



# Turner Valley Gas Plant

**Hydrocarbon Containment and Remediation**

**September 2007**





Photo circa 1914



PLANT SITE — TURNER VALLEY, ALBERTA  
NATURAL GAS PROCESSING AND PURIFICATION PLANT

Photo circa early 1960's



**Air Photo (July 2005)**

## SCOPE OF WORK



- **Design a containment system to prevent the release of hydrocarbon contamination outside of the Gas Plant site.**
- **Design a treatment system to treat hydrocarbon contamination present on site.**
- **Develop and implement a long-term risk management plan.**



# DESIGN TEAM



## Sub-consultants:



## •Contractor:



Stantec

# HYDROCARBONS



Commonly found in soils and groundwater on former Oil and Gas sites

Typically consist of a mixture of compounds which can be characterized as:

**Benzene (B)**

**Toluene (T)**

**Ethylbenzene (E)**

**Xylene (X)**

**F1-F4 hydrocarbons**

**Polyaromatic hydrocarbons (PAHs)**



# DESIGN



## CONTAINMENT:

- Bentonite Slurry Wall (impermeable) aligned along the downhill side of plant site
- Weeping Tile groundwater collection along northern property boundary

## REMEDIATION:

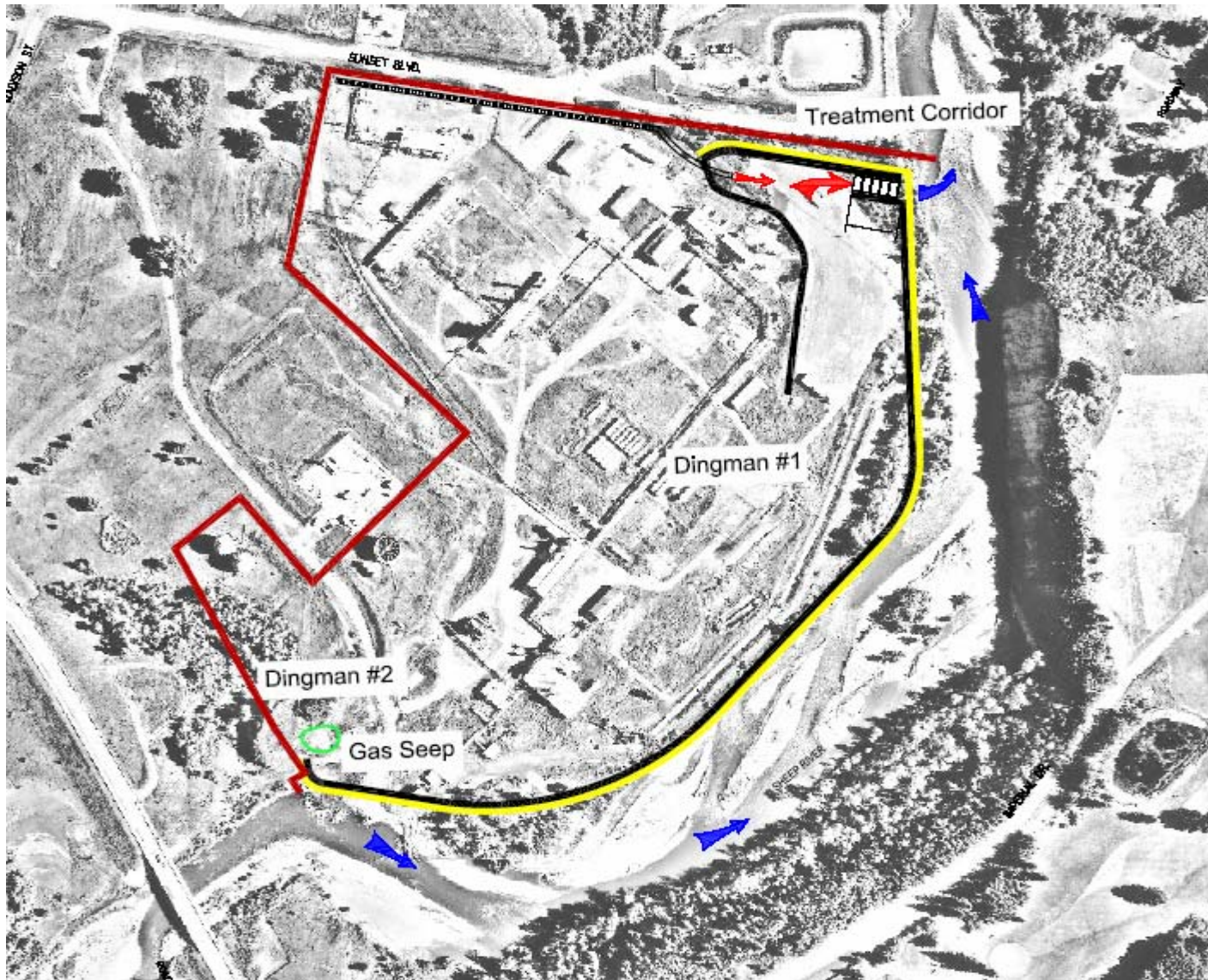
- Passive in-situ groundwater remediation system

