Memorandum

Environmental
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Date: 16 October 2009

Subject: Summary of Remedial Alternatives, Riverbank Source Control Measure, Arkema Inc., Portland Oregon

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On behalf of Legacy Site Services, LLC (LSS), agent for Arkema, Inc. (Arkema), ERM-West, Inc. (ERM) has prepared this memorandum in support of the Riverbank Alternatives Evaluation (RAE) for the Former Arkema Chemicals facility in Portland, Oregon (the site).

The purpose of this memorandum is to present a summary of remedial alternatives being assembled as part of the RAE for the Riverbank Source Control Measure (SCM) at the Arkema site.

As directed by the Oregon Department of Environmental Quality (DEQ) in the 21 July 2009 comments on the *Draft Riverbank Erodible Soil Source Control Screening Evaluation* (ERM 2008), these alternatives are being presented in advance of the RAE in order to obtain agreement prior to submission of the full RAE report.

The overall objectives of the Riverbank SCM process are to:

- Identify areas of the Arkema riverbank that, if erodible, present a risk of contamination (or recontamination) of river sediment;
- Prevent long-term transport of riverbank soil to the river via erosion in areas of the riverbank with constituent concentrations above appropriate risk-based values;
- Prevent riverbank soil transport to the river during SCM implementation;

- Ensure compatibility with the Groundwater SCM and Storm Water SCM that are currently underway;
- Ensure compatibility with other potential remedial actions (e.g. in-water early action Engineering and Cost Analysis [EE/CA], Hot spot removal etc.), including a phased design and implementation schedule; and
- Ensure compatibility with the upland feasibility study and final site remedy selection.

RIVER BANKALTERNATIVES EVALUATION

The area that will be considered in the RAE extends downstream along the riverbank to the northern boundary of the Arkema property and upstream to the southern boundary of the site. The southern boundary of the property runs along the top of bank. The area of riverbank below the top of bank line is owned by Genstar Roofing Co. (Genstar), Inc. However, at DEQ's request, LSS is including the Genstar portion in the RAE. The approximate limit of the riverbank evaluation area is presented in Figure 1.

For the purpose of the RAE, the riverbank has been divided into three sub-areas based on general physical characteristics and existing chemical data (Figure 2):

- <u>Lots 1 and 2</u> – This area is characterized by dredge fill spoils with a gradually sloping bank. Invasive vegetation has become established and provides considerable bank stabilization. This area generally contains the lowest constituent concentrations found in the riverbank, with typically decreasing constituent concentrations from the top of bank down to the beach.
- <u>Lot 3 & Salt Pads</u> – This area is characterized by a relatively steep bank with a mixture of debris/riprap and vegetation that provides substantial stabilization of the steep bank. This area is further comprised of two sections: the riverbank between the Lot 2/Lot 3 boundary and Dock 1, and the riverbank south of Dock 2. It also includes the riverbank along the south boundary of the site that is owned by Genstar Roofing Co., Inc. Riverbank materials are a mixture of dredge and miscellaneous fill.

- Docks 1 and 2 – This area is characterized by a relatively steep bank with extensive debris/riprap and vegetation that provides substantial stabilization. This area is immediately upland of the envisioned EE/CA early action area; however, the final EE/CA boundary has not yet been defined. This area is generally associated with the highest constituent concentrations along the riverbank. Riverbank materials are a mixture of dredge, miscellaneous fill/debris and riprap.

For the purposes of the RAE, the riverbank is defined as the area between the top of the bank and the break in slope between the bank and the beach (Figure 3). As defined in the Riverbank SCE, "erodible soils" are defined as soil shallower than 2 feet below ground surface, which have a higher potential to erode. It should be noted that, based on existing site observations, there is no evidence of significant bank erosion (i.e. sloughing slopes, washouts) along the river bank.

In general, the riverbank is steeply sloped and covered with debris and riprap, large chunks of concrete and asphalt for much of its length. The concrete and asphalt rubble serve as riprap for erosion control and slope stability. Invasive vegetation along the riverbank is growing in between the riprap, and is characterized by early successional species (mainly invasive weeds) that thrive on disturbed areas. A conceptual cross section of the existing riverbank is presented in Figure 3.

The RAE will present a condition survey of the riverbank. This will include a review of existing topographic and soil analytical data, as well as an assessment of existing bank stabilization measures and vegetation condition. The purpose of the condition survey will be to:

- Identify areas of riverbank soil that are erodible, as well as areas with lower erosion potential;
- Identify areas of riverbank soil that exceed ODEQ Hot Spot criteria (as determined in the Hot Spot Evaluation);
- Identify areas of riverbank soil that exceed relevant and appropriate Site-Specific Human Health and Ecological Risk Based Concentrations (RBCs);
- Identify areas of riverbank soil which, if erodible, could pose a re-contamination potential to river sediments following completion of the EE/CA; and

- Identify areas of riverbank soil which, if erodible, could pose a re-contamination potential to river sediments in the Areas of Potential Concern (AOPC) that are being derived in the Portland Harbor Superfund process.

