Tarawa Terrace Aquifer

Contours of equal altitude at the top of the Tarawa Terrace aquifer are shown in Figure B9. This aquifer occurs at or near land surface north of Tarawa Terrace at about altitude 25 ft. Minimum altitude is about –30 ft near the southeastern limit of the study area and north of the headwaters of Wallace Creek (Table B5). Surface altitudes decline at a generally uniform rate northwest to southeast. Altitudes in the vicinity of Tarawa Terrace and Montford Point also decline to the south and southeast toward Northeast Creek. Borehole logs completed by Roy F. Weston, Inc. (1992, 1994) indicate the lithology of the Tarawa Terrace aquifer in the northern part of Tarawa Terrace and vicinity is a fine-grained, gray silty sand containing thin beds and lenses of frequently sandy silt and clay. In the southern part of Tarawa Terrace, the aquifer is a mix of tan, gray and white-colored, well-sorted, medium-grained sand, reportedly of "moderately high permeability" (borehole logs completed by Richard Catlin & Associates, Inc. 1995a). At Montford Point, in the vicinity of well M-267 and borehole T-12, the Tarawa Terrace aquifer is a fine- to medium-grained tan or gray silty sand, possibly also containing thin lenses or beds of clay. Similar lithologies occur in the vicinity of Brewster Boulevard where the Tarawa Terrace aquifer is composed of a fine white sand at wells HP-699 and HP-704. Southeast of Brewster Boulevard the Tarawa Terrace aquifer is composed of light gray to white medium-grained, fossiliferous sand (borehole T-7). At borehole T-1, near the southeastern limit of the study area, lithology at the top of the aquifer is shell limestone that grades with depth into a fine- to medium-grained sand.

Northeast Creek and New River in the vicinity of Tarawa Terrace and Montford Point are incised into the upper part of the Tarawa Terrace aquifer. Consequently, contours shown on Figure B9 that cross these streams and their larger tributaries in these areas represent relict rather than contemporary structure. The downstream channel of Wallace Creek also may be incised within the uppermost part of the Tarawa Terrace aquifer and contours shown at the top of the aquifer in this area also may represent relict rather than modern conditions.

The Tarawa Terrace aquifer as defined herein is equivalent to the uppermost part of the "surficial aquifer" described by Roy F. Weston, Inc. (1992, 1994) during investigations of groundwater contamination at ABC One-Hour Cleaners north and west of Tarawa Terrace. Similarly, the "surficial aquifer" described by Law Engineering, Inc. (1994a, b, 1995a, b), Richard Catlin & Associates, Inc. (1995a), and other investigations of groundwater in the vicinity of underground fuel storage tanks at Tarawa Terrace corresponds largely to the Upper Castle Hayne aquifer–River Bend unit and the lowermost part of the Tarawa Terrace aquifer of this study.

Thickness of the Tarawa Terrace aquifer is least, about 11 ft, in the immediate vicinity of Tarawa Terrace and near Brewster Boulevard and Paradise Point (Figure B10). Thickness generally increases from the northern part of Tarawa Terrace to the west and southeast to a maximum of about 50 ft near the intersection of SR 24 and the unnamed road that extends east of Brewster Boulevard. Thickness increases rapidly from about 12 to 30 ft westward between Tarawa Terrace and Montford Point and from 20 to about 50 ft southeast of Northeast Creek.

Table B5. Altitude at the top of the Tarawa Terrace aquifer, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.

[NGVD 29, National Geodetic Vertical Datum of 1929; –, below NGVD 29]

Site name[1]	Location coordinates[2]		Unit altitude, in feet above or below NGVD 29
	East	North	
HP-611 (old)	2495393	350856	–9
HP-612 (old)	2497144	352386	–6
HP-613	2499335	352969	–11
HP-621 (new)	2505510	354290	–14
HP-629 (new)	2504800	355152	–10
HP-641	2504106	353016	–18
HP-643	2494346	356083	1
HP-645	2497333	356430	3
HP-646	2497870	357826	2
HP-648	2506809	355200	–3
HP-649	2508630	354860	–9
HP-650	2510615	354300	–9
HP-651	2503790	348090	–29
HP-663	2510881	352712	–22
HP-698	2492410	355870	1
HP-699	2490430	355560	1
HP-700	2488520	355270	–6
HP-701	2487690	353540	–10
HP-703	2496450	358140	6
HP-706	2502990	355940	–2
HP-708	2514450	353090	–29
HP-709	2505650	351270	–14
HP-711	2509200	352130	–22
LCH-4006	2499585	358589	0
M-244	2475713	361306	20
M-267	2476609	359232	17
M-628	2479434	362735	14
ON-T2-87	2487495	353878	–3
S190A	2487640	353870	–4
T-1	2507870	355030	–15
T-7	2500628	349685	–18
T-9	2490489	364648	29
T-10	2487680	364960	25
T-11	2485278	365352	23
T-12	2476550	355830	6
T-13	2481170	363930	22
T-14	2476788	364170	25
TT-25	2491984	364042	19
TT-52	2489060	362321	25

