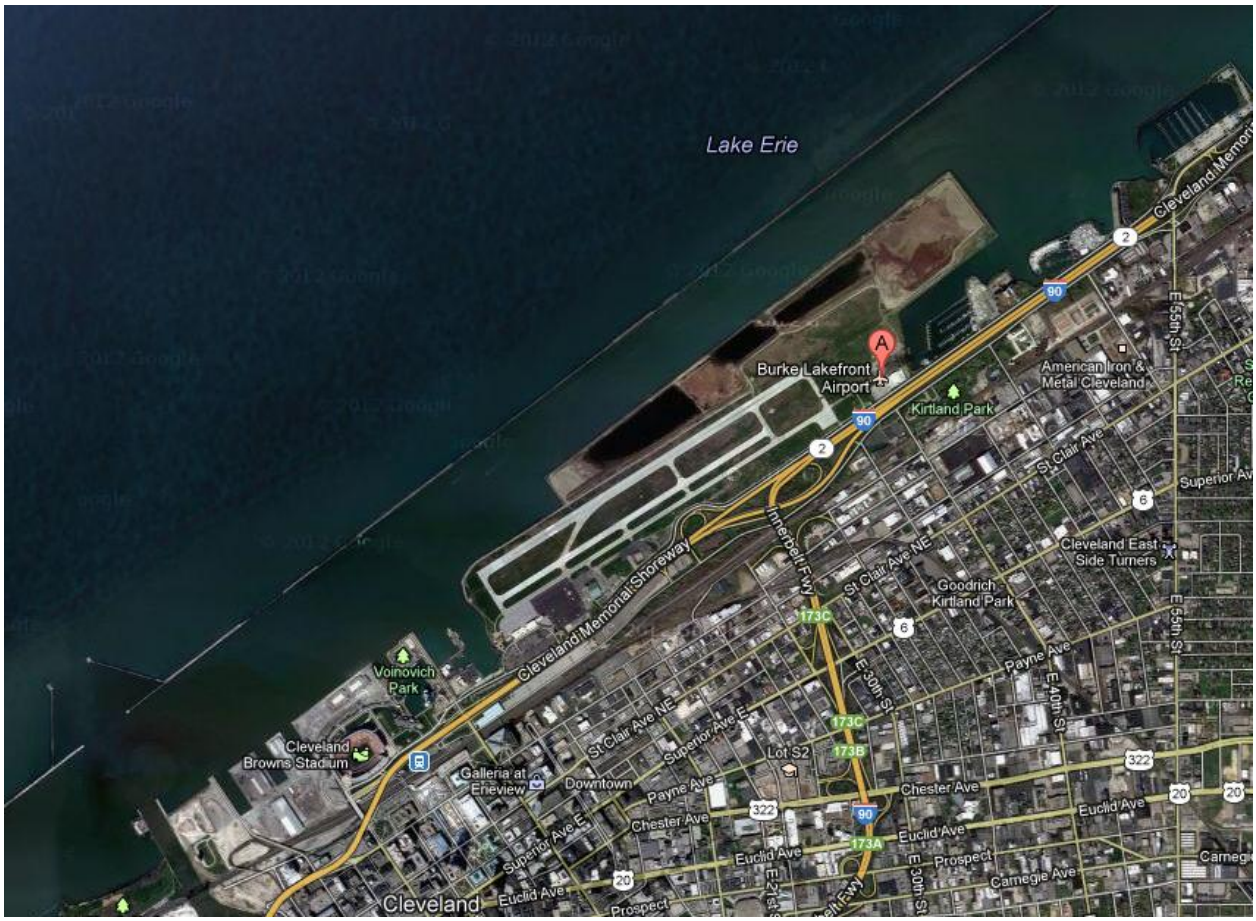

Figure 1: Location of Burke along the Lake Erie Shoreline

On Friday, March 22 representatives from The City of Cleveland, FEMA, and Parsons Brinckerhoff met to discuss the claim that Burke Lakefront Airport (BKL) has regarding the damage to the revetment in Lake Erie and the airfield caused by Hurricane Sandy. After the meeting, PB went out on the airfield and did a site investigation of the shoreline to assess the damage that occurred.

Parsons Brinckerhoff has given 3 grading scales for the shoreline inspection:

A = No damage apparent.

B= Damage to the stone present on the slope.

C= Damages are extensive with areas of little or no stone protecting the shoreline.

20 sections along the airfield were identified. The areas are marked on the ground with bright orange paint. See the accompanying pictures for each section. The sections are marked via stationing measured on the ground along the shoreline. Station 0+00 is the beginning point and this location is at the far eastern corner of the damaged revetment where the BKL shoreline meets the shoreline for the CDF 10 site operated by the US Army Corps of Engineers. The stationing extends to the west along the shoreline approximately 1,860 LF to Station 18+60. Every 300' (at stations 0+00, 3+00, 6+00, 9+00, 12+00, 15+00, and 18+00) a stake has been pounded in the ground and marked with orange paint. There is one section (Section 20) that is not stationed because of its distance from the last area of damage. This 200 LF section begins approximately 100' NW of the Localizer Shelter on the western edge of the airfield.

II. Scope of Services

The following scope items are required for the professional services required for the design and construction of the repaired revetment at Burke Lakefront Airport:

Scope of Work – Prior to Construction

Engineering consultant will work with the DPC to provide support services, related to the FEMA application process, including a field investigation and report, cost estimate of cost to repair in kind, cost estimate of cost to repair meeting current regulations and standards, cost estimate of cost to mitigate the revetment, figures, review of applicable standards and regulations, and recommendations.