The assessment process will allow LSS to determine where specific technologies, or a combination of the technologies, can be implemented.

LSS notes that the major design elements of the EE/CA, such as the extent of the area and the final remedial options, are yet to be finalized. LSS assumes that if the EE/CA remedial technology will effectively prevent riverbank soil transport to the river, no further work will be performed under the Riverbank SCM for the riverbank area covered by the EE/CA. For example, if a nearshore confined disposal facility (CDF) is constructed immediately riverside of the Docks 1 and 2 area, thus effectively containing that soil, no further remedial activity would be expected in that area.

Given the uncertainty in the EE/CA design, and future site remedial actions (e.g., storm water SCM, final site remedy, Portland Harbor remedy, etc.), the RAE process is a mechanism to identify the need and options for river bank source control. The schedule for design and implementation of the river bank source control options will be determined, in large part, by the schedule of these future remedial actions, and particularly the EE/CA and Portland Harbor Remedial Investigation/Feasibility Study process.

RIVERBANK ALTERNATIVE APPROACHES

Based on the Riverbank SCE and DEQ comments, the remedial approaches that will be considered in the RAE consist of following:

- No action;
- No action with institutional controls;
- Re-grading and stabilization;
- Soil removal and stabilization; and
- Combinations of the above as appropriate.

The remedial alternatives presented in this memorandum have been grouped by these primary technologies and are discussed further below.

No Action

This alternative will consist of leaving the river bank in its current state. It is retained as an alternative in the evaluation process as a viable alternative and also in order to provide a baseline comparison to the other alternatives.

No Action with Institutional Control

This alternative will consist of leaving the river bank in its current state. However, institutional controls, such as land use covenants, will be implemented to prevent river bank soil becoming mobilized. Controls to prohibit clearing or soil disturbing activities (i.e. road building) will be implemented. Vegetation maintenance would be periodically conducted in order maintain the existing river bank conditions.

Re-grading

This alternative consists of cutting and filling soil along the riverbank in order to create a consistent slope from the top of the bank to the beach that is more resistant to erosion (Figure 4). Where possible, existing soil will be left in place. For this alternative, no riverbank material will leave the site, except for limited amounts of excavated debris and/or hot spot material (if required). The new slope will be stabilized with imported materials to prevent erosion of riverbank soils and essentially “capping” the river bank. The stabilization technologies alternatives are discussed below.

Removal

This alternative consists of removing soil and debris and cutting back the steep areas of the bank to decrease the slope of the riverbank (Figure 5). The excavated material (debris and soil) will be disposed of off-site, or by other agency-approved means. To meet the objectives of the Riverbank SCM, the extent of the removal will be based on physical bank stability constraints rather than chemical concentrations. The new slope will then be stabilized with imported materials to prevent erosion of riverbank soils. The stabilization technologies alternatives are discussed below.

Combination of Institutional Controls, Re-grading, and Removal

This alternative consists of selectively implementing no action, institutional controls, re-grading, or removal, based on the characteristics of the riverbank within each sub-area. The factors that will be considered during the technology selection include:

- Results of the condition survey discussed above;
- The nature of the existing riverbank soils (i.e. demolition debris, dredge spoils, riprap, etc.);
- Proximity and potential interference with existing site facilities;
- Proximity and potential interference with existing and planned uplands infrastructure (i.e. existing dock structures, groundwater recovery wells, storm water detention ponds, and water treatment facilities); and
- Potential implementation schedule.

RIVERBANK STABILIZATION TECHNOLOGY ALTERNATIVES

A total of four riverbank stabilization technology categories will be considered in the RAE. A summary of the design, implementation, and compatibility of each technology is presented in Table 1. Conceptual cross-sections of each technology are shown in Figure 6.

Terraced/Vegetated Slope

This alternative consists of constructing a terrace, or bench, at a midpoint elevation along the length of a slope in order to reduce the overall average bank slope, and therefore runoff velocities and erosional forces. The terraced slope method of bank stabilization is based on the understanding that a slope is more stable and resistant to erosion as slope steepness decreases. Installing a terrace effectively shortens the length of a long, steep slope and also typically reduces the potential for slope failure due to sliding and deep-seated rotational forces. Additionally, the newly constructed slope can be stabilized with vegetation and/or erosion mats. This prevents erosion of the surficial material due to runoff at moderate to high velocities parallel or perpendicular to the slope.