## RISK MANAGEMENT:

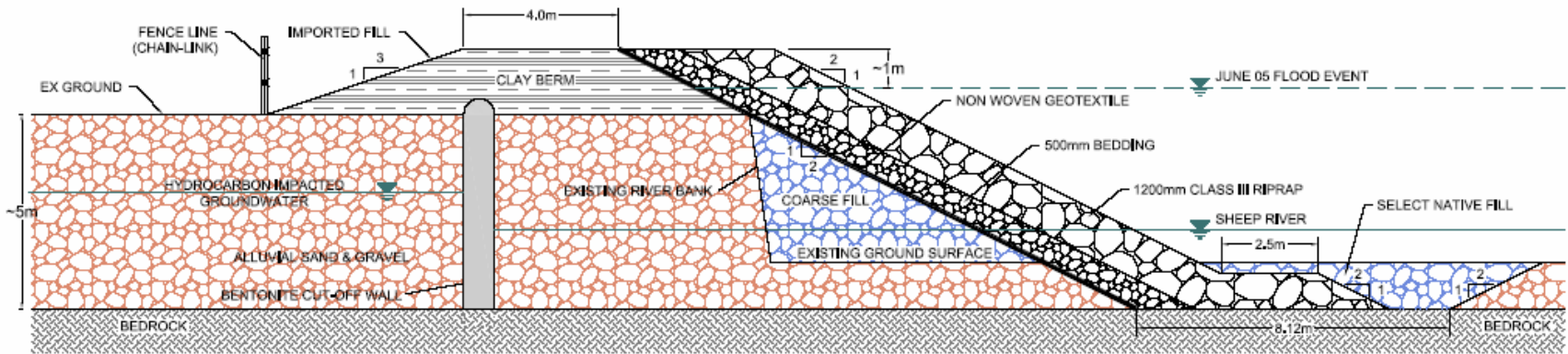
- Hydrocarbons present on site will be controlled to within the property boundaries
- Ongoing monitoring of groundwater discharge and treatment system operation







