Aircraft
Noise
Study

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Report No. 2653
Job No. 11946

AIRCRAFT NOISE STUDY
MARINE CORPS AIR STATION (H)
NEW RIVER
JACKSONVILLE, N. CAROLINA

October 1973

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Submitted to:

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Atlantic Division
Naval Facilities Engineering Command
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Department of the Navy
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I. INTRODUCTION AND CONCLUSIONS

This report provides descriptions of the aircraft noise environment in the vicinity of MCAS (H) New River, Jacksonville, N. Carolina. The purpose of this study is to describe and interpret the present noise environment and to predict the future (1980) noise environment with respect to land use. This study is intended to provide guidance for military and civil action that would tend to lessen the impact of this noise on the surrounding community (zoning and land purchases). This study has been made by Bolt Beranek and Newman Inc. (BBN) at the request of the Atlantic Dividion, Naval Facilities Engineering Command, U.S. Navy.

Noise resulting from current aircraft operations at MCAS (H) New River is considered in some detail in this report. The information concerning aircraft and aircraft operations was obtained during a number of visits to the station in April and May, 1973. A number of station personnel were interviewed at these times to determine the operational conditions.

The techniques of the Composite Noise Ratings (CNR), as given in NAVDOCKS P-98, "Land Use Planning Relating to Aircraft Noise," have been used to assess the aircraft noise exposure on and in the vicinity of the station. Selected noise measurements were made to provide refinement of application of the CNR assessment techniques to the particular conditions prevailing at the station.

Section II of this report summarizes the aircraft operations at the Air Station which are important in determining the noise environment. Section III discusses the analysis procedures and techniques used in the study. Section IV summarizes the noise measurements. Section V reviews community reaction based on complaints and various criteria. Section VI presents descriptions of the existing noise environment and the predicted noise environment for 1980.

CONCLUSIONS

A Composite Noise Rating contour has been prepared for MCAS (H) New River for flight operations occurring in 1973. The contour is comparatively small due to the quiet aircraft (helicopters for the most part) operating from this air station. (Helicopters are 20 to 40 dB quieter than jet fighter aircraft.) The contours in NAVFAC Design Manual No. 35 do not agree with the measured helicopter noise data produced during this survey. The measured helicopter noise data was used to prepare the CNR Contours presented herein. GCA approaches are a major contributor to the off-station portion of the noise contours due to the shallow approach angle used during these operations. Since MCAS New River is totally surrounded by government owned land, only a small portion of the Zone 2 contour (less than two-tenths of a square mile) falls outside of government owned land areas. The Zone 3 contour lies almost entirely on-station. Less than one-tenth of a square mile falls off-station (on government owned property). A CNR contour was also calculated for the operations forecast for 1980. There are no major changes forecast in flight operations or aircraft for this time period as compared to 1972. Therefore, the 1980 contour is identical to the 1972 contour.

II. AIRCRAFT OPERATIONS

Due to the flexibility of helicopter operations relative to normal fixed-wing aircraft operations, flight paths, runway use, number of operations, etc. were much less precisely determined in this report as compared to other reports in this series.

Helicopter takeoffs take place from almost any location on the runways. Low altitude operations take place in taxi and parking areas and over certain grass field areas northwest of each end of Runway 5-23. Touch-and-go and standard takeoff paths are shown in Fig. 1. The results of a five-day survey conducted by the MCAS (H) New River control tower are presented in Tables 1 and 2. These tables show the number of flights per day, runway use, and turns after takeoff by aircraft type for the aircraft stationed at MCAS New River. The AH-1 and UH-1 helicopters taxi from parking position to takeoff position while airborne since they are not equipped with wheels.

There are about 35 to 45 GCA approaches per day divided over all types of aircraft. These take place on runway 5 only. About 10 to 30 of these are H-53 aircraft which control the GCA contour size. The level portion of the GCA pattern is flown at 1600 ft for all aircraft under VFR conditions. Touch-and-go and break pattern altitude for helicopters is 500 ft, for fixed wing aircraft 1000 ft. OV-10 aircraft runups occur in excess of 5 times per day. The average runups lasts between one and five minutes.