Existing information to be obtained includes the following:

- Obtain and review data and reports from the Army Corps of Engineers (USACE) and others regarding the adjacent existing confined disposal facility (CDF) site.
    - Obtain and review data and reports from the Army Corps of Engineers (USACE) and others regarding the adjacent existing confined disposal facility (CDF) site.
    - Obtain original CDF 10B design analysis from USACE (including geotechnical and wave analysis) and design plans.
    - Obtain information on the existing combined sewer overflow pipes (or drainage pipes) from the Northeast Ohio Regional Sewer District (NEORSD)(or Cleveland Water Pollution Control) that could need to be extended or have their ends modified. Determine size and elevation of these pipes.
    - Obtain existing bathymetric survey information from USACE, if available.
    - Obtain available geotechnical information from the USACE 10B project and any existing BKL geotechnical information from DPC, including the current RSA project.
    - Obtain and review historical water level data (various).
- Survey of the BKL shoreline.
    - Licensed Land Surveyor will provide survey of shoreline area, including topography and utilities.
    - Bathymetric survey will provide the topographic information beneath Lake Erie required to meet ODNR and USACE wave analysis regulations.

- Aerial survey to enhance the topographic ground model.

Project Meetings

- Meeting with USACE regarding permit requirements (404) including obtaining recommendations for Nationwide and/or Individual permit application process.
- Meeting with Army Corps of Engineers to discuss how the 10B riprap armoring section performed during Hurricane Sandy.
- Meeting with the ODNR regarding the permitting requirements.
- Meeting with Ohio EPA regarding permit requirements, including stormwater regulations and 401 permit.
- Meetings with DPC regarding project, including meetings with FEMA project specialists and representatives.

Permitting

- Consulting engineering, environmental, and survey services will be required for preparation of the following permits and regulatory requirements:
  - USACE 404 Individual Permit
  - ODNR Shore Structure Permit
  - ODNR Submerged Lands Lease
    - Filing of Submerged Lands Lease with County Recorder's Office
  - Ohio EPA – 401 water quality certification
  - Ohio EPA – Notice of Intent (NOI) & Storm Water Pollution Prevention Plan (SWP3)
  - City of Cleveland Ordinance 573 Permit
  - City of Cleveland Division of Water Pollution Control Approval
  - FAA Form 7460 for construction within an airport's airspace

Design

- Obtain geotechnical information and make technical recommendations for shoreline armoring and typical section that would be needed based on subsurface conditions. Geotechnical field investigations including borings and sediment particle data will be required, from land and via watercraft.
- Review and determination of the impacts wave action would have on BKL. ODNR and USACE require wave analysis utilizing the bathymetric and topographic surveys.
- Develop typical sections based on structural stability calculations and materials. The revetment will include armor stone, toe protection stone, splash apron, and filter layer per ODNR and USACE design requirements.
- Develop site layout plan.
- Develop site grading plans. These plans will have areas that require changes to the ground around the revetment.
- Develop roadway repair plans.
- Determine recommended minimal distance per FAA regulations.
- Develop a preliminary project schedule for the engineered design and construction of the

BKL shoreline repair.

- Cost Benefit Analysis for a remediation alternative.
- Preparation of contract documents including detailed plans, schedule of quantities, and project specifications.

Scope of Work – During Construction

Ongoing professional engineering services related to answering questions during bidding, evaluating bids, and attending pre-bidding and pre-construction meetings will be required. Ongoing professional engineering services to answer requests for information, review contractor submittals, perform site visits, and attend periodic meetings throughout the period of construction.

Professional construction administration and construction inspection services related to the construction of the restored revetment will be required. These services are related to verifying the work is performed per bid documents and regulations; material testing; responding to RFIs and submittals; processing change orders; and resolving issues in the field.

Construction contractors will be required to repair and/or reconstruct portions of the BKL revetment per contract documents. The work is anticipated to include required permits and regulation compliance such as a Storm Water Pollution Prevention Plan and associated permit, landfill disposal permits, identification badges and/or escort fees for contractor access onto the restricted access airfield. Anticipated items of work include: site preparation; excavation; material disposal; material delivery; geotextile fabric; filter stone and armor stone; site drainage repair including drainage pipe cleanout, drainage pipe extension, or drainage pipe replacement; repair of the perimeter road including base course and surface course; embankment material and aggregate base; erosion and sedimentation control; dust control; maintenance of construction schedule; construction field office and temporary sanitation convenience facilities; survey and benchmarking; preparation of record drawings .

III. Cost Estimates

Repair Revetment to Meet Current Design Standards

Typical Section

The typical sections for the repair revetments at Burke Lakefront Airport follow the standards set in the *Ohio Coastal Design Manual: Guidance for Professionals designing structures along Lake Erie-First Edition (OCDM)* from 2011 published by the Ohio Department of Natural Resources (ODNR). This design manual follows the US Army Corps of Engineers' *Coastal Engineering Manual* (*CEM) (EM 1110-2-1100) and Design of Coastal Revetments, Seawalls, and Bulkheads (EM 1110-2-1614)*. Appendix A to this report is the Ohio Coastal Design Manual.

Figure 2 below from the OCDM shows an example of the typical section of a desired revetment.

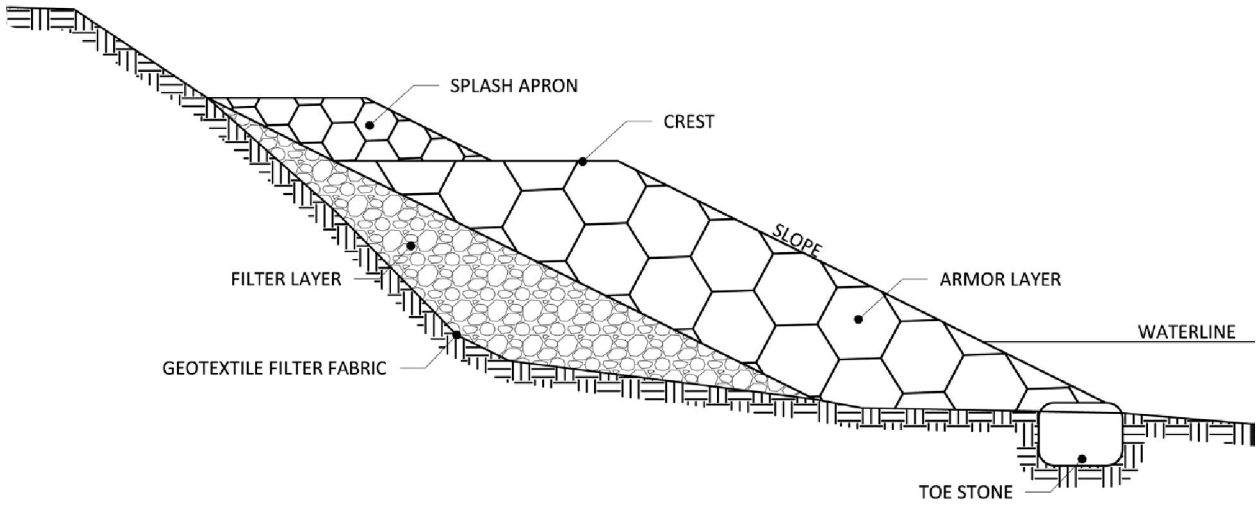

Figure 2: Typical Revetment Section (Source: ODNR OCDM)