[1]See Plate 1 for location

[2]Location coordinates are North Carolina State Plane coordinates, North American Datum of 1983

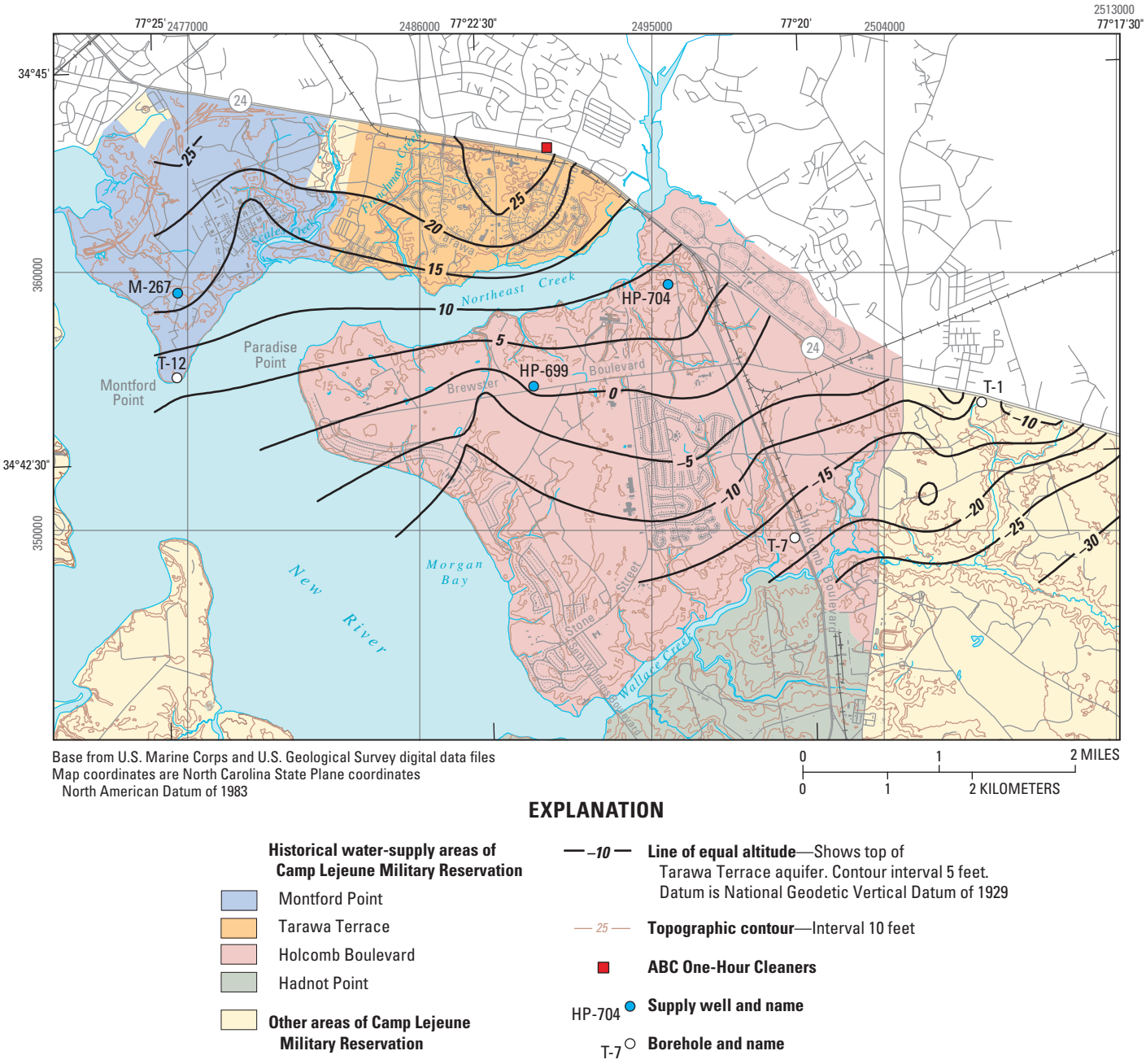


Figure B9. Altitude at the top of the Tarawa Terrace aquifer, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.