Aircraft operations for 1980 are expected to be similar to those occurring at this time. The exception is that more powerful versions of some of the aircraft are expected to be in use at that time. (It is not expected that the noise levels of these aircraft will increase enough to cause them to change CNR contour group.)

Figure 1. FLIGHT PATHS

TABLE 1

AIRCRAFT FLIGHTS PER DAY*

Aircraft	T/O or Lands	Touch & Go
CH-53D	100 +	10 - 30
AH-1J	30 - 100	10 - 30
CH-46, UH-1N	100 +	10 - 30
OV-10	10 - 30	1 - 3

*0700 to 2200. Less than 1 flight per average night (2200-0700) is normal.

TABLE 2

RUNWAY USE AND TURNS AFTER TAKEOFF

Runway	% Use	Turns % Left	Turns % Straight	Turns % Right
H-53				
5	30	22	11	67
18	13	66	14	20
23	39	35	22	43
36	18	53	--	47
H-46				
5	29	26	17	57
18	22	78	9	13
23	37	40	18	42
36	12	17	--	63
AH-1, UH-1				
5	31	24	24	52
18	19	77	12	11
23	49	41	24	35
36	1	--	--	--
OV-10				
5	30	23	42	35
18	27	44	26	30
23	30	65	4	31
36	13	18	9	73

III. ANALYSIS PROCEDURES AND TECHNIQUES

The major objective in this study is to determine the noise environment and to interpret it in terms of the probable reaction of people living or working in areas exposed to aircraft noise. The study can be separated into two general steps. The first step is based upon the measurement and analysis of aircraft noise plus information concerning the flight paths used and the location of other activities such as ground runup operations associated with aircraft maintenance. This information is then used to establish noise level contours for the land area of concern.

The noise levels associated with these contours are expressed in terms of perceived noise level measured in PNdB. The perceived noise level is a single number rating of the noise, calculated from the measured data. This rating has been developed specifically for rating the noisiness or relative acceptability of aircraft sound; it takes into account the amplitude and frequency characteristics of the sound in a manner that closely matches human judgment of the relative noisiness of aircraft sounds. The perceived noise level is used widely in this country and abroad for describing aircraft noise because it provides a useful basis for comparing the sound produced by different types of aircraft.[1,2]

Although the perceived noise level contours can provide an indication of the relative noisiness occurring in different land areas, community response to noise is generally not determined uniquely by the levels of noise alone; an interpretative second step is needed. For example, consideration must be given to the frequency of occurrence (number of landings and takeoffs per day), the duration of the noise (in the case of ground

runups), and the time of occurrence (day or night). It is necessary to apply corrections to the perceived noise level values, based upon these factors, in order to determine a Composite Noise Rating (CNR) which can then be related to the expected community reaction.

The Noise Exposure Forecast (NEF)[3] methodology has been developed as a further refinement of the CNR methodology. The noise levels of aircraft flight events are expressed in Effective Perceived Noise Levels (EPNL). The NEF approach has not been adopted for military use because EPNL data are not directly comparable to existing CNR studies done for many military bases.

IV. SUMMARY OF NOISE MEASUREMENTS

Previous helicopter work in this series dealt with a) training operations at NAS Ellyson where special measurements were made, and b) NAS Norfolk and MCAS Cherry Point, where NAVFAC Design Manual No. 35, "Family Housing," was used as a source for helicopter contours. An extensive set of special measurements were made during this survey under controlled conditions at Camp Davis (an abandoned facility southwest of MCAS New River). Each helicopter executed the following maneuvers: 1) takeoff and landing before, abeam, and beyond the microphone position; 2) hover and turn 360° while in ground effect and at 100 ft altitude; 3) flyover at 500 ft altitude at traffic pattern speed and at cross-country speed; 4) (where applicable) taxi by microphone position (AH-1, UH-1). These measurements are summarized in Table 3. Table 4 shows a comparison of the contours from Design Manual No. 35 and the data measured at Camp Davis. The data from the Camp Davis measurements was used to generate the CNR contours presented in this report. Measurements were also made at MCAS New River of OV-10 takeoffs, landings, and runups. Far-field runup data for the OV-10 was combined with North American Rockwell Co. close-in runup data to yield runup noise contours for the OV-10. Due to the small off-station noise impact at this facility, no community noise measurements were made during this survey.