The typical section for areas that require extensive repairs, and are classified as a Grade "C", is shown below. The revetments are required to have between a 1.5:1 and 2.5:1 slope. For estimating purposes, a 2:1 slope has been assumed for recreating the existing slope. This section has an exterior ODOT "A" stone which has a size range of the largest rocks from 18"-30" diameters with an average diameter of 24". The thickness of this layer is 2 times the average diameter of the stone which is 4'. The underlying rock is recommended to be an ODOT crushed aggregate slope protection (ODOT "C" Stone) which is predominately 2.5" to 4" diameter stones. The thickness of this layer is 2 times the average size of the stone with is 2'.

The section below in Figure 3 is the typical section used for the adjacent 10B CDF disposal site. This section was the basis for the estimate because it was specifically designed for this location on Lake Erie within the Cleveland Harbor area. The typical section below is the basis for our quantity calculation.

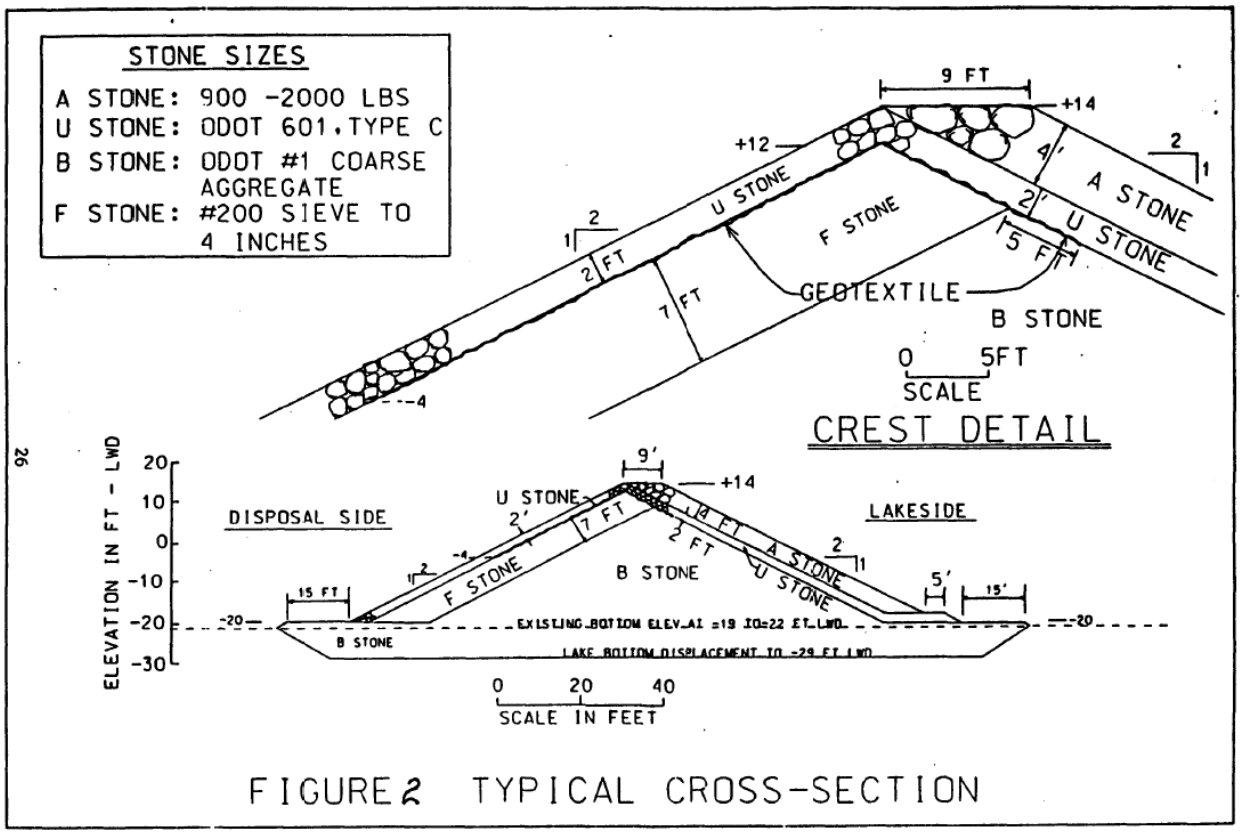

Figure 3: Typical Section for CDF-10 Site (adjacent property)

The assumption for areas given a grade of "B" will require less work than the Grade "C" areas. It is estimated that approximately 60% of the total slope will require ODOT "A" stone. This stone will be used to repair the revetment to a 2:1 slope. Underlying ODOT "C" stone will be required as needed which is estimated approximately per each area.

A typical section for the full remediation was drawn and shown in Figure 3 below. Information is provided below on the major cost drivers items in the scope of work. This estimate assumes:

Areas of Damage

- Areas measured off on March 25, 2013
- See OVERALL DAMAGE ASSESMENT in Section IV below.
- Total Length of Area Graded "C" = 1415 LF
- Total Length of Area Graded "B"= 700 LF

Permanent Item: ODOT "A" Stone

- Per each LF of shoreline it is assumed there is 253 SF of ODOT "A" stone needed for Grade "C" areas (See Figure 4).