## Alignment of Erosion Protection and Groundwater Containment



Typical Cross Section



## Slurry Wall Construction



## Slurry Wall Construction



## Slurry Wall Construction



## Slurry Wall Construction



## Slurry Wall Construction



## Slurry Wall Construction



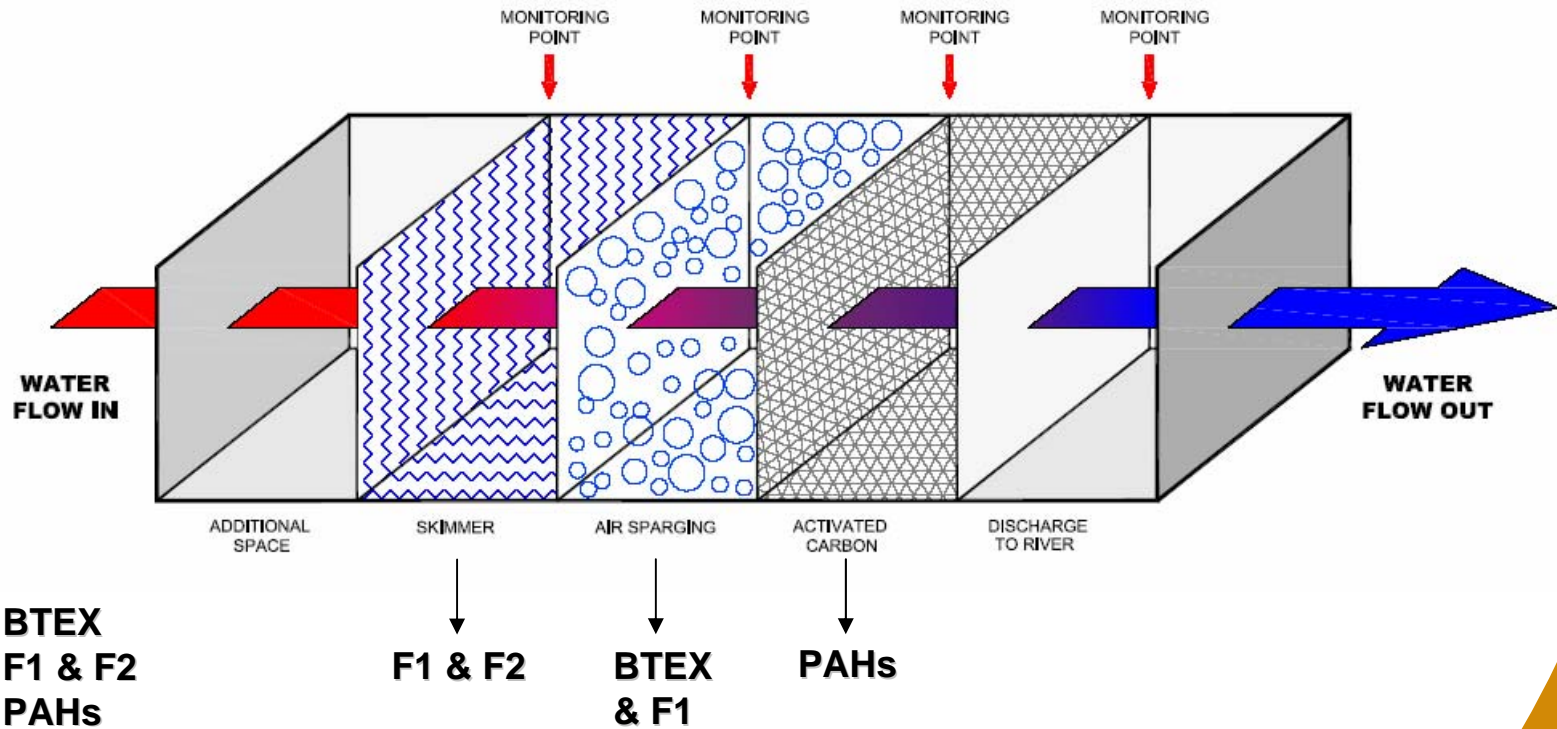


2007/03/15

## Weeping Tile Construction

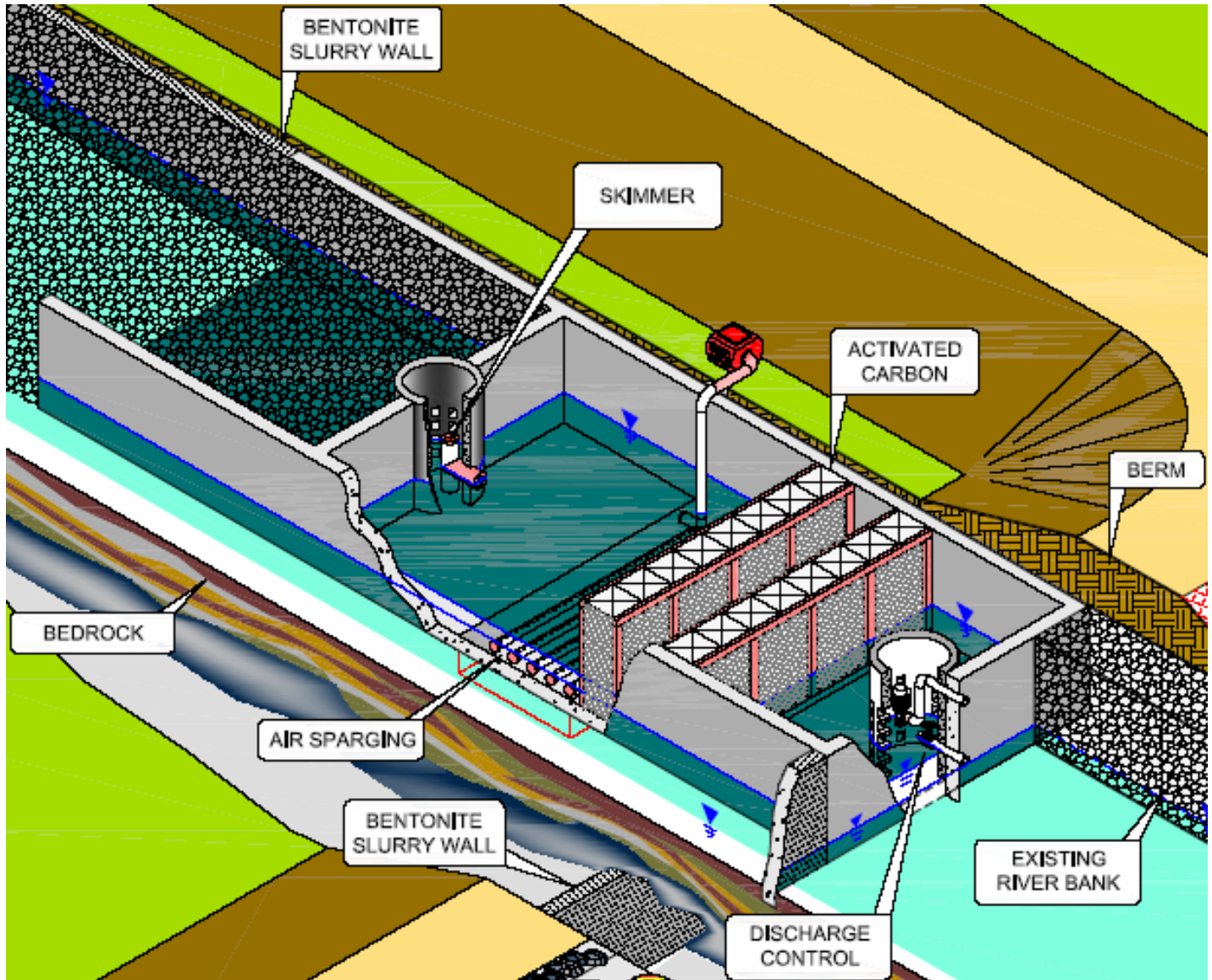


## Weeping Tile Construction



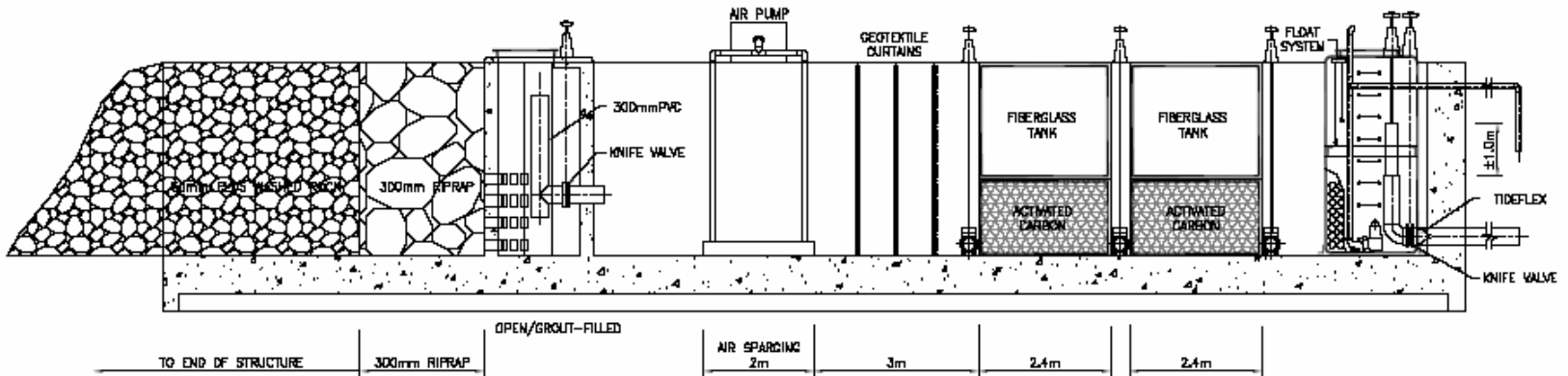
## Groundwater Treatment Concept



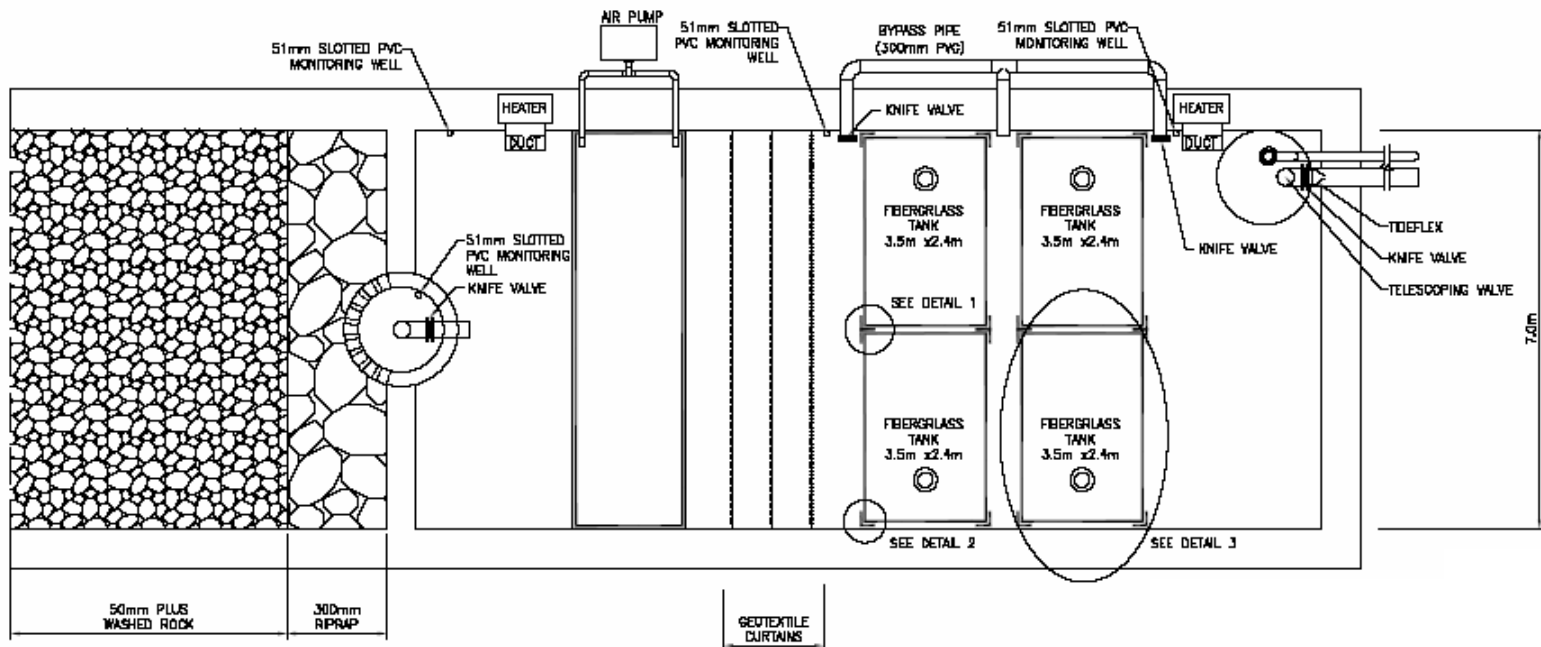


### Conceptual Design of Treatment System





## Detailed Design of Treatment System (DRAFT) Side View



## Detailed Design of Treatment System (DRAFT) Top View



**Treatment Corridor**



**Treatment Corridor**



Table 1.0 Treatment Corridor Groundwater Analytical Results

Parameter	Canadian Drinking Water Guidelines <sup>1</sup>	CCME Guidelines for the Protection of Aquatic Life	April 16, 2007	April 16, 2007	April 16, 2007	April 16, 2007
			TURNER VALLEY TCMW01	TURNER VALLEY TCMW02	TURNER VALLEY TCMW03	TURNER VALLEY TCMW04
<b>Routine (lab) (mg/L unless otherwise noted)</b>						
pH (pH units)	6.5-8.5 <sup>(AO)</sup>	6.5 - 9.0	7.6	7.7	7.7	9.2
Conductivity (Lab - $\mu$ S/cm)	NC	NC	1400	1410	1360	1160
Total Dissolved Solids	500 <sup>(AO)</sup>	NC	624	619		299
Hardness	NC	NC	<5	<5		65
