

APRIL 1976

NATIONAL RADIO ASTRONOMY OBSERVATORY

APRIL PROJECT REPORT

VLA PROJECT

May 11, 1976

NATIONAL RADIO ASTRONOMY OBSERVATORY

MONTHLY PROGRESS REPORT

VLA PROJECT

APRIL 1976

SITE AND WYE

Subcontract VLA-167; Site Warehouse and Maintenance Shop Buildings;
Paul D. Goar Construction Company; \$147,805

1. The walls, roof, and all insulation of the maintenance building are complete. The interior masonry walls have been constructed, and all of the interior has been painted. Overhead roll-up doors are installed and painted in both buildings. The ceramic tile wainscot and floor of the bathroom is complete. The plumbing and glazing are 100% complete.
2. All switches, ceiling-hung heaters, and lighting fixtures and lamps have been installed in both buildings. The two 277/480V panels have been made-up and energized. Branch circuits and feeders are 100% complete.

This contract is estimated at 97% complete.

Subcontract VLA-149; Wye Construction; Burn Construction Company, Inc.;
\$2,913,000

1. All remaining piers to be constructed under this contract have been completed at antenna foundations CN-5 through CN-9 and BW-8 through AW-8. Grade beams have been poured at DE-1, 2, 3, 7, 8, and 9, CE-5, and DN-2, 3, 4, and 5. Grade beam forms are being set at DN-6, while grade beam steel is in place at DN-7 and 8, and rough excavation is complete at CE-6 and 7. Antenna pedestals have been poured at DW-6, 7, 8, and 9.
2. Embankment for the west arm is complete to station 56 3+25.
3. Mainline trackage has been laid to station 171+35 on the west arm, and spur trackage at CW-7 and CW-8. Trackage is being laid between CW-5 and the apex while ballast is being distributed along the east arm and the north/east connection.
4. Transformer pads and secondary service to antenna pedestals are being roughed-in. Primary and secondary stub-ups are placed for east arm pads TE-7 through TE-12, including DE-9 and CE-9 isolating switches, and west arm pads TW-14 through TW-20, including BW-9 isolating switch.

This contract is estimated at 58% complete.

Subcontract VLA-65; George A. Rutherford, Inc.; \$2,395,400

1. The water reservoir electrode unit, the fire pump controller, and the booster pump controls have been installed. Lightning protection for the Control and Cafeteria buildings is 100% complete.
2. The final testing of the digital room RF shielded enclosure has been performed. The Control Building mechanical equipment room piping has been insulated with aluminum jacketing. Vinyl-asbestos tile has been laid for the floor of the lab and work area.

This contract is estimated at 99% complete.

Waveguide runs between DW-2 and DW-7 have been set to line and grade and backfilled with 12" of bedding material. The waveguide trench between DW-7 and DW-9 has been compacted and graded, and waveguide is ready to be set to line and grade. Improved techniques of waveguide installation have been developed which are resulting in the apparent stabilization of waveguide grade.

ANTENNA DIVISION

Progress in the Antenna Division during the month of April consisted of the following:

Antenna No. 3

All alignment and servo acceptance tests were completed on April 16. After completion of painting and minor structural corrections the antenna was accepted from E-Systems on April 20. The antenna was moved to the maintenance pad on April 27 for the installation of the AUI supplied equipment.

Antenna No. 4

During the month of April E-Systems completed the antenna pedestal, installed gear reducers, elevation wheel and gear segments; and the reflector back-up structure was completed. On April 23 the reflector structure was mated to the pedestal and panel installation was started. Azimuth lean was adjusted, bearing run-out checked and orthogonality of the elevation axis to the azimuth axis was measured as 4.1 arc seconds.

Antenna No. 5

Trial assembly of major components has been completed in Hobbs. Painting was also completed and shipment of component parts to the Site accomplished. Assembly of the reflector structure was started on April 26.

The first subreflector was received from the new supplier.