- Each CY of ODOT "A" stone weighs approximately 2.5 tons
- For each linear foot of shoreline of Grade "C" condition, 23.5 Tons of ODOT "A" stone is needed.
- For each linear foot of shoreline of Grade "B" condition, 15.0 Tons of ODOT "A" stone is needed.
- A cost of $70 per ton was developed after talking to local quarries who supply this type of stone, calculating trucking and placement costs, and comparing this to the bid tabulation of the CDF 10B site.

Permanent Item: ODOT "C" Stone

- Per each LF of shoreline it is assumed there is 129 SF of ODOT "C" stone needed for a full support section, however, it assumed that 20% of existing material could be used as support material.
- Each CY of ODOT "C" stone weighs approximately 2.5 tons.
- For each linear foot of shoreline of Grade "C" condition, 10 Tons of ODOT "C" stone is needed.
- For each linear foot of shoreline of Grade "B" condition, it is assumed the existing rock will support, and 1 Ton of ODOT "C" stone is needed.
- A cost of $50 per ton was developed after talking to local quarries who supply this type of stone, calculating trucking and placement costs, and comparing this to the bid tabulation of the CDF 10B site.

Permanent Item: Areas of Fill for Roadway Settlement

- Each area is different size so it is a case by case basis.
- Assume that fill bottom of settlement area with 1' of ODOT "C" stone, and fill the rest with ODOT Item 304 aggregate base.
- For the ODOT Item 304 aggregate base, a cost of $20/ton was estimated from past projects of similar size and placement.

Non-Permanent Item: Excavation and Disposal

- For areas of Grade "C" assume that 10 CY per linear foot of excavation of unsuitable material.
- For areas of Grade "B" assume that 1 CY per linear foot of excavation of unsuitable material.
- All unsuitable material will be required to be taken to a permitted waste disposal site.
- The nearest disposal site to Burke Lakefront Airport is:
  Boyas Excavating, 11311 Rockside Road, Cleveland, OH 44125

- A cost of $19/CY was developed by looking at the following:
  - One truckload contains 10 CY
  - Burke to Dump Round Trip + Loading + Dump = 1.5 hrs * $75/hr = $112/load
  - Excavator+OP+Labor =$150/hr*15 min/load = $38/load
  - Dump Royalty Fee = $40/Load
  - Total: $190/load @ 10 CY/Load = $19/CY

Non-Permanent Item: Other Assumptions

- Erosion and Sediment Control will be 1% of Construction Costs
- Site Preparation will be 1.5% of Construction Costs
- Mobilization and Demobilization will be 5% of Construction Costs

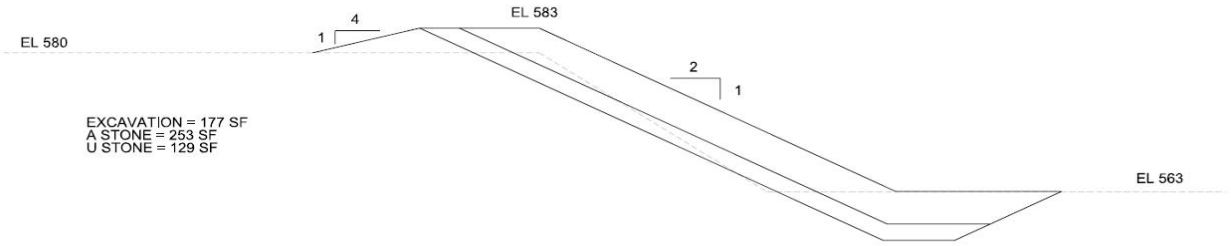

Figure 4: Typical Section Proposed Revetment up to ODNR Design Standards.

Figure 5 below is a cost estimate for repair the Burke Lakefront Airport Revetment to meet current design standards from ODNR and the US Army Corps of Engineers.

	Repair Revetment to ODNR/USACE Standards			
Permanent Items	Unit	Quantity	Unit Price	Total
Crushed Aggregate Base Course	TON	585	$40	$23,400
ODOT Type A Stone	TON	43752.5	$70	$3,062,675
Underlayer Stone (ODOT Type C)	TON	14850	$50	$742,500
Subtotal Permanent Items				***$3,828,575***
Non-Permanent Items	Unit	Quantity	Unit Price	Total
Mobilization and Demobilization (Assume 5% of Construction Cost)	LS	1	N/A	$191,429
Erosion & Sedimentation Control (1% of Construction Cost)	LS	1	N/A	$38,286
Site Preperation (1.5% of Construction Cost)	LS	1	N/A	$57,429
Excavation & Disposal	CY	14850	$19	$282,150
Subtotal Non-Permanent Items				***$569,293***
Total Estimated Project Cost (2013 Dollars)				**$4,397,868**

Figure 5: Cost Estimate for the Repair of BKL Revetment to ODNR/USACE Standards

Repair Revetment to Pre-Storm Conditions Only

Typical Section

The typical sections for the repair revetments at Burke Lakefront Airport to meet pre-storm conditions will not follow the standards set in the *Ohio Coastal Design Manual: Guidance for Professionals designing structures along Lake Erie-First Edition (OCDM), the* US Army Corps of Engineers' *Coastal Engineering Manual* (*CEM) (EM 1110-2-1100) and Design of Coastal Revetments, Seawalls, and Bulkheads (EM 1110-2-1614)*.

The existing section for the BKL revetment appears to have a 3' layer of large stone on top of layers of smaller stone. It is assumed that the exterior of the section has stone similar to the ODOT "A" stone that is recommended in previous section. The ODOT "A" stone has a size range of the largest rocks from 18"-30" diameters with an average diameter of 24". The thickness of this layer is less than the 2 times the average diameter of the stone which is 4'. The underlying rock is recommended to be an ODOT crushed aggregate slope protection (ODOT "C" Stone) which is predominately 2.5" to 4" diameter stones. The thickness of this layer is appears to be approximately 1.5'.

The assumption for areas given a grade of "B" will require less work than the Grade "C" areas. It is estimated that approximately 40% of the total slope will require ODOT "A" stone. This stone will be used to repair the revetment to its current slope. Underlying ODOT "C" stone will be required as needed which is estimated approximately per each area.