TABLE 3

REPRESENTATIVE PEAK AIRCRAFT NOISE LEVELS

	Octave Band Center Frequency - Hz									
	63	125	250	500	1K	2K	4K	8K	PNdB	dBA
H-53D										
Takeoff-350'	96	100	101	99	93	84	73	61	100	99
Land-350'	99	99	98	96	93	85	75	64	109	98
Hover-390'	101	101	100	100	95	87	77	65	111½	101
585' Flyover 80K+	87	88	89	85	82	76	67	56	99	87
650' Flyover 140K+	92	88	90	87	83	77	68	56	100½	90
AH-1J										
Takeoff-350'	91	90	89	88	89	90	72	67	106½	94
Land-350'	88	89	85	83	88	90	73	62	105½	93
Hover-370'	93	93	87	87	85	86	72	65	104½	90
650' Flyover 80K+	86	81	79	79	78	76	64	51	95	81
590' Flyover-HiSpeed	93	88	89	83	79	78	68	54	99½	85
Taxi-350'	89	88	89	86	86	87	73	61	104	91
CH-46F										
Takeoff-365'	85	78	82	85	82	81	76	67	100	88
Land-365'	91	90	90	90	85	82	76	66	103	90
Hover-370'	94	85	86	90	85	80	75	66	102	90
550' Flyover-LoSpeed	81	81	81	79	74	73	70	57	94	81
500' Flyby-HiSpeed	91	88	88	84	79	75	72	60	99	85
UH-1N										
Takeoff-340'	91	89	85	83	85	78	69	60	99	87
Land-340'	93	90	88	87	86	78	68	63	100½	90
Hover-350'	92	92	90	89	82	77	69	62	101½	88
460' Flyby 80K+	90	83	86	79	75	71	62	54	95½	81
520' Flyby 120K+	92	89	83	81	76	72	62	51	96	80
Taxi-340'	89	87	86	83	80	75	66	58	97	84
OV-10										
T/O 315'	91	92	98	91	88	82	74	64	106	92
T/O 525'	91	97	85	88	79	73	76	56	102	86
Taxi-660'	86	92	81	74	83	82	73	60	101	85
T/O 700'	88	94	90	90	82	80	65	50	102	87
Runup 2500' (100°)	78	85	75	65	62	57	48	41	87	69

TABLE 4

NAVFAC DM-35 "FAMILY HOUSING" HELICOPTER NOISE CONTOURS vs CAMP DAVIS MEASUREMENT LEVELS

All Levels in PNdB

Aircraft	Extrapolated 1000' level from measured data	DM-35 Contour base level 1000'	DM-35 Correction	DM-35 Sum	BBN suggested correction to DM-35 contour	Sum
CH-53D	103	91	0	91	+10	101
AH-1J	96	91	not listed	-	+5	96
CH-46	93	91	0	91	0	91
UH-1N	93	91	-10	81	0	91

V. COMMUNITY REACTION

The Composite Noise Rating value is used to establish zones of relative acceptability for estimating community response to aircraft noise. The specific CNR values which are used in defining the zone boundaries for varying degrees of community response have been determined from past case histories in which noise measurements have been related to the observed reaction of communities exposed to the noise. Table 5 shows the Composite Noise Ratings which correspond to the boundaries of three zones of relative acceptability with a description of the anticipated community response in each zone. The zones are developed from separate sets of CNR's for flyover and ground runups. The flyover-runup difference in CNR ratings arises from differences in summing the duration characteristics of the two types of operation.