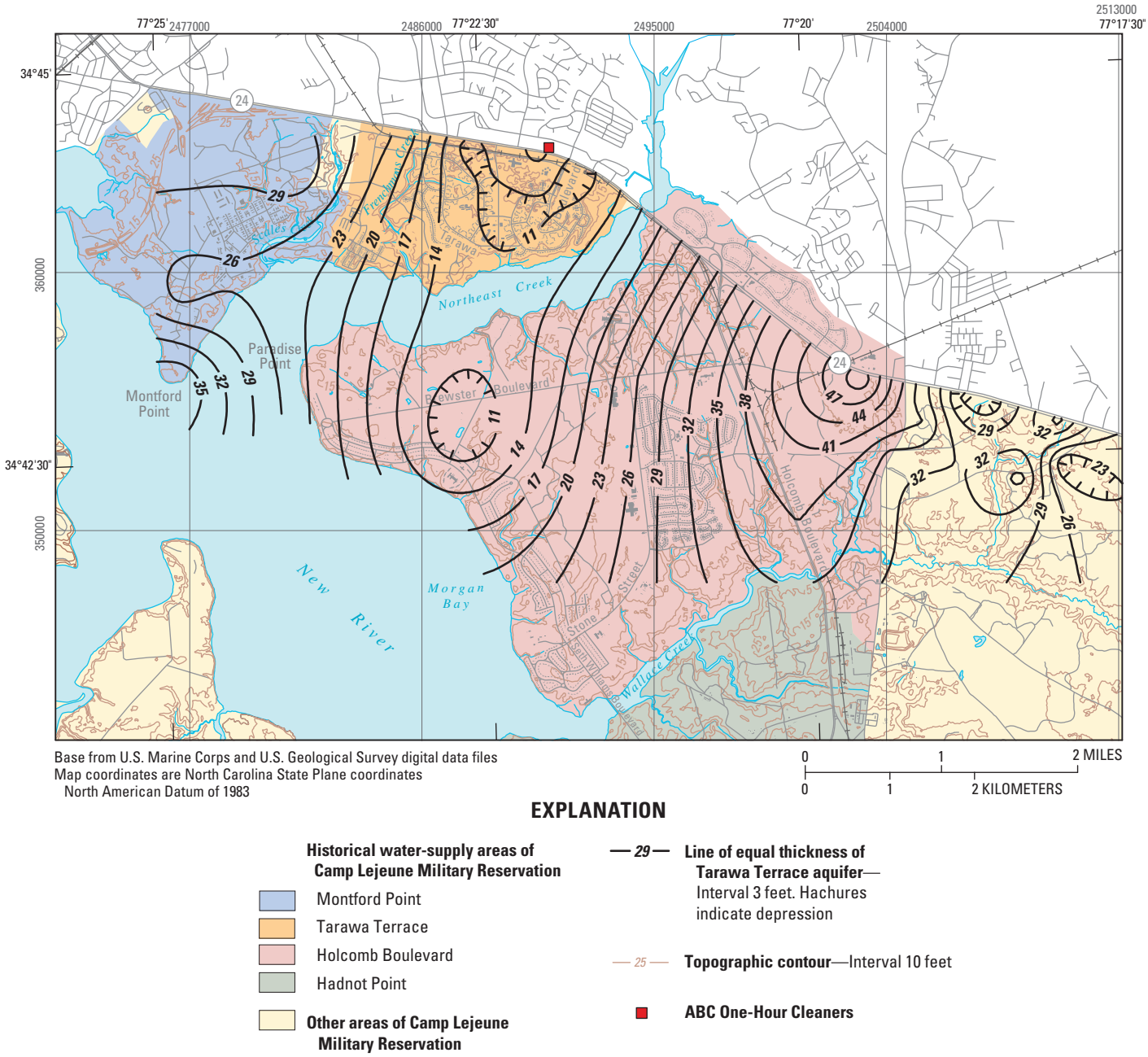


Figure B10. Thickness of the Tarawa Terrace aquifer, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.

