DOE/NV/11718--779

ALTERNATIVE LANDFILL COVER AND MONITORING SYSTEM FOR LANDFILLS IN ARID ENVIRONMENTS

PROJECT CLOSEOUT REPORT

Accelerated Site Technology Deployment
NV09SS21

Prepared by

Bechtel Nevada

Prepared for

U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office

September 2002

DISCLAIMER NOTICE

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ACRONYMS and ABBREVIATIONS

ASTD	Accelerated Site Technology Deployment
cm	centimeter
DOE/NV	U.S. Department of Energy, Nevada Operations Office
ET	Evapotranspiration
ft	foot (feet)
FY	fiscal year
m	meter(s)
m^2	square meter(s)
NNSA/NV	National Nuclear Security Administration Nevada Site Office
NTS	Nevada Test Site
RCRA	Resource Conservation and Recovery Act
RWMS	Radioactive Waste Management Site
TDR	Time-Domain Reflectrometry

EXECUTIVE SUMMARY

In December 2000, a performance monitoring facility was constructed adjacent to the mixed waste disposal unit U-3ax/bl at the Area 3 Radioactive Waste Management Site at the Nevada Test Site. This facility consists of eight drainage lysimeters measuring 10 feet in diameter, 8 feet deep, and backfilled with native soil. The lysimeters have three different surface treatments: two were left bare, two were revegetated with native species, and two were allowed to revegetate with invader species (two are reserved for future studies). The lysimeters are instrumented with an array of soil water content and soil water potential sensors and have sealed bottoms so that any drainage can be measured. All sensors are working properly and indicate that the bare lysimeters are the wettest, as expected. The vegetated lysimeters, both seeded and those allowed to revegetate with invader species, are significantly drier than the bare cover treatments. No drainage has occurred in any of the lysimeters. The Accelerated Site Technology Deployment program under the U.S. Department of Energy's Office of Science and Technology provided the funding for this project with the objective of reducing the uncertainty associated with the performance of monolayer-evapotranspiration waste covers in arid regions such as the one deployed at U-3ax/bl.

Background

Traditional Resource Recovery and Conservation Act (RCRA) landfill covers are typically layered, including layers of compacted clay and coarse gravel to isolate waste. This type of cover was originally to be deployed for the closure of the U-3ax/bl waste disposal unit located within the Area 3 Radioactive Waste Management Site (RWMS) of the Nevada Test Site (NTS) (Figure 1). Concerns regarding differential subsidence and subsequent shearing of the traditional RCRA-type cover prompted an internal 1997 study to investigate subsidence and closure covers. Findings from this study indicate that a monolayer-evapotranspiration (ET) cover consisting of native alluvium would be most effective in isolating waste under subsidence conditions. Modeling results and a multiple-year data record from a weighing lysimeter facility in nearby Area 5 provide evidence that the use of a partially vegetated monolayer cover will effectively isolate waste from infiltrating water via evapotranspiration back to the atmosphere, even during wetter-than-average years (Levitt *et al.*, 1996 ; Schmeltzer *et al.*, 1996). Additionally, other studies indicate that in the arid southwestern United States, monolayer-ET covers may be more effective at isolating waste than the layered covers because of the tendency of the clay layers to desiccate and crack, thereby creating preferential pathways for infiltrating water (O'Donnell, 1998; Dwyer, 1998). These studies led to the selection of a monolayer-ET cover deployment for the closure of disposal unit U-3ax/bl.

In fiscal year (FY) 1999, the Accelerated Site Technology Deployment (ASTD) program accepted the U.S. Department of Energy's Nevada Operations Office (DOE/NV) proposal to deploy a monolayer-ET closure cover and a performance monitoring system on U-3ax/bl disposal unit at the NTS, Area 3 RWMS. The monolayer-ET cover is an alternative to a layered cover typically specified by RCRA. The monitoring system consists of two parts: instrumentation in the closure cover and instrumentation in an adjacent lysimeter facility (see *Figure 1*), which allows some parameters to be varied for comparison with physical conditions in the cover. The deployment was jointly funded by the ASTD Program and the DOE/NV. The ASTD program funded construction of the lysimeter facility, whereas the DOE/NV funded construction of the alternative closure cover and its instrumentation.

This facility was constructed such that soil conditions are identical to the closure cover of U-3ax/bl. The lysimeters were constructed to collect and measure any drainage, and thereby provide an indirect measure of drainage though the closure cover. Additionally, the lysimeters were constructed with three surface treatments: two were left bare, two were revegetated with native species, and two were allowed to revegetate with invader species and (two were reserved for future studies) (see Figure 2). The lysimeter facility was funded for the purpose of collecting data to reduce the uncertainty associated with monolayer-ET waste cover performance in arid environments.

Each lysimeter is instrumented with an array of soil water content sensors (time-domain reflectrometry [TDR] probes) and soil water potential sensors (heat dissipation probes) as shown in Figure 3 and Attachment 1. U-3ax/bl is instrumented with soil water content sensors only as shown in Figure 4. All sensors in both the closure cover and lysimeter facility are working properly, with no indication of damage to any sensor during construction.

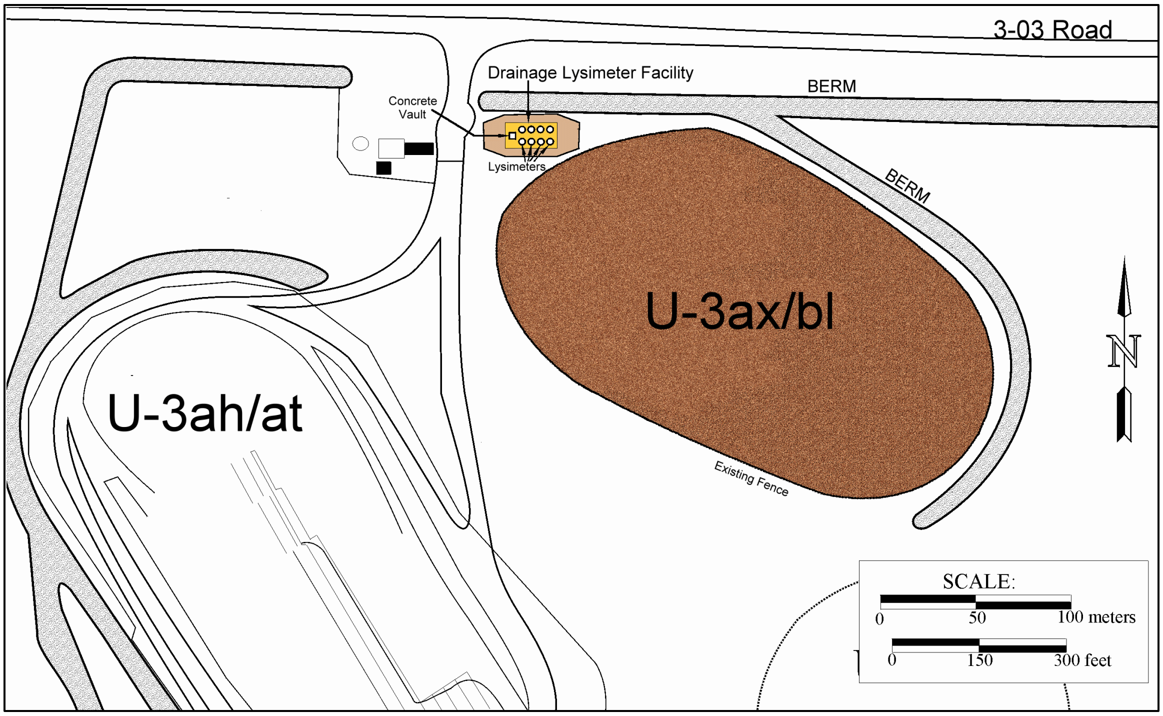

Figure 1 Location of U-3ax/bl and the Drainage Lysimeter Facility

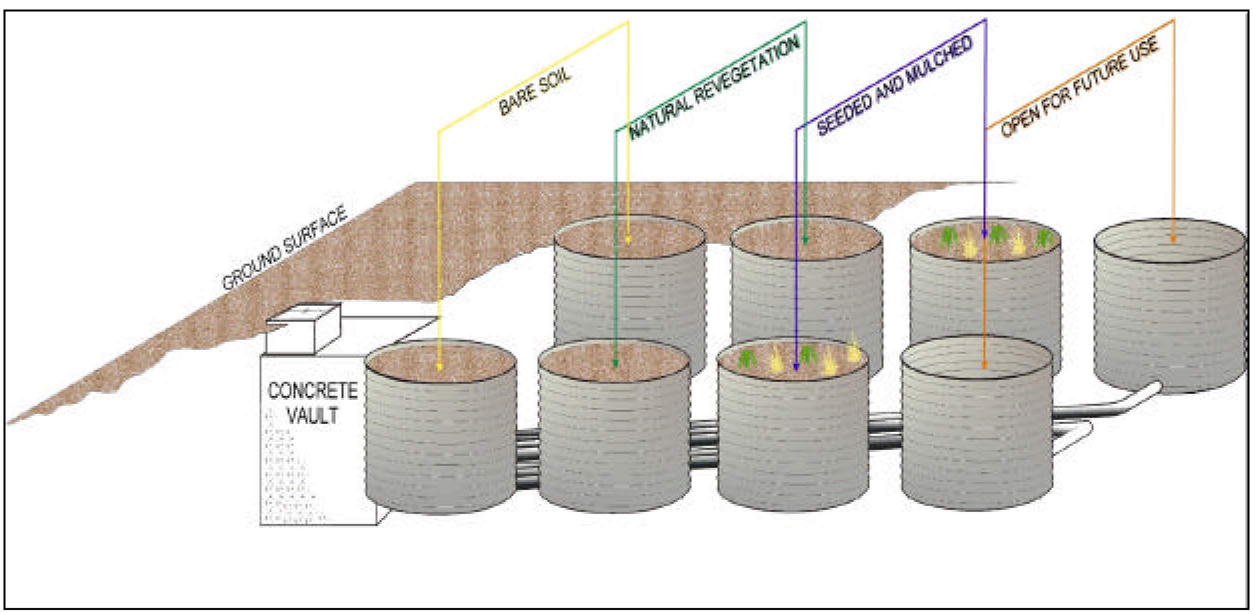

Figure 2 Surface treatments of the eight lysimeters (all are now filled with soil)

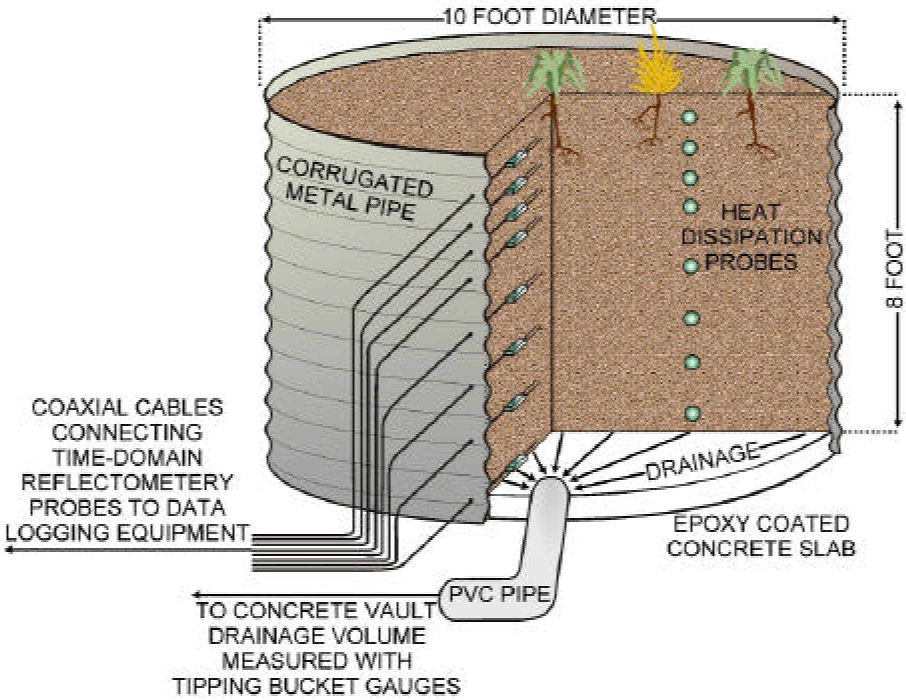

Figure 3 Location of sensors within one drainage lysimeter

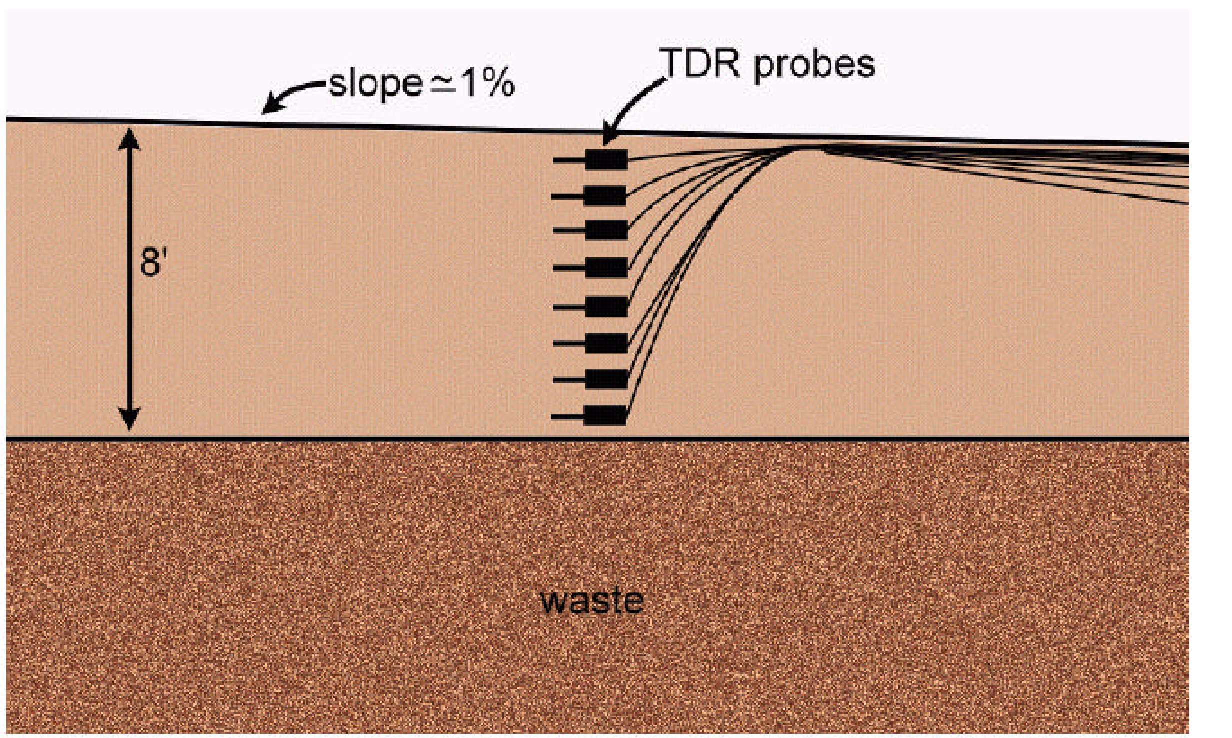

Figure 4 Schematic cross-section of sensor locations in the U-3ax/bl closure cover

In November 2000, construction of the final closure cover of U-3ax/bl began with the application of 30 centimeters (cm) (1 foot [ft]) of soil from a nearby borrow pit to the original 2.4- to 3.0 meter (m) (8- to 10 ft) thick operational closure cover. The final closure cover ranges in thickness from approximately 2.7 to 3.4 m (9 to 11 ft). Re-vegetation activities began in December 2000 with seeding of native species (see Table 1) and straw mulching of the closure cover and two of the drainage lysimeters. The percentage of each species used in the seed mix is based on the relative contribution of a particular species to the total perennial plant cover typical of adjacent native plant communities, the size of the seed, rooting characteristics (i.e., shallow-rooted species), and experience with the species at the NTS (DOE/NV, 2000). Seeded areas were irrigated briefly to promote plant growth.