The procedures used in describing the noise environment resulting from aircraft operations have been developed by BBN over the past twenty-two years during the measurement, analysis and interpretation of aircraft noise at many military and civilian air fields. The procedures for interpreting the impact of aircraft noise in residential areas are based on those developed by BBN and discussed in a report "Land Use Planning Relating to Aircraft Noise" submitted to the Department of Defense and the Federal Aviation Agency, and issued as NAVDOCKS P-98, "Land Use Planning with Respect to Aircraft Noise." These procedures reflect continued development and refinement in the techniques used by us in earlier reports to the Navy. In P-98, military aircraft are divided into groups for takeoffs, landings and runups, in terms of their different noise-producing properties.

TABLE 5

CHART FOR ESTIMATING COMMUNITY RESPONSE FROM THE COMPOSITE NOISE RATING

Zone[1]	Composite Noise Rating		Description of Community Response[2]
	Flyovers	Runups	
1	Less than 100	Less than 80	Essentially no complaints would be expected. The noise may, however, interfere occasionally with certain activities of the residents
2	100 to 115	80 to 95	Residents in the community may complain, perhaps vigorously. Concerted group action is possible.
3	Greater than 115	Greater than 95	Individual reactions would likely include repeated, vigorous complaints. Concerted group action would be expected.

[1]In much earlier BBN work for the Bureau of Yards and Docks concerning the relative noise exposure for Capehart Housing sites, a four zone rating of acceptability was used. In our present procedure, based upon a three zone rating method, we have essentially combined the old Zones 2 and 3. Thus, the present Zone 1 (CNR of less than 100) corresponds to the old Zone 4; the present Zone 2 (CNR of 100 to 115) includes all of Zones 2 and 3; the present Zone 3 (CNR greater than 115) corresponds to old Zone 1.

[2]In considering on-base and off-base land use, one must consider that military personnel may tolerate somewhat higher noise exposure from military operations than will civilians who may have little interest in or appreciation of an air station's mission.

As a further aid for land development, Table 6 compares the CNR ratings vs. compatibility with a number of land use categories. This table is based upon a typical range of tasks which are normal for various land uses, the effects of aircraft noise on speech communications, and case histories of numerous aircraft noise surveys at various civilian and military airports. The land use compatibility assumes standard, lightweight building construction with fixed or operable single-pane windows. A "satisfactory" indicates that there should be little or no adverse effect from the aircraft noise. "Unsatisfactory" indicates that unless extensive precautions are taken, noise will likely constitute a severe interference to land use.

The United States Department of Housing and Urban Development (HUD) has issued noise assessment guidelines relating aircraft noise exposure to eligibility for HUD load assistance. Table 7 indicates the various acceptability categories for locations within specific CNR zones. You will note that they term locations within CNR Zone 3 to be clearly unacceptable and that locations within Zone 2 are normally acceptable. To quote from the guidelines, normally unacceptable areas are those where "The noise exposure is significantly more severe so that unusual and costly building construction are necessary to insure some tranquility indoors and barriers must be erected between the site and priminent noise sources to make the outdoor environment tolerable." Note this description is for Zone 2, not Zone 3 in the CNR methodology. The HUD description of Zone 3 location is as follows: "The noise exposure at the site is so severe that the construction costs to make the indoor environment acceptable would be prohibitive and the outdoor environment would still be intolerable."

TABLE 6

LAND USE COMPATIBILITY FOR AIRCRAFT NOISE

COMPOSITE NOISE RATING			LAND USE COMPATIBILITY								
Takeoffs and Landings	Runups	CNR Zone	Residential	Commercial	Hotel, Motel	Offices, Public Buildings	Schools, Hospitals, Churches	Theatres, Auditoriums	Outdoor, Amphi-Theatres, Theatres	Outdoor Recreational (non-spectator)	Industrial
Less than 100	Less than 80	1	Satis	Satis	Satis	Satis	Note (C)	Notes (A) & (C)	Note (A)	Satis	Satis
100 to 115	80 to 95	2	Note (B)	Satis	Note (C)	Note (C)	Note (C)	Notes (A) & (C)	Note (A)	Satis	Satis
Greater than 115	Greater than 95	3	Unsat	Note (C)	Note (C)	Unsat	Unsat	Unsat	Unsat	Satis	Note (C)

Note (A) — A detailed noise analysis should be undertaken by qualified personnel for all ind-or or outdoor music auditoriums and all outdoor theatres.