SYSTEM INTEGRATION DIVISION

The interruption in regular interferometer observing tests was used to perform additional single dish tests on Antenna No. 2. For that purpose, the single dish test trailer was moved to station CW9, and will be kept there until needed for the testing of Antenna No. 3.

Thirty hours of testing were principally devoted to new measurements of the aperture efficiency at 1.3 cm wavelength, which appeared to be low from measurements last January. The efficiency has now been measured at 42% at 50° elevation angle, comparing well with Antenna No. 1.

The outfitting of Antenna No. 3 has started and was approximately 13% complete at the end of the month.

ELECTRONICS DIVISION

A contract has been placed with J. J. Gustincic for development of a new feed for 6 cm wavelength. A full scale model will be delivered before the end of May. This will be a corrugated horn and the expected antenna efficiency that will be obtained with it is approximately 65% compared with 57% using the present 6 cm feed. An order has been placed with the Applied Electronics Division of AIL for parametric amplifiers for antennas 9-12. Two stages with a gain of 12.5 dB each will be used, followed by a room temperature GaAs FET transistor amplifier with a 3 dB noise figure. The front end for antenna No. 3 has been running in the laboratory for most of the month and a few minor adjustments are now being made. Completion of the assembly of further front ends is awaiting delivery of parametric amplifiers from Comtech. A test of the effect of the tilting of the antenna on the front end performance shows that the physical temperature changes by only 0.7°K from 90° elevation (the zenith position of the antenna) to 10°, being lower when the antenna is tipped to 10° elevation.

On April 20 measurements were again made of the attenuation of the 1.24 km of waveguide between CW5 and CW9. The results showed no change from the values measured on December 22 of last year except that at 60 GHz the latest value is higher by 0.02 dB per km which may not be significant since it is no greater than the measurement accuracy. An investigation to find a better method to install the waveguide has been started and results look very promising. A length of waveguide was installed on the inner part of the west arm and straightness tests with the mechanical mouse were made after each step. The trench was excavated about six inches deeper than the waveguide level and backfilled to the required level with sand. The waveguide was laid and found to have a radius of curvature of 1500-2000 meters. The trench was backfilled with about one foot of earth, and the straightness did not deteriorate until a compactor was used which reduced the radius of curvature to 700-1000 meters. The procedure was then repeated but the compacting process was modified to compact the fill at the sides of the waveguide before compacting on top. This greatly decreased the change in radius of curvature resulting from compacting. Further investigation is proceeding.

In other areas of the electronics, systems for antennas 3 to 6 are in the final stages of completion, and 105 out of the 108 modules being constructed in Charlottesville have been tested and are ready for shipment to the Site. Racks for antennas 3 to 6 are all completed and are being shipped to the VLA Site as of the month's end. Testing and modification of the prototype local oscillator system is progressing. In the monitor and control system improvements to the design of the data set and antenna buffer modules are being made prior to starting assembly of units for antennas 7 to 10. The test system for monitor and control modules has now been brought into operation for local buffer modules. In the delay and multiplier system checkout of most of the racks and cards for the six antenna system is complete. Samplers for five antennas are on hand and construction of the remainder for antennas 6 through No. 12 is about to begin.

Plans for installation of signal and local oscillator cables in the new control building are well advanced including procurement of parts. Cabling will be completed for installation of racks for the west arm of the array by early August.

COMPUTER DIVISION

Asynchronous Subsystem

During April DEC completed their work to get the FFT device connected and working with the DEC-18 system. Test results revealed that the device fails to meet time specification by about a factor of three and that it causes excessive degradation of DEC-18 performance. As a result, the device has been declared unacceptable and procurement of another FFT array processor has begun. The problem was basically that DEC chose to implement a design based on addressing DEC memory, and the access times for this are such that it could not meet timing specifications.

The programs developed to test the capabilities of the PDP11-based graphic systems were integrated into an interim system based upon menu selection of programs and parameters. A basic map display capability is therefore now available while continued development of a more flexible system is under way.