Table 1 Revegetation activities

	Scientific Name	Common Name	PLS[1] lbs/Acre	Total PLS lbs of Seed	Approximate Number of Viable Seeds/m²
Shrubs	***Artemisia spinescens***	**Budsage**	**0.1**	**0.8**	**108**
	Atriplex confertifolia	**Shadscale**	**4.4**	**32.0**	**70**
	Ephedra nevadensis	**Nevada Ephedra**	**3.0**	**21.6**	**15**
	Ericameria nauseosa	**Rubber Rabbitbrush**	**1.5**	**11.2**	**151**
	Eriognum fasciculatum	**Buckwheat**	**0.3**	**2.4**	**37**
	Grayia spinosa	**Spiny Hopsage**	**0.5**	**4.0**	**23**
	Hymenoclea salsola	**Burrobush**	**2.2**	**16.0**	**59**
	Kraschenninnikovia lanata	**Winterfat**	**4.9**	**36.0**	**69**
	Lycium andersonii	**Desert Thorn**	**0.2**	**1.6**	**10**
Grasses	***Achnatherum hymenoides***	**Indian Ricegrass**	**3.4**	**24.8**	**136**
	Elymus elymoides	**Squirreltail**	**1.0**	**7.4**	**48**
Forbs	***Sphaeralcea ambigua***	**Globemallow**	**0.7**	**4.8**	**81**
	Totals		**22.2**	**162.6**	**807**

[1]**Pure Live Seed**

Details on the background and installation of the lysimeter facility, and the closure and monitoring of U-3ax/bl can be found in Dixon *et al*. (2000), Fitzmaurice and Levitt (2000), Levitt and Fitzmaurice (2001), and NNSA/NV (2001). Details on the regulatory approval process for the closure of U-3ax/bl can be found in Smith and Fitzmaurice (2001).

Data Summary

All monitoring data from the lysimeter facility, including drainage, are electronically collected and recorded with data loggers mounted inside the underground monitoring vault (see Figure 5). A direct communication link using coaxial cable communications technology was installed between the vault and a nearby meteorological tower, and a phone line link to the meteorological tower for easy remote access to all data. A meteorology tower located within 122 m (400 ft) of the lysimeter facility has been operational since July 1995. Measurements at the tower include

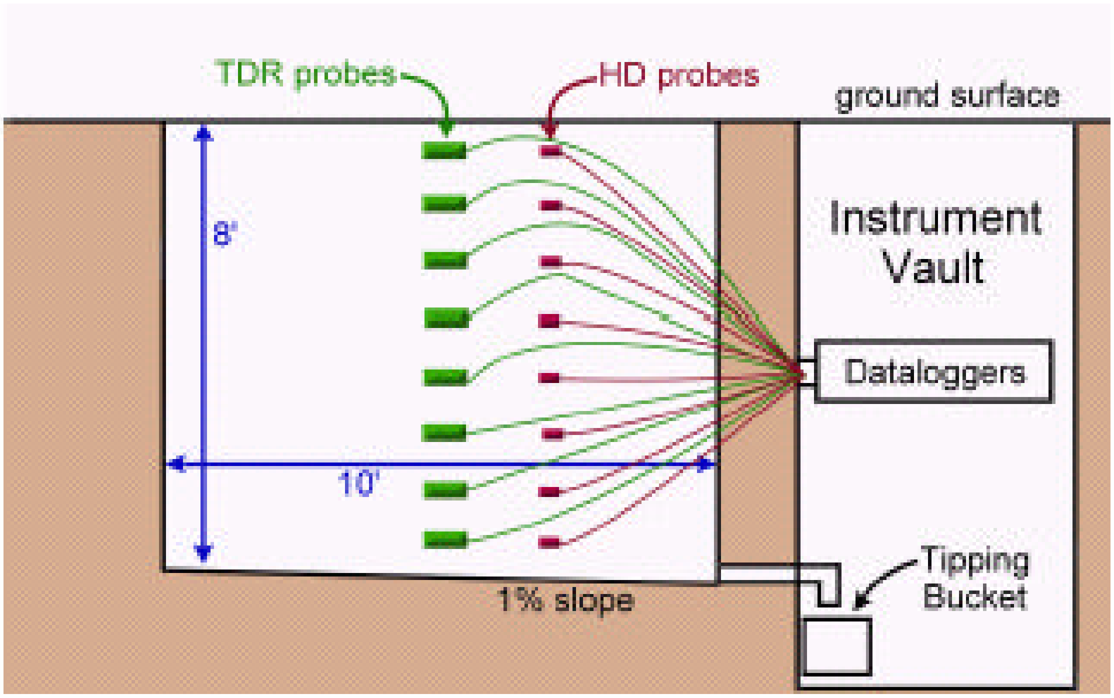

Figure 5 Schematic cross-section of sensor locations in each of the eight drainage and instrumentation vaults

air temperature, wind speed and direction, relative humidity, barometric pressure, and solar radiation. Precipitation is measured in a stand-alone rain gauge near the tower. Meteorology data provide the necessary components to approximate evapotranspiration based on the surface energy balance.

A vegetation survey was conducted on both the U-3ax/bl cap and the seeded lysimeter cells in spring 2002 (see Table 2). Absolute plant cover was estimated by recording the amount of cover within a meter-square quadrant. The measurements from 50 quadrants were used to determine the average cover for the U-3ax/bl cap. Percent cover for U-3ax/bl and the seeded lysimeters as of April 2002 are 6 and 12 percent, respectively. The long-term goal for the vegetative cover is 12 percent and is based on vegetation density of similar native environments. The amount of cover on the lysimeter plots decreased from about 31 percent in June 2001 to 12 percent in April 2002. Although 12 percent cover on the lysimeter plots is higher than expected after one year, species diversity is very low. Vegetation density on the lysimeter plots decreased from over 100 plants/square meter (m^2) in 2001 to 28 plants/m^2 in 2002 (see Table 3). The most significant decrease in plant numbers was for winterfat, which decreased from 67 plants/m^2 to less than 3 plants/m^2; and Indian ricegrass, which decreased from 11.8 plants/m^2 to 1.3 plants/m^2. Dead plants of winterfat were scattered over the lysimeter plots. Browsers, probably rabbits, had cut the stems. The facility is now fenced with the same fencing design as U-3ax/bl to prevent further consumption of vegetation from browsers. Reseeding of the lysimeters using the original

Table 2 Average percent cover

Lifeform	% Cover			
	Cover Cap June 2001	Cover Cap April 2002	Lysimeter June 2001	Lysimeter April 2002
Seeded Species	2.6	6.0	31.3	12
Annuals	5.2	0	2.0	0
Mulch	43.6	24.1	51.3	63

Table 3 Plant density by species

Lifeform	Scientific Name	Common Name	Density	
			Closure Cap April 2002	Lysimeter April 2002
SHRUBS	*Artemisia spinescens*	Budsage	0	70.0
	Atriplex confertifolia	Shadscale	10.3	0
	Ephedra nevadensis	Nevada Ephedra	6.7	0
	Ericameria nauseosa	Rubber Rabbitbrush	0.7	0
	Eriognum fasciculatum	Buckwheat	4.2	0
	Grayia spinosa	Spiny Hopsage	0.1	0
	Hymenoclea salsola	Burrobush	0	0
	Kraschenininnikovia lanata	Winterfat	2.7	1.8
	Lycium andersonii	Desert Thorn	0.0	0
	Atriplex canescens (not seeded)	Fourwing Saltbush	0.1	0
	TOTAL SHRUBS		24.8	71.8
GRASSES	*Achnatherum hymenoides*	Indian Ricegrass	1.3	0
	Elymus elymoides	Squirreltail	0.2	0
	TOTAL GRASSES		1.5	0
FORBS	*Sphaeralcea ambigua*	Globemallow	<0.1	0
	TOTAL FORBS		<0.1	0

seed mixture is planned for fall 2002 to increase plant diversity. Because of the below-average precipitation in 2002, supplemental irrigation of U-3ax/bl is also being considered to maintain the established plant community.

The data indicate that the lysimeters and closure cover have dried rapidly, despite elevated soil water contents (due to dust control) introduced during installation of soil and sensors. Wetting fronts from precipitation events have infiltrated less than 3 feet in the bare cover locations and less than 2 feet at seeded locations (both closure cover and lysimeters) before being returned to the atmosphere via evapotranspiration. Figures 6 and 7 illustrate soil water content with time for

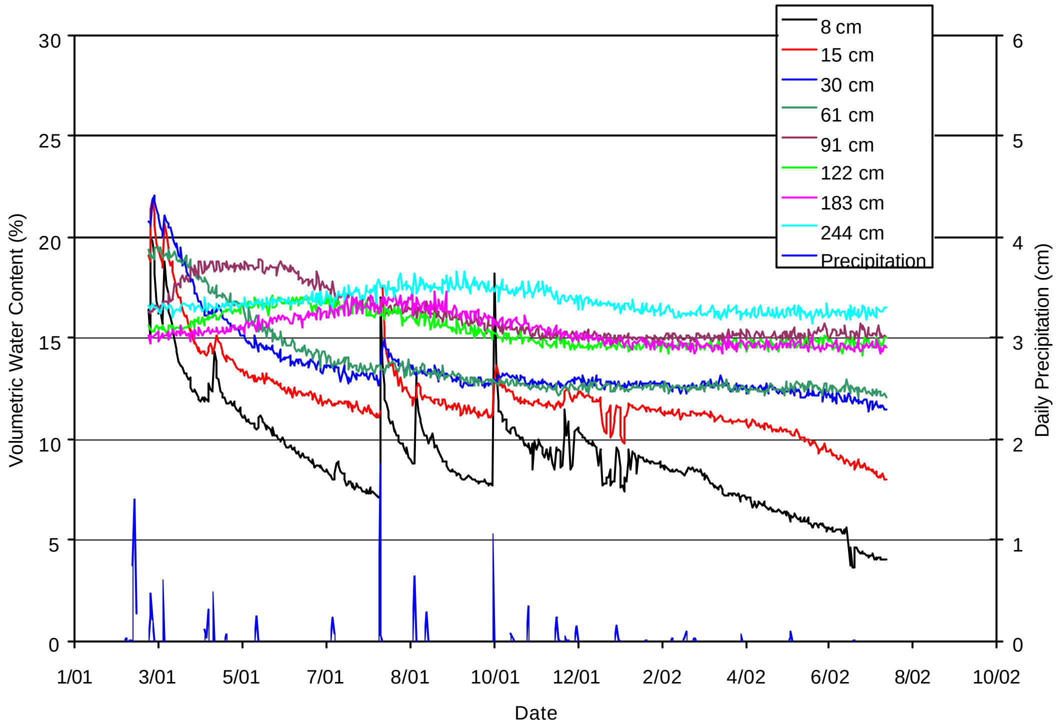

Figure 6 Soil water content in bare drainage lysimeter (A) using TDR system

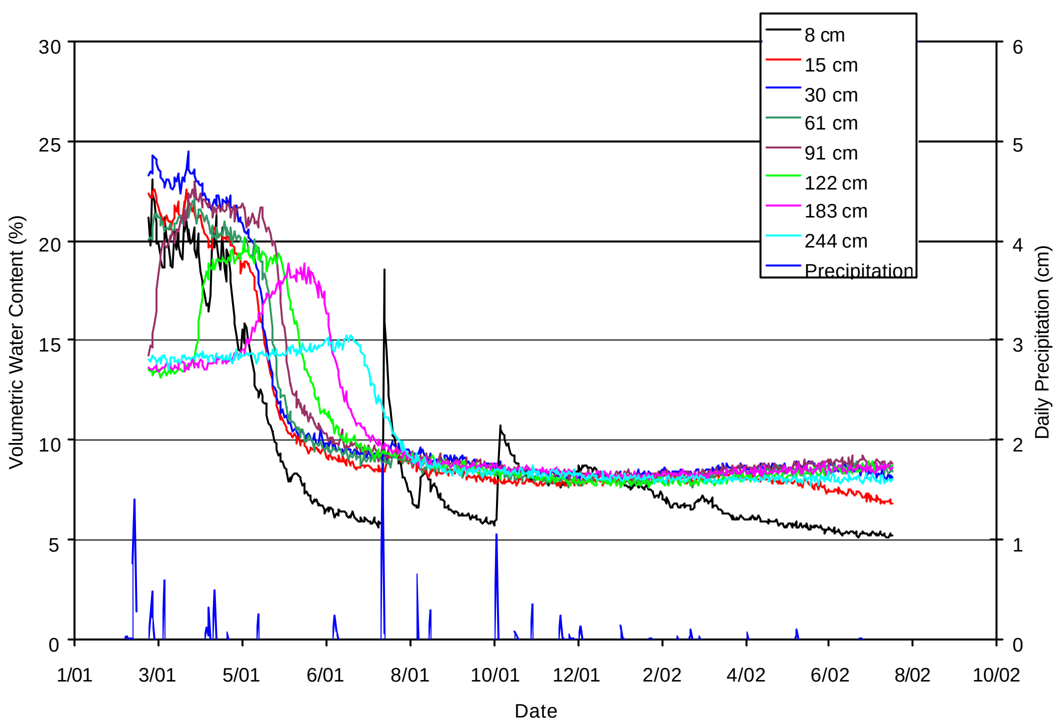

Figure 7 Soil water content in native vegetated drainage lysimeter (E) using TDR system

lysimeters A and E, respectively. Lysimeter A has a bare-soil surface, while lysimeter E was revegetated with native plant species. These figures illustrate that the vegetated lysimeter is significantly drier than the bare lysimeter. Additionally, the soil water contents in the vegetated plots are essentially uniform below 30 cm (1 ft), whereas the soil water content generally increases with depth in the bare lysimeters.