(B) — Case history experience indicates that individuals in private residences may complain, perhaps vigorously. Concerted group action is possible.

(C) — An analysis of building noise reduction requirements should be made and needed noise control features should be included in the building design.

TABLE 7

HUD GUIDELINES RELATING
SITE EXPOSURE TO AIRCRAFT NOISE
TO ACCEPTABILITY AS RESIDENCE SITE

Distance from Site to the Center of the Area Covered by the Principal Runways	Acceptability Category
Outside the NEF-30 (CNR-100) contour at a distance greater than or equal to the distance between the NEF-30 and NEF-40 (CNR-100, CNR-115) contours	Clearly Acceptable
Outside the NEF-30 (CNR-100) contour, at a distance less than the distance between the NEF-30 and NEF-40 (CNR-100, CNR-115) contours	Normally Acceptable
Between the NEF-30 and NEF-40 (CNR-100, CNR-115) contours*	Normally Unacceptable
Within the NEF-40 (CNR-115) contour**	Clearly Unacceptable

* CNR Zone 2
** CNR Zone 3

VI. COMPOSITE NOISE CONTOURS

With one major and one minor addition, the computational method of NAVDOCKS P-98 was used in determining the composite noise contours presented in this report. The major addition is that the noise made during level aircraft flight, such as in patterns, has been measured and estimated to be equal to the landing noise plus 10 dB. This contour was used for all break patterns. The minor addition is that fairing was done at the intersection of contours strictly in accordance with the rules of decibel addition. This fairing is illustrated in Fig. 2. This figure indicates that at the intersection of equal contour levels, the perceived noise level is 3 dB higher than that of the contour. In accordance with P-98 events occurring with a frequency of less than once a day were disregarded. Also, break pattern interiors were filled in to account for early turns.

Figure 3 shows the 1973/1980 CNR contours for MCAS (H) New River. Table 8 below reports the areas on and off station in the two contour zone areas.

TABLE 8

ANALYSIS OF CONTOURS — MCAS (H) NEW RIVER

	Zone 2	Zone 3
ON BASE	2.1 sq mi	1.4 sq mi
WATER	1.5 sq mi	<0.1 sq mi
OFF BASE	2.0 sq mi	<0.1 sq mi
	(Less than 0.2 sq mi off government property)	