A preliminary monitor data base was designed and implemented with access and display routines. Further development will wait until the move to the site when actual data will be accessed and routines desired by operations or engineering staff implemented.

Significant progress was made on design and implementation of a linked system for mapping and map display from CANDID. Routines for accessing map subsections and rows were implemented. A new set of ADDS graphics operators was introduced that will permit more flexible user control of special purpose displays. The so-called curly-bracketed-expressions that will be the primary means of specifying parameters or selecting data in CANDID routines now work as planned and will be extensively used in all future routine development. VLA data tape contents have been successfully put into the previously designed run data base, and with a few minor problems to be solved, routines for data editing, correcting, and calibrating can begin development. Testing of the fast tape drives is under way to discover whether DEC has corrected the problems that turned up during the acceptance testing.

Synchronous Subsystem

Most of the effort of the synchronous computer group during April was directed to a redefinition of the on-line program input formats and analysis of data taken in by the interferometer in March. The latter includes improvement of the analysis programs. In addition, the off-line capability to average data has been added to the system.

PROJECT MANAGEMENT

Procurement activity for the month of April 1976 was for an estimated \$600,000. Of this total, 225 were purchase orders amounting to \$175,000 and subcontracts amounting to \$425,000.

Rail take up was completed at Redstone Arsenal, Mrytle Beach AFB and Bastrop, Texas. New take up work commenced at Crab Orchard, Ill., and at Fort Sam Houston, Texas.

Preparations are under way for the installation of cabling in the Control Building during the summer.

Personnel

The personnel changes as of April 30, 1976 are as follows:

<u>Division</u>	<u>Previous Level</u>	<u>Additions</u>	<u>Reductions</u>	<u>Current Level</u>
Site and Wye	7	0	0	7
Antenna	9	0	0	9
Electronics	38	0	0	38
Computer	14	0	0	14
System Integration	3	0	0	3
Project Management	<u>21</u>	<u>0</u>	<u>0</u>	<u>21*</u>
TOTALS	92	0	0	92

*Includes one part-time person.



p4-76-1

Antenna No. 4 in Assembly Building



p4-76-2

Service Building, New Warehouse Building,
New Shop Building and Antenna No. 3 on Maintenance Pad

VLA PROJECT
MAJOR SUBCONTRACTS AND PURCHASE ORDERS PLACED

<u>NUMBER P.O. SUBCONTRACT</u>	<u>VENDOR</u>	<u>ITEM DESCRIPTION</u>	<u>DATE PLACED</u>	<u>DOLLAR AMOUNT</u>	<u>DELIVERY DATE</u>	<u>CURRENT STATUS - ALL FIRM FIXED PRICE CONTRACTS EXCEPT WHERE NOTED</u>
VLA-5	BWH/CVR Joint Venture	E/A Title I and II	6/17/73	\$ 1,028,269	3/15/74 4/30/75 12/21/76	Title I - Completed Title II - Completed Title III - Work in progress in conjunction with VLA-65 and VLA-149. Fixed price plus cost reimbursables.
VLA-6	E-Systems, Inc.	28 Radio Telescopes	10/18/73	\$17,591,262	8/9/75	NRAO has taken possession of Antenna Nos. 1, 2, and 3. Antenna No. 4 is on schedule for the 5/24/76 delivery.
VLA-14	Comtech Lab., Inc.	Parametric Amplifiers	3/13/74	\$ 221,000	7/15/75	10 each additional parametric amplifiers purchased on Amendment No. 1. Seven units have been received.
VLA-29	Sterling-Detroit	Focusing Feed Mounts	6/17/74	\$ 328,582	3/1/75	Sterling Mount for Antennas No. 3 and 4 have been received and are being outfitted. Mounts for Antennas 5 through 10 are complete and undergoing acceptance tests.
VLA-44	Digital-Equip. Corporation	Asynchronous Computer	6/17/74	\$ 990,869	2/15/75	FFT did not pass acceptance tests and this portion of the order may be cancelled.
VLA-53	R. F. System	K and Ku Band Feed Horns	1/26/76	\$ 73,776	4/15/76 5/24/76	K and Ku Band Feed Horns for Antennas 3 through 6 are on schedule. K and Ku Band Horns will be shipped 5/7/76 for Antenna No. 3.
VLA-65	Geo. A. Rutherford Inc.	Site Construction Phase II	12/16/74	\$ 2,395,400	6/1/76	Work is about 99% complete.
VLA-70 P.O. 52322	Sumitomo Electric USA, Inc.	3313 pieces of waveguide 3410 each coupling sleeves	1/27/75	\$ 1,085,129	3/30/76	2313 pieces of waveguide and 2350 coupling sleeves have been received.