Figures 8 and 9 illustrate soil water content with time for U-3ax/bl and show how the soil water content has generally decreased with time as the vegetation on the cap has grown. Comparison of TDR data from the seeded lysimeters and the U-3ax/bl cover indicate that the seeded lysimeters are somewhat drier than the closure cover. This difference can be attributed the much higher vegetation density on the seeded lysimeters as compared to the closure cover. Vegetation surveys conducted in June of 2001 and May of 2002 found the percent cover on the lysimeters to be four and two times higher than the U-3ax/bl cover, respectively. This difference is the result of a higher germination success on the lysimeters.

Figure 10 illustrates the total soil water storage with time for all eight lysimeters. Total water storage is the calculated total amount of the depth of water in each lysimeter. If one lysimeter were completely saturated, its total water storage would be about 90 cm (3 ft). From *Figure 10*, three groups are readily discernable: bare (wettest), native and invaders (driest), and one invader (intermediate). This figure illustrates that 3 of the 4 cells allowed to re-vegetate with invaders species have thus far been nearly as effective as the seeded species in reducing the soil water storage in the top eight feet of soil.

Figure 11 illustrates the bare to native vegetated lysimeter water storage ratio with time, starting at essentially 1 (equal storage) then dipping below 1 for approximately two months due to the irrigation of the vegetated plot. From mid-May 2001, this ratio curve rises sharply as the vegetation grows and transpires water from the lysimeter. The storage ratio curve leveled off in the fall of 2001 to about 1.7 and decreased slowly to its current ratio of approximately 1.6.

Figures 12 and 13 illustrate soil water potential with time at various depths in lysimeters A and E. Note the sensitivity of these sensors to rainfall, where potential can rapidly change by orders of magnitude. Although soil water content is conceptually easier to understand than soil water potential, measurements of water potential are more important for understanding the movement of water in waste covers. These figures generally indicate an upward matric potential gradient. Additionally, some locations within the vegetated lysimeter are dry beyond the measurement range of the senor and show the evapotranspiration effects of drying visible to the bottom of the lysimeter (2.4 m [8 ft] deep).

Conclusions

The data collected from the drainage lysimeter facility and instrumented U-3ax/bl cover may provide valuable information for the design of landfill covers in arid environments. The nearly two years of data collected from these facilities indicate that all sensors are operating properly and the facilities are performing well. Due to the below average precipitation conditions, the

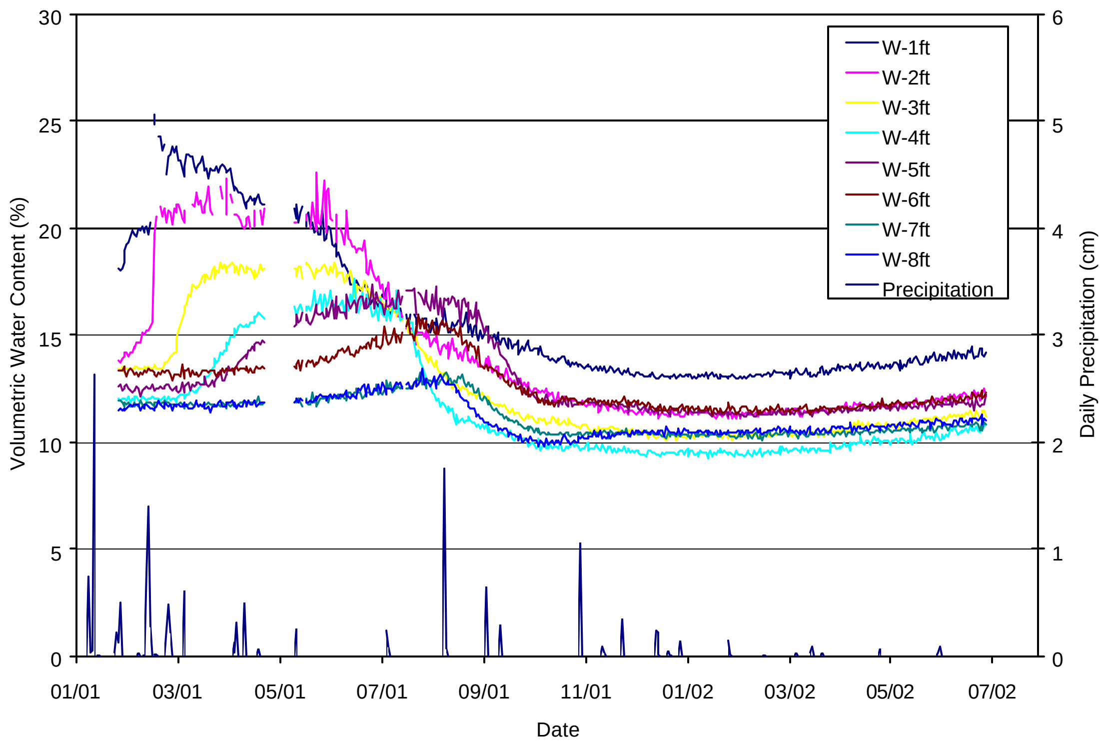

Figure 8 Soil water content in U-3ax/bl cover (west station) using TDR system

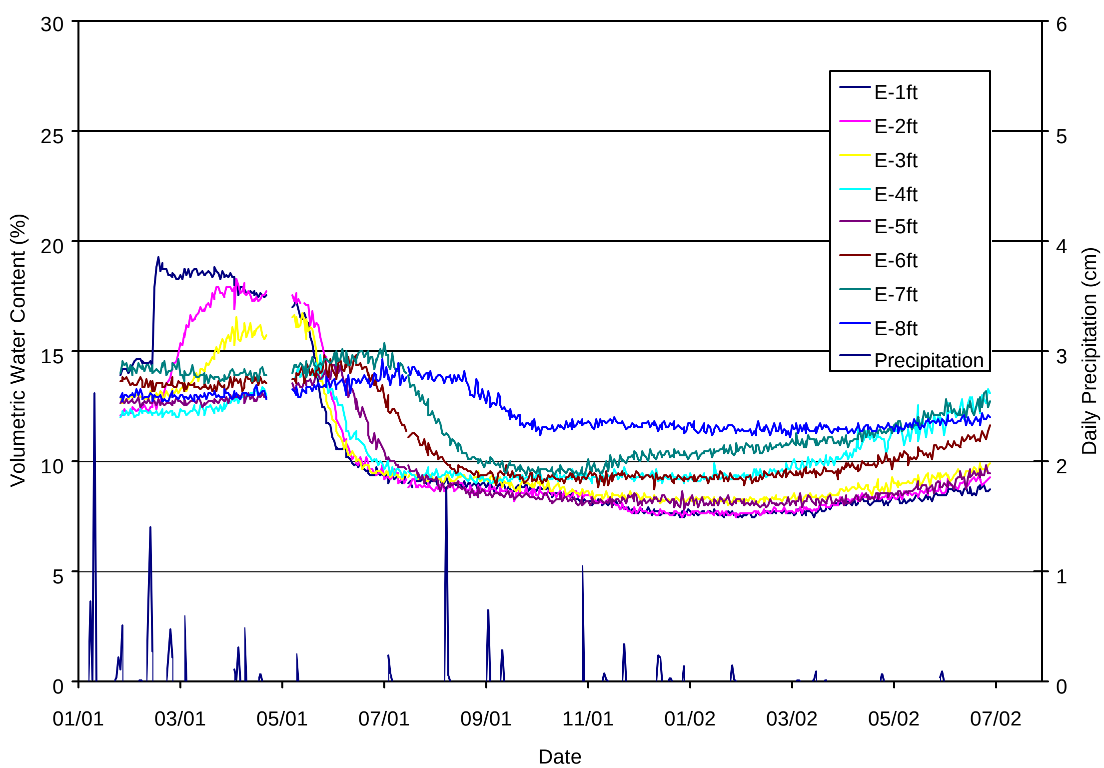

Figure 9 Soil water content in U-3ax/bl cover (east station) using TDR system

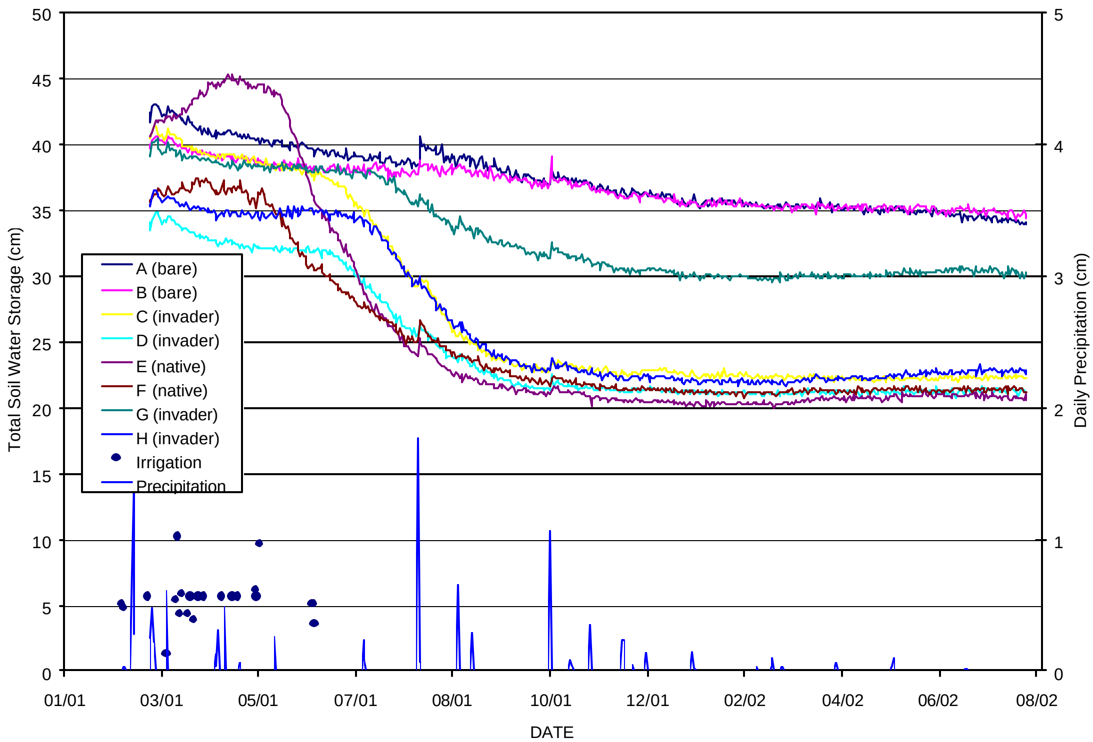

Figure 10 Total soil water storage in drainage lysimeters

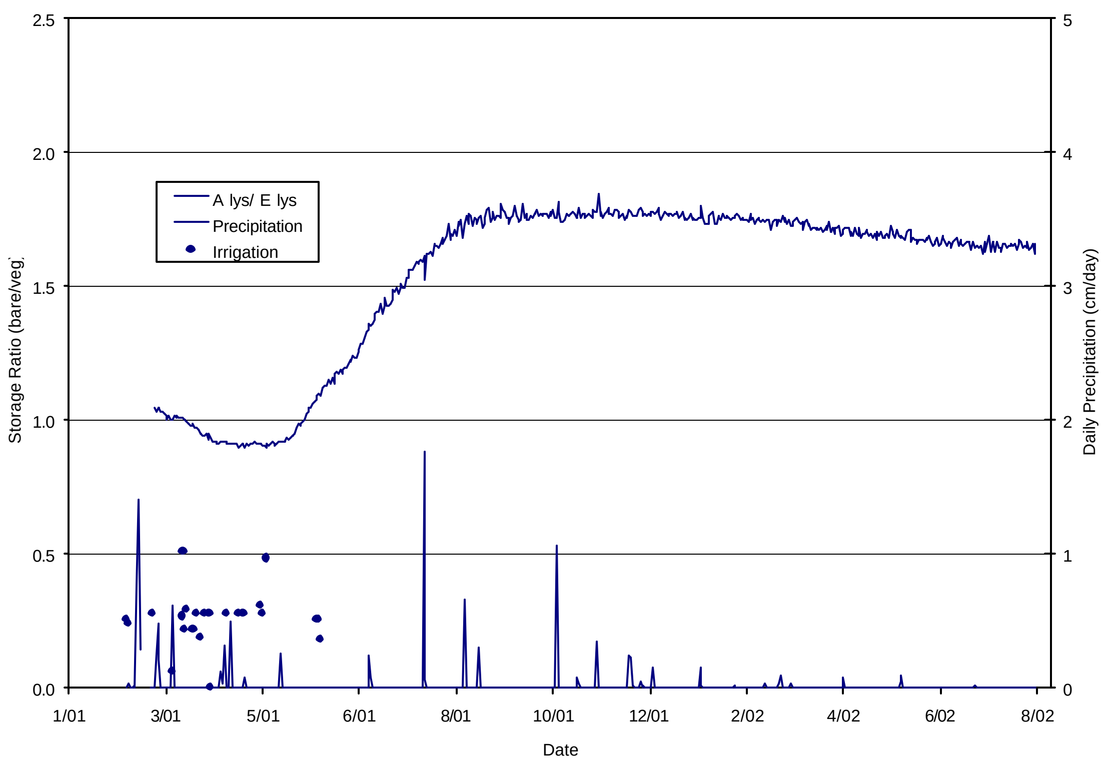

Figure 11 Soil water storage ratio (bare to native vegetated)

