FINAL PHASE 1 MARSH MONITORING INSPECTION REPORT FOR ALCOA RESTORATION MARSH ON POWDERHORN LAKE

Prepared for:

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December 2008

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

In accordance with the Alcoa Consent Decree and Marsh Implementation Plan (2004), Alcoa constructed a 69.3 acre intertidal saltmarsh on the north shore of Powderhorn Lake in Calhoun County, Texas; on the eastern edge of the Aransas Wildlife Refuge. At the end of the first growing season (December 2006), Alcoa conducted a Phase 1 Vegetation Survival Survey to determine if vegetation survival criteria had been achieved. The vegetation survival survey was the first in a series of Phase 1 Monitoring Events specified in the Alcoa Consent Decree and Marsh Implementation Plan (2004).

Alcoa conducted its first Annual Phase 1 Marsh Monitoring Inspection in December 2007 and submitted a monitoring report in February 2008. The purpose of that inspection was to determine if marsh growth and development was progressing normally and to determine if additional corrective action was necessary. Corrective action was required in October of 2007 to reduce erosion across the transition zone. The results of that approved action were documented in the 2007 Annual Phase 1 Monitoring Inspection report (February 2008).

Alcoa conducted the Final Phase 1 Marsh Monitoring Inspection on 2 December 2008, at the end of the third growing season. The primary objective of this inspection was to determine if all of the Phase 1 performance criteria, specified in the Marsh Implementation Plan (3.1 Performance Criteria), had been achieved and to document the condition of the marsh before the project enters Phase 2 (the final monitoring phase).

This report presents the results of the 2008 Final Phase 1 Marsh Monitoring Inspection as required by the Consent Decree and Marsh Implementation Plan, and completes Phase 1 of the Marsh Monitoring Program.

1.2 PERFORMANCE CRITERIA

Performance criteria define short-term milestones that, if met, will provide reasonable assurance of project success in the long term. Monitoring provides information necessary to determine whether the project is trending toward these milestones or whether corrective action may be

appropriate. Performance Criteria for this project as specified in the Marsh Implementation Plan (MIP) are listed below.

3.1 Performance Criteria

a. Phase 1 - The performance criterion for Phase 1 is growth of emergent marsh vegetation that results in achievement of the "Phase 1 Milestone". The Phase 1 Milestone shall be considered achieved when the planted areas of the constructed marsh, on average, have at least 75% foliar cover in the Onshore Marsh and at least 75% foliar cover in the Offshore Marsh.

b. Phase 2 – The performance criterion for Phase 2 is sustained life of emergent marsh vegetation that results in achievement of the "Phase 2 Milestone ." Once the Phase 1 Milestone is achieved, the project will enter Phase 2 monitoring which will continue until the Phase 2 Milestone is achieved. The Phase 2 Milestone is achieved when the planted areas of the constructed marsh, on average, continue to have at least 75% foliar cover and this condition is maintained without Major Corrective Action for a period of two (2) years.

c. In determining whether the Phase 1 Milestone or the Phase 2 Milestone has been achieved, the following additional criteria must be met:

(i) The foliar cover of acceptable plant species (as identified at Section 3.2.5) must be approximately 90% of the total foliar cover estimate;

(ii) Primary channels must be open and free flowing, without substantial sediment buildup or evidence of closure;