A typical section for the full remediation was drawn and shown in Figure 3 below. This estimate assumes:

<u>Areas of Damage</u>

- Areas measured off on March 25, 2013
- See OVERAL DAMAGE ASSESMENT in Section IV below.
- Total Length of Area Graded "C" = 1415 LF
- Total Length of Area Graded "B"= 700 LF

<u>Permanent Item: ODOT "A" Stone</u>

- Per each LF of shoreline it is assumed there is 150 SF of ODOT "A" stone needed for Grade "C" areas.
- Each CY of ODOT "A" stone weight 2.5 tons
- For each linear foot of shoreline of Grade "C" condition, 14 Tons of ODOT "A" stone is needed.
- For each linear foot of shoreline of Grade "B" condition, 10 Tons of ODOT "A" stone is needed.
- A cost of $70 per ton was developed after talking to local quarries who supply this type of stone, calculating trucking and placement costs, and comparing this to the bid tabulation so the CDF 10B site.

<u>Permanent Item: ODOT "C" Stone</u>

- Per each LF of shoreline it is assumed there is 77 SF of ODOT "C" stone needed for a full support section, however, it assumed that 20% of existing material could be used as support material.
- Each CY of ODOT "C" stone weighs 2.5 tons.
- For each linear foot of shoreline of Grade "C" condition, 6 Tons of ODOT "C" stone is needed.
- For each linear foot of shoreline of Grade "B" condition, it is assumed the existing rock will support, and 0.5 Ton of ODOT "C" stone is needed.
- A cost of $50 per ton was developed after talking to local quarries who supply this type of stone, calculating trucking and placement costs, and comparing this to the bid tabulation so the CDF 10B site.

Permanent Item: Areas of Fill for Roadway Settlement

- Each area is different size so it is a case by case basis.
- Assume that fill bottom of settlement area with 1' of ODOT "C" stone, and fill the rest with ODOT Item 304 aggregate base.
- For the ODOT Item 304 aggregate base, a cost of $20/ton was estimated from past projects of similar size and placement.

Non-Permanent Item: Excavation and Disposal

- For areas of Grade "C" assume that 6 CY per linear foot of excavation of unsuitable material.
- For areas of Grade "B" assume that 0.5 CY per linear foot of excavation of unsuitable material.
- All unsuitable material will be required to be taken to a permitted waste disposal site.
- The nearest disposal site to Burke Lakefront Airport is:
  Boyas Excavating, 11311 Rockside Road, Cleveland, OH 44125

- A cost of $19/CY was developed by looking at the following:
  - One truckload contains 10 CY
  - Burke to Dump Round Trip + Loading + Dump = 1.5 hrs * $75/hr = $112/load
  - Excavator+OP+Labor =$150/hr*15 min/load = $38/load
  - Dump Royalty Fee = $40/Load
  - Total: $190/load @ 10 CY/Load = $19/CY

Non-Permanent Item: Other Assumptions

- Erosion and Sediment Control will be 1% of Construction Costs
- Site Preparation will be 1.5% of Construction Costs
- Mobilization and Demobilization will be 5% of Construction Costs

Figure 6 below is a cost estimate for repair the Burke Lakefront Airport Revetment to meet current design standards from ODNR and the US Army Corps of Engineers.

	Repair Revetment to Pre-Storm Condition Only			
Permanent Items	Unit	Quantity	Unit Price	Total
Crushed Aggregate Base Course	TON	585	$20	$11,700
ODOT Type A Stone	TON	26810	$70	$1,876,700
Underlayer Stone (ODOT Type C)	TON	8840	$50	$442,000
Subtotal Permanent Items				***$2,330,400***

Non-Permanent Items	Unit	Quantity	Unit Price	Total
Mobilization and Demobilization (Assume 5% of Construction Cost)	LS	1	N/A	$191,429
Erosion & Sedimentation Control (1% of Construction Cost)	LS	1	N/A	$38,286
Site Preperation (1.5% of Construction Cost)	LS	1	N/A	$57,429
Excavation & Disposal	CY	8840	$19	$167,960
Subtotal Non-Permanent Items				***$455,103***

Total Estimated Project Cost (2013 Dollars)	**$2,785,503**

Figure 6: Cost Estimate for the Repair of BKL Revetment to Pre-Storm Condition Only

Repair Revetment for Mitigation Against Damage From Future Storms

Typical Section

The typical section for the repair of the revetment at Burke Lakefront Airport that will provide mitigation against potential future storm damage follow the standards set in the *Ohio Coastal Design Manual: Guidance for Professionals designing structures along Lake Erie-First Edition (OCDM)* from 2011 published by the Ohio Department of Natural Resources (ODNR). This design manual follows the US Army Corps of Engineers' *Coastal Engineering Manual* (*CEM) (EM 1110-2-1100) and Design of Coastal Revetments, Seawalls, and Bulkheads (EM 1110-2-1614)*. Appendix A to this report is the Ohio Coastal Design Manual.

Figure 2 above from the OCDM shows an example of the typical section of a desired revetment.

The typical section for the extensive repair of the revetment to provide mitigation against future storm damage is shown in Figure 7. The revetments are required to have between a 1.5:1 and 2.5:1 slope. For estimating purposes, a 2:1 slope has been assumed for recreating the existing slope. This section has an exterior ODOT "A" stone which has a size range of the largest rocks from 18"-30" diameters with an average diameter of 24". The thickness of this layer is 2 times the average diameter of the stone which is 4'. The underlying rock is recommended to be an ODOT crushed aggregate slope protection (ODOT "C" Stone) which is predominately 2.5" to 4" diameter stones. The thickness of this layer is 2 times the average size of the stone with is 2'.

The section below in Figure 6 is the typical section used for the adjacent 10B CDF disposal site. This section was the basis for the estimate because it was specifically designed for this location on Lake Erie within the Cleveland Harbor area. The typical section below is the basis for our quantity calculation.