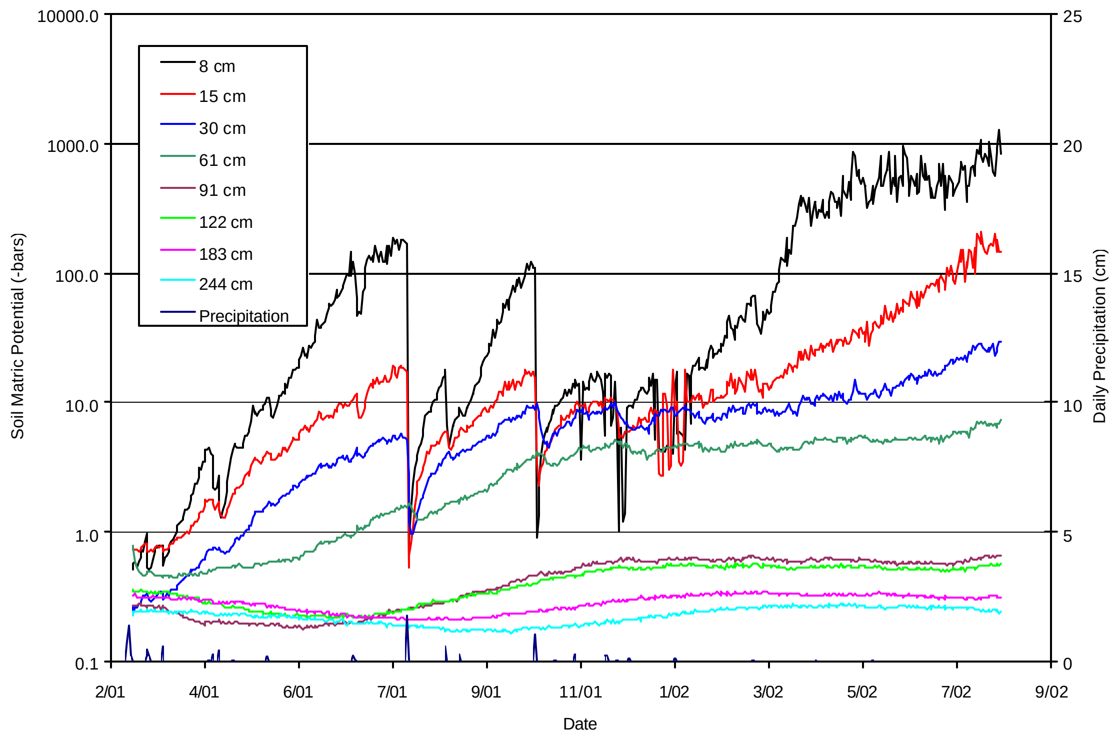

Figure 12 Water potential in lysimeter A (bare soil)

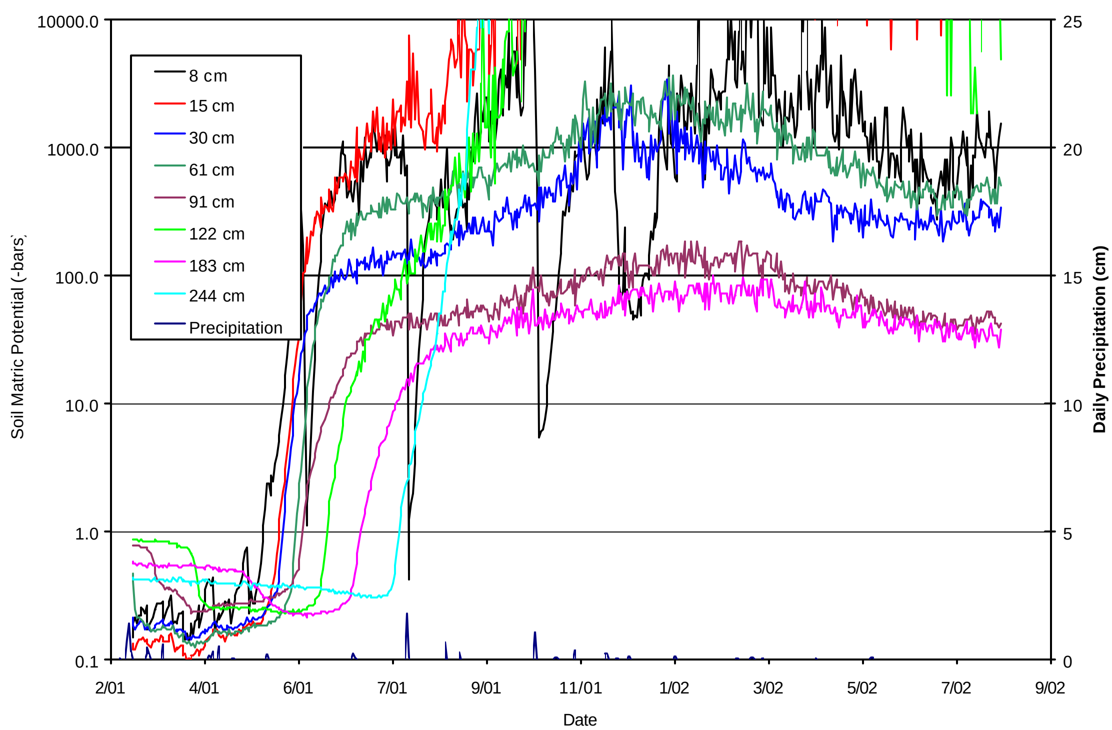

Figure 13 Water potential in lysimeter E (native vegetation)

primary concern at these facilities thus far has been the health of the plant community. Re-seeding of vegetated lysimeters due to consumption of vegetation by browsers is planned for fall 2002 (facility now fenced) while supplemental irrigation of vegetation on U-3ax/bl is also being considered. Experience gained to date suggests that contingency plans for supplemental irrigation or reseeding and routine vegetation surveys should be accounted for in the planning stages of deploying an ET cover.

Data from the drainage lysimeter facility indicate that surface treatments are a key component of performance of monolayer closure covers. This is illustrated in *Figure 11* which shows the current bare to seeded cover soil water storage ratio as 1.6 to 1 (i.e., the bare cover treatment is holding 1.6 times the water than the seeded cover treatment). Somewhat surprisingly, three of the four invader species treatment cells have been nearly as effective as the seeded cells in removing soil water (see *Figure 10*). It may then be questioned whether the expense of seeding landfill covers is warranted. Although thus far the invader species cells have performed well, the spatial density of invader species growth and therefore effectiveness over a multi-acre cover, is uncertain. However, these data do suggest that a loss of seeded vegetation may be compensated for by the growth of invader species.

Future Work

Funding for long-term enhanced precipitation (irrigation) is currently being pursued. Irrigation of some of the lysimeters will help define the limits of monolayer-ET cap performance by evaluating what level of precipitation will result in drainage. Reseeding of the native vegetation lysimeters is planned for fall 2002 to increase the plant diversity. Future work at this facility may also include studies of root growth and deployment of a surface treatment on lysimeters G and H.

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Attachment 1

As-Built Drawings for the Area 3 Lysimeter Facility

UNITED STATES DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE

LAS VEGAS, NEVADA

ALTERNATIVE CLOSURE COVER MONITORING SYSTEM - ASTD

AREA 03

DRAWING INDEX

DRAWING NUMBER		DRAWING TITLE
TITLE		
00068-003-CAU110-T1	REV 1	TITLE SHEET
00068-003-CAU110-T2	REV 1	NOTES, LEGEND & ABBREVIATIONS
CIVIL		
00068-003-CAU110-C1	REV 1	SITE PLAN
00068-003-CAU110-C2	REV 1	EXCAVATION PLAN & SECTIONS
00068-003-CAU110-C3	REV 1	GRADING PLAN & SECTIONS
00068-003-CAU110-C4	REV 1	VAULT & LYSIMETER DETAILS
00068-003-CAU110-C5	REV 0	VAULT & LYSIMETER DETAILS

SCOPE OF WORK

CONSTRUCT A MONITORING SYSTEM TO ACCOMPANY THE CLOSURE OF U3 ax/bl. CONSISTING OF 8 DRAINAGE LYSIMETERS AND A BELOW-GROUND, PRE-FABRICATED CONCRETE VAULT, CENTRAL MONITORING FACILITY (CMF).

AREA EVALUATION FOR RESIDUAL SOIL CONTAMINATION SHALL BE PERFORMED BY THE CONTRACTOR IN ACCORDANCE WITH DOE/NV 5480.11 AND THE CONTRACTOR'S STANDARD OPERATING PROCEDURES PRIOR TO COMMENCING CONSTRUCTION ACTIVITIES.

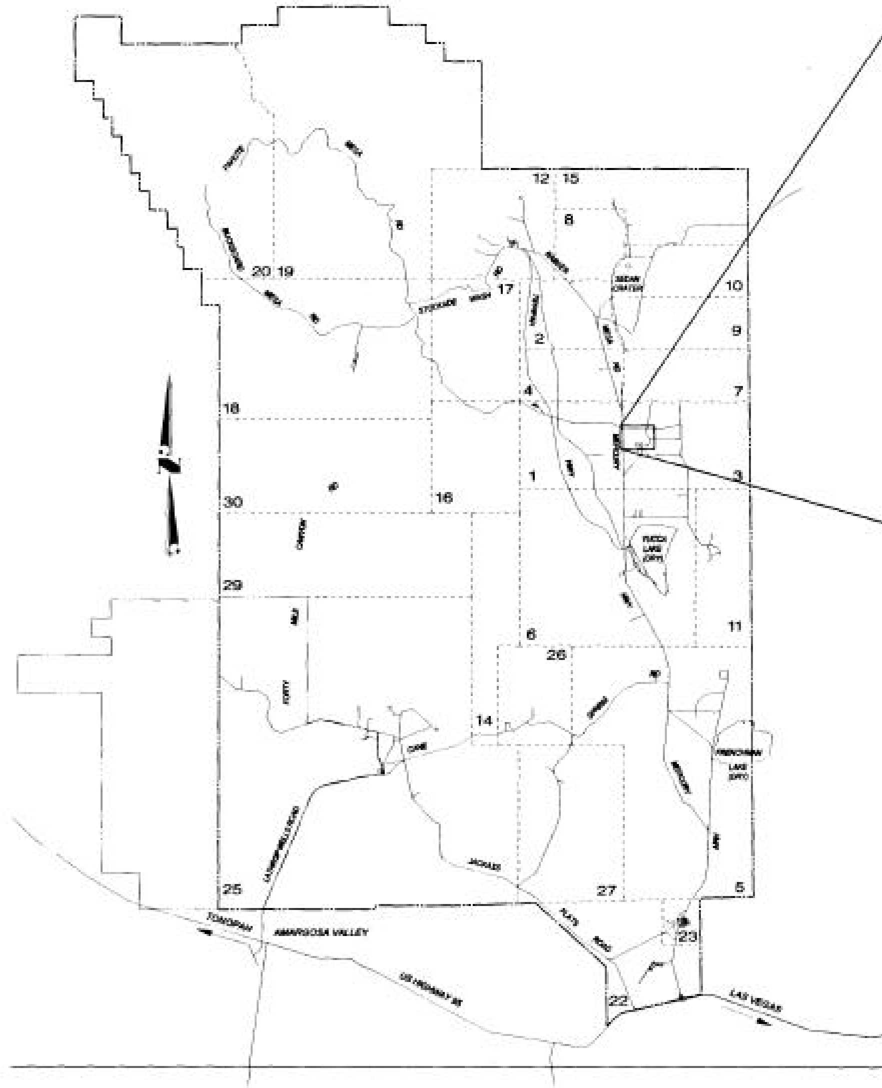
PROJECT NOTES

ALL CONSTRUCTION FEATURES, MATERIALS, TESTS AND DETAILS SHALL CONFORM TO CONSTRUCTION SPECIFICATIONS FOR "U3ax/bl ALTERNATIVE CLOSURE COVER MONITORING SYSTEM."

BASIS FOR HORIZONTAL CONTROL IS THE NORTH AMERICAN DATUM 1927, STATE PLANE, NEVADA CENTRAL ZONE, FEET. BASIS FOR VERTICAL CONTROL IS THE NORTH AMERICAN VERTICAL DATUM OF 1929, FEET.

METRIC NOTE

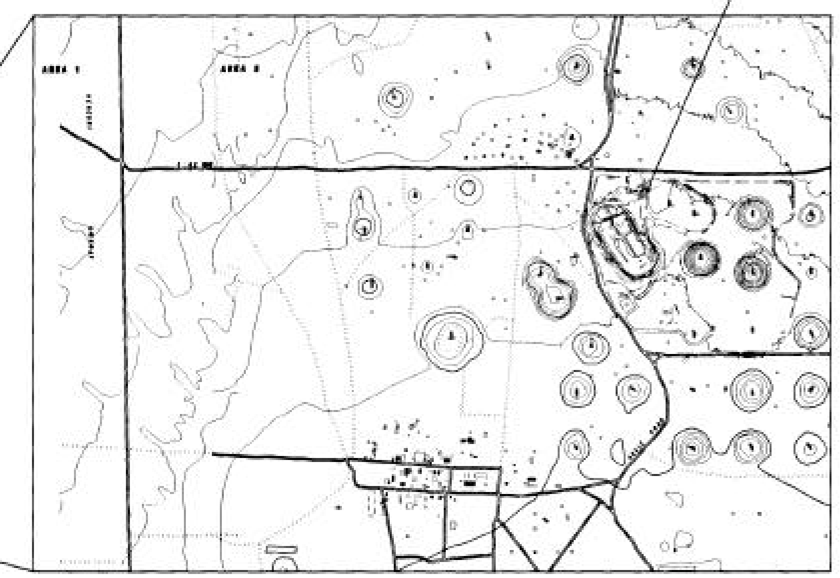
ALL DESIGN DIMENSIONS ARE SHOWN ENGLISH AND METRIC. NOMINAL CUSTOMARY ENGLISH CALLOUTS ARE MAINTAINED. METRIC CALLOUTS ARE USED WHERE NO ENGLISH CALLOUT EXISTS OR WHERE VENDOR SUPPLIED ITEMS ARE METRIC BY DESIGN.