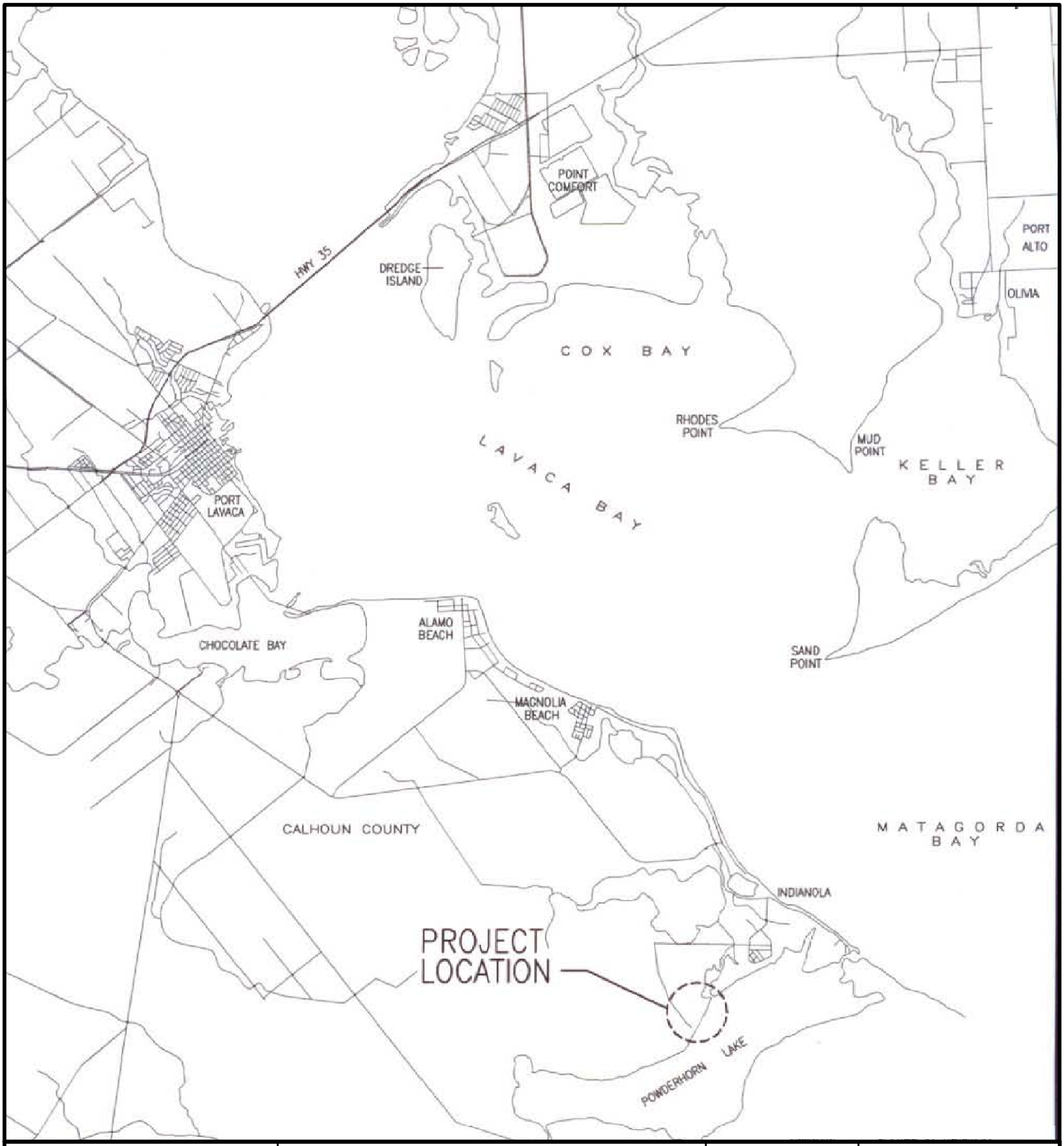
(iii) The minimum water depth at average low water level shall be no less than 0.5 ft in the primary channels, and secondary channels must provide water flow at average high water, but need not contain standing water at average low water level;

(iv) Approximately 45 acres of emergent marsh must be present based on aerial photo review.

d. Maintenance of compliance with construction criteria shall not be required following Certification of Marsh Construction and shall not be a performance criterion.

1.3 SITE DESCRIPTION

The Alcoa Marsh was constructed on the north shore of Powderhorn Lake in Calhoun County, Texas. The project occupies approximately 70 acres on the eastern edge of the Myrtle Whitmire Foester Division of the Aransas National Wildlife Refuge (Figure 1). The project is located approximately 15 miles southeast of Port Lavaca on Highway 316, and west of the town of Indianola. A 30.3-acre portion of the marsh was constructed on existing coastal uplands, and is located on refuge property. A 39-acre portion of the marsh was constructed on submerged bay bottom in Powderhorn Lake and is located on property owned by the Texas General Land Office (TGLO). The Alcoa constructed marsh, once certified, will be managed by the United States Fish and Wildlife Service (USFWS).