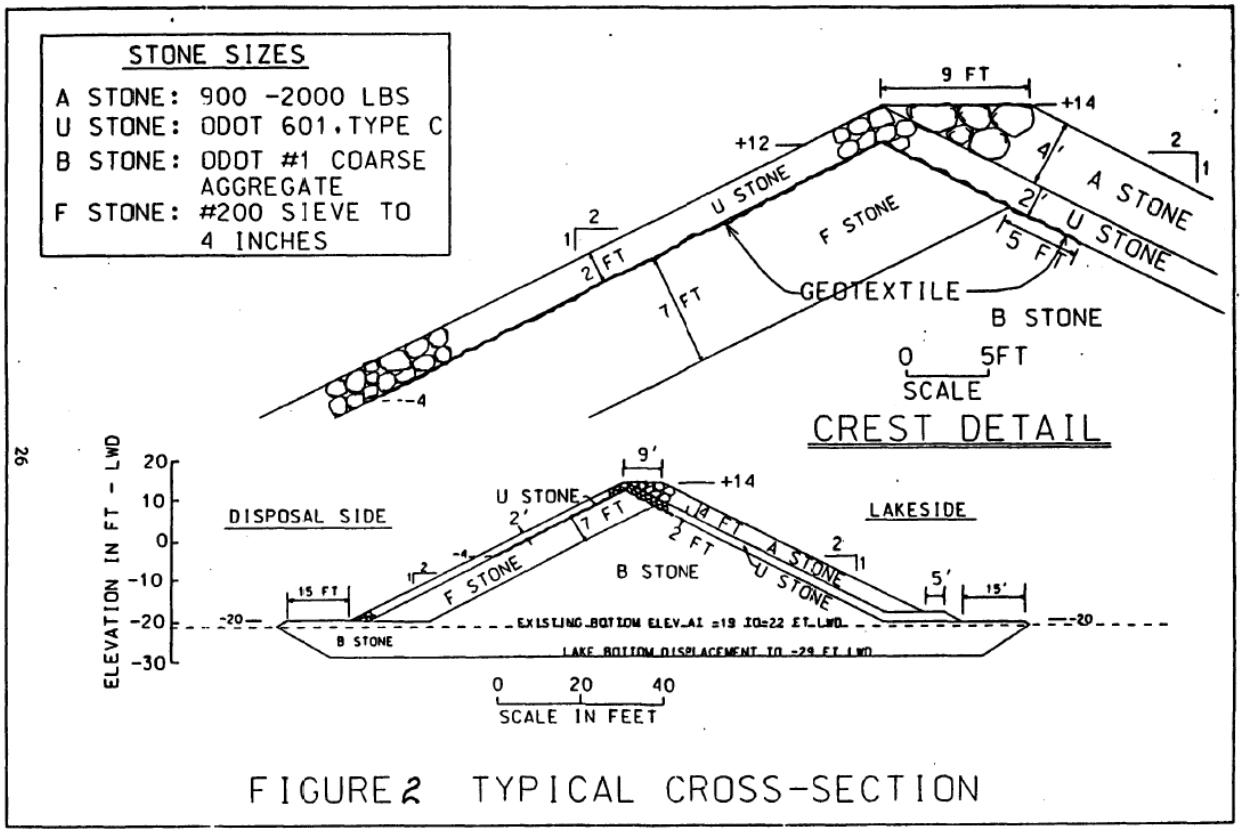

Figure 7: Typical Section for CDF-10 Site (adjacent property)

A typical section for the full remediation was drawn and shown in Figure 4 above. This estimate assumes:

Areas of Damage

- Length of area require complete remediation construction is = 1800 LF

Permanent Item: ODOT "A" Stone

- Per each LF of shoreline it is assumed there is 253 SF of ODOT "A" stone needed (See Figure 3).
- Each CY of ODOT "A" stone weight 2.5 tons
- For each linear foot of shoreline, 23.5 Tons of ODOT "A" stone is needed.

- A cost of $70 per ton was developed after talking to local quarries who supply this type of stone, calculating trucking and placement costs, and comparing this to the bid tabulation so the CDF 10B site.

Permanent Item: ODOT "C" Stone

- Per each LF of shoreline it is assumed there is 129 SF of ODOT "C" stone needed.
- Each CY of ODOT "C" stone weighs 2.5 tons.
- For each linear foot of shoreline, 12 Tons of ODOT "C" stone is needed.
- A cost of $50 per ton was developed after talking to local quarries who supply this type of stone, calculating trucking and placement costs, and comparing this to the bid tabulation so the CDF 10B site.

Permanent Item: Geotextile Fabric

- Assume 15 SY of Geotextile fabric is needed per linear foot of shoreline.

Permanent Item: Storm Sewers

- Two storm sewers currently discharge through the revetment.
- Each storm sewer would require 10' extension to allow the discharge point to be past the revetment.
- Each storm sewer would require a new end section with grate to protect pipe from debris from the lake.
- The storm sewers have diameters of 36" and 42", respectively.

Non-Permanent Item: Excavation and Disposal

- Assume that 12 CY per linear foot of excavation of unsuitable material.
- All unsuitable material will be required to be taken to a permitted waste disposal site.
- The nearest disposal site to Burke Lakefront Airport is:
  Boyas Excavating, 11311 Rockside Road, Cleveland, OH 44125

- A cost of $19/CY was developed by looking at the following:
  - One truckload contains 10 CY
  - Burke to Dump Round Trip + Loading + Dump = 1.5 hrs * $75/hr = $112/load
  - Excavator+OP+Labor =$150/hr*15 min/load = $38/load
  - Dump Royalty Fee = $40/Load
  - Total: $190/load @ 10 CY/Load = $19/CY

Non-Permanent Item: Other Assumptions

- Erosion and Sediment Control will be 1% of Construction Costs
- Site Preparation will be 1.5% of Construction Costs
- Mobilization and Demobilization will be 5% of Construction Costs

Figure 8 below is a cost estimate for repair the Burke Lakefront Airport Revetment to mitigate against future storm damage s from ODNR and the US Army Corps of Engineers.