Advantages associated with constructing terraced slopes include the ability to use natural, aesthetically pleasing materials and the creation of natural slope configurations. Disadvantages include the generation of potentially impacted cut material when the terrace and upgradient portion of the slope are constructed, increased slope footprint perpendicular to the slope, and susceptibility to erosion from high velocity or relatively long duration flow events (i.e. flooding).

Armor

This alternative consists of applying hardened materials for armoring the slope (similar to the existing conditions), thereby preventing potential erosion that may be associated with potential surface water runoff and resisting scour from river flooding. The most common method of armoring a slope consists of installing an engineered layer of rock (riprap) on the surface of the slope. Large diameter rock is resistant to erosional forces associated with wave action and high velocity floodwaters. Typically, a geotextile or gravel filter is installed between the sub-base soil and riprap to prevent subsurface scour, undercutting and potential failure of the revetment. Riprap is an effective alternative to erosion prevention methods employing rigid materials such as concrete because it has the ability to adapt to changing subsurface conditions (i.e. periodic changes in riverbed elevation due to high flow events) and can adjust to changes in subgrade support without failing.

An alternative armoring technology that will be considered is the use of gradational rock sizing. This will generally consist of using larger diameter riprap on the upper portion of the riverbank, particularly at mean high water and flood stage elevations to prevent scouring during high flow events. In the lower portion of the riverbank, at approximately mean low water, smaller diameter rocks, (i.e. “fish-mix”) will be used as in-fill between the larger diameter rocks. The smaller diameter rocks will provide improved habitat for fish migration, yet be protected from scour by the larger diameter rocks.

Advantages associated with armoring include ease of installation, durability, low maintenance cost, and widespread acceptance as an erosion countermeasure. Disadvantages include susceptibility to subsurface scour and potential unavailability of suitable material at reasonable cost.

Geocell

This alternative consists of a surface anchored geocell matrix that is in-filled with soil above the river normal pool elevation. A geocell matrix is a hollow honeycomb pattern of durable high-density polyethylene. The hollow “cells” can be in-filled with various materials, including soil, gravel, concrete, etc., depending on the level of erosion protection required. Erosion is prevented through each cell acting as containment for the in-fill materials, which are prevented from migrating. Commonly, in soil in-fill applications, the surface is seeded to create a grass/vegetation covered appearance, which masks the supporting geocell.

The advantages of geocells include durability, low maintenance cost, and widespread acceptance as an erosion countermeasure and slope stabilization technique. Additionally, geoecells can be implemented in areas with steep slopes (i.e. 1V:1H). The main disadvantages are high material cost and labor-intensive installation.

Structural Wall (Sheet Pile)

This alternative consists of a series of steel sheet piles driven through the riverbank to form a retaining wall. Much like a retaining wall of other materials, such as concrete or timber, the sheet pile resists the tendency of the surface soil to migrate down-slope, and also prevents contact with the flowing river water, thus eliminating scour and erosion. The gap created between the driven sheet piles and existing slope is backfilled with soil or similar materials, creating additional land surface. The permeability of the wall can be adjusted to suit the specific application via the design of the interlock between the individual piles.

Sheet piling is primarily used for the purpose of a retaining wall in industrial and marine applications where a structural element is required, or slope layback is not desirable or possible. The advantages of sheet pile include durability and nearly maintenance-free slope stabilization. However steel sheet pile can result in extremely high material and installation costs. The appearance of the alternative is often considered a disadvantage as the sheet pile wall cannot readily be covered or hidden and will discolor over time.

LSS notes that a structural wall used for stabilization of river bank soil for this RAE, would be unrelated to the EE/CA and would be separate from any sheet pile potentially used in a CDF or other EE/CA selected technology. Obviously, if the EE/CA selects a CDF as the preferred remedy, it would obviate the purpose/need for this consideration in that area.

EVALUATION CRITERIA

The RAE process will be used to select the technology, or combination of riverbank technologies, that will be implemented at the site. The RAE will identify the design considerations and assess each alternative against specific selection criteria.

Design Considerations

The major design elements that will be considered during the evaluation of the re-grading and removal alternatives are:

- Slope stability;
- Temporary erosion prevention during construction;
- Long-term bank stabilization;
- Equipment access;
- Options for off-site transport and disposal of debris, if required; and
- Potential interference with the additional remedial actions (i.e. EE/CA, Portland Harbor, Groundwater SCM, Storm Water SCM, final site remedy).

Selection Factors

Under Oregon's environmental cleanup law (OAR 340-122-0090[3]), the feasibility of each remedial action alternative is to be assessed based on a balance of five selection factors including effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost.