N

Legend

Notes

Alcoa
Point Comfort Operations

Final Phase 1 Monitoring Inspection

Site Map

Project: sitemap.mxd

Date: 12-10-08

Figure 1

M:\\98003\042\arc\whitmire_monitoring\utmz14\site_map.mxd

2.0 METHODS

The field methods used to assess the Alcoa Marsh included the evaluation of a recent aerial photograph of the marsh to identify potential problem areas, and a quantitative walk-through inspection of marsh vegetation along predetermined transects. As part of the inspection, percent foliar cover was estimated at sample points on each transect and areas identified on the aerial photograph as potential problem areas were evaluated. The primary advantage of this method is that it allows scientists to visually inspect all of the marsh in a systematic way (from transects), and then to map and closely inspect problem areas that are identified. The method also allows scientists to locate and inspect sites that were identified on the aerial photograph as potential problem areas, and verify their condition in the field.

The marsh inspection was conducted by scientists from Benchmark Ecological Services Inc, under contract to Alcoa. The inspection process was monitored by Mr. Ken Rice, a scientist with USFWS and a representative for the Trustee Agencies. Photographs collected during the inspection and referenced in this report are presented in Attachment A.

An aerial photograph of the marsh was taken by Lanmon Aerial Photography, Corpus Christi, Texas, on 18 October 2008 (Figure 2). The photograph was geo-referenced and projected in UTM, NAD 83 (Zone 14 North). A CD containing a copy of the aerial photograph is included in Attachment B.

2.1 POTENTIAL PROBLEM AREA IDENTIFICATION

The aerial photograph was examined by scientists with Alcoa and the Trustee agencies. Thirty two potential problem areas were identified based on their uncharacteristic color or physical change from the 2007 aerial photograph. The potential problem areas were outlined in ArcView, and assigned a number. The outlines were downloaded onto Global Positioning System (GPS) units which were used in the field to locate the potential problem areas. During the field evaluation, scientists visited each of the sites to determine if there was reason for concern. The suspect areas are shown in Figure 2, and comments about each site are presented in Table 2.

N

0 125 250 500 Feet

Legend

Boundary of Potential Problem Areas

Potential Problem Area ID's

Notes

December 2008 Aerial Photo - Whitmire Marsh

UTM Nad 83, Zone 14 North

Alcoa
Point Comfort Operations

Final Phase 1 Marsh Monitoring Inspection

2008 Aerial Photograph

Project: problem_areas.mxd

Date: 12-08-08

Figure 2

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2.2 FOLIAR COVER ESTIMATION

Scientists determined the condition of emergent vegetation in the marsh by walking predetermined transects through the marsh to estimate percent foliar cover and evaluate vegetative species composition. Parallel transects placed 100 meters apart were entered into a GPS (Figure 3). Inspectors walked through the marsh along each transect, estimating percent foliar cover at predetermined sample points, and evaluating potential problem areas.

The primary objective of the walk-through inspection was to quantitatively estimate the percent foliar cover at each sample point (25 meters apart) on each of the transects (Figure 3). Alcoa inspectors stopped at each sample point to estimate percent foliar cover within 2 meters of the sample point. To facilitate and standardize the estimation process, percent foliar cover was divided into five categories. Percent foliar cover was estimated at each point and coordinates for the points were recorded in the GPS. The foliar cover categories are described in Table 1.

Table 1. Foliar Cover Categories Used in the Marsh Inspection

Percent Foliar Cover	Description
0 – 24%	Bare soil with sparse clumps and single culms.
25 - 49%	Scattered clumps of grass. Site dominated by bare soil.
50 – 74%	Scattered clumps of grass. Moderate amount of bare soil.
75 – 84%	Small areas with bare soil. Site dominated by grass clumps.
85 – 100%	Tightly bunched grass clumps. No visible soil.

The second objective of the walk-through inspection was to evaluate potential problem areas that were identified on the aerial photograph (Figure 2) and to document any other problem spots (e.g., bare spots, dead vegetation, excessive erosion, and unacceptable plant species) that were not identified on the aerial photograph. Potential problem areas were closely evaluated during the inspection and conditions were documented with photographs.