VLA PROJECT
MAJOR SUBCONTRACTS AND PURCHASE ORDERS PLACED

<u>NUMBER P.O.</u> <u>SUBCONTRACT</u>	<u>VENDOR</u>	<u>ITEM DESCRIPTION</u>	<u>DATE</u> <u>PLACED</u>	<u>DOLLAR</u> <u>AMOUNT</u>	<u>DELIVERY</u> <u>DATE</u>	<u>CURRENT STATUS - ALL FIRM FIXED PRICE CONTRACTS</u> <u>EXCEPT WHERE NOTED</u>
VLA-72 P.O. 52432	Hitachi Shibaden Corp. of America	3 ea. waveguide signal distributors	2/7/75	\$ 230,000	12/15/75	Units are in storage at VLA Site. Due for installation and final acceptance in June 1976.
P.O. 53637	Faron Gutierrez	Labor Hour for Carpenter Work	6/16/75	\$ 5,000	6/5/76	Approx. \$3,387 spent effective 4/30/76.
VLA-134 P.O. 53578	Air Products and Chemicals, Inc.	Helium Compressors and Cryogenic Refrigerators	8/15/75	\$ 139,545	10/17/75	C.O. No. 1 issued to purchase units for Antennas 7-10.
VLA-146 P.O. 053619	Spacecom, Inc.	Mixers for IF/L0 Modems	2/20/76	\$ 74,600	5/31/76	Delivery is on schedule.
VLA-149	Burn Construction Co., Inc.	Site Construction Phase III	9/25/75	\$2,979,600	10/25/76	Work is approx. 58% complete.
P.O. 53880	N. M. Tech.	Labor Hour Contract	9/1/75	\$ 15,000	8/31/75	Approx. \$6,571 spent effective 4/30/76.
VLA-160 P.O. S-00120	Wutzke RR Tie Co.	20,000 Used Cross Ties	10/17/75	\$ 109,000	12/31/75	15,033 ties have been delivered.
VLA-160 P.O. S-00271	Timber Mtn. Forest Products	20,000 Used Cross Ties	10/17/75	\$ 115,000	12/31/75	9,790 ties have been delivered.
VLA-167	Paul Goar Construction Co.	Prefabricated Metal Warehouse and Maintenance Buildings	1/6/76	\$ 147,805	4/30/76	Work is approx. 97% complete.
VLA-174	Lawrence Hefner	Provide Labor and Equipment	1/26/76	\$ 62,400	2/28/77	Approx. \$3,915 spent effective 4/30/76.
P.O. S-00815	DeLuna Bluebird Bus Sales of N.M.	Coach	3/25/76	\$ 53,626	8/1/76	Delivery is on schedule.
VLA-177 P.O. S-00985	Fujikura Cable Works Ltd.	Waveguide Coupling Components	3/5/76	\$ 134,985	6/1/76	Delivery of partial shipment by 6/1/76 is on schedule.

