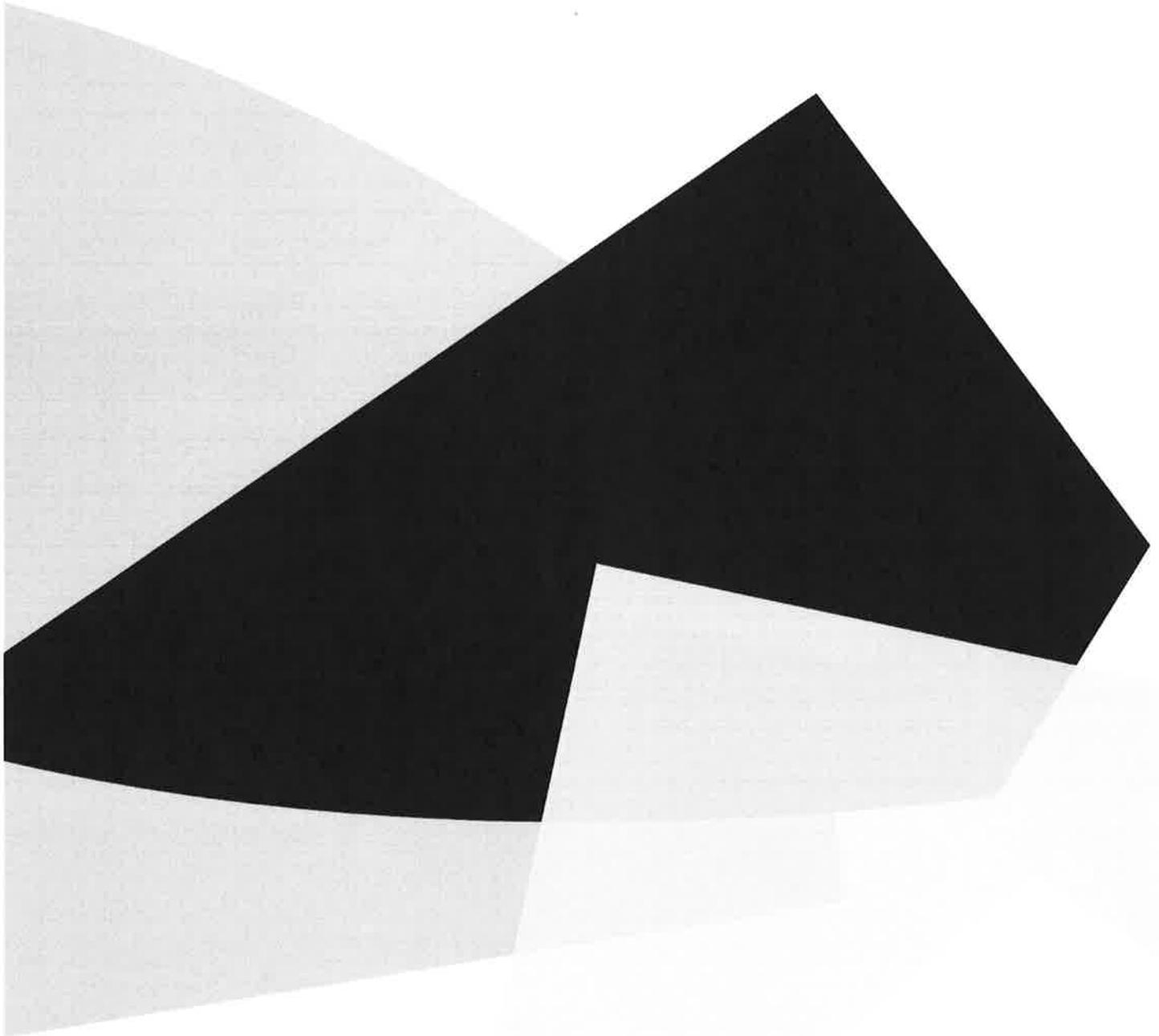


Addendum No. 1 to the Technical Drainage Study  
for TIMET Site Remediation

October 21, 2013

**ATKINS**



**Plan Design Enable**

**WEST CHANNEL**

**RIPRAP CALCULATIONS**

# RIPRAP CALCULATION

## For Channel Lining

Project: West Channel

### Riprap D<sub>50</sub>

Equation 734 (CCRFCD HCDDM)

$$D_{50} = [V(S^{0.17})/3(Ss-1)]^2$$

S<sub>s</sub> = specific gravity

2.65

V = velocity

6.76

ft/s      10 ft/s Max

S = slope

0.02

ft/ft

$$D_{50} = [V(S^{0.17})/3(Ss-1)]^2$$

0.49

ft

5.9

in

# RIPRAP CALCULATION

## RCB Outlet Protection

Project: 5' x 3' RCB at West Channel - Downstream Riprap

**If the flow is supercritical use  $H_a$  for H:**

Equation 763 (CCRFCD HCDDM)

$$H_a = 1/2 (H + Y_n)$$

$Y_n$  = normal depth of supercritical flow in the culvert  
(from Flowmaster or WSPG) 1.27 ft