A
B
C
D
E
F
G
H
I
J
K
A
B
C
D
Powderhorn Lake

N

0 125 250 500 Feet

Legend

Transect Points

Percent Foliar Cover

- 25-49 %
- 50-74 %
- 75-84 %
- 85-100 %

ABC Transect ID's

Original Shoreline

Notes

December 2008 Aerial Photo - Whitmire Marsh

UTM Nad 83, Zone 14 North

Alcoa
Point Comfort Operations

Final Phase 1 Marsh Monitoring Inspection

Marsh Monitoring
Transects and Sample Points

Project: transects.mxd

Date: 12-05-08

Figure 3

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2.3 MARSH ACREAGE CALCULATION

The MIP specifies that the constructed marsh shall contain no less than 45 acres of emergent marsh. To calculate the area of constructed marsh, excluding the freshwater inflow channel, the perimeter of the marsh was carefully outlined in ArcView® (Figure 4). The line between emergent vegetation and open water within the marsh (the edge of all ponds and channels) was also traced. The size of the outlined marsh was calculated in Arcview®.

2.4 UNACCEPTABLE PLANT SPECIES

During the inspection, Alcoa inspectors also searched for colonies of the unacceptable vegetation listed in the MIP (Section 3.2.5). Colonies of unacceptable plant species were documented in the field notes and photographed. Areas where the percent foliar cover, on average, included more than 10% of unacceptable species, a GPS was used to document and map the site. ArcView® was then used to estimate the area of marsh where the percent of foliar cover of unacceptable species was greater than 10% on average.

2.5 INSPECTION OF CHANNELS AND BREAKWATER

Alcoa inspectors qualitatively evaluated the primary and secondary channels and the limestone breakwater during the walk-through inspection. The goal of the evaluation was to determine if the channels have remained open and free flowing, without substantial sediment buildup or evidence of closure, and if the breakwater has remained intact without subsidence or washout.

2.6 EVALUATION OF WILDLIFE UTILIZATION

Finally, Alcoa inspectors documented the wildlife that was utilizing the marsh system during the inspection. A list of wildlife observed in the marsh was placed in the field notes. Photographs were collected when possible.

N

0 125 250 500 Feet

Legend

- Marsh Boundary
- Original Shoreline
- Emergent Marsh

Notes

December 2008 Aerial Photo - Whitmire Marsh

UTM Nad 83, Zone 14 North

Alcoa
Point Comfort Operations

Final Phase 1 Marsh Monitoring Inspection

Alcoa Marsh Boundary and Emergent Marsh

Project: planting_120508.mxd

Date: 12-05-08

Figure 4

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N

0 125 250 500 Feet

Legend

Construction Parcels

Notes

December 2008 Aerial Photo - Whitmire Marsh

UTM Nad 83, Zone 14 North

Alcoa
Point Comfort Operations

Final Phase 1 Marsh Monitoring Inspection

Construction Parcels

Project: figure5.mxd

Date: 12-11-08

Figure 5

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3.0 RESULTS

3.1 EVALUATION OF POTENTIAL PROBLEM AREAS

Areas that were identified as potential problem areas were evaluated during the walk-through inspection. The inspectors found that there were two primary reasons for the discoloration of marsh areas on the aerial photograph. First, there were a few areas where vegetation was sparse and soil was exposed. Some of these spots were shallow depressions that held water, and some had clay soils on the surface. Most of these areas are remnants of the elevation correction work that was conducted in Parcels K and L during October of 2007 (Photos 1 and 2). These areas are listed in Table 2 as sites 1 through 16. The combined size of all the bare areas that were left by the elevation correction work is less than ½ acre (0.485 acre). There was some evidence that the open spots are being used as loafing and feeding areas by shorebirds and waterfowl. The lightly vegetated areas are described in Table 2.