VLA PROJECT
MAJOR SUBCONTRACTS AND PURCHASE ORDERS PLACED

<u>NUMBER P.O. SUBCONTRACT</u>	<u>VENDOR</u>	<u>ITEM DESCRIPITON</u>	<u>DATE PLACED</u>	<u>DOLLAR AMOUNT</u>	<u>DELIVERY DATE</u>	<u>CURRENT STATUS - ALL FIRM FIXED PRICE CONTRACTS EXCEPT WHERE NOTED</u>
P.O. S-00986	Hitachi Shibaden Corp. of America	Waveguide Adaptors	3/25/76	\$ 47,800	6/30/76	Delivery of partial shipment by 6/30/76 is on schedule
P.O. S-01147	Fujikura Cable Works Ltd.	Rotary Joints	3/30/76	\$ 696	6/30/76	Delivery is on schedule.
VLA-179 P.O. S-01046	AIL Div. of Cutler Hammer	Parametric Amplifiers	4/29/76	\$ 62,320	10/12/76	Awaiting acknowledgement of P.O.
S-01134	Digital Equip. Corp.	Eight Line Comm. Group	4/5/76	\$ 5,060	8/30/76	Delivery is on schedule.
VLA-191 P.O. S-01162	Longwill-Scott Inc.	Rail Take Up Crab Orchard, Ill	4/7/76	\$118,385	7/31/76	Vendor started work 4/28/76.

VLA PROJECT
PROCUREMENT ACTIVITIES INITIATED

<u>RFP NUMBER</u>	<u>ITEM DESCRIPTION</u>	<u>ESTIMATED COST</u>	<u>ISSUE DATE</u>	<u>BID DUE DATE</u>	<u>SUBMISSION TO NSF DATE</u>	<u>AWARD DATE</u>	<u>CURRENT STATUS</u>
VLA-70 P.O. 052322 C.O. No. 3	TE ₀₁ Mode 60 mm Circular Waveguide	\$361,505	-----	-----	4/5/76		Requested approval to issue C.O. No. 3 to purchase 5,300 additional meters of waveguide.
VLA-149 Amendment No. 1	Site Construction Phase III	\$ 57,600	-----	-----	4/27/76		Requested approval to issue Amendment No. 1 to extend power from AW-6 to AW-8.

NATIONAL RADIO ASTRONOMY OBSERVATORY

VLA--FINANCIAL STATUS REPORT
(in thousands)

As of: April 30, 1976

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Item	Project Ceiling	Allocation to Date			Unallo- cated Balance	Outlook			Notes
		Allocated	Expended and Committed	Allocated Balance		Est. to Complete	Est. Total	(Over) Under Ceiling	
Site and Wye	27,860	11,906	10,563	1,343	15,954	17,160	27,723	137	
Antennas	20,400	8,590	8,044	546	11,810	13,170	21,214	(814)	
Electronics	17,000	7,465	5,791	1,674	9,535	11,367	17,158	(158)	
Computer	4,850	2,529	2,067	462	2,321	3,278	5,345	(495)	
Systems Integration	400	194	69	125	206	299	368	32	
Project Management	2,650	1,569	1,127	442	1,081	1,750	2,877	(227)	
Subtotal	73,160	32,253	27,661	4,592	40,907	47,024	74,685	(1,525)	
Contingency	2,840	948	---	948	1,892	3,438	3,438	(598)	
Total	76,000	33,201	27,661	5,540	42,799	50,462	78,123	(2,123)	

Notes: (1) Basic estimate is that of August, 1975.

(2) Escalation included for future years at 6% for site and wye work; National Radio Astronomy Observatory labor, and minor antenna equipment items. Antenna estimate is based on the existing contract costs for fabrication of the antennas. No future escalation has been included for electronics or computer purchased equipment.

(3) Estimate excludes the following deferred items: Transporters #2 and #3, \$615 K; Air Strip, \$268 K.

Explanation to Accompanying Statement

Column (2) - Project Ceiling: Original estimates

Column (3) - Allocated: Funded by NSF and included in total funds provided in Contract C-780.

Column (4) - Expended and Committed: Actual cash paid out and orders written and accepted by vendors.