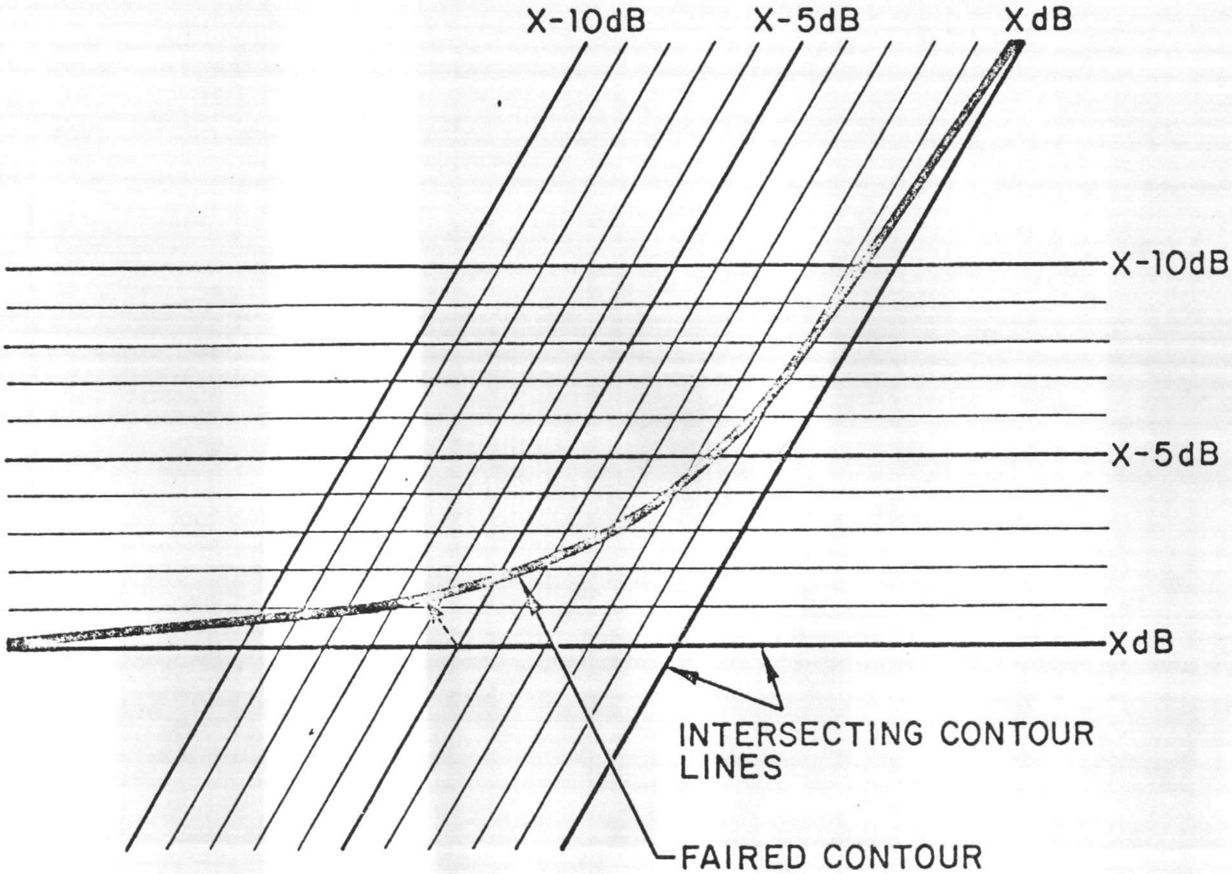


Figure 2. FAIRING OF CONTOURS

This example shows the fairing at XdB contour lines. The X-10, X-5, and intermediate contour lines have been added to show the relative position of the faired contour line. The faired line follows the formula:

$$\text{dB increase} = 10 \log \left(\frac{\text{antilog } X + \text{antilog crossing contour line}}{\text{antilog } X}\right)$$