NEVADA TEST SITE

NOT TO SCALE

ASTD PROJECT LOCATION



VICINITY MAP

NOT TO SCALE

AS-BUILT

Bechtel Nevada 9/12/02

ORIGINAL MYLAR SIGNED BY:

ADDED DRAWING C5 AND ISSUED FOR AS-BUILT DATED 09/12/02

ISSUED FOR CONSTRUCTION 08/08/00

NEVADA TEST SITE — AREA 03

ALTERNATIVE CLOSURE COVER MONITORING SYSTEM - ASTD

TITLE SHEET

DUAL ENGLISH/METRIC DRAWING

ALL METRIC DIMENSIONS AND NOTATIONS ARE SHOWN BELOW THE DIMENSION LINE OR IN PARENTHESIS.

WHOLE NUMBERS INDICATE MILLIMETERS

DECIMAL NUMBERS SHOWN TO TWO (2) PLACES INDICATE METERS

DECIMAL NUMBERS SHOWN TO THREE (3) PLACES INDICATE KILOMETERS

DRAWING NUMBER 00068-003-CAU110-T1 REV 1

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CIVIL NOTES

1. ALL EXISTING UNDERGROUND UTILITIES WITHIN THE CONSTRUCTION SITE SHALL BE LOCATED BY MEANS OF AN ELECTRONIC METAL DETECTING DEVICE AND MARKED.
2. ALL GRADE ELEVATIONS SHOWN ARE FINISH GRADES, UNLESS OTHERWISE NOTED. SUBGRADE ELEVATIONS MUST BE ESTABLISHED WHERE REQUIRED PRIOR TO FINAL GRADING.
3. ALL CONCRETE SHALL BE PLACED IN NEAT EXCAVATION AGAINST FIRM, UNDISTURBED OR COMPACTED MATERIAL.
4. IN AREAS UNDER CONCRETE SLABS, ALL SUBGRADE SHALL BE COMPACTED TO NOT LESS THAN 95 PERCENT OF MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D1557-91, ASTM D2922-91 AND ASTM D3017-88, TO A DEPTH OF 6 INCHES.
5. IN AREAS OF EXCAVATION REQUIRING FILL, SCARIFY THE TOP SIX INCHES OF EXISTING GROUND.
6. FIELD DENSITY TESTS WILL BE PERFORMED IN SUFFICIENT NUMBER TO ENSURE THAT THE SPECIFIED DENSITY IS BEING OBTAINED.

AS-BUILT
Bechtel Nevada 9/12/02

CIVIL LEGEND AND SYMBOLS

SYMBOL	DESCRIPTION
(4000)	EXISTING CONTOUR
4000	FINISH CONTOUR
(3934.7)	EXISTING SPOT ELEVATION
3935.0	FINISH GRADE ELEVATION
	CENTER LINE
	LIMIT OF EARTHWORK
	EXISTING DIRT ROAD
	EDGE OF EXISTING ASPHALT PAVING
	EDGE OF NEW ASPHALT PAVING
	CONCRETE
	EARTH
	BACKFILL
	EXISTING FLOW LINE
	NEW FLOW LINE
	CAPPED SEWER OR WATER LINE
	EXISTING SANITARY SEWER CLEANOUT
	NEW SANITARY SEWER CLEANOUT
8"W	EXISTING UTILITY LINE (SIZE & TYPE)
8"W	NEW UTILITY LINE (SIZE & TYPE)
	EXISTING MANHOLE
	NEW MANHOLE
	SURVEY MONUMENT
	EXISTING POWER POLE
	NEW POWER POLE
TOP / TOE	EXISTING SLOPE
TOP / TOE	NEW SLOPE
	EXISTING GATE VALVE
	NEW GATE VALVE
	EXISTING BUILDING OR STRUCTURE
	NEW BUILDING
	EXISTING FIRE HYDRANT
	NEW FIRE HYDRANT
	EXISTING POST INDICATOR VALVE
	NEW POST INDICATOR VALVE
	EXISTING CULVERT
	NEW CULVERT
	EXISTING FENCE
	NEW FENCE
	SURVEY CONTROL POINT

CIVIL LEGEND AND SYMBOLS

ALUMINUM	AL
AMERICAN ASSOCIATION OF STATE HIGHWAY & TRANSPORTATION OFFICIALS	AASHTO
AMERICAN NATIONAL STANDARDS INSTITUTE	ANSI
AMERICAN SOCIETY FOR TESTING & MATERIALS	ASTM
AND	&
APPROVED	APVD
APPROXIMATE	APPROX
AT	@
AVERAGE	AVG
BECHTEL NEVADA	BN
BOTTOM	BOT
BRACING	BRCG
BRACKET	BRKT
BUILDING	BLDG
BURIED CABLE	BC
CEMENT	CEM
CENTER	CTR
CENTER LINE	℄
CENTER TO CENTER	CTOC
CIRCULAR	CIRC
CLEAR	CLR
COMMUNICATION UNDERGROUND	CUG
CONCRETE	CONC
CONSTRUCTION	CONSTR
CONSTRUCTION JOINT	CJ
CONSTRUCTION SPECIFICATION	CONSPEC
CONTINUATION/CONTINUOUS	CONT
CONTROL JOINT	CLJ
CORRUGATED METAL PIPE	CMP
CUBIC YARD	CY
DETAIL	DET
DEGREE	DEG
DEPARTMENT OF ENERGY	DOE
DIAGONAL	DIAG
DIAMETER	DIA
DIMENSION	DIM
DOUBLE	DBL
DRAWING	DWG
EACH	EA
EAST	E
ELECTRIC/ELECTRICAL	ELEC
ELEVATION	EL
ENGINEER	ENGR
ENTRANCE	ENTR
ENVIRONMENTAL	ENVIR
EXISTING	EXST
EXPOSED	EXP
FEET	FT
FIBER OPTICS	FO
FIELD	FLD
FINISH	FNSH
FINISH GRADE	FG
FLOOR	FL
FOOT	FT
FOOTING	FTG
FOUNDATION	FDN
GAGE OR GAUGE	GA
GALVANIZED	GALV
GATE VALVE	GTV
GENERAL	GENL
GRADE	GR
HIGH	H
HORIZONTAL	HORIZ
INCH	IN
INSIDE DIAMETER	ID
INVERT	INVT
JOINT	JT
LONG	L
MANUFACTURER	MFR
MATERIAL	MATL
MAXIMUM	MAX
MINIMUM	MIN
MISCELLANEOUS	MISC
NEVADA	NV
NEVADA TEST SITE	NTS
NON RISING STEM	NRS
NORTH	N
NOT TO SCALE	NTS
OUTSIDE DIAMETER	OD
OVERHEAD	OVHD
POLYVINYL CHLORIDE	PVC
POWER	P
POWER OVERHEAD	POH
POWER POLE	PP
POWER SURFACE LAID	PSL
POWER UNDERGROUND	PUG
PROJECT ENGINEER	PE
QUANTITY	QTY
RADIATION	RAD
RADIOACTIVE WASTE MANAGEMENT SITE	RWMS
REFERENCE	REF
REINFORCING	REINF
REQUIRED	REQD
REVISIONS/REVERSE	REV
RIGHT	R
ROAD	RD
SANITARY SEWER	SS
SCHEDULE	SCHED
SECTION	SECT
SOUTH/SEWER	S
SPECIFICATION	SPEC
STEEL	STL
SUBGRADE	SG
TEMPORARY	TEMP
TOP OF CONCRETE	TOC
TYPICAL	(TYP)
UNDERGROUND	UGND
UNITED STATES	US
VERTICAL	VERT
WATER/WEST/WIDE	W
WEIGHT	WT
WITH	W/
WITHOUT	W/O

DUAL ENGLISH/METRIC DRAWING
ALL METRIC DIMENSIONS AND NOTATIONS ARE SHOWN BELOW THE DIMENSION LINE OR IN PARENTHESIS
WHOLE NUMBERS INDICATE MILLIMETERS
DECIMAL NUMBERS SHOWN TO TWO (2) PLACES INDICATE METERS
DECIMAL NUMBERS SHOWN TO THREE (3) PLACES INDICATE KILOMETERS

REV	DATE	REVISION DESCRIPTION
1	9/12/02	AS-BUILT - NO CHANGE, DATED 09/12/02
0		ISSUED FOR CONSTRUCTION 08/08/00

ORIGINAL MYLAR SIGNED BY:

DESIGNED JMD/NDJ — SUBMITTED BECHTEL NEVADA E.C. LANER 8/8/00
DRAWN NDJ
CHECKED JAS — USER STUART E. RAWLINSON 8/8/00
NNSA PROJECT ENGINEER E. FRANK DI SANZA 8/10/00
BN PROJECT NUMBER N/A — ENGINEERING NUMBER 00068A03 — PROJECT NUMBER N/A — ACTIVITY CODE CRYASTDA

NEVADA TEST SITE — AREA 03
ALTERNATIVE CLOSURE COVER
MONITORING SYSTEM - ASTD
NOTES, LEGEND & ABBREVIATIONS

National Nuclear Security Administration
NEVADA OPERATIONS OFFICE
Bechtel Nevada
P.O. BOX 98521 LAS VEGAS, NV 89193-8521

DRAWING NUMBER 00068-003-CAU110-T2
SHEET OF REV 1

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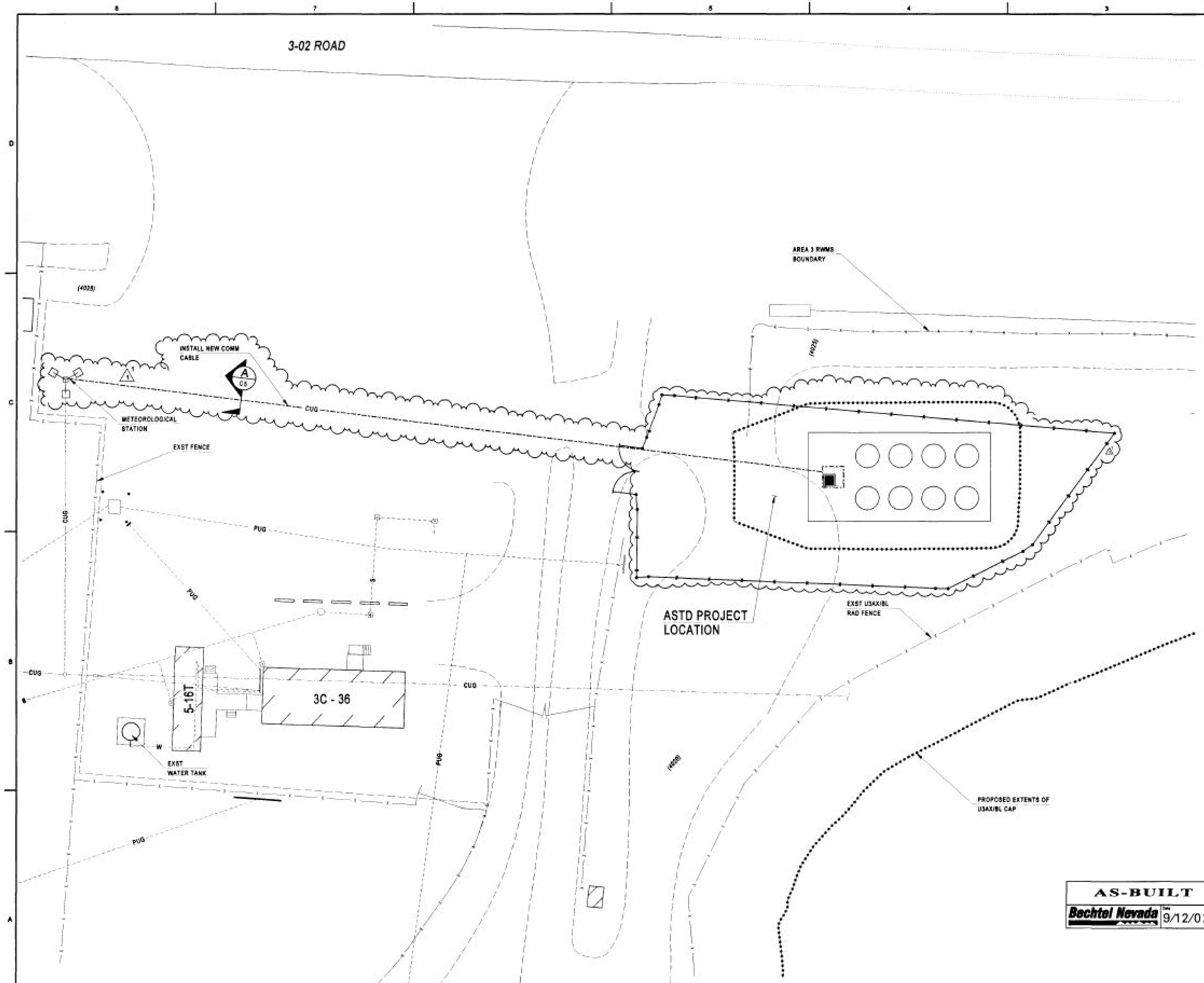


SITE PLAN

SCALE : 1" = 20'

REFERENCES

TITLE SHEET	00068-003-CAU110-T1
NOTES, LEGEND & ABBREVIATIONS	00068-003-CAU110-T2
EXCAVATION PLAN & SECTIONS	00068-003-CAU110-C2
GRADING PLAN & SECTIONS	00068-003-CAU110-C3
VAULT & LYSIMETER DETAILS	00068-003-CAU110-C4

MATERIAL QUANTITIES

MATERIAL	QUANTITY
EXCAVATION	1478 YD^3 (1130 M^3)
NATIVE BACKFILL	1611 YD^3 (1232 M^3)
10 ' DIA GALVANIZED CMP (12GA)	72 LF (22 M)

GRAPHIC SCALE

0 10 20 40 60 FEET

1" = 20'

AS-BUILT

Bechtel Nevada 9/12/02

DUAL ENGLISH/METRIC DRAWING

ALL METRIC DIMENSIONS AND NOTATIONS ARE SHOWN BELOW THE DIMENSION LINE OR IN PARENTHESIS.
WHOLE NUMBERS INDICATE MILLIMETERS
DECIMAL NUMBERS SHOWN TO TWO (2) PLACES INDICATE METERS
DECIMAL NUMBERS SHOWN TO THREE (3) PLACES INDICATE KILOMETERS

ORIGINAL MYLAR SIGNED BY:

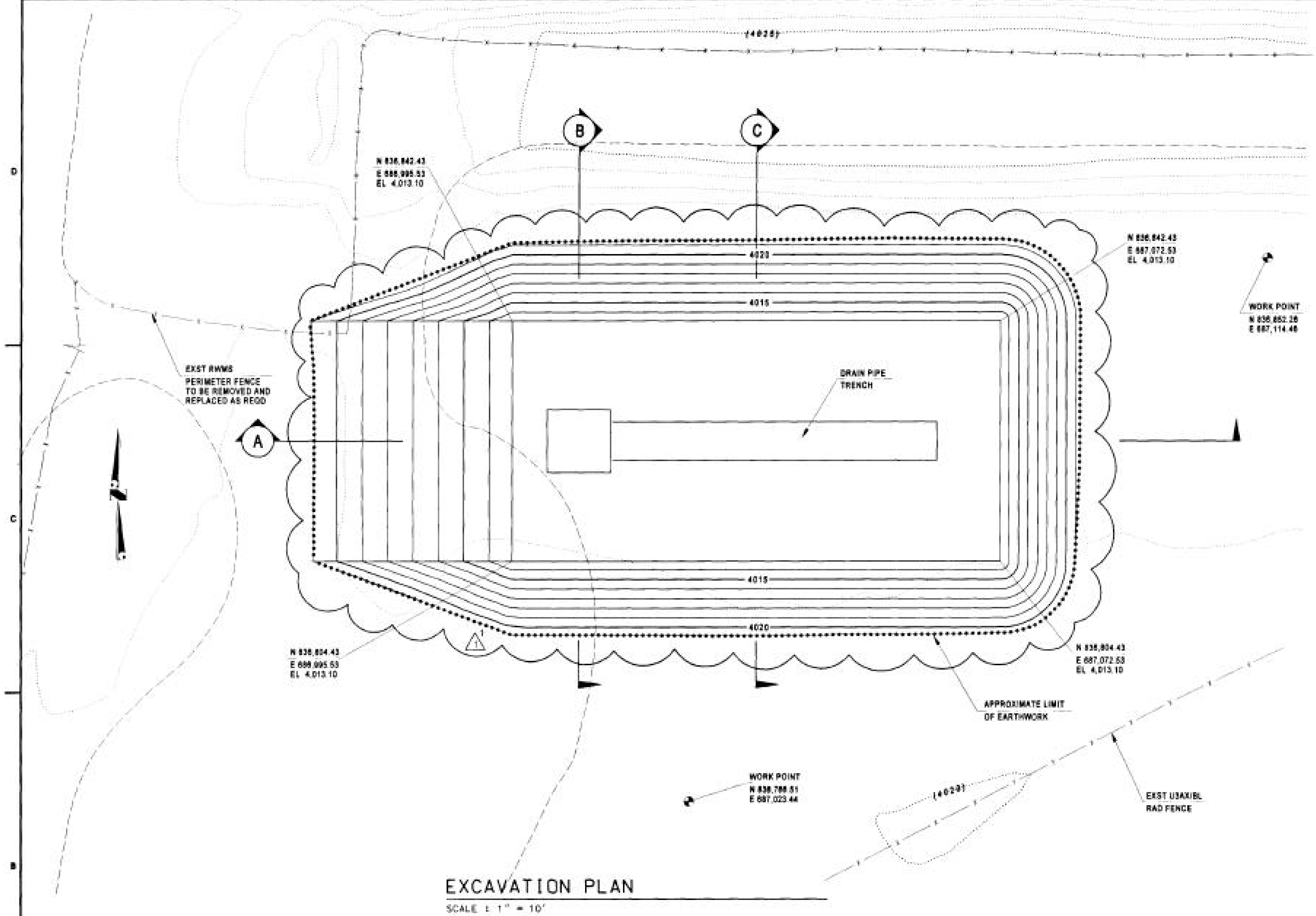
NO	DATE	REVISION DESCRIPTION
1		AS-BUILT, DATED 09/12/02, ADDED FENCE AND COMM CABLE
0		ISSUED FOR CONSTRUCTION 08/08/00

DESIGNED JMD/NDJ — E.C. LANER 8/8/00
DRAWN NDJ
CHECKED JAS — STUART E. RAWLINSON 8/8/00
E. FRANK DI SANZA 8/10/00
N/A — 00068A03 — N/A — CRYASTDA

NEVADA TEST SITE — AREA 03
ALTERNATIVE CLOSURE COVER MONITORING SYSTEM - ASTD
SITE PLAN

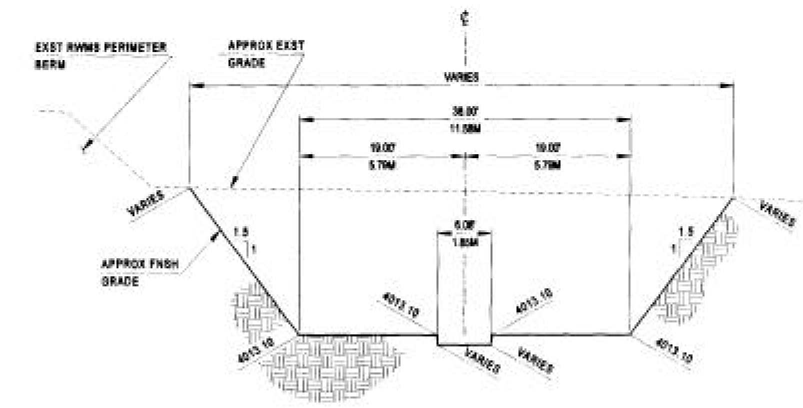
NNSA National Nuclear Security Administration, Nevada Operations Office
Bechtel Nevada, P.O. BOX 98521 LAS VEGAS, NV 89193-8521

DRAWING NUMBER 00068-003-CAU110-C1 REV 1



EXCAVATION PLAN

SCALE : 1" = 10'



SECTION (C)

SCALE : HORIZ. 1"=10' VERT. 1"=5'

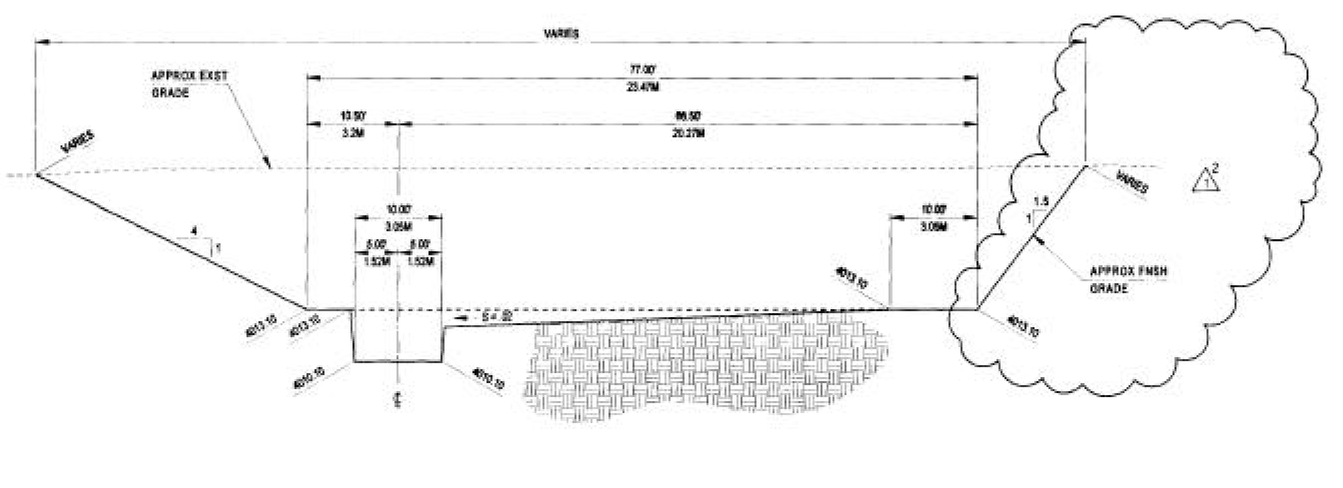
GENERAL NOTES

1. ALL EXCAVATION SHALL BE PERFORMED IN ACCORDANCE WITH SPEC SECTION 02222.
2. EXCAVATED SIDE SLOPES GIVEN ARE A MAXIMUM. SLOPES MAY BE SHALLOWER AS REQUIRED FOR EQUIPMENT.

REFERENCES

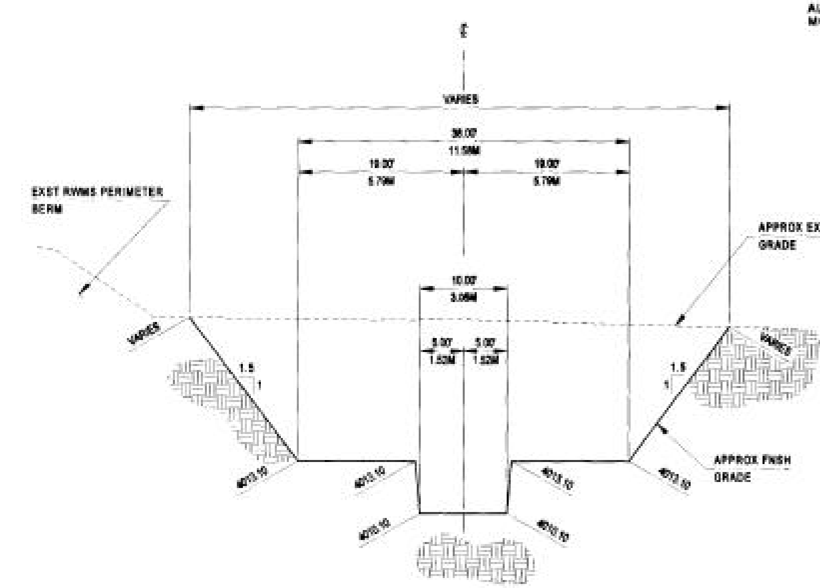
TITLE SHEET	00068-003-CAU110-T1
NOTES, LEGEND & ABBREVIATIONS	00068-003-CAU110-T2
SITE PLAN	00068-003-CAU110-C1
GRADING PLAN & SECTIONS	00068-003-CAU110-C3
VAULT & LYSIMETER DETAILS	00068-003-CAU110-C4
SPECIFICATION FOR U3AX/BL ALTERNATIVE CLOSURE COVER MONITORING SYSTEM, 02222	SP-00068A03-C0012

AS-BUILT
Bechtel Nevada
Date 9/12/02



SECTION (A)

SCALE : HORIZ. 1"=10' VERT. 1"=5'



SECTION (B)

SCALE : HORIZ. 1"=10' VERT. 1"=5'

GRAPHIC SCALE

0 10 20 30 FEET
1" = 10'

0 5 10 15 FEET
1" = 5'

DUAL ENGLISH/METRIC DRAWING
ALL METRIC DIMENSIONS AND NOTATIONS ARE SHOWN BELOW THE DIMENSION LINE OR IN PARENTHESIS.
WHOLE NUMBERS INDICATE MILLIMETERS
DECIMAL NUMBERS SHOWN TO TWO (2) PLACES INDICATE METERS
DECIMAL NUMBERS SHOWN TO THREE (3) PLACES INDICATE KILOMETERS

NO	DATE	REVISION DESCRIPTION
2		INCORPORATED DCN 01/10-420, REVISED PLAN, SECTION A AND ISSUED FOR AS-BUILT DATED 09/12/02
0		ISSUED FOR CONSTRUCTION 08/10/00

ORIGINAL MYLAR SIGNED BY:

DESIGNED JMD/NDJ — SUBMITTED BECHTEL NEVADA E.C. LANER — DATE 8/8/00
DRAWN NDJ — APPROVAL BLOCK
CHECKED JAS — USER STUART E. RAWLINSON — DATE 8/8/00
NNSA PROJECT ENGINEER E. FRANK DI SANZA — DATE 8/10/00
BN PROJECT NUMBER N/A — ENGINEERING NUMBER 00068A03 — PROJECT ACTIVITY NO N/A — ACTIVITY CODE C9YA57DA

NEVADA TEST SITE — AREA 03
ALTERNATIVE CLOSURE COVER
MONITORING SYSTEM - ASTD
EXCAVATION PLAN & SECTIONS

National Nuclear Security Administration
NEVADA OPERATIONS OFFICE
Bechtel Nevada

DRAWING NUMBER 00068-003-CAU110-C2
SHEET OF REV 1

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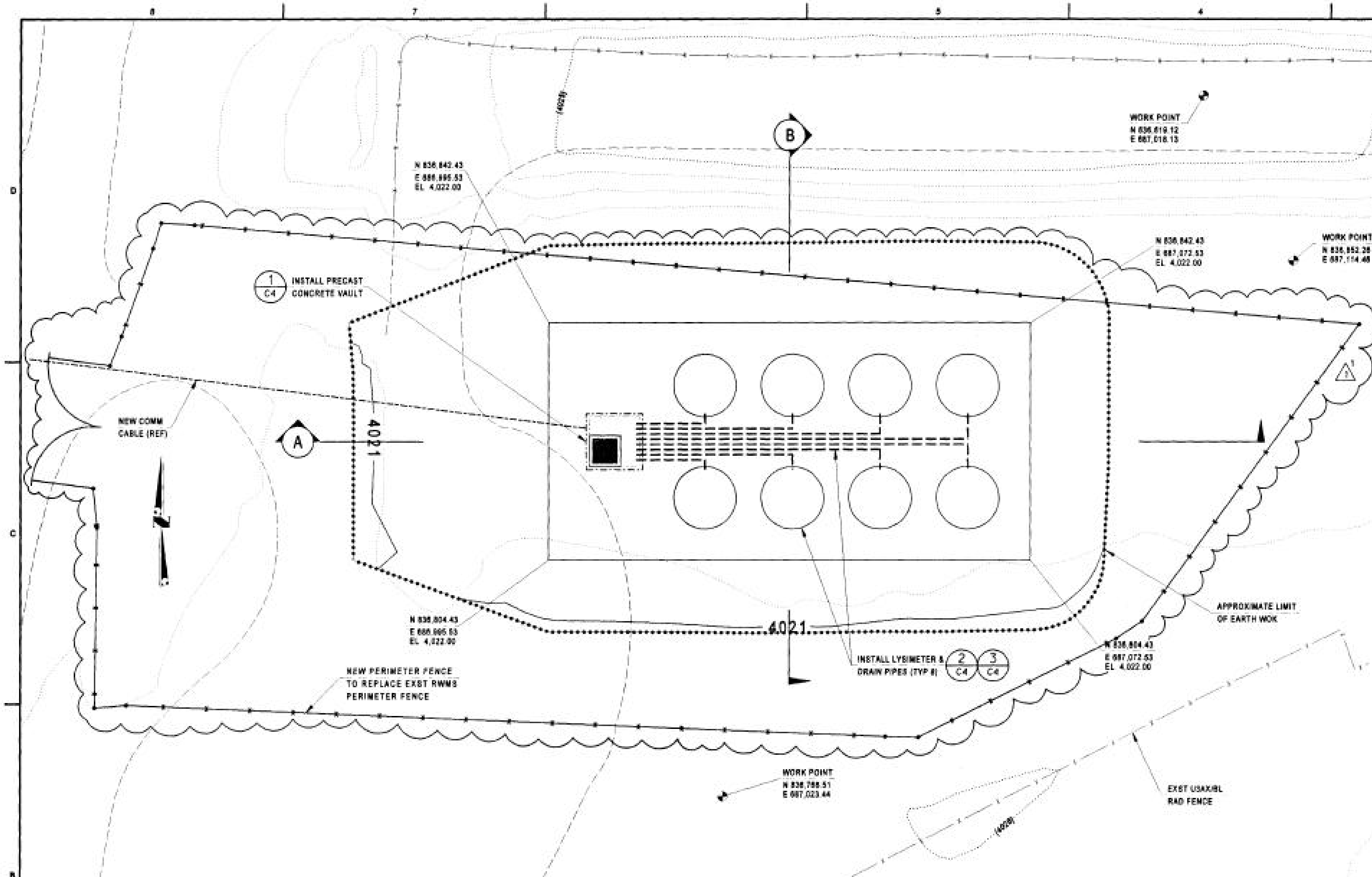