Column (5) - Allocated Balance: Column 3 less Column 4. (Current funds available for expenditure and commitment.)

Column (6) - Unallocated Balance: Column 2 less Column 3. (Funds due from NSF to fund the total project as originally estimated.)

Column (7) - Estimate to Complete: Original estimate updated to take into account current or known costs.

Column (8) - Estimated Total: Column 4 plus Column 7.

Column (9) - (Over) Under: Column 2 less Column 8.

CY-1976
 VERY LARGE ARRAY
 Status as of April 30, 1976

<u>Project Number</u>	<u>Description</u>	<u>Allocation</u>	<u>Monthly</u>	<u>Expended</u>	<u>Committed</u>	<u>Total</u>	<u>Balance</u>	<u>Outstanding Obligations Pending</u>	<u>Net Balance</u>
11000	Site and Wye	5,111,000	533,102	1,598,674	2,187,662	3,786,336	1,324,664	470,677,	853,987
12000	Antenna System	3,081,000	74,652	589,181	1,945,522	2,534,703	546,297	149,429	396,868
13000	Electronic System	2,876,000	175,649	552,751	647,634	1,200,385	1,675,615	506,368	1,169,247
14000	Computer System	720,000	28,653	221,630	36,749	258,379	461,621	188,675	272,946
16000	Systems Integration	148,000	4,650	18,468	4,190	22,658	125,342	36,136	89,206
17000	Project Management	662,000	44,533	159,536	74,723	234,259	427,741	205,492	222,249
	Contingency	948,000	---	---	---	---	948,000	---	948,000
Total VLA		13,546,000	861,239	3,140,240	4,896,480	8,036,720	5,509,280	1,556,777	3,952,503