RIVERBANK ALTERNATIVES EVALUATION REPORT

Upon agreement between LSS, DEQ, and other stakeholder agencies, as appropriate, regarding the riverbank alternatives, the RAE will be prepared to evaluate the alternatives. The RAE report will present:

- A description and conceptual design of each technology alternative or combination of technologies;
- The outcomes of the selection factor assessment, including preliminary project costs;
- Identification of recommended riverbank SCM alternatives and estimated implementation schedule of these alternatives;
- Any additional required design and planning elements for the recommend SCM alternative;
- A determination of the appropriate juncture for performing the final river bank SCM alternative selection in the each river bank sub-area; and
- A preliminary design and implementation schedule.

If you have questions or comments pertaining to this technical memorandum, please contact us at (503) 488-5282.

REFERENCES

ERM-West, Inc. 2009. *Draft Riverbank Erodible Soil Source Control Screening Evaluation.* December 2008.

Department of Environmental Quality. 2009. Letter correspondence: *DEQ Comments on the Draft Riverbank Erodible Soil Source Control Screening Evaluation*. 21 July 2009.

Department of Environmental Quality. 1998. *Guidance for Identification of Hot Spots*. 23 April 2009 (Updated 31 May 2005).

Figures

Project: 0093634.07

Date: 09/02/2009

Drawn By: mike.appel

File: \\rmdenfs02\dataRM\dataDEN\RM106\A\Arkema\0093634 Riverbank Soil Screening\GIS\SCMSiteLayout.mxd

Aerial Photography - July, 2005

Legend

- Top of Bank (appoximate)
- Mean High Water
- Ordinary Low Water Line

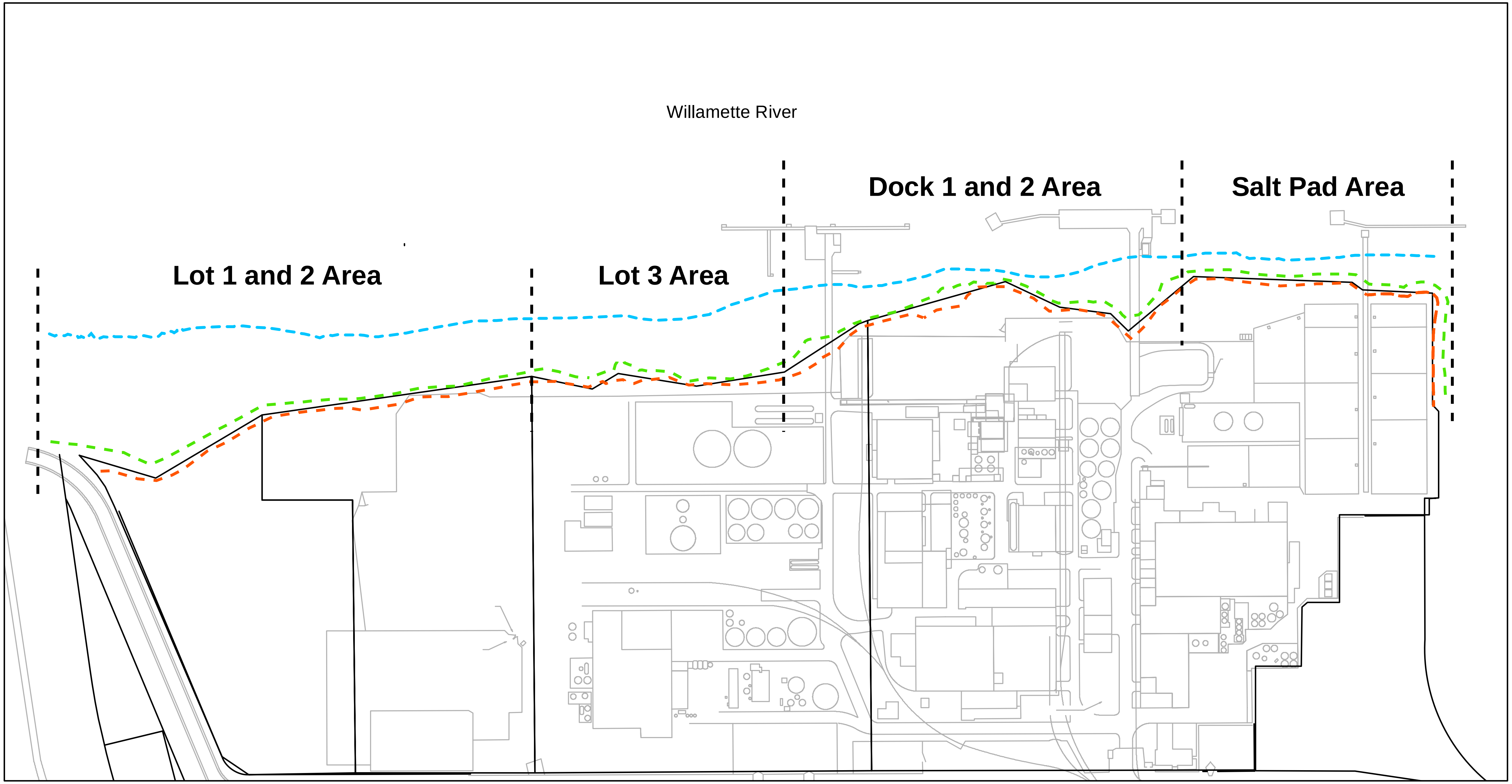
N

0 200 400 Feet

Figure 1

Site Layout and Riverbank
Riverbank Erodible Soil
Source Control Measures
Arkema, Inc.
Portland, Oregon