H = height of box 3 ft

$H_a$  = average depth at supercritical flow 2.14 ft

$Q/WH^{1.5} =$  4.43

**If  $Q/WH^{1.5} \geq 4.0$  use:**

Equation 761b (CCRFCD HCDDM)

$$d_{50} = H \times 0.0019 \times [(Q/WH^{1.5})^{2.5} / (Y_t/H)^2]$$

### Riprap $d_{50}$

H = height of box culvert 2.14 ft

W = width of box culvert 5 ft

Q = design discharge 115 cfs

$Y_t$  = tailwater depth ; if unknown use  $Y_t = H \times 0.4$  1.4 ft

$d_{50}$  = rock size 1.392 ft  
16.7 in

# RIPRAP LENGTH OF PROTECTION

Project: 5' x 3' RCB at West Channel - Downstream Riprap

## Riprap Pad Length

Equation 764 (CCRFCD HCDDM)

$$L = \left( \frac{1}{2 \tan \theta} \right) \left[ \left( \frac{A_t}{Y_t} \right) - D \right]$$

$[1/(2 \tan \theta)]$  = expansion angle of culvert flow  
(from Figure 714 or 715) 6.5

$Q_{100}$  = Discharge 115 cfs

$A_t$  = area of flow at allowable velocity =  $Q/V$  7.76 ft<sup>2</sup>  
 $V = 15.59$  ft/s

$Y_t$  = tailwater depth ; if unknown use  $Y_t = D \times 0.4$  1.5 ft

$D$  = diameter of RCP or width of RCB 5 ft

$L$  = Length of protection 1 ft

Check:

If Equation 764 yields an unreasonable result, use the following:  
(Per section 707.4.3 CCRFCD Design Manual)

For RCB if  $Q/WH^{1.5} \leq 8.0$  then; 1.2857

For RCP if  $Q/D^{2.5} \leq 6.0$  then; 2.06

$L \geq 3H$  or  $3D$  15 ft min  
OR

$L \leq 10H$  or  $10D$  50 ft max

**EAST CHANNEL**

**RIPRAP CALCULATIONS**

# RIPRAP CALCULATION

## For Channel Lining

Project: East 3+00\_2.0Slope

### Riprap D<sub>50</sub>

Equation 734 (CCRFCD HCDDM)

$$D_{50} = [V(S^{0.17})/3(Ss-1)]^2$$

S<sub>s</sub> = specific gravity

2.65

V = velocity

8.21

 ft/s      10 ft/s Max

S = slope

0.02

 ft/ft

$$D_{50} = [V(S^{0.17})/3(Ss-1)]^2$$

0.73

 ft

8.7

 in

**9" d50 riprap provided  
from STA 5+06 to downstream end of riprap**

# RIPRAP CALCULATION

## For Channel Lining

Project: East 5+06 to 10+57

### Riprap D<sub>50</sub>

Equation 734 (CCRFCD HCDDM)

$$D_{50} = [V(S^{0.17})/3(S_s-1)]^2$$

S<sub>s</sub> = specific gravity

2.65

V = velocity

6

ft/s

10 ft/s Max

S = slope

0.02

ft/ft

$$D_{50} = [V(S^{0.17})/3(S_s-1)]^2$$

0.39

ft

4.7

in

**8" d50 riprap provided**

# RIPRAP CALCULATION

## For Channel Lining

Project: East\_10+57 to 12+09 2%Slope

### Riprap D<sub>50</sub>

Equation 734 (CCRFCD HCDDM)

$$D_{50} = [V(S^{0.17})/3(Ss-1)]^2$$

S<sub>s</sub> = specific gravity

2.65

V = velocity

5.66

 ft/s      10 ft/s Max

S = slope

0.02

 ft/ft

$$D_{50} = [V(S^{0.17})/3(Ss-1)]^2$$

0.35

 ft

4.1

 in

**8" d50 riprap provided**

# RIPRAP CALCULATION

## For Channel Lining

Project: East\_12+09 to 12+83 4%Slope

### Riprap D<sub>50</sub>

Equation 734 (CCRFCD HCDDM)

$$D_{50} = [V(S^{0.17})/3(S_s-1)]^2$$

S<sub>s</sub> = specific gravity

2.65

V = velocity

5.59

ft/s

10 ft/s Max

S = slope

0.02

ft/ft

$$D_{50} = [V(S^{0.17})/3(S_s-1)]^2$$

0.34

ft

4.0

in

**8" d50 riprap provided**