GRADING PLAN

SCALE : 1" = 10'

GENERAL NOTES

1. BACKFILL INSIDE AND AROUND LYSIMETERS SHALL BE PLACED IN SUCH A WAY TO NOT CRUSH THE CMP.
2. BACKFILL MATERIALS SHALL MEET THE REQUIREMENTS OF SPEC SECTION 02223
3. PIPE SAND BEDDING SHALL BE PLACED PER SECTION 02233. BACKFILL SHALL BE PLACED IN ACCORDANCE WITH SPEC SECTION 02223
4. LYSIMETERS SHALL HAVE MAXIMUM OF 2" (51MM) EXPOSED ABOVE FINISH GRADE.
5. DRAIN PIPE SAND BEDDING SHALL BE PER SPEC SECTION 02223

REFERENCES

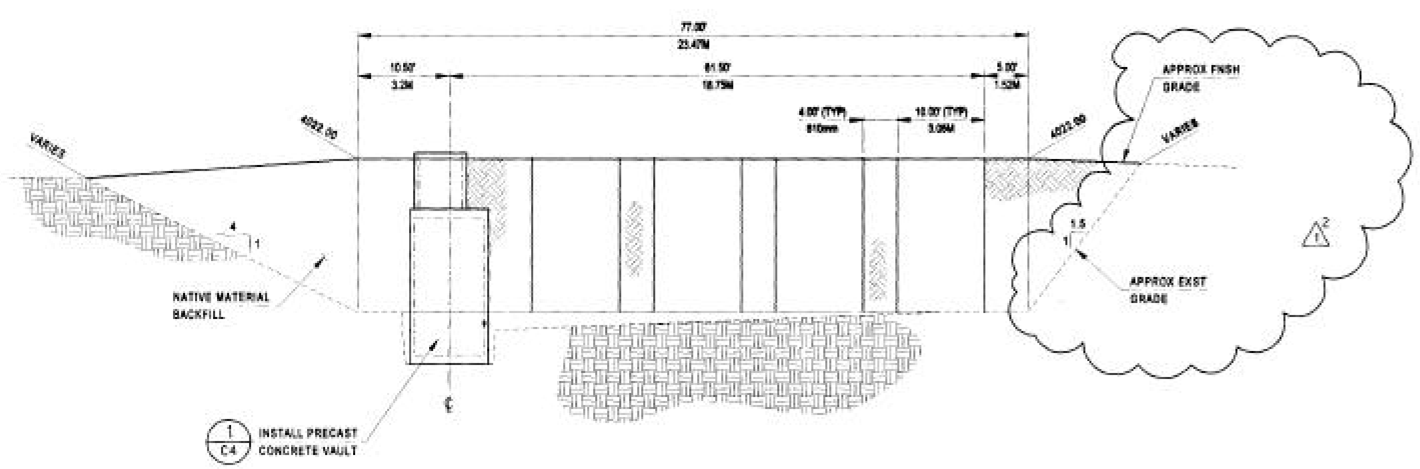
TITLE SHEET	00068-003-CAU110-T1
NOTES, LEGEND & ABBREVIATIONS	00068-003-CAU110-T2
SITE PLAN	00068-003-CAU110-C1
GRADING PLAN & SECTIONS	00068-003-CAU110-C2
VAULT & LYSIMETER DETAILS	00068-003-CAU110-C4
SPECIFICATION FOR U3AX/BL ALTERNATIVE CLOSURE COVER MONITORING SYSTEM, 02223	SP-00068A03-C0012

GRAPHIC SCALE

0 10 20 30 FEET
1" = 10'

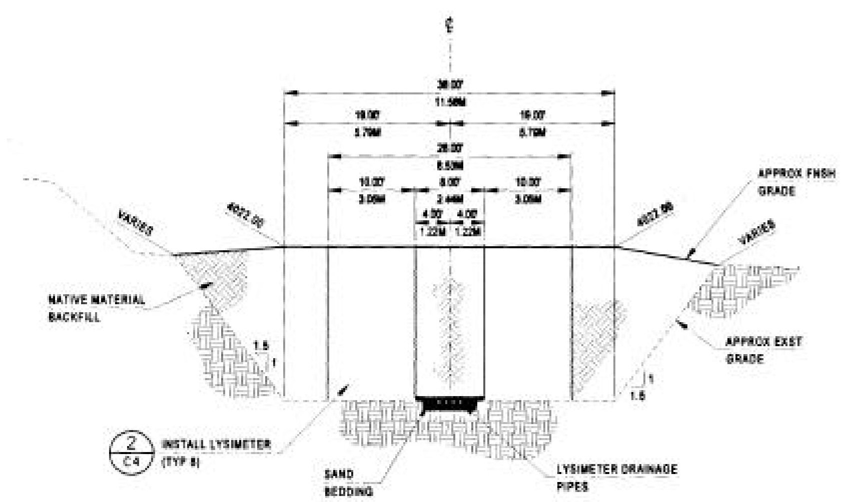
0 5 10 15 FEET
1" = 5'

AS-BUILT
Bechtel Nevada
Date 9/12/02



SECTION A

SCALE : HORIZ. 1"=10' VERT. 1"=5'



SECTION B

SCALE : HORIZ. 1"=10' VERT. 1"=5'

DUAL ENGLISH/METRIC DRAWING

ALL METRIC DIMENSIONS AND NOTATIONS ARE SHOWN BELOW THE DIMENSION LINE OR IN PARENTHESIS.
WHOLE NUMBERS INDICATE MILLIMETERS
DECIMAL NUMBERS SHOWN TO TWO (2) PLACES INDICATE METERS
DECIMAL NUMBERS SHOWN TO THREE (3) PLACES INDICATE KILOMETERS

REV	DATE	REVISION DESCRIPTION
2	9/12/02	INCORPORATED DCN 01110-431, REVISED PLAN, SECTION A, FENCE LINE AND ISSUED FOR AS-BUILT DATED 09/12/02
0		ISSUED FOR CONSTRUCTION 08/28/00

ORIGINAL MYLAR SIGNED BY:

DESIGNED JMD/NDJ; DRAWN NDJ; CHECKED JAS
SUBMITTED BECHTEL NEVADA: E.C. LANER, 8/8/00
STUART E. RAWLINSON, 8/9/00
NNSA PROJECT ENGINEER: E. FRANK DI SANZA, 8/10/00
ENGINEERING NUMBER 00068A03; PROJECT ACTIVITY NO. N/A; ACTIVITY CODE CRYASTDA; BN PROJECT NUMBER N/A

NEVADA TEST SITE — AREA 03

ALTERNATIVE CLOSURE COVER MONITORING SYSTEM - ASTD

GRADING PLAN & SECTIONS

National Nuclear Security Administration
NEVADA OPERATIONS OFFICE

Bechtel Nevada
P.O. BOX 98521 LAS VEGAS, NV 89193-8521

DRAWING NUMBER 00068-003-CAU110-C3
SHEET OF REV 1

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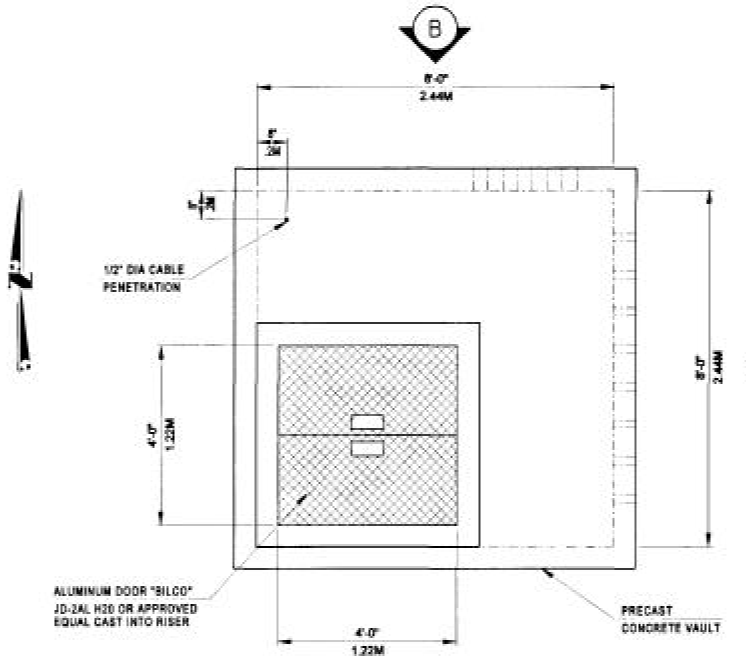
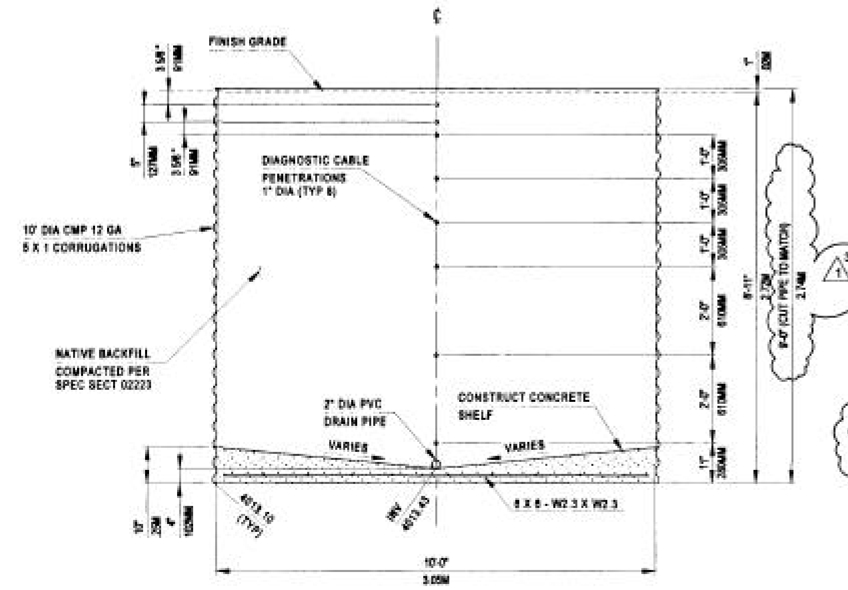
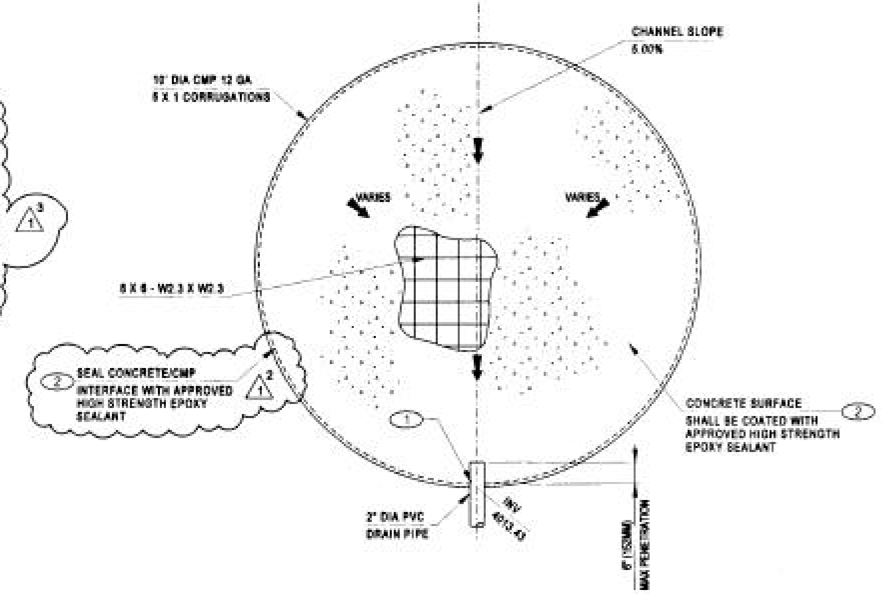


CONCRETE VAULT DETAILS
TOP VIEW (1) C3
SCALE : 1/2" = 1'-0"