Calcium	NC	NC	<5	<5		<5
Magnesium	NC	NC	512	507		353
Potassium	NC	NC				
Sodium	200 <sup>(AO)</sup>	NC				
Chloride	250 <sup>(AO)</sup>	NC				
Sulphate	500 <sup>(AO)</sup>	NC				
Bicarbonate	NC	NC	624	619	576	299
Carbonate	NC	NC	<5	<5	<5	65
Hydroxide	NC	NC	<5	<5	<5	<5
Alkalinity, total (as CaCO <sub>3</sub> )	NC	NC	512	507	472	353
Iron - Dissolved	0.3 <sup>(AO)</sup>	0.3				
Manganese - Dissolved	0.05 <sup>(AO)</sup>	NC				
Ionic Balance (%)	NC	NC				
Nitrate - N	45 <sup>(MAC)</sup>	13				
Nitrite - N	NC	0.06				

## Analytical Results - Routine

**Table 1.0 Treatment Corridor Groundwater Analytical Results**

Parameter	Canadian Drinking Water Guidelines <sup>1</sup>	CCME Guidelines for the Protection of Aquatic Life	April 16, 2007	April 16, 2007	April 16, 2007	April 16, 2007
			TURNER VALLEY TCMW01	TURNER VALLEY TCMW02	TURNER VALLEY TCMW03	TURNER VALLEY TCMW04
<b>Hydrocarbons (mg/L)</b>						
F2 (>C10-C16)	NC	NC	0.09	0.29	0.33	0.05
F3 (C16-C34)			1.2	1.6	2.0	0.05
F4 (C34-C50)			0.74	0.66	0.82	0.05
Benzene	0.005	0.370	<0.00050	<0.00050	<0.00050	<0.00050
Toluene	0.024	0.002	<b>0.00312</b>	<0.00050	<0.00050	0.00098
Ethylbenzene	0.0024	0.090	<0.00050	<0.00050	<0.00050	<0.00050
Xylenes	0.300	NC	<0.00050	<0.00050	<0.00050	<0.00050
F1 - BTEX	NC	NC	<0.1	<0.1	<0.1	<0.1
Fraction 1 (C6 - C10)	NC	NC	<0.1	<0.1	<0.1	<0.1