ERM *09/09*



Legend

- Top of Bank (appoximate)
- Mean High Water
- Ordinary Low Water Line
- Parcel and Property Boundaries

N

0 200 400 Feet

Figure 2

Conceptual Remedial Action Areas
Riverbank Erodible Soil
Source Control Measures
Arkema, Inc.
Portland, Oregon

ERM 09/09

Project: 0093634.07
Date: 09/02/2009
Drawn By: mike.appel
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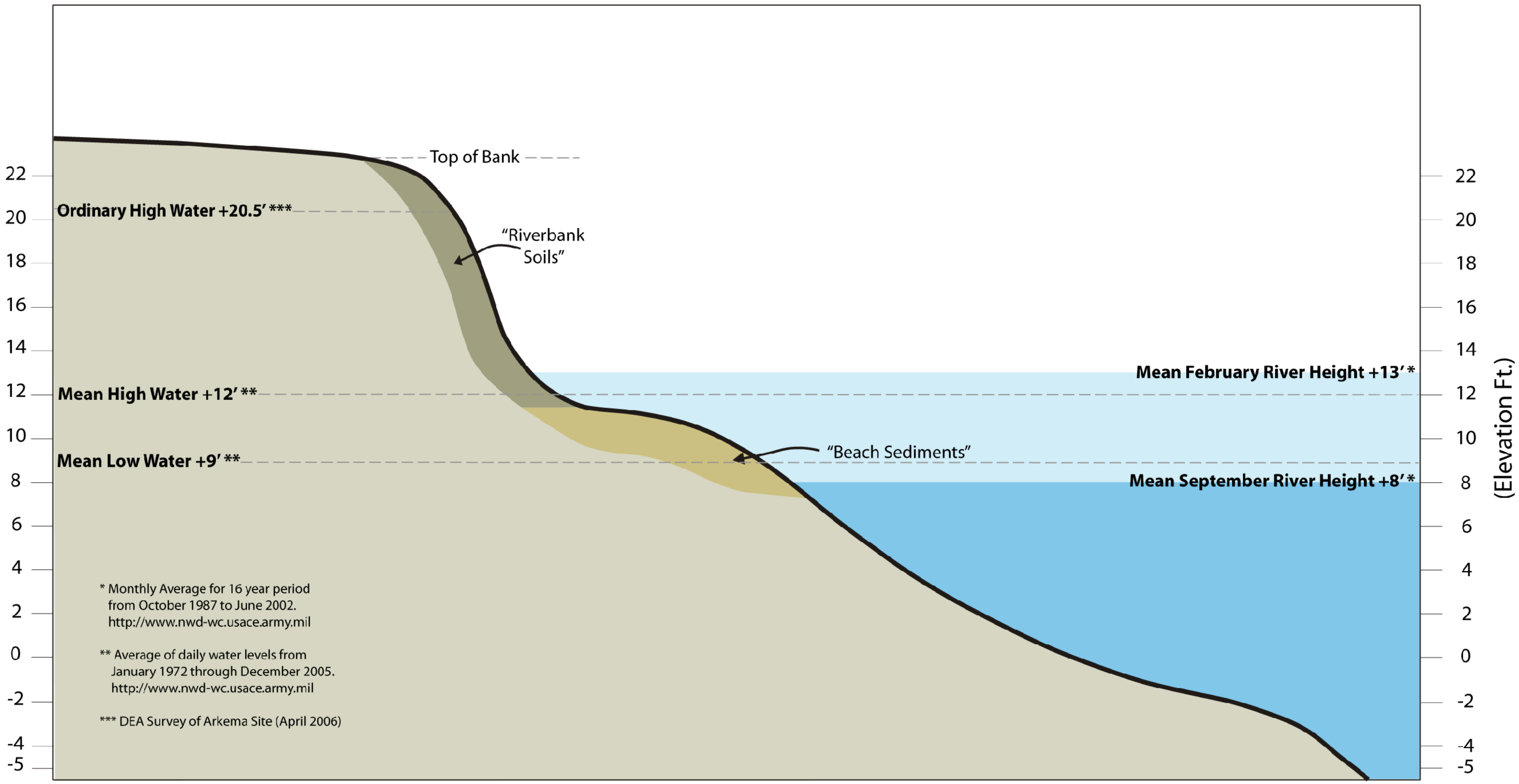
Schematic Willamette River Bank Cross Section