The lightly colored areas observed in the southeast portion of the marsh (Figure 2) were actually large mats of dead cordgrass stems pushed together by the storm tides that preceded Hurricane Ike (13 September 2008). Dead grass stems from the 2007 grass crop were dislodged from planting beds near the breakwater and pushed into piles forming grass mats. The formation of grass mats by unusually high tides is not uncommon. The mats were perched on top of the existing vegetation and were covering the vegetation growing underneath (Photos 3 and 4). These areas are listed in Table 2 as sites 18-21 and 24-32.

The death of above ground vegetation in the marsh each year is a natural event, and as the grass deteriorates, it becomes part of the layer of organic detritus on the marsh floor. Larval and juvenile crustaceans rely on organic detritus, algae, phytoplankton, and bacteria accumulated on the marsh floor as their primary sources of food. The mats in the Alcoa marsh will slowly deteriorate and contribute to the organic layer that fuels the marsh ecosystem, and new grass will refill the area. The planting beds near the breakwater that were the source of the grass stems (Site 17, Table 2), are now covered with thick healthy cordgrass (Photo 5).

Sites 22 and 23 (0.759 acres combined) are the areas where the growth of cordgrass has been very slow. The slow growth of grass in these areas was documented in the 2007 Annual Phase

1 Marsh Monitoring Report. The sites were fertilized and replanted during June of 2008 and are finally beginning to cover with vegetation (Photo 6). They will probably be fully covered with vegetation during the next growing season.

Table 2. Size and Description of Potential Problem Areas Identified on the Aerial Photograph

Site Number	Size (ac)	Description
1	0.062	Stiff clay surface soils. Shorebird loafing and feeding area.
2	0.032	Stiff clay surface soils. Remnants of elevation correction work in Parcel L.
3	0.013	Stiff clay surface soils. Remnants of elevation correction work in Parcel L.
4	0.061	Stiff clay surface soils. Remnants of elevation correction work in Parcel L.
5	0.017	Stiff clay surface soils. Remnants of elevation correction work in Parcel L.
6	0.031	Stiff clay surface soils. Remnants of elevation correction work in Parcel L.
7	0.010	Slight depression. Remnants of elevation correction work in Parcel L.
8	0.020	Stiff clay surface soils. Remnants of elevation correction work in Parcel L.
9	0.008	Stiff clay surface soils. Remnants of elevation correction work in Parcel K.
10	0.009	Stiff clay surface soils. Remnants of elevation correction work in Parcel K.
11	0.059	Stiff clay surface soils. Remnants of elevation correction work in Parcel K.
12	0.098	Stiff clay surface soils. Remnants of elevation correction work in Parcel K.
13	0.007	Stiff clay surface soils. Remnants of elevation correction work in Parcel K.
14	0.038	Stiff clay surface soils. Remnants of elevation correction work in Parcel K.
15	0.009	Stiff clay surface soils. Remnants of elevation correction work in Parcel K.
16	0.012	Stiff clay surface soils. Remnants of elevation correction work in Parcel K.
	0.485	**Sum of acreages 1-16**
17	0.045	Normal emergent grass density. Light shade due to abundance of new growth.
18	0.022	Grass mats produced by storm tides. Some live spartina underneath.
19	0.040	Grass mats produced by storm tides. Some live spartina underneath.
20	0.036	Grass mats produced by storm tides. Some live spartina underneath.
21	0.059	Grass mats produced by storm tides. Some live spartina underneath.
22	0.311	Poor surface soils. Corrective action taken in fall of 2008. New grass growing.
23	0.448	Poor surface soils. Corrective action taken in fall of 2008. New grass growing.
	0.759	**Sum of acreages 22-23.**
24	0.048	Grass mats produced by storm tides. Some live spartina underneath.
25	0.092	Grass mats produced by storm tides. Some live spartina underneath.
26	0.016	Grass mats produced by storm tides. Some live spartina underneath.
27	0.047	Grass mats produced by storm tides. Some live spartina underneath.
28	0.016	Grass mats produced by storm tides. Some live spartina underneath.
29	0.060	Grass mats produced by storm tides. Some live spartina underneath.
30	0.047	Grass mats produced by storm tides. Some live spartina underneath.
31	0.043	Grass mats produced by storm tides. Some live spartina underneath.
32	0.034	Grass mats produced by storm tides. Some live spartina underneath.
Site 17 is a normal emergent grass bed with abundant new growth. Sites 18-21 are areas covered with grass mats and will recover as soon as the grass deteriorates. Sites 24-32 are areas covered with grass mats and will recover as soon as the grass deteriorates.		