## Analytical Results - Hydrocarbons

**Table 1.0 Treatment Corridor Groundwater Analytical Results**

Parameter	Canadian Drinking Water Guidelines <sup>1</sup>	CCME Guidelines for the Protection of Aquatic Life	April 16, 2007	April 16, 2007	April 16, 2007	April 16, 2007
			TURNER VALLEY TCMW01	TURNER VALLEY TCMW02	TURNER VALLEY TCMW03	TURNER VALLEY TCMW04
<b>Polycyclic Aromatic Hydrocarbons (mg/L)</b>						
Naphthalene	NC	0.0011	0.00003	0.00003	0.00003	0.00002
Quinoline	NC	0.0034	<0.00001	<0.00001	0.00008	0.00011
Acenaphthene	NC	0.0058	<0.00001	<0.00001	<0.00001	<0.00001
Fluorene	NC	0.003	<0.00001	<0.00001	<0.00001	0.00002
Phenanthrene	NC	0.0004	<0.00001	<0.00001	0.00003	0.00006
Anthracene	NC	0.000012	<b>0.00003</b>	<b>0.00003</b>	<b>0.00003</b>	<0.00001
Acridine	NC	0.00004	<0.00001	<0.00001	<0.00001	<0.00001
Fluoranthene	NC	0.000025	<0.00001	<0.00001	<0.00001	<0.00001
Pyrene	NC	0.000018	<0.00001	<0.00001	<0.00001	<0.00001
Benzo(a)anthracene	NC	NC	<0.00001	<0.00001	<0.00001	<0.00001
Chrysene	NC	NC	<0.00001	<0.00001	<0.00001	<0.00001
Benzo(b)fluoranthene	NC	NC	<0.00001	<0.00001	<0.00001	<0.00001
Benzo(k)fluoranthene	0.00001	0.000015	<0.00001	<0.00001	<0.00001	<0.00001
Benzo(a)pyrene	NC	NC	<0.00001	<0.00001	<0.00001	<0.00001
Indeno(1,2,3-cd)pyrene	NC	NC	<0.00001	<0.00001	<0.00001	<0.00001
Dibenzo(a,h)anthracene	NC	NC	<0.00001	<0.00001	<0.00001	<0.00001
Nitrobenzene d5	NC	NC	73	69	69	71
2-Fluorobiphenyl	NC	NC	61	59	53	61
p-Terphenyl d14	NC	NC	70	67	70	78

## Analytical Results – PAH's



**Table 1.0 Treatment Corridor Groundwater Analytical Results**

Parameter	Canadian Drinking Water Guidelines <sup>1</sup>	CCME Guidelines for the Protection of Aquatic Life	April 16, 2007	April 16, 2007	April 16, 2007	April 16, 2007
			TURNER VALLEY TCMW01	TURNER VALLEY TCMW02	TURNER VALLEY TCMW03	TURNER VALLEY TCMW04
<b>Major Ions &amp; Dissolved Trace Metals</b>						
Chloride (Cl)	250 <sup>(AO)</sup>	NC	35.5	36.1	34.3	40.1
Silver (Ag)	NC	0.0001	<0.005	<0.005	<0.005	<0.005
Aluminum (Al)	0.100	0.005	<0.01	<b>0.04</b>	<0.01	<b>0.30</b>
Boron (B)	1 <sup>(MAC)</sup>	NC	<0.05	<0.05	0.06	0.07
Barium (Ba)	5 <sup>(MAC)</sup>	NC	0.097	0.098	0.098	0.018
Beryllium (Be)	NC	NC	<0.001	<0.001	<0.001	<0.001
Cadmium (Cd)	0.005 <sup>(MAC)</sup>	0.000017	<0.001	<0.001	<0.001	<0.001
Cobalt (Co)	NC	NC	<0.002	<0.002	<0.002	<0.002
Chromium (Cr)	0.05 <sup>(MAC)</sup>	NC	<0.005	<0.005	0.005	0.005
Copper (Cu)	1.0 <sup>(AO)</sup>	0.002	0.002	0.002	0.002	0.001
Molybdenum (Mo)	NC	0.073	<0.005	<0.005	<0.005	<b>0.249</b>
Nickel (Ni)	NC	0.025	0.012	0.012	0.009	0.007
Lead (Pb)	0.010 <sup>(MAC)</sup>	0.001	<0.005	<0.005	<0.005	<0.005
Tin (Sn)	NC	NC	<0.05	<0.05	<0.05	<0.05
Strontium (Sr)	NC	NC	0.637	0.615	0.598	0.537
Titanium (Ti)	NC	NC	0.002	0.001	0.002	0.010
Thallium (Tl)	NC	NC	<0.05	<0.05	<0.05	<0.05
Vanadium (V)	NC	0.03	0.002	0.001	0.002	0.030
Zinc (Zn)	5.000	NC	1.58	0.236	0.494	0.074
Calcium (Ca)	NC	NC	226	227	206	72.9
Potassium (K)	NC	NC	5.6	5.8	20.2	71.0
Magnesium (Mg)	NC	NC	47.3	48.7	48.1	37.1
Sodium (Na)	200 <sup>(AO)</sup>	NC	32	38	43	104

