

CONSTRUCTION COST TABLES

CANAL LINING DEMONSTRATION PROJECT

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INTRODUCTION

Traditional canal-lining materials typically include compacted clay, reinforced or unreinforced concrete, and (more recently) buried geomembranes. However for some jobs, these materials are not always viable because either 1) they are not locally available (such as compacted clay), 2) they are too expensive (such as reinforced concrete), 3) they require large right-of-way for heavy construction equipment (such as unreinforced concrete), or 4) they require extensive over-excavation and subgrade preparation (such as buried geomembranes). This study looks at alternative canal-lining materials that are less expensive, easier to construct with limited access, and compatible with severe rocky subgrades such as the fractured volcanic basalt typically found in the Pacific Northwest.

To date, 34 test sections have been constructed on nine irrigation districts (five irrigation districts on the Deschutes river in central Oregon, two in Idaho, two in Montana, and one in Oklahoma). The lining materials include combinations of geosynthetics, shotcrete, roller compacted concrete, grout mattresses, soil, elastomeric coatings, and sprayed-in-place foam. The test sections now range in age from 6 months to 9 years. Two additional test sections are planned for construction in the spring of 2001.

There are five reports in this series. The first report "*Deschutes - Construction Report*" (Reclamation Report R-94-06, 1994) documented the construction of the original 18 test sections on the Arnold and North Unit Irrigation Districts near Bend, Oregon. These 18 test sections were constructed over severe rocky subgrade conditions. The construction report detailed construction techniques, construction materials, unit construction costs, and ponding tests to determine seepage rates both before and after construction of the test sections. Post-construction seepage rates were 10 to 100 times lower than pre-construction rates.

The second report, "*Deschutes - Year-2 Durability Report*" (Reclamation Report R-94-14, 1994), assessed the condition of the original 18 test sections after about 2 years of service (through April 1994).

The third report "*Deschutes - Year 5 Durability Report*" (Reclamation Report R-97-01) detailed the construction of 4 additional test sections. Unit construction costs for the 4 additional test sections are included in table 2. That report also assessed the condition of all 22 test sections after up to 5 years of service (through October 1996).

The fourth report "*Deschutes - Year 7 Durability Report*" (Reclamation Report R-99-06) details the construction of five new test sections. Unit construction costs for the new test sections are also included in table 2. This report also assesses the condition of all 27 test sections after up to 7½ years of service (through March 1999). The test sections are evaluated for cost, durability, maintenance requirements, and effectiveness in reducing seepage. These factors are combined to calculate life-cycle costs for use in Benefit-Cost Analysis.

The fifth report "*Deschutes - 2000 Supplemental Report*" (Reclamation Report R-00-01) details the construction of two test sections constructed in the fall of 1999.

One new test section has been installed in the spring of 2001 and may be found on the Bureau of Reclamation WEB Page at www.pn.usbr.gov/wat/index.html. This report cover the construction installation and cost for each material. The attached table shows the cost comparison of all lining materials used to date.

These costs should be used for comparison purposes only. Material costs are believed accurate, but should be verified with the geomembrane manufacturer. These cost estimates are based on a minimum job size of 100,000 to 200,000 square feet (i.e. full truck load of lining material). Actual construction bids may be somewhat higher depending on additional items such as mobilization, design costs, additional subgrade preparation, attachment to structures, contingencies and unlisted items. This table will be updated as new test sections are constructed.