3.2 PERCENT FOLIAR COVER

The percent foliar cover estimates developed for sample points on the marsh transects (Figure 3) were averaged to determine a percent foliar cover for the entire marsh. The average percent foliar cover for all of the Alcoa marsh was 85.5%. The average percent foliar cover for sample points within the Onshore Marsh was 85.2%. The average percent foliar cover for sample points within the Offshore Marsh was 85.7%. Foliar Cover estimates for the two marsh sections are presented in Tables 3 and 4.

Both the Onshore and Offshore marsh sections exceeded their respective Performance Criteria of 75% foliar cover.

3.3 MARSH ACREAGE

After carefully outlining the marsh perimeter, ponds and channels on the aerial photograph, it was determined that the entire marsh system, including ponds and channels, but excluding the breakwater and freshwater inflow channel, was 72.1 acres. Alcoa was required to construct 69.3 acres of intertidal saltmarsh. Most of the excess marsh (2.8 acres) was created by expansion of the original planting beds on the west side of the marsh into the channel excavated outside marsh perimeter to contain eroded soil. The “sacrificial channel” has filled with soil eroded from the adjacent uplands and is now covered with smooth cordgrass.

The portion of the marsh covered with emergent grass (excluding ponds and channels) was found to be 55.4 acres. Alcoa was required to construct no less than 45 acres of emergent grass beds between elevation +0.5 ft NGVD and +1.6 ft NGVD. These data show that Alcoa has exceeded the marsh acreage requirements specified in the MIP.

3.4 PERCENT UNACCEPTABLE SPECIES

During the inspection, Alcoa scientists searched for unacceptable plant species listed in the MIP (Section 3.2.5). No live colonies of unacceptable plant species were found anywhere in the marsh. The only section of the marsh where species other than smooth cordgrass (*Spartina alterniflora*) and marshhay cordgrass (*Spartina patens*) have been found, is the northwest corner near the inlet for the freshwater inflow channel. During growing seasons with average or better rainfall (2006 and 2007); small colonies of cattails (*Typha* spp), salt marsh bulrush

(*Schoenoplectus robustus*), and loosestrife (*Lysamachia* spp) were observed along the banks of the primary channels. Due to the lack of rainfall in 2008 and the higher salinities that persisted, all of the colonies of these species have retreated to the inflow channel or Foester Lake channel.

During the monitoring event inspectors found several small clusters of Black mangrove trees growing in sheltered areas. The Black Mangrove is not an unacceptable species and could add unexpected diversity to the marsh near the breakwater. A few trees (less than 3 ft tall) were found in the planting beds behind the breakwater. A small cluster of mangrove trees was also discovered on the south edge of the adjacent natural marsh between Parcels B and K (Figure 5). These trees will probably grow and spread, and provide additional habitat diversity, until the first hard freeze hits the marsh.

Table 3. Percent Foliar Cover for Sample Points in the Offshore Section of the Alcoa Marsh

Offshore Marsh					
Sample Point	Category	Mean Value	Sample Point	Category	Mean Value
A3	75-84	80	G7	85-100	93
A4	85-100	93	G8	85-100	93
A5	85-100	93	G9	85-100	93
A6	85-100	93	G10	85-100	93
A7	85-100	93	G11	75-84	80
B5	85-100	93	G12	50-74	62
B6	85-100	93	G13	85-100	93
B7	85-100	93	H5	85-100	93
B8	85-100	93	H6	85-100	93
B9	85-100	93	H7	85-100	93
B10	75-84	80	H8	75-84	80
C6	85-100	93	H9	75-84	80
C7	85-100	93	H10	50-74	62
C8	85-100	93	H11	75-84	80
C9	85-100	93	I3	85-100	93
C10	85-100	93	I4	85-100	93
C11	85-100	93	I5	85-100	93
D8	85-100	93	I6	75-84	80
D9	85-100	93	I7	25-49	37
D10	85-100	93	I8	85-100	93
D11	75-84	80	I9	75-84	80
D12	85-100	93	I10	85-100	93
E11	85-100	93	J1	75-84	80
E12	75-84	80	J2	85-100	93
E13	85-100	93	J3	75-84	80
E14	85-100	93	J4	85-100	93
E15	75-84	80	J5	75-84	80
E16	85-100	93	J6	75-84	80
F9	85-100	93	J7	85-100	93
F10	75-84	80	K1	85-100	93
F11	75-84	80	K2	85-100	93
F12	85-100	93	K3	50-74	62
F13	75-84	80	K4	50-74	62
F14	50-74	62	K5	25-49	37
			K6	85-100	93