## Analytical Results – Major Ions and Dissolved Trace Metals





**Table 1.0 Treatment Corridor Groundwater Analytical Results**

Parameter	Canadian Drinking Water Guidelines <sup>1</sup>	CCME Guidelines for the Protection of Aquatic Life	April 16, 2007	April 16, 2007	April 16, 2007	April 16, 2007
			TURNER VALLEY TCMW01	TURNER VALLEY TCMW02	TURNER VALLEY TCMW03	TURNER VALLEY TCMW04
<b>Microtox</b>						
Turbidity			LOW	LOW	LOW	LOW
Color			COLORLESS	COLORLESS	COLORLESS	COLORLESS
Color Correction			NONE	NONE	NONE	NONE
Clarification			CENTRIFUGATION	CENTRIFUGATION	CENTRIFUGATION	CENTRIFUGATION
Initial pH			7.24	7.30	7.22	8.88
Final pH			7.24	7.30	7.22	6.81
Lab Treatment			NONE	None	NONE	NONE
<b>MICROTOX ORIGINAL</b>						
EC 50 (15min)			>100	>100	>82	>82
EC 20 (15min)			>100	>100	>82	>82
EC 50 (5min)			>100	>100	>82	>82
EC 20 (5min)			>100	>100	>82	>82
Interpretation			NON TOXIC	NON TOXIC	PASS	PASS
<b>MICROTOX TREATED</b>						
EC 50 (15min) Treated			NA	NA	NA	NA
EC 20 (15min) Treated			NA	NA	NA	NA
EC 50 (5min) Treated			NA	NA	NA	NA
EC 20 (5min) Treated			NA	NA	NA	NA
MICROTOX			NA	NA	NA	NA
Interpretation			NA	NA	NA	NA

## Analytical Results - Microtox








VA 1106 (sheet 1) 110800330 drawing (fig. 7) Alignment of erosion protect and groundwater containment/tying  
 2004-07-26 10:00AM By: site

July, 2008  
 110800330 103-110



- Legend**
-  Groundwater Containment Well
  -  Weeping Tile
  -  Monitoring Well



**Client/Project:**  
 ALBERTA INFRASTRUCTURE AND TRANSPORTATION  
 TURNER VALLEY GAS PLANT  
 HYDROCARBON CONTAINMENT AND REMEDIATION

**Figure No:**  
 7.0

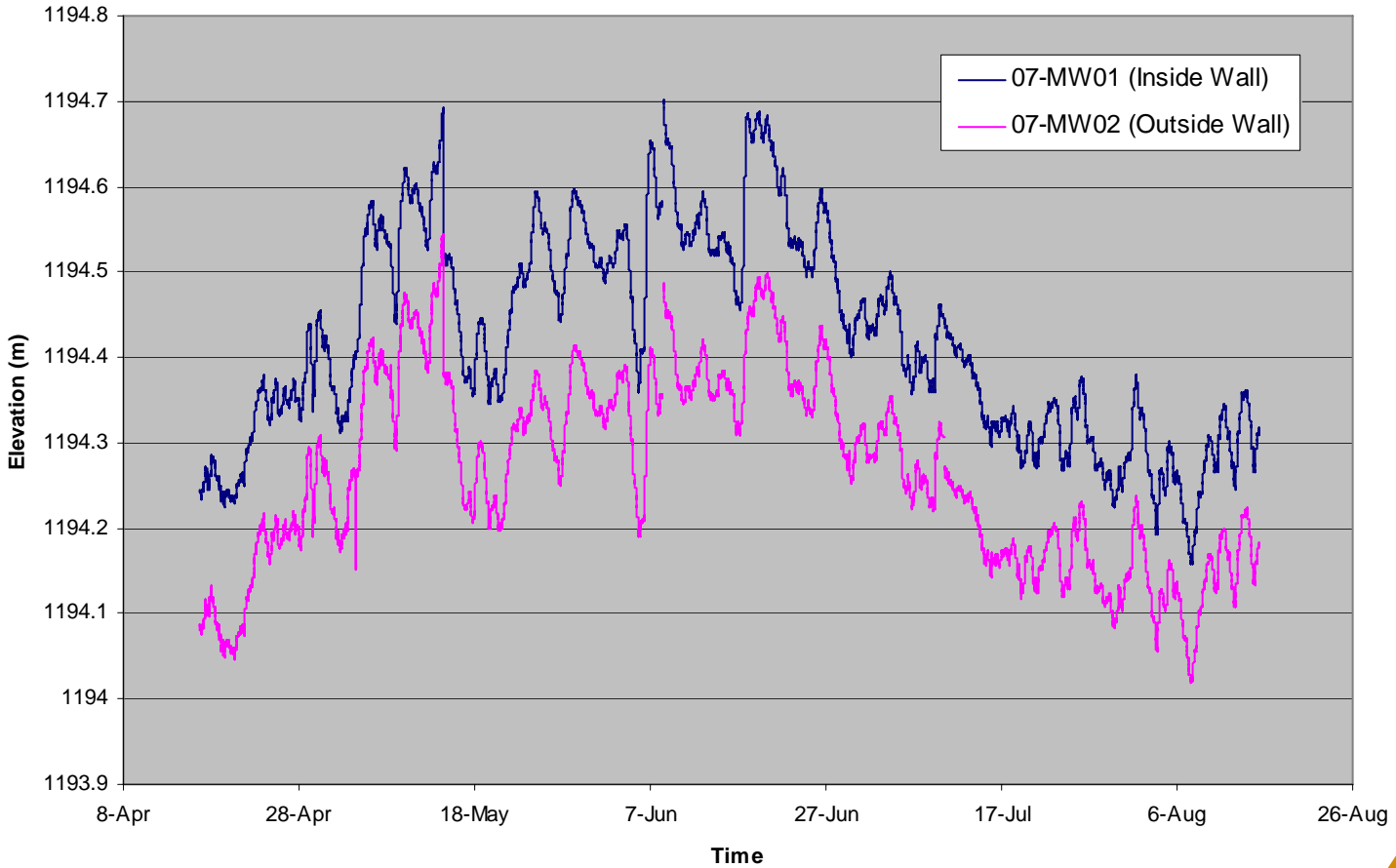
**Title:**  
 Alignment of Erosion Protection and  
 Groundwater Containment