Vertical Datum: NAVD88 (For River Mile 7 to 8 Subtract 5.2 feet for elevation in CRD

Figure 3
Schematic Willamette River Bank Cross-Section
River Bank Erodible
Soil Source Control Measure
Arkema, Inc.
Portland, Oregon

ERM 09/09

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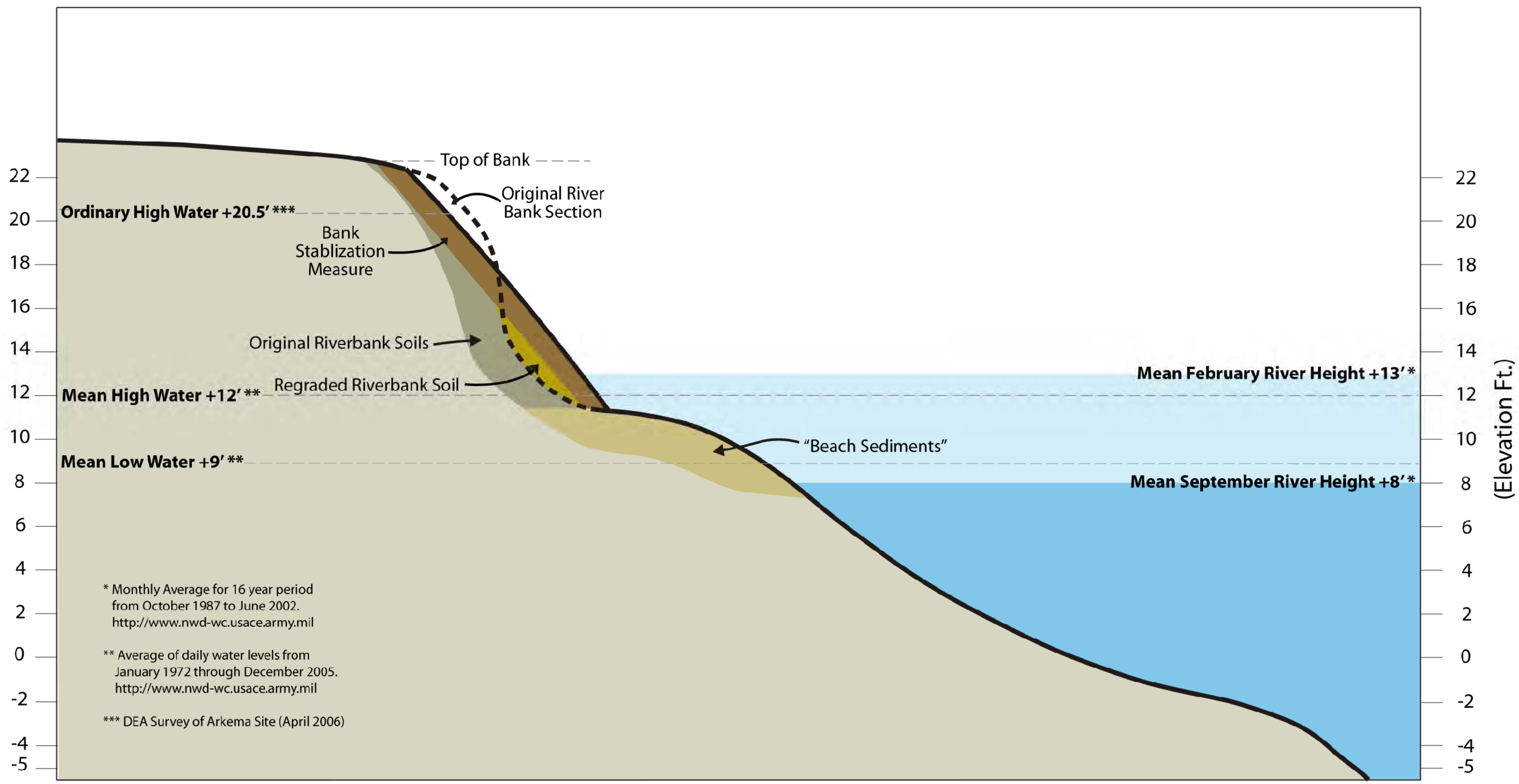
Schematic Willamette River Bank Cross Section



Vertical Datum: NAVD88 (For River Mile 7 to 8 Subtract 5.2 feet for elevation in CRD

Figure 4

Conceptual River Bank Soil Regrade
River Bank Erodible
Soil Source Control Measure
Arkema, Inc.
Portland, Oregon

ERM 09/09

Project: 0093634
DATE 10/12/2009
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Schematic Willamette River Bank Cross Section