Canal Lining Costs—Arnold and North Unit Test Sections

Section No.	Description	Lining Material				Subgrade Preparation \$ / sq. ft	Installation \$ / sq. ft	Overhead and profit (%)	Total \$ / sq. ft
		Geomembrane \$ / sq. ft	Geotextile \$ / sq. ft	Shotcrete \$ / sq. ft	Other cost \$ / sq. ft				
A-1	4-mil PE Geocomposite with Shotcrete cover Unreinforced Shotcrete Polyfiber reinforced Shotcrete	\$0.30		\$0.87		\$0.26	\$0.65	17%	\$2.43
		\$0.30		\$0.87	\$0.06 ^a	\$0.26	\$0.65	17%	\$2.50
A-2	30-mil VLDPE textured geomembrane with 16-oz. geotextile cushion and unreinforced Shotcrete cover	\$0.25	\$0.12	\$0.87		\$0.26	\$0.65	17%	\$2.52
A-3	Exposed 80-mil HDPE textured geomembrane	\$0.70	\$0.12			\$0.26	\$0.10	17%	\$1.38
A-4	Exposed 30-mil PVC with geotextile UV cover cushion	\$0.45	\$0.07			\$0.26	\$0.12	17%	\$1.05
A-5	Exposed 45-mil Hypalon with 16-oz. geotextile cushion	\$0.45	\$0.12			\$0.26	\$0.12	17%	\$1.11
A-6	Exposed 36-mil Hypalon with bonded 8-oz. geotextile cushion	\$0.50				\$0.26	\$0.12	17%	\$1.03
A-7	40-mil PVC with 3-inch Grout-Filled Mattress	\$0.35		\$0.65	\$0.45	\$0.12	\$0.60	17%	\$2.54
A-8	3-inch Unreinforced Grout-Filled Mattress			\$0.65	\$0.45	\$0.04	\$0.50	17%	\$1.92
A-9 and A-10	60-mil VLDPE or HDPE with 12-oz. geotextile cushion and 3-inch Grout-Filled Mattress on side slopes only	\$0.55	\$0.12	\$0.21	\$0.16	\$0.04	\$0.45	17%	\$1.79
Section No.	Description								
N-1	Spray-applied Polyurethane Foam with Urethane 500/550 protective coating				\$2.41	\$0.04	\$1.25	17%	\$4.33
N-2	Spray-applied Polyurethane Foam with Geothane 5020 protective coating				\$2.06	\$0.04	\$1.25	17%	\$3.92
N-3	Tietex Geotextile with Spray-applied Geothane 5020 protective coating		\$0.07		\$0.90	\$0.04	\$1.25	17%	\$2.64
N-4	Phillips Geotextile with Spray-applied Geothane 5020 protective coating		\$0.07		\$0.90	\$0.04	\$1.25	17%	\$2.64
N-5	RCC invert + Shotcrete side slopes	Contract Bid Price							\$2.00
N-6	Shotcrete - Steel-Fiber Reinforced 50 lbs. per cubic yard 25 lbs. per cubic yard			\$1.08	\$0.22	\$0.04	\$0.65	17%	\$2.33
				\$1.08	\$0.11	\$0.04	\$0.65	17%	\$2.20
N-7 and N-8	Shotcrete Polyfiber Reinforced 3 lbs. per cubic yard 1-1/2 lbs. per cubic yard			\$1.08	\$0.12	\$0.04	\$0.65	17%	\$2.21
				\$1.08	\$0.06	\$0.04	\$0.65	17%	\$2.14
N-9	Unreinforced Shotcrete			\$1.08		\$0.04	\$0.65	17%	\$2.07

^a Cost of Polyfibers

Canal Lining Costs—Tumalo, Lugert-Altus, Juniper Flat, Ochoco, Frenchtown, Twin Falls, Lewiston, and Buffalo Rapids Test Sections

Section No.	Description	Lining Material				Subgrade Preparation \$ / sq. ft	Installation \$ / sq. ft	Overhead and Profit %	Total \$ / sq. ft
		Geomembrane \$ / sq. ft	Geotextile \$ / sq. ft	Shotcrete \$ / sq. ft	Other Cost \$ / sq. ft				
T-1	Liquid Boot over an existing concrete flume	\$1.20				\$0.15	\$0.10	17%	\$1.70
T-2	Liquid Boot over a sandblasted steel flume	\$1.00				\$0.15	\$0.10	17%	\$2.16
T-3	Liquid Boot over a broomed steel flume	\$1.00				\$0.10	\$0.10	17%	\$1.40
L-1	Exposed 160-mil Teranap	\$0.95				\$0.26	\$0.10	17%	\$1.53
J-1	Exposed 160-mil Teranap	\$0.95				\$0.26	\$0.10	17%	\$1.53
O-1a	Covered GCL - Bentomat DN	\$0.29				\$0.26	\$0.15	17%	\$0.82
O-1b	Covered GCL - Bentomat CL	\$0.33				\$0.26	\$0.15	17%	\$0.87
O-2a	Exposed GCL - Bentomat DN	\$0.29				\$0.26	\$0.10	17%	\$0.76
O-2b	Exposed GCL - Bentomat CL	\$0.33				\$0.26	\$0.10	17%	\$0.81
O-3a	Exposed 45-mil EPDM PondGard with 8-oz geotextile on sideslopes only	\$0.30	\$0.06			\$0.26	\$0.10	17%	\$0.84
O-3b	Exposed 45-mil EPDM PondGard with 8-oz geotextile on sideslopes only and covered invert	\$0.30	\$0.06			\$0.26	\$0.12	17%	\$0.87
O-4	Exposed 30-mil LLDPE EnviroLiner with 8-oz geotextile on sideslopes only	\$0.25	\$0.06			\$0.26	\$0.10	17%	\$0.78
O-5	Exposed 160-mil Coletanche	\$0.93				\$0.26	\$0.10	17%	\$1.51
F-1	Exposed 45-mil PP over a broomed steel flume	\$0.40			\$0.12 ^a	\$0.10	\$0.15	17%	\$0.90
TF-1	Exposed 40-mil Wet-applied Polyurethane Geocomposite over existing concrete	\$0.75			\$0.15 ^b	\$0.12	\$0.20	17%	\$1.43
L-1	Exposed 45-mil Reinforced Metallocene	\$0.32	\$0.10		\$0.07 ^a	\$0.26	\$0.10	17%	\$0.99
BR-1a	Exposed 60-mil GSE White Textured HDPE with 10-oz geotextile cushion	\$0.60	\$0.12			\$0.26	\$0.10	17%	\$1.26
BR-1b	Exposed 60-mil GSE White Textured HDPE	\$0.60				\$0.26	\$0.10	17%	\$1.12

^a Cost for fabricating panels in the plant

^b Cost of resin freight