## Monitoring Wells



**Stantec**

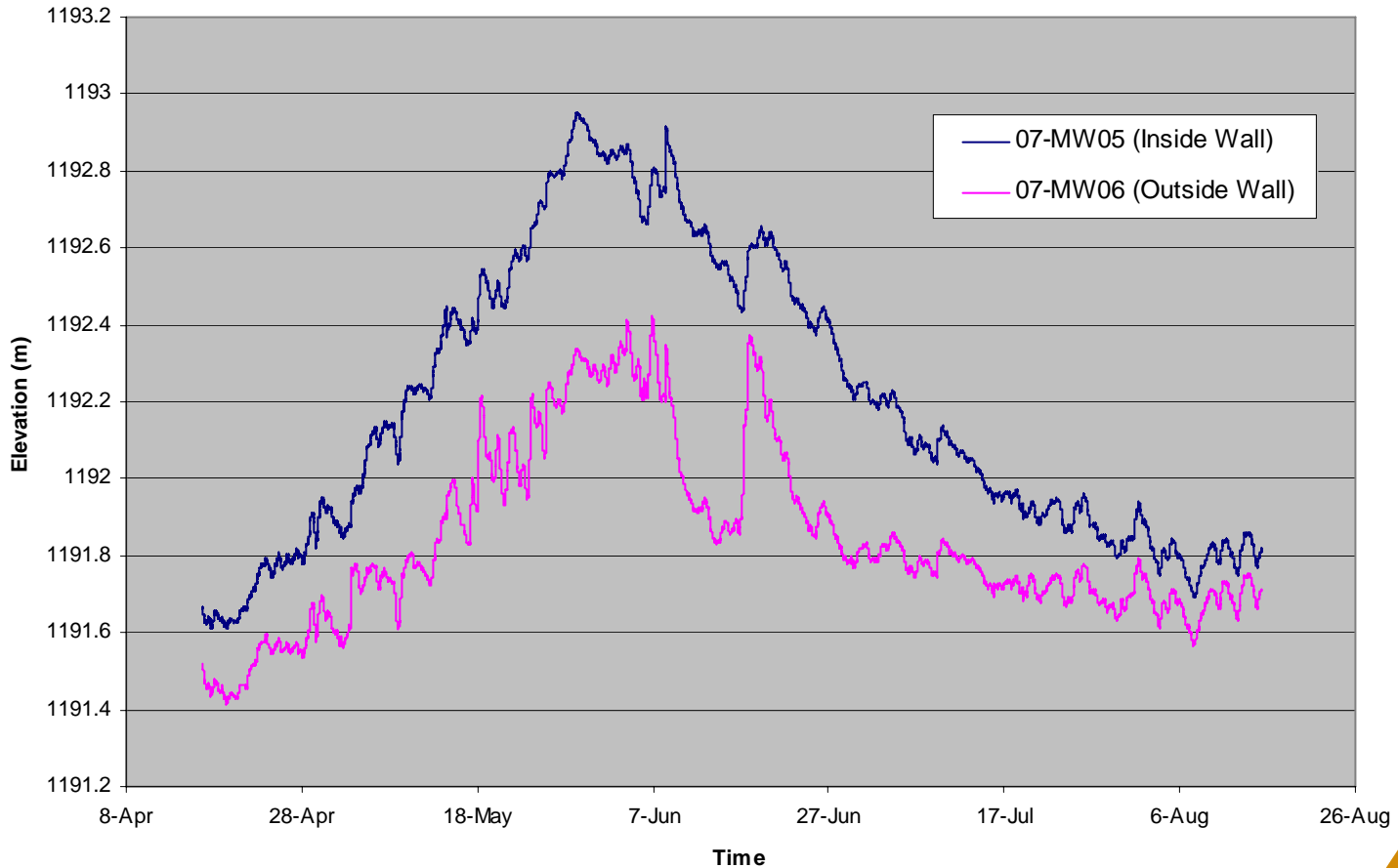
Elevation (m) vs. Time



**Monitoring Results**  
**07-MW01 vs. 07-MW02**



Elevation (m) vs. Time

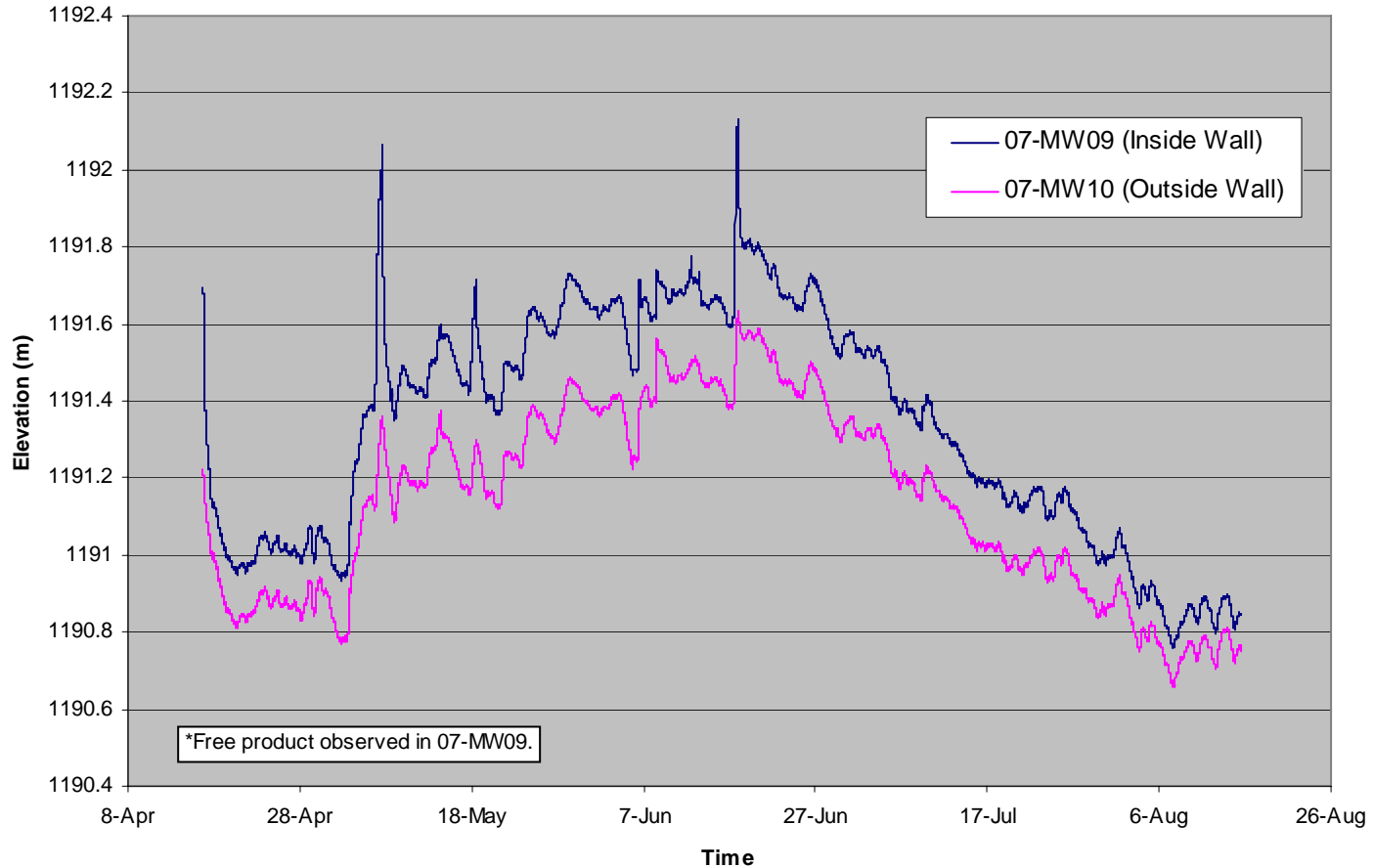