Percent Foliar Cover	85.7

Sample Point - Point on transects A-K where evaluation was made.
Category - Foliar cover category in percent foliar cover, described in Methods.
Mean Value - The mean percent value of the foliar cover category.

Table 4. Percent Foliar Cover for Sample Points in the Onshore Section of the Alcoa Marsh

Onshore Marsh					
Sample Point	Category	Mean Value	Sample Point	Category	Mean Value
A1	85-100	93	F1	85-100	93
A2	75-84	80	F2	85-100	93
B1	85-100	93	F3	85-100	93
B2	85-100	93	F4	85-100	93
B3	85-100	93	F5	85-100	93
B4	85-100	93	F6	85-100	93
C1	85-100	93	F7	75-84	80
C2	85-100	93	F8	75-84	80
C3	85-100	93	G1	75-84	80
C4	85-100	93	G2	75-84	80
D1	85-100	93	G3	85-100	93
D2	85-100	93	G4	75-84	80
D3	75-84	80	G5	75-84	80
D4	85-100	93	G6	85-100	93
D5	85-100	93	H1	85-100	93
D6	75-84	80	H2	75-84	80
D7	25-49	37	H3	85-100	93
E1	85-100	93	H4	75-84	80
E2	25-49	37	I 1	75-84	80
E3	50-74	62	I2	25-49	37
E4	75-84	80			
E5	85-100	93	Percent Foliar Cover		85.2
E6	85-100	93			
E7	85-100	93			
E8	85-100	93			
E9	85-100	93			
E10	85-100	93			

Sample Point - Point on transects A-I where evaluation was made.
Category - Foliar cover category in percent foliar cover, described in Methods.
Mean Value - The mean percent value of the foliar cover category.

3.5 CONDITION OF CHANNELS AND BREAKWATER

Marsh Channels - The only channel that exhibited greater than expected sedimentation was the channel that parallels the western shoreline and the transition zone (Figure 2). Sand and silt washed down from the surrounding upland areas and soil eroded from the Type 1 and Type 2 surplus soil piles have accumulated in the channel. Sediment was exposed in the lower portion of the channel (Parcel D, and the boundary between Parcels E and F)(Figure 5) on the day of the inspection (Photos 7 and 8). The sediments were exposed because of the unusually low tides that had developed in Powderhorn Lake and the Alcoa marsh. A combination of low winter tides and north winds pushed the water out of the marsh. The water level was so low that it was difficult to accurately determine water surface elevation on the tide gauges. There was very little water around the base of the gauge in Parcel D and oysters that had attached to the pole were obscuring the gauge (Photo 9).

Tidal studies in Powderhorn Lake and elevation surveys of vegetation in the surrounding natural marshes, showed that the normal tidal range for the shoreline where the Alcoa marsh was constructed, is from a mean low tide of +0.5 ft NGVD to a mean high tide of +1.6 ft NGVD. Water level in the marsh on the day the of the inspection was estimated to be 1.0 to 1.5 ft below mean low tide. At mean high tide level the western channel (Photos 7, 8, and 9) probably contains about 1.0 foot of water.

Primary channels in other parts of the marsh have received 1 to1.5 ft of sediment but still hold 2 to 3 ft of water during a mean high tide. All of the primary channels, except the western most channel held 0.5 to 2.0 ft of water on the day of the inspection.