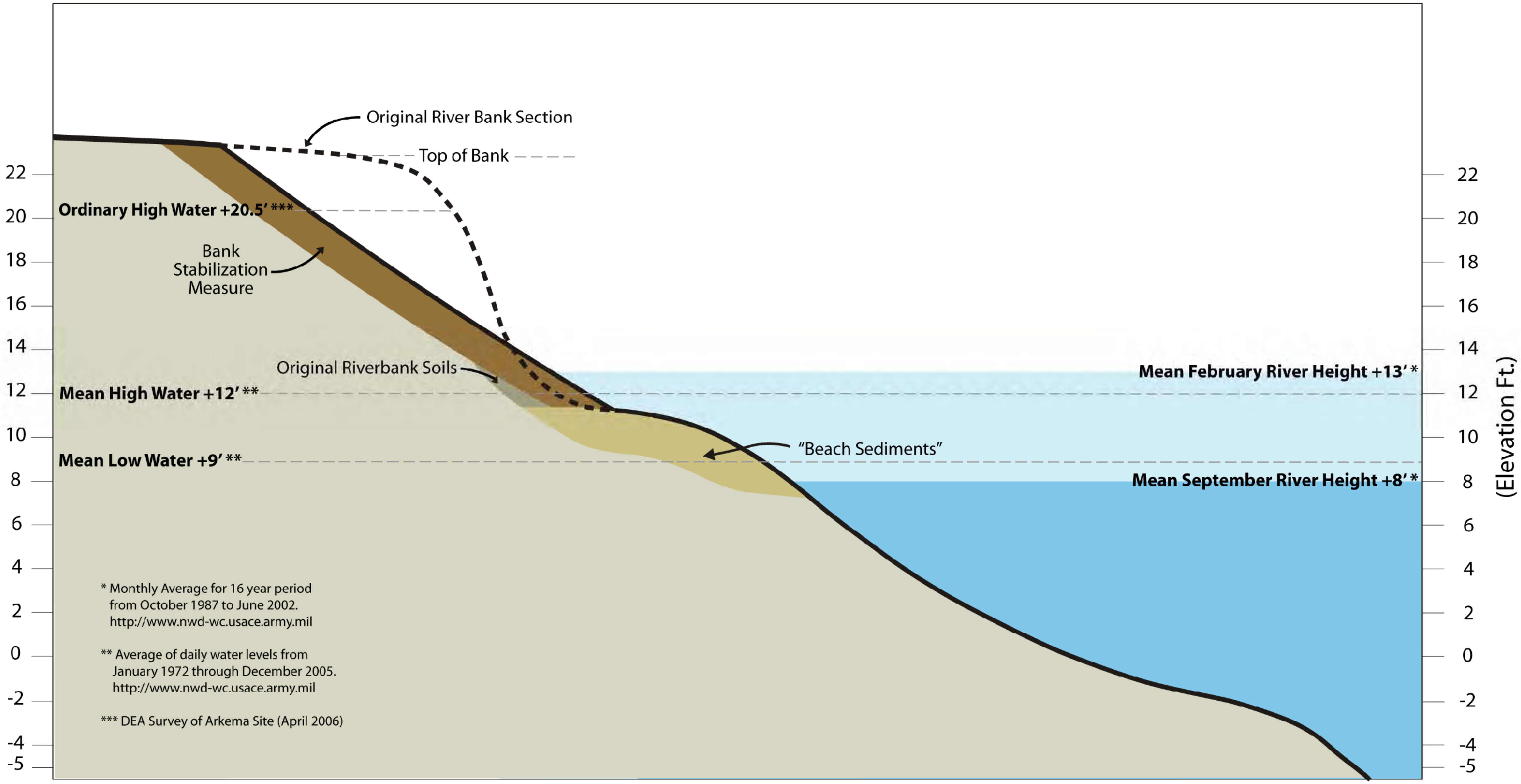

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Figure 5
Conceptual River Bank Soil Removal
River Bank Erodible
Soil Source Control Measure
Arkema, Inc.
Portland, Oregon