TOTAL PROJECT

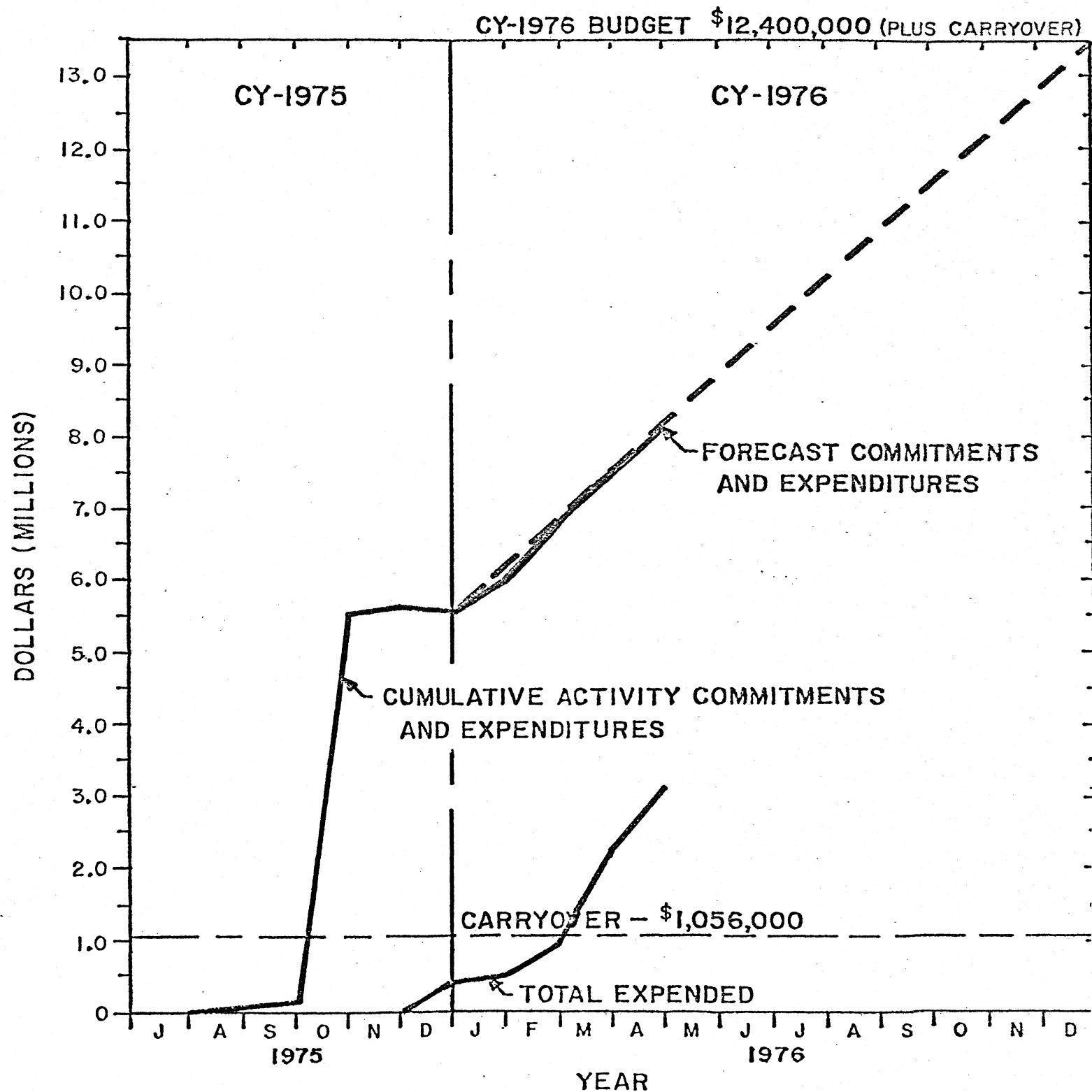
VERY LARGE ARRAY

Status as of April 30, 1976

<u>Project Number</u>	<u>Description</u>	<u>Allocation</u>	<u>Monthly</u>	<u>Expended</u>	<u>Committed</u>	<u>Total</u>	<u>Balance</u>	<u>Outstanding Obligations Pending</u>	<u>Net Balance</u>
11000	Site and Wye	11,906,406	638,550	7,840,091	2,722,818	10,562,909	1,343,497	470,677	872,820
12000	Antenna System	8,590,344	74,666	6,096,249	1,947,204	8,043,453	546,891	149,429	397,462
13000	Electronic System	7,464,934	223,934	5,038,135	752,928	5,791,063	1,673,871	506,368	1,167,503
14000	Computer System	2,528,589	28,653	1,800,115	266,704	2,066,819	461,770	188,675	273,095
16000	Systems Integration	194,000	4,718	65,007	4,211	69,218	124,782	36,136	88,646
17000	Project Management	1,568,961	44,533	1,051,799	75,595	1,127,394	441,567	205,492	236,075
	Contingency	948,066	---	---	---	---	948,066	---	948,066
Total YLA		33,201,300 (1)	1,015,054	21,891,396	5,769,460	27,660,856	5,540,444	1,556,777	3,983,667

(1) Total Project Allocation does not include \$283,000 withheld by NSF for Army Corp of Engrs. and \$15,700 for ECAC Study.