Figure 8: Cost Estimate for the Repair of BKL Revetment to Mitigate Against Future Storms

	Repair of Revetment to Mitigate Against Future Storms			
Permanent Items	Unit	Quantity	Unit Price	Total
Geotextile	SY	25000	$3	$75,000
Crushed Aggregate Base Course	TON	585	$40	$23,400
ODOT Type A Stone	TON	47000	$70	$3,290,000
Underlayer Stone (ODOT Type C)	TON	24000	$50	$1,200,000
Connections to existing pipes	EA	2	$5,000	$10,000
Extend 36" Dia Pipe	LF	10	$600	$6,000
Extend 42" Dia Pipe	LF	10	$700	$7,000
End Section (36" & 42" Dia)	EA	2	$10,000	$20,000
Topsoil and Seeding	ACRE	1.5	$30,000	$45,000
Subtotal Permanent Items				***$4,676,400***

Non-Permanent Items	Unit	Quantity	Unit Price	Total
Mobilization and Demobilization (Assume 5% of Construction Cost)	LS	1	N/A	$233,820
Erosion & Sedimentation Control (1% of Construction Cost)	LS	1	N/A	$46,764
Site Preparation (1.5% of Construction Cost)	LS	1	N/A	$70,146
Excavation & Disposal	CY	23000	$19	$437,000
Subtotal Permanent Items				***$787,730***

Total Estimated Project Cost (2013 Dollars)	**$5,464,130**

Figure 9 below shows a comparative costs for the three estimates.

	Summary of Cost Estimates		
	Permanent Items	Non-Permanent Items	Total
Repair Revetment to Pre-Storm Condition Only	$ 2,330,400	$ 455,103	**$ 2,785,503**
Repair Revetment to ODNR/USACE Standards	$ 3,828,575	$ 569,293	**$ 4,397,868**
Repair of Revetment to Mitigate Against Future Storms	$ 4,676,400	$ 787,730	**$ 5,464,130**

Figure 9: Comparison of the Three Construction Cost Estimates

Attached in Appendix B is the complete cost estimates broken down by sections described in Section IV below.

IV. Overall Damage Assessment:

Below are the descriptions of the damage that has occurred along the Burke Lakefront Airport shoreline and recommendations for each area.

Section 1: Station 0+00 to 0+30 - Grade "C"

Total Linear Footage of Shoreline: 30 LF

There is extensive damage on the top of the slope with no slope protection at the top of the revetment. There is little protection of the top of slope which will lead to more erosion and undercutting of the airfield.

RECOMMENDATION FOR THIS AREA: Since there is little structural support and damage is extensive, we recommend that new Type A stone be placed at a 2:1 slope from the top of slope to the lake bed. This should be placed on-top of the existing revetment. Some loose or unstable rocks should be removed, and new core material should be added.

Section 2: Station 0+30 to 0+75 - Grade "B"

Total Linear Footage of Shoreline: 45 LF

This section exhibits damage but with stone present on the slope. It will require additional shoring up such as addition of new armor stone along the slope.

RECOMMENDATION FOR THIS AREA: Add new Type A stone in areas that require additional shoring. Relocate existing stone in areas that are unstable. Add some select core material to provide strength under existing and new armor stone.

Section 3: Station 0+75 to 1+50- Grade "C"

Total Linear Footage of Shoreline: 75 LF

There is significant damage on the top of the slope with no slope protection at the top of the revetment. There is little protection of the top of slope which will lead to more erosion and undercutting of the airfield.

RECOMMENDATION FOR THIS AREA: Since there is little structural support and damage is extensive, we recommend that new Type A stone be placed at a 2:1 slope from the top of slope to the lake bed. This should be placed on-top of existing revetment. Some loose or unstable rocks should be removed, and new core material should be added.

Section 4: Station 1+50 to 2+10- Grade "B"

Total Linear Footage of Shoreline: 60 LF

This section exhibits damage but with stone present on the slope. It will require additional shoring up such as addition of new armor stone along the slope.

RECOMMENDATION FOR THIS AREA: Add new Type A stone in areas that require additional shoring. Relocate existing stone in areas that are unstable. Add some select core material to provide strength under existing and new armor stone.

Section 5: Station 2+10 to 3+20- Grade "C"

Total Linear Footage of Shoreline: 110 LF

Severe damage on top of revetment and undercutting of the perimeter road. There are portions of the protective large rocks that have no underlying stone providing no support to the protective stone.

Station 3+00 to 3+20- Grade "C"

There are several large stones that are cantilevered in the air with nothing underneath to protect them. Severe damage and little stone protection at the top of the slope.

RECOMMENDATION FOR THIS AREA: Since there is little structural support and damage is extensive, we recommend that new Type A stone be placed at a 2:1 slope from the top of slope to the lake bed. This should be placed on-top of existing revetment. Where there are large cantilevered rocks with no support, these rocks should be removed and put back with proper support under them. Where there is undercutting, additional granular fill needs to be added to provide strength for the roadway. New roadway surface is needed.Section 6: Station 3+20 to 4+00- Grade "B"

Total Linear Footage of Shoreline: 80 LF

This section exhibits damage but with stone present on the slope. It will require additional shoring up such as addition of new armor stone along the slope.

RECOMMENDATION FOR THIS AREA: Add new Type A stone in areas that require additional shoring. Relocate existing stone in areas that are unstable. Add some select core material to provide strength under existing and new armor stone.

Section 7: Station 4+00 to 4+95- Grade "C"

Total Linear Footage of Shoreline: 95 LF

Extensive undercutting of the support stone with no slope stabilization. There are portions of the protective large rocks that have no underlying stone providing no support to the protective stone.

RECOMMENDATION FOR THIS AREA: Since there is little structural support and damage is extensive, we recommend that new Type A stone be placed at a 2:1 slope from the top of slope to the lake bed. This should be placed on-top of existing revetment. Where there are large cantilevered rocks with no support, these rocks should be removed and put back with proper support under them.

Section 8: Station 4+95 to 5+45- Grade "B"

Total Linear Footage of Shoreline: 50 LF

This section exhibits damage but with stone present on the slope. It will require additional shoring up such as addition of new armor stone along the slope.

RECOMMENDATION FOR THIS AREA: Add new Type A stone in areas that require additional shoring. Relocate existing stone in areas that are unstable. Add some select core material to provide strength under existing and new armor stone.