**Monitoring Results**  
**07-MW05 vs. 07-MW06**





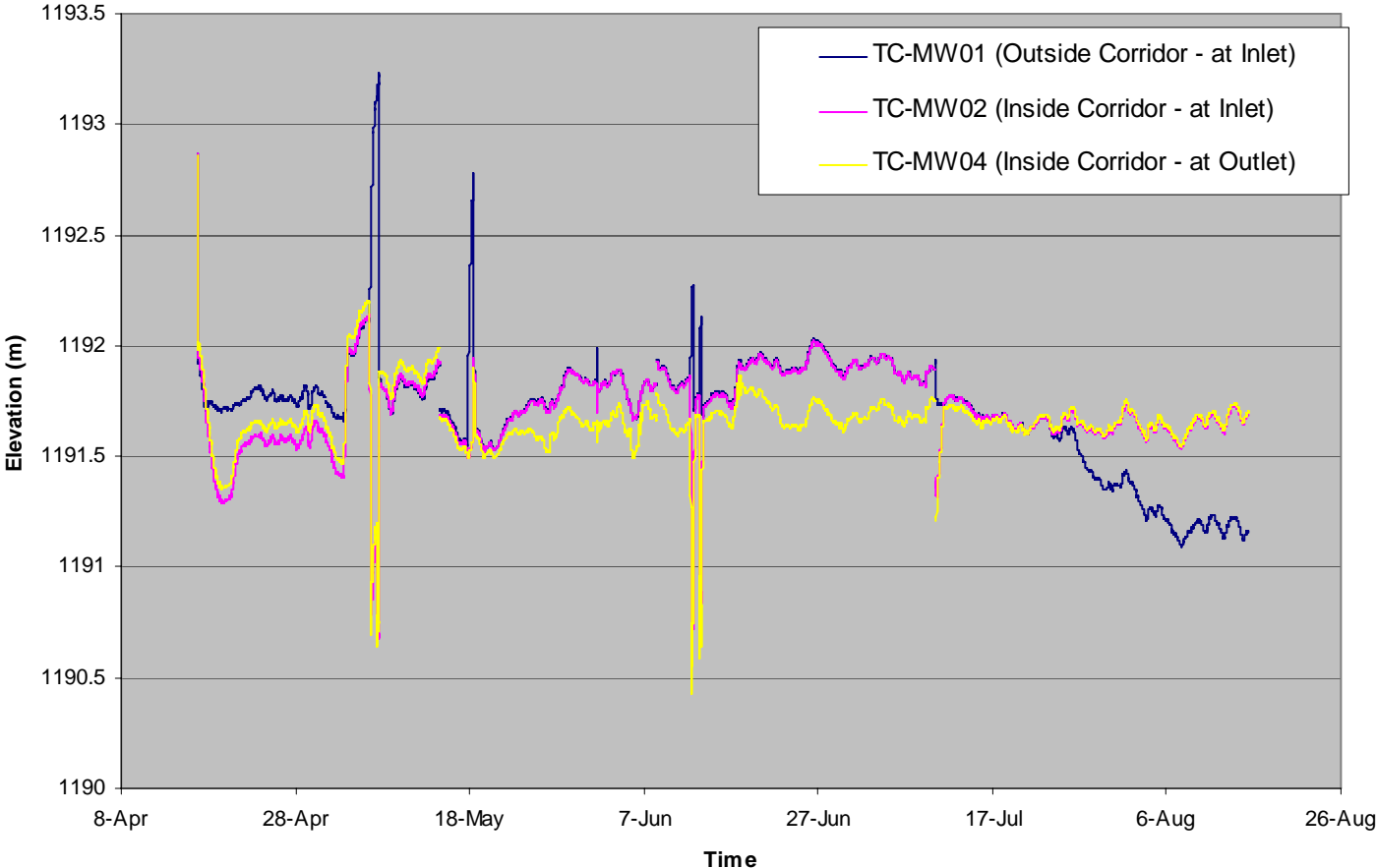
Elevation (m) vs. Time



### Monitoring Results 07-MW09 vs. 07-MW10



Elevation (m) vs. Time



**Monitoring Results**  
**Treatment Corridor Monitoring Wells**