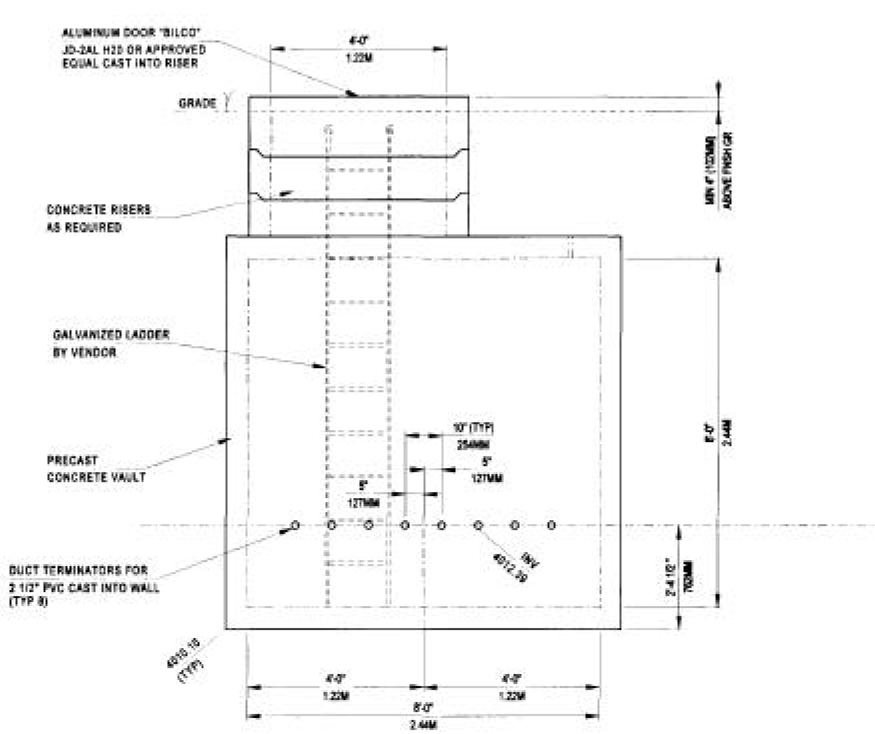
LYSIMETER DETAIL (2) C3
SCALE : 1/2" = 1'-0"



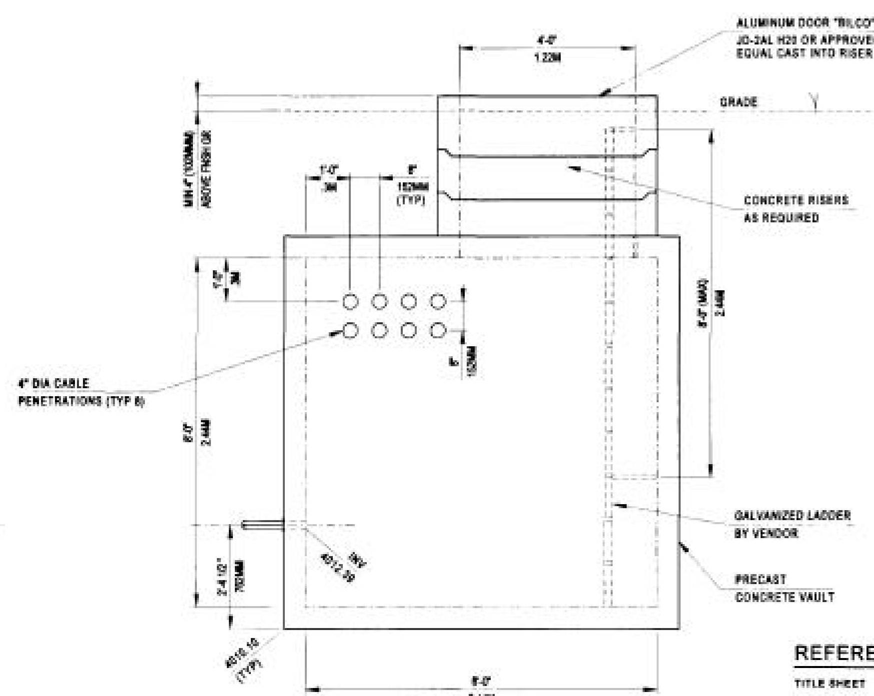
SHELF DETAIL (3) C3
SCALE : 1/2" = 1'-0"

GENERAL NOTES

1. ATTACH MEDIA RETENTION NOZZEL TO PVC PIPE INLETS:
   AISI TYPE 316L STAINLESS STEEL, MEDIA RETENTION NOZZEL
   2.375 INCH STANDARD WOUND WEDGE WIRE SCREEN
   2.5 INCH EFFECTIVE SCREEN LENGTH
   2 INCH 150# HALF COUPLING ON ONE END, OPPOSITE END TO BE CAPPED
   SCREEN SLOT = 0.015 INCH, US STANDARD EQUIVALENT 40 MESH
2. USE 2" PVC FOR DRAINAGE PIPES, SCHED 40
3. ALL LYSIMETER AND VAULT PENETRATIONS SHALL BE FILLED WITH HANDI-FOAM, EXPANDING INSULATION FOAM, OR APPROVED EQUAL.
4. CONSTRUCTION SHALL FOLLOW THE BACKFILLING REQUIREMENTS IDENTIFIED ON SPEC. SP-00068A03-C0012.0 BACKFILLING SECTION 02223.
5. TO PREVENT THE CMP FROM POSSIBLE FAILURE DUE TO HEAVY COMPACTION EQUIPMENT DURING THE BACKFILLING AND COMPACTION OPERATIONS, ENGINEERING RECOMMENDS THE FOLLOWING GUIDELINES:
   (A) USE HAND COMPACTION EQUIPMENT WHEN COMPACTING WITHIN AN AREA DEFINED AS "LOADING ZONE OF INFLUENCE", DETAIL 4 ON DWG C5
   (B) NO HEAVY CONSTRUCTION EQUIPMENT (BACKHOES, GRADERS, BULLDOZERS, AND THE LIKES) ARE TO BE USED WITHIN THIS "LOADING ZONE OF INFLUENCE"
   (C) "LOADING ZONE OF INFLUENCE" IS DEFINED AS THE AREA ENCOMPASSED WITHIN THE TRIANGLE SHOWN IN DETAIL 4 DWG C5



CONCRETE VAULT ELEV
FRONT (A)
SCALE : 1/2" = 1'-0"



CONCRETE VAULT ELEV
RIGHT SIDE (B)
SCALE : 1/2" = 1'-0"

AS-BUILT
Bechtel Nevada Date 9/12/02

KEY NOTES

(1) SECURE PIPE PENETRATION WITH COUPLING AND SEAL WITH EPOXY BOOT.

(2) EPOXY SHALL BE PLACED IN STRICT ACCORDANCE WITH MANUFACTURERS PRINTED INSTRUCTIONS. INSPECTOR SHALL BE PRESENT DURING EPOXY APPLICATION.

VAULT NOTES

1. THE VAULT SHALL BE A NOMINAL 8 FT (W) X 8 FT (L) X 8 FT (H) INSIDE DIMENSIONS CAST WITH LIFTING LUGS FOR PLACEMENT OF ALL REQUIRED STRUCTURES. THE CONCRETE VAULT MANUFACTURER SHALL FURNISH ALL COMPONENTS REQUIRED FOR A COMPLETE VAULT INSTALLATION AND ALL MATERIALS REQUIRED FOR A WATER TIGHT CONDITION.
2. CONCRETE VAULT DESIGN, SHALL CONFORM TO THE MINIMUM REQUIREMENTS OF AASHTO H-20 TRAFFIC LOADING (16,000 LBS WHEEL LOAD) AND A LATERAL EARTH PRESSURE.
3. CONCRETE COMPRESSIVE STRENGTH, 4,000 PSI AT 28 DAYS.
4. STEEL REINFORCING YIELD STRENGTH, Fy=60,000 PSI PER ASTM A-706 OR ASTM A-615.
5. FIVE COPIES OF THE STRUCTURAL CALCULATIONS AND SHOP DRAWINGS, SHALL BE SUBMITTED TO BECHTEL NEVADA ENGINEERING DEPARTMENT FOR REVIEW AND APPROVAL. FABRICATION SHALL NOT COMMENCE PRIOR TO THIS APPROVAL.

REFERENCES

TITLE SHEET	00068-003-CAU110-T1
NOTES, LEGEND & ABBREVIATIONS	00068-003-CAU110-T2
EXCAVATION PLAN & SECTIONS	00068-003-CAU110-C2
GRADING PLAN & SECTIONS	00068-003-CAU110-C3
SPECIFICATION FOR U3AX/BL ALTERNATIVE CLOSURE COVER MONITORING SYSTEM, 02223	SP-00068A03-C0012

GRAPHIC SCALE
0 1 2 3 4 5 6 FEET
1/2" = 1'-0"

DUAL ENGLISH/METRIC DRAWING
ALL METRIC DIMENSIONS AND NOTATIONS ARE SHOWN BELOW THE DIMENSION LINE OR IN PARENTHESIS.
WHOLE NUMBERS INDICATE MILLIMETERS
DECIMAL NUMBERS SHOWN TO TWO (2) PLACES INDICATE METERS
DECIMAL NUMBERS SHOWN TO THREE (3) PLACES INDICATE KILOMETERS

NO	DATE	REVISION DESCRIPTION
3/1		INCORPORATED DCN 01110-432, 01110-441 AND DCN 01/11-454 AND ISSUED FOR AS-BUILT DATED 09/12/02
0		ISSUED FOR CONSTRUCTION 08/08/00

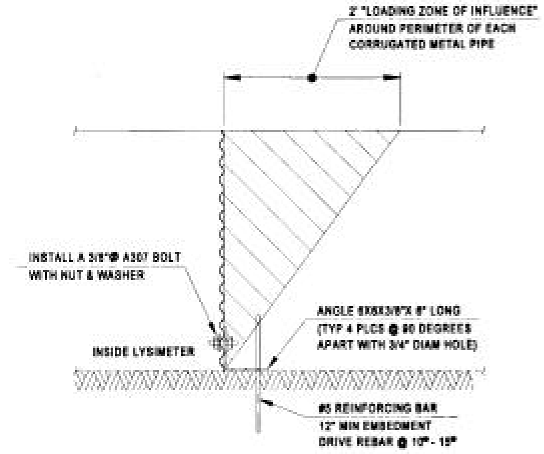
ORIGINAL MYLAR SIGNED BY:

DESIGNED JMD/NDJ	SUBMITTED BECHTEL NEVADA E.C. LANER	DATE 8/8/00
DRAWN NDJ	APPROVAL BLOCK	
CHECKED JAS	NNSA STUART E. RAWLINSON	DATE 8/8/00
PROJ ENGINEER	NNSA PROJECT MANAGER E. FRANK DI SANZA	DATE 8/10/00
BN PROJECT NUMBER N/A	ENGINEERING NUMBER 00068A03	PROJECT AREA NO N/A / ACTIVITY CODE C9YASTDA

NEVADA TEST SITE — AREA 03
ALTERNATIVE CLOSURE COVER MONITORING SYSTEM - ASTD
VAULT & LYSIMETER DETAILS

National Nuclear Security Administration — NEVADA OPERATIONS OFFICE
Bechtel Nevada — P.O. BOX 98521 LAS VEGAS, NV 89193-8521

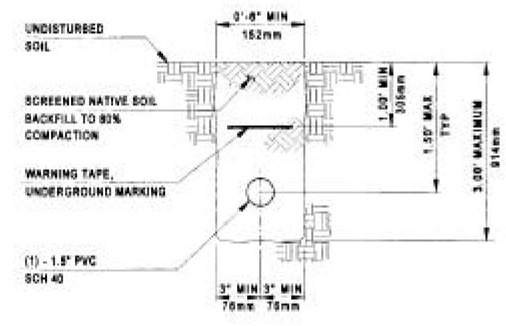
DRAWING NUMBER 00068-003-CAU110-C4
SHEET OF — REV 1



LYSIMETER ANCHORAGE DETAIL

SCALE : NOT TO SCALE

4 C4



SECTION

SCALE : NOT TO SCALE

A C1

GENERAL NOTES

1. ALL LYSIMETER AND VAULT PENETRATIONS SHALL BE FILLED WITH HANDI-FOAM, EXPANDING INSULATION FOAM, OR APPROVED EQUAL.
2. CONSTRUCTION SHALL FOLLOW THE BACKFILLING REQUIREMENTS IDENTIFIED ON SPEC. SP-00068A03-C0012.0 BACKFILLING SECTION 02223.
3. TO PREVENT THE CMP FROM POSSIBLE FAILURE DUE TO HEAVY COMPACTION EQUIPMENT DURING THE BACKFILLING AND COMPACTION OPERATIONS, ENGINEERING RECOMMENDS THE FOLLOWING GUIDELINES:

   (A) USE HAND COMPACTION EQUIPMENT WHEN COMPACTING WITHIN AN AREA DEFINED AS "LOADING ZONE OF INFLUENCE"

   (B) NO HEAVY CONSTRUCTION EQUIPMENT (BACKHOES, GRADERS, BULLDOZERS, AND THE LIKES) ARE TO BE USED WITHIN THIS "LOADING ZONE OF INFLUENCE"

   (C) "LOADING ZONE OF INFLUENCE" IS DEFINED AS THE AREA ENCOMPASSED WITHIN THE TRIANGLE SHOWN IN DETAIL 4

REFERENCES

TITLE SHEET	00068-003-CAU110-T1
NOTES, LEGEND & ABBREVIATIONS	00068-003-CAU110-T2
EXCAVATION PLAN & SECTIONS	00068-003-CAU110-C2
GRADING PLAN & SECTIONS	00068-003-CAU110-C3
SPECIFICATION FOR USAX/BL ALTERNATIVE CLOSURE COVER MONITORING SYSTEM, 02223	SP-00068A03-C0012

DUAL ENGLISH/METRIC DRAWING

ALL METRIC DIMENSIONS AND NOTATIONS ARE SHOWN BELOW THE DIMENSION LINE OR IN PARENTHESIS.

WHOLE NUMBERS INDICATE MILLIMETERS
DECIMAL NUMBERS SHOWN TO TWO (2) PLACES INDICATE METERS
DECIMAL NUMBERS SHOWN TO THREE (3) PLACES INDICATE KILOMETERS

NEVADA TEST SITE — AREA 03

ALTERNATIVE CLOSURE COVER MONITORING SYSTEM - ASTD

VAULT & LYSIMETER DETAILS

REV 0: AS-BUILT DATED 8/12/02, INCORPORATED INSPECTORS REDLINES, ISSUED AS PAGE 2 OF DCN 01101-475 AND PAGE 2 OF DCN 01110-441

National Nuclear Security Administration, Nevada Operations Office

Bechtel Nevada

DRAWING NUMBER 00068-003-CAU110-C5

SHEET OF REV 0

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