ERM 09/09

Project: 0093634.02
DATE 10/12/2009
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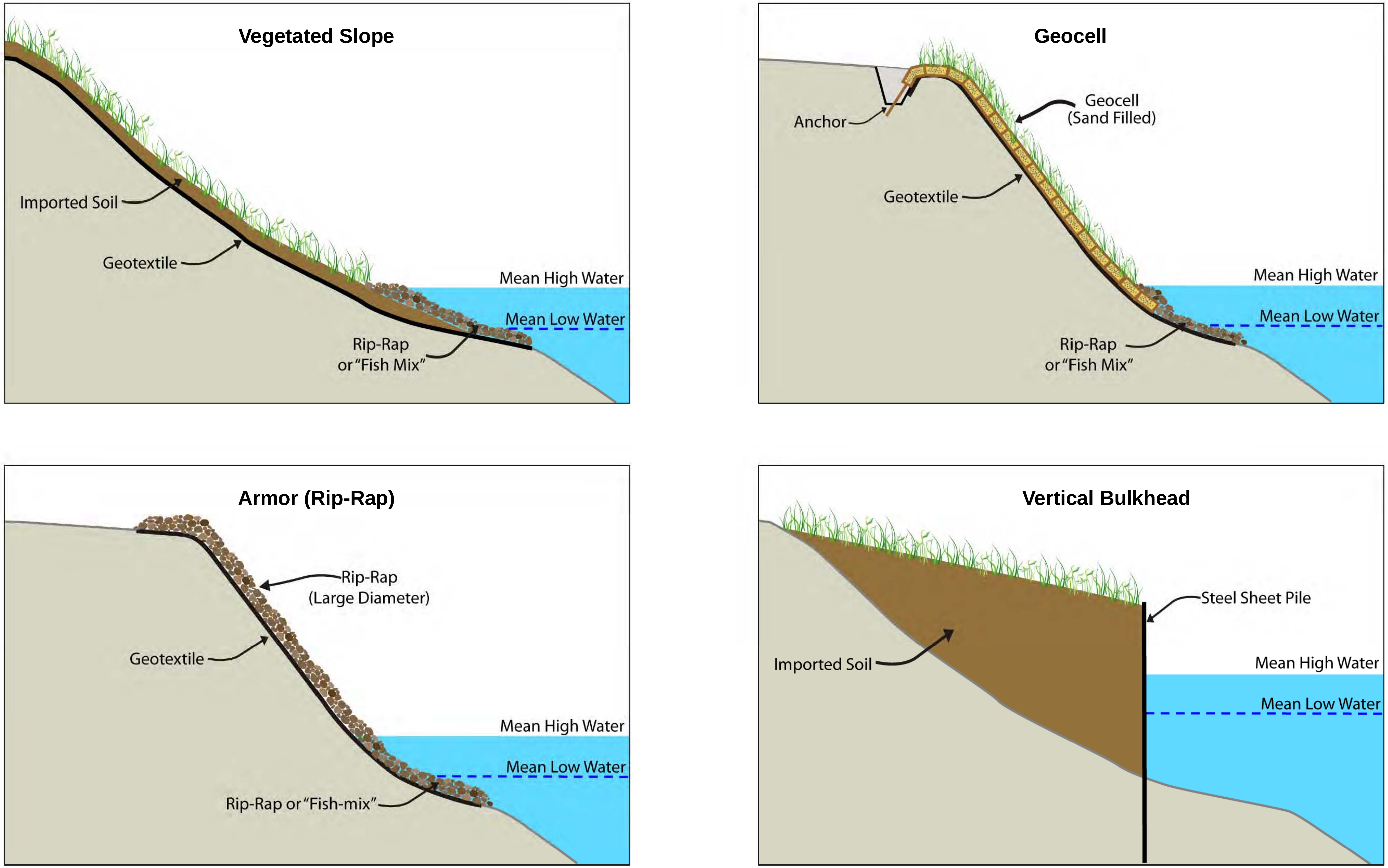

Figure 6
Conceptual Riverbank Stabilization Technology
River Bank Erodible Soil Source Control Measure
Arkema, Inc.
Portland, Oregon

ERM 09/09

Tables

Table 1
River Bank Stabilization Technology Alternatives
River Bank Source Control Evaluation
October 2009

Technology	**Design**			**Implementation**				**Comments**
	Slope	**Surface Cover**	**Scour Protection**	**Grading**	**Installation**	**Maintenance**	**Durability**	
Terraced/Vegetated Slope	Low	Vegetation (hydroseeding)	Geotextile	Extensive excavation	Labor intensive	High	Low	Long slope may interfere with upland SCM infrastructure
Geocell/Geotextile	Steep	Vegetation (hydroseeding)	Geotextile/ riprap	Some regrading/ excavation	Mechanical, labor intensive	Moderate	Moderate	Limited amount of riprap may be required at terminal end of geocell mat below water line
Armor (Rip-Rap)	Steep	Rock	Geotextile	Limited regrading/ excavation	Mechanical	Low	High	May be able to incorporate improved fish habitat materials below water line
Sheet Pile	Vertical	Steel	Not Required	In-water work platform, back fill behind wall	Mechanical	Very Low	Very High	Some potential interference with Stormwater SCM if outfall(s) impacted

SCM = Source Control Measure
EECA = In-water early action Engineering Evaluation/Cost Analysis
Uplands SCMs = Groundwater, Stormwater, and Soil SCMs