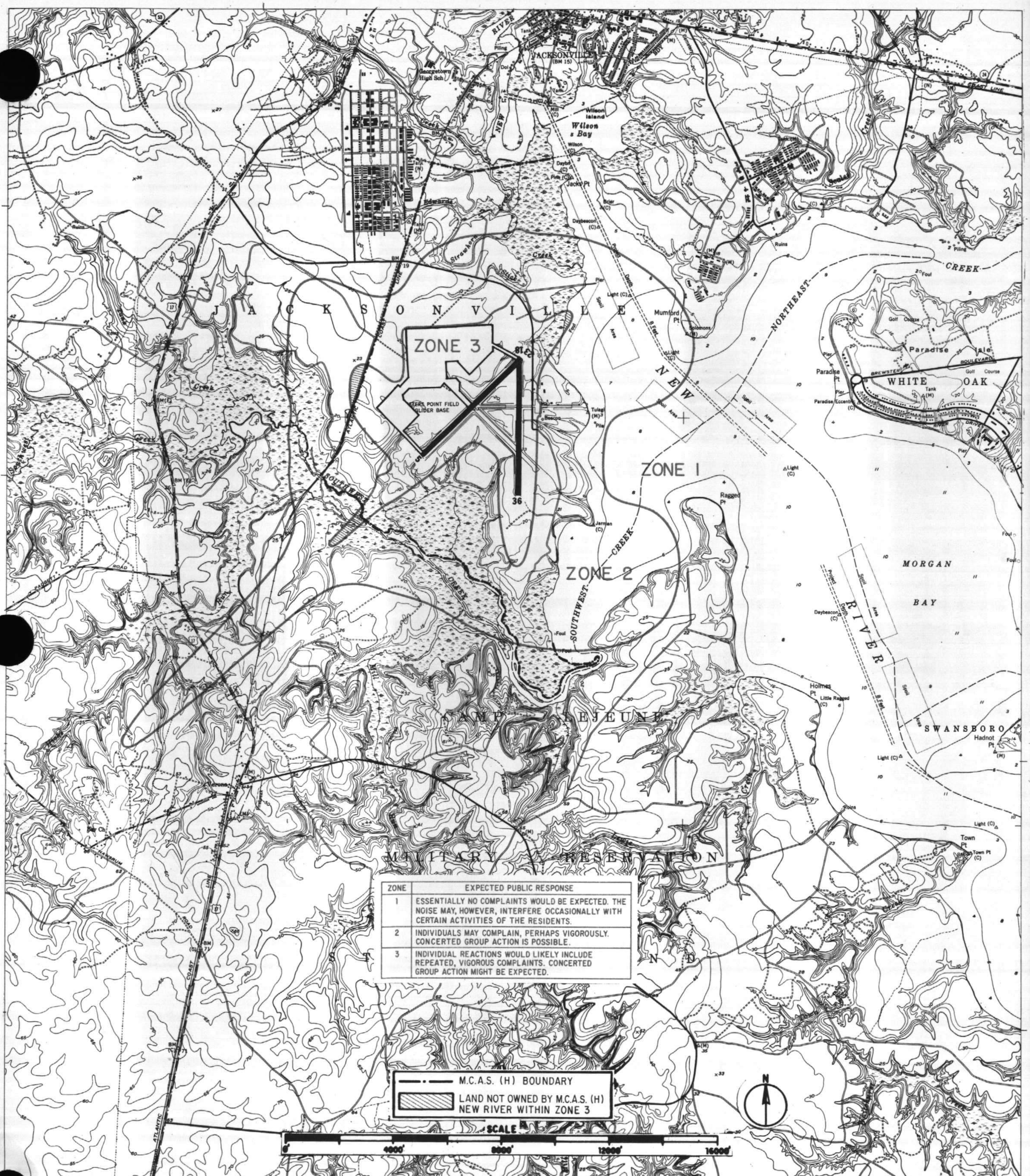
$$\text{Example: dB increase} = 10 \log \left(\frac{\text{antilog } 90 + \text{antilog } 85}{\text{antilog } 90}\right)$$

$$= 10 \log \left(\frac{10^9 + 3.16 \times 10^8}{10^9}\right)$$

$$= 10 \log \ 1.316$$

$$= 1.19$$

These contours are controlled for the most part by H-53 operations. Specifically, the Zone 3 contour is controlled by H-53 takeoffs and landings, H-53 GCA approaches, OV-10 runups, and UH-1 and AH-1 taxi operations. These contour areas represent a relatively small threat of complaint generation. This is especially true when it is noted that less than 2/10 of a sq mi. of the Zone 2 contour area falls outside of government owned land.



ZONE	EXPECTED PUBLIC RESPONSE
1	ESSENTIALLY NO COMPLAINTS WOULD BE EXPECTED. THE NOISE MAY, HOWEVER, INTERFERE OCCASIONALLY WITH CERTAIN ACTIVITIES OF THE RESIDENTS.
2	INDIVIDUALS MAY COMPLAIN, PERHAPS VIGOROUSLY. CONCERTED GROUP ACTION IS POSSIBLE.
3	INDIVIDUAL REACTIONS WOULD LIKELY INCLUDE REPEATED, VIGOROUS COMPLAINTS. CONCERTED GROUP ACTION MIGHT BE EXPECTED.