VLA - NRAO PROJECT REPORT EXPENDITURES AND COMMITMENTS CY - 1976 CUMULATIVE ACTIVITY

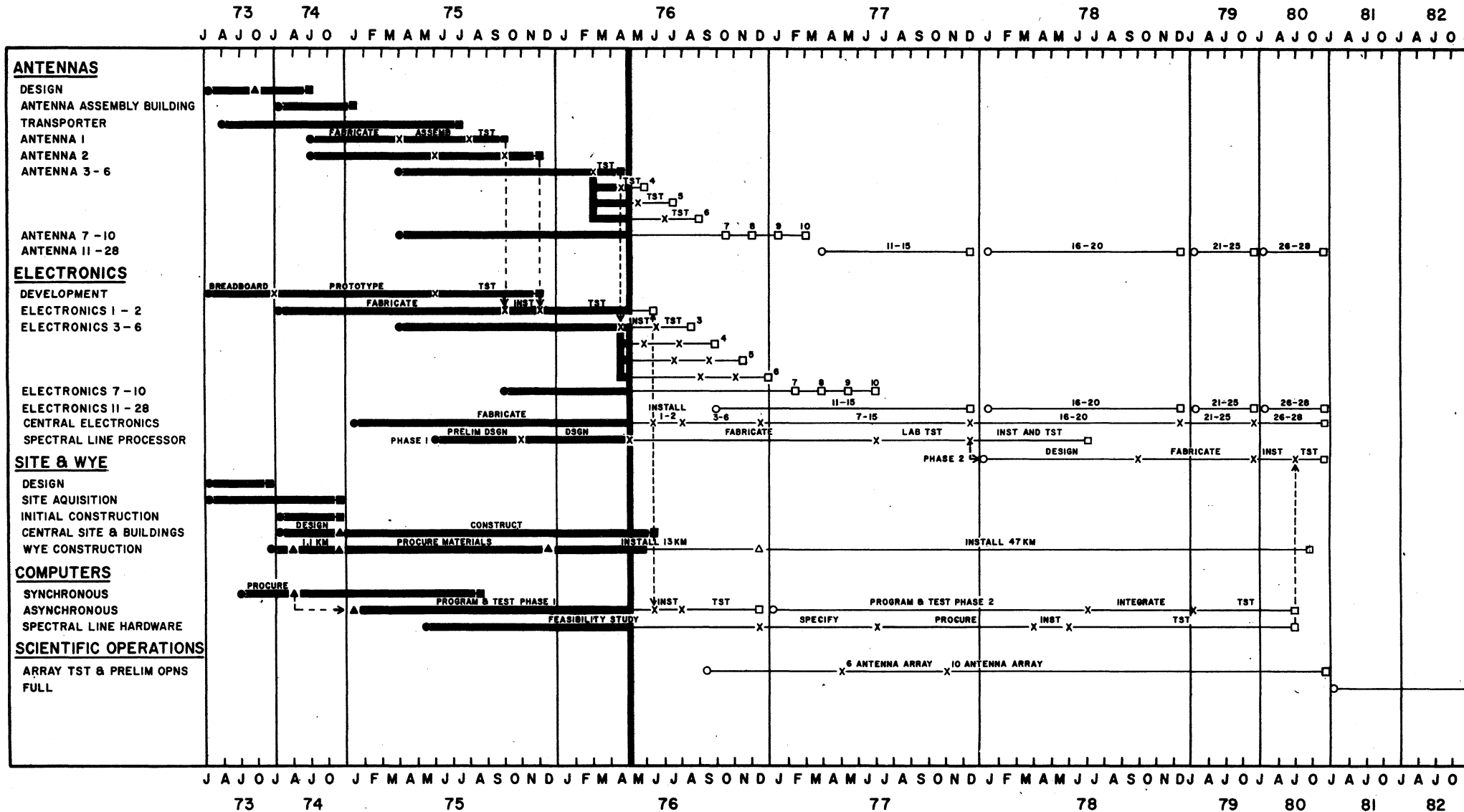


NATIONAL RADIO ASTRONOMY OBSERVATORY

VLA ACTIVITY SCHEDULE

11/15/75

UPDATE DATE: 5/1/76



ABBREVIATIONS

ASSEMBLE - ASSEMB	CH-VILLE - CV	INSTALL - INST	PRELIMINARY - PRELIM
COMPLETE - CMPL	DESIGN - DSGN	INTEGRATE - INTG	SELECT - SLCT
CONTRACT - CNTR	DETAIL - DTL	OPERATIONS - OPNS	TEST - TST

SYMBOLS

O START OF A PHASE	Δ CONTRACT AWARD
X END OF AN ACTIVITY	□ END OF A PHASE

REV. NO.	REV. DATE	REVISION
1	12/4/75	WYE CMPL 10/80