The aerial photograph shows that some of the planting beds near the mouths of the primary channels have receded and the adjacent channels have expanded (Figure 2). During the inspection, scientists found that the edge of the cordgrass beds had retreated but the soil on the planting beds did not show signs of excessive erosion (Photos 8, 9, 10, and 11). The retreating grass lines were probably caused by the moderately high wave action that continuously passes through the gap in the breakwater from Powderhorn Lake. The wave energy has kept emergent grass from growing on the beds, and created intertidal mud flats which are serving as open

water habitats for mussels, oysters and polychaete worms. They also serve as loafing and feeding areas for birds during low tides.

The northern most gap in the breakwater in Parcel L has silted in at the mouth. It is very near the original Powderhorn shoreline in shallow water and has refilled to its previous shoreline elevation Photos 12 and 13). Water still flows through the gap during high tide and at average high tide there is approximately 1 ft of water in the channel.

Additional evidence that all of the channels are open and free flowing is provided by the aerial photograph. The photograph was taken during a high tide event and the marsh was full of water (Figure 2). It is clear from the photo that there is standing water in all of the primary channels and no channel bottoms are exposed. Water can also be seen flowing from the mouths of the primary channels through the breakwater (different shades of green), indicating that the channels are open and free flowing.

Breakwater – The limestone breakwater constructed between the marsh and Powderhorn Lake is performing exceptionally well. The barrier shows no signs of subsidence or sagging, and the limestone rocks are now locked in place by the sand and water. There are no signs of washout behind the barrier and the adjacent marsh is in excellent shape (Photos 14 and 15)

The bay side of the breakwater is sub-tidal most of the year and now supports a diverse hard bottom community of oysters (*Crassostrea virginica*), hooked mussels (*Brachidontes reourvus*), barnacles (*Balanus* spp.), and serpulid worms (*Eupomatus dianthus*). The deeper bull rock is covered with clusters of hooked mussels and large eastern oysters. The rocks had been exposed for several days before the inspection due to the unusually low tides and most of the soft bodied organisms and crabs had disappeared.

3.6 WILDLIFE UTILIZATION

The Alcoa inspectors observed many species of shore birds and migratory waterfowl using the marsh. Many of the bird species that were found in the marsh during the summer and fall had moved south for winter. Shorebirds that were abundant in the marsh during the monitoring inspection were Great Blue Heron, Great Egret, Little Blue Heron, Green-backed Heron, Ibis, Roseate Spoonbill, Sandpipers, Sanderlings, Plovers, and Willets (Photo 16). Migratory

waterfowl seen in the marsh were Mottled ducks and Scaup. There was evidence in several parts of the marsh that geese had been feeding on spartina sprouts in the bare areas (Photos 1 and 2).

While the water level was low throughout the marsh, the inspectors also observed mullet and other forage fish feeding in the channels. Red drum were also observed chasing fish and shrimp in the channels and pools. The bottoms of several of the larger pools showed signs of Black drum foraging. The bottoms were covered with pits that were probably excavated by the fish as they fed (Photo 17). The bay side of the breakwater has developed into a very diverse hard bottom benthic community. The rocks that are intertidal and subtidal were covered with adult oysters, oyster spat, mussels, barnacles, and serpulid worms.

There was also evidence that feral hogs had been feeding and resting on some of the planted islands. No alligators were found in the marsh during the inspection but several were observed in the marsh during September and October 2008.

4.0 CONCLUSIONS

The results of this study show that the Alcoa Restoration Marsh system has achieved all of its Performance Criteria, and has developed to the point where no further Corrective Action is anticipated. The marsh system is steadily maturing into a productive self-sustaining estuarine ecosystem and supports a variety of aquatic, avian, and terrestrial wildlife species. The abundance of birds and fish in the Alcoa marsh, compared with the abundance of wildlife in surrounding marshes, suggests that the Alcoa Marsh is as attractive to coastal wildlife as any of the natural marshes in that area.

5.0 REFERENCES

Alcoa, 2004. Marsh Implementation Plan. Exhibit 3 to Consent Decree. AUS01:313503.9 Revised 18 June 2004.

United States et al. V. Alcoa Inc., et al., 2005. Consent Decree for CERCLA Response Actions and Response Costs (Civil Action Number V: 04-CV-119). February.