Section 9: Station 5+45 to 6+00- Grade "C"

Total Linear Footage of Shoreline: 55 LF

Undercutting of roadway is evident. No top of slope protection. Several areas with shear drop-offs into the lake (~8')

Since there is little structural support and damage is extensive, we recommend that new Type A stone be placed at a 2:1 slope from the top of slope to the lake bed. This should be placed on-top of existing revetment. This section will require significant core material added under the Type A stone. Where there is undercutting, additional granular fill needs to be added to provide strength for the roadway. New roadway surface is needed.

Section 10: Station 6+00 to Station 7+10- Grade "B"

Total Linear Footage of Shoreline: 110 LF

This section exhibits damage but with stone present on the slope. It will require additional shoring up such as addition of new armor stone along the slope.

Station 6+50 to 7+10- Grade "B"

Fix top of slope. Large stones at the bottom can provide support.

RECOMMENDATION FOR THIS AREA: Add new Type A stone in areas that require additional shoring. Relocate existing stone in areas that are unstable. Add some select core material to provide strength under existing and new armor stone.

Section 11: Station 7+10 to 7+40- Grade "C"

Total Linear Footage of Shoreline: 30 LF

No shoreline protection at the one point. Severe undercutting. No top of slope protection. Several areas with shear drop-offs into the lake.

Since there is little structural support and damage is extensive, we recommend that new Type A stone be placed at a 2:1 slope from the top of slope to the lake bed. This should be placed on-top of existing revetment. This section will require significant core material added under the Type A stone.

Section 12: Station 7+40 to 8+60- Grade "B"

Total Linear Footage of Shoreline: 120 LF

This section exhibits damage but with stone present on the slope. It will require additional shoring up such as addition of new armor stone along the slope. Top of revetment needs repair.

RECOMMENDATION FOR THIS AREA: Add new Type A stone in areas that require additional shoring. Relocate existing stone in areas that are unstable. Add some select core material to provide strength under existing and new armor stone.

Section 13: Station 8+60 to 12+30- Grade "C"

Total Linear Footage of Shoreline: 370 LF

Station 8+60 to 11+00- Grade "C"

Severe undercutting of slope and roadway. No top of slope protection. Several areas with shear drop-offs into the lake.

Station 11+00 to 12+30- Grade "C"

Severe undercutting of slope and roadway. Severe undercutting. No top of slope protection. Several areas with shear drop-offs into the lake. No support for the slope which will cause further erosion.

RECOMMENDATION FOR THIS AREA: Since there is little structural support and damage is extensive, we recommend that new Type A stone be placed at a 2:1 slope from the top of slope to the lake bed. This should be placed on-top of existing revetment. This section will require significant core material added under the Type A stone. Where there is undercutting, additional granular fill needs to be added to provide strength for the roadway. New roadway surface is needed.

Section 14: Station 12+30 to 12+40- Grade "B"

Total Linear Footage of Shoreline: 10 LF

This exhibits damage but with stone present on the slope. It will require additional shoring up such as addition of new armor stone along the slope. Top of revetment needs repair.

RECOMMENDATION FOR THIS AREA: Add new Type A stone in areas that require additional shoring. Relocate existing stone in areas that are unstable. Add some select core material to provide strength under existing and new armor stone.

Section 15: Station 12+40 – Grade "C"

Total Linear Footage of Shoreline: 5 LF

Large hole in area, and large rocks are unsupported in this area. Needs significant repair.

RECOMMENDATION FOR THIS AREA: Since there is little structural support and damage is extensive, we recommend that new Type A stone be placed at a 2:1 slope from the top of slope to the lake bed. This should be placed on-top of existing revetment. Where there are large cantilevered rocks with no support, these rocks should be removed and put back with proper support under them.

Section 16: Station 12+40 to 13+10- Grade "B"

Total Linear Footage of Shoreline: 70 LF

This section exhibits damage but with stone present on the slope. It will require additional shoring up such as addition of new armor stone along the slope. Top of revetment needs repair.

RECOMMENDATION FOR THIS AREA: Add new Type A stone in areas that require additional shoring. Relocate existing stone in areas that are unstable. Add some select core material to provide strength under existing and new armor stone.

Section 17: Station 13+10 to 16+45 – Grade "C"

Total Linear Footage of Shoreline: 335 LF

No support on slope. Needs significant additional protection on top to repair the area.

Station 13+60 to 15+00- Grade "C"

The slope has not failed, however, no support at bottom and steep sheer slopes. Pieces are large rectangle concrete slabs on steep slopes with little support.

Station 15+00 to 16+45-Grade "C"

No support in this section with portions of the slope sliding into the lake.

RECOMMENDATION FOR THIS AREA: Since there is little structural support and damage is extensive, we recommend that new Type A stone be placed at a 2:1 slope from the top of slope to the lake bed. This should be placed on-top of existing revetment. Where there are large cantilevered rocks with no support, these rocks should be removed and put back with proper support under them.

Section 18: Station 16+45 to 18+00- Grade "B"

Total Linear Footage of Shoreline: 155 LF

Some undercutting but with stone present on the slope. Shoreline protection is at a very steep slope.

RECOMMENDATION FOR THIS AREA: Add new Type A stone in areas that require additional shoring. Relocate existing stone in areas that are unstable. Add some select core material to provide strength under existing and new armor stone.

Section 19: Station 18+00 to 18+60- Grade "C"

Total Linear Footage of Shoreline: 60 LF

Severe undercutting with extensive settlement voids in the armoring.

RECOMMENDATION FOR THIS AREA: Since there is little structural support and damage is extensive, we recommend that new Type A stone be placed at a 2:1 slope from the top of slope to the lake bed. This should be placed on-top of existing revetment.

Section 20: Portions along the west edge of property by Localizer Shelter– Grade "C"

Total Linear Footage of Shoreline: 200 LF

Severe damage evident. Several areas of undercut with no shoreline protection. Total of about 200 LF of area needing restoration.

RECOMMENDATION FOR THIS AREA: Since there is little structural support and damage is extensive, we recommend that new Type A stone be placed at a 2:1 slope from the top of slope to the lake bed. This should be placed on-top of existing revetment.