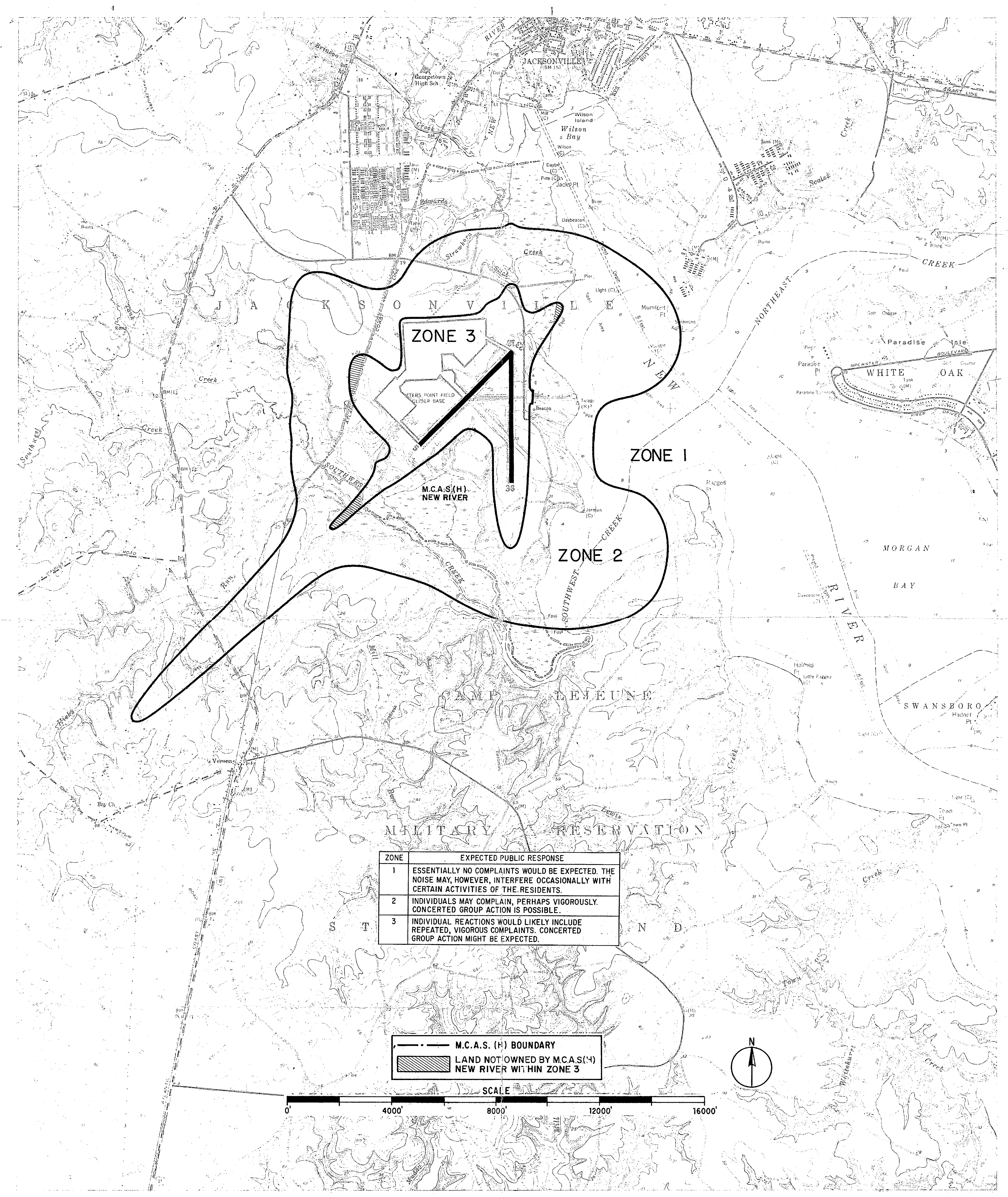
Figure 3. 1973/1980 CNR CONTOURS

REFERENCES

1. Kryter, K.D., "The Meaning and Measurement of Perceived Noise Level," Noise Control, 5, 12-27 (September-October, 1960).

2. Kryter, K.D., K.S. Pearsons, "Some Effects of Spectral Content and Duration on Perceived Noise Level," NASA TN D-1873, April, 1963.

3. Galloway, W.J., D.E. Bishop, "Noise Exposure Forecasts: Evaluation, Extensions and Land Use Interpretations," FAA Report FAA-No-70-8, December, 1969.



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DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NORFOLK, VA.

MCAS (H) NEW RIVER 1973/80 CNR CONTOURS

SIZE	CODE IDENT. NO.	NAVFAC DRAWING NO.
F	80091	

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