Tarawa Terrace Confining Unit

The Tarawa Terrace confining unit in the vicinity of Tarawa Terrace and Montford Point is comprised of a tan to gray, medium-grained, sandy and silty clay (well M-267). Southeast of Tarawa Terrace and Montford Point, the Tarawa Terrace confining unit is largely undifferentiated in drillers' logs. Based on electric-log signatures and highly generalized descriptions at wells HP-607, HP-623, HP-663, and HP-705, the confining unit is characterized by white, green to blue clay and sandy clay. Altitude at the top of the Tarawa Terrace confining unit varies between a maximum of about 10 ft (Table B6) in the northern part of Tarawa Terrace to a minimum of about –55 ft north of Wallace Creek in the southeastern part of the study area (Table B6, Figure B11). Altitude decreases rapidly to the southeast and southwest across Tarawa Terrace to about –5 ft in the vicinity of Northeast Creek and relatively uniformly and less rapidly from about –10 ft to a minimum of about –55 ft north of Wallace Creek.

Confining unit thickness varies between about 10 ft at Tarawa Terrace and Montford Point to more than 35 ft in the southeastern part of the study area near the headwaters of Wallace Creeks (Figure B12). Patterns of thickness are somewhat irregular but generally trend lesser to greater northwest to southeast.

Table B6. Altitude at the top of the Tarawa Terrace confining unit, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.

[NGVD 29, National Geodetic Vertical Datum of 1929; –, below NGVD 29]

Site name[1]	Location coordinates[2]		Unit altitude, in feet above or below NGVD 29
	East	North	
C3	2491433	364437	23
C9	2491730	364800	18
CCC-1	2483873	360997	4
HP-607 (new)	2496820	352510	–31
HP-614 (new)	2512180	353670	–44
HP-619 (new)	2515870	352640	–46
HP-621 (new)	2505510	354290	–52
HP-622	2494248	353323	–44
HP-623	2495617	350860	–51
HP-629 (new)	2504800	355152	–49
HP-641	2504106	353016	–52
HP-643	2494346	356083	–25
HP-645	2497333	356430	–31
HP-646	2497870	357826	–32
HP-647	2499461	356343	–42
HP-648	2506809	355200	–29
HP-649	2508630	354860	–36
HP-650	2510615	354300	–45
HP-651	2503790	348090	–61
HP-663	2510881	352712	–42
HP-701	2487690	353540	–19
HP-703	2496450	358140	–26
HP-704	2495650	359580	–34
HP-705	2501260	356200	–48
HP-706	2502990	355940	–54
HP-708	2514450	353090	–53
HP-709	2505650	351270	–44
HP-711	2509200	352130	–58
LCH-4009	2499585	358589	–38
M-244	2475713	361306	–7
M-267	2476609	359232	–8
M-628	2479434	362735	–14
ON-T2-87	2487495	353878	–11
PZ-05&06	2490707	364926	17
S2	2490787	364883	16
S5	2491244	364081	20
S6	2490617	364938	11
S8	2491312	364938	15
S9	2491682	364593	19
S190A	2487640	353870	–12
T-1	2507870	355030	–39
T-7	2500628	349685	–56
T-9	2490489	364648	14
T-10	2487680	364960	15
T-11	2485278	365352	1
T-12	2476550	355830	–32
T-13	2481170	363930	–9
T-14	2476788	364170	–5
TT-25	2491984	364042	10
TT-52	2489060	362321	17

[1]See Plate 1 for location

[2]Location coordinates are North Carolina State Plane coordinates, North American Datum of 1983

Boring logs in the vicinity of ABC One-Hour Cleaners and northern Tarawa Terrace indicate that confining unit occurrence is possibly lensoidal and somewhat to largely discontinuous. The confining unit is thin and possibly entirely missing in the southern part of Tarawa Terrace near Tarawa Boulevard.

Comparison of altitudes at the top of the Tarawa Terrace confining unit to altitudes reported by Cardinell et al. (1993, Table 3, Sections A–A' and B–B') at the top of the "Castle Hayne confining unit" at Tarawa Terrace indicate substantial agreement at borehole sites T-9, T-10, and T-11 and at well TT-25. Poor agreement occurs at Montford Point and, with the exception of a small area in the vicinity of well HP-701, little or no correlation occurs between the Tarawa Terrace confining unit and the "Castle Hayne confining unit" in the remainder of the study area south and southeast of Northeast Creek. The "Castle Hayne confining unit" of Cardinell et al. (1993) typically occurs above the Tarawa Terrace confining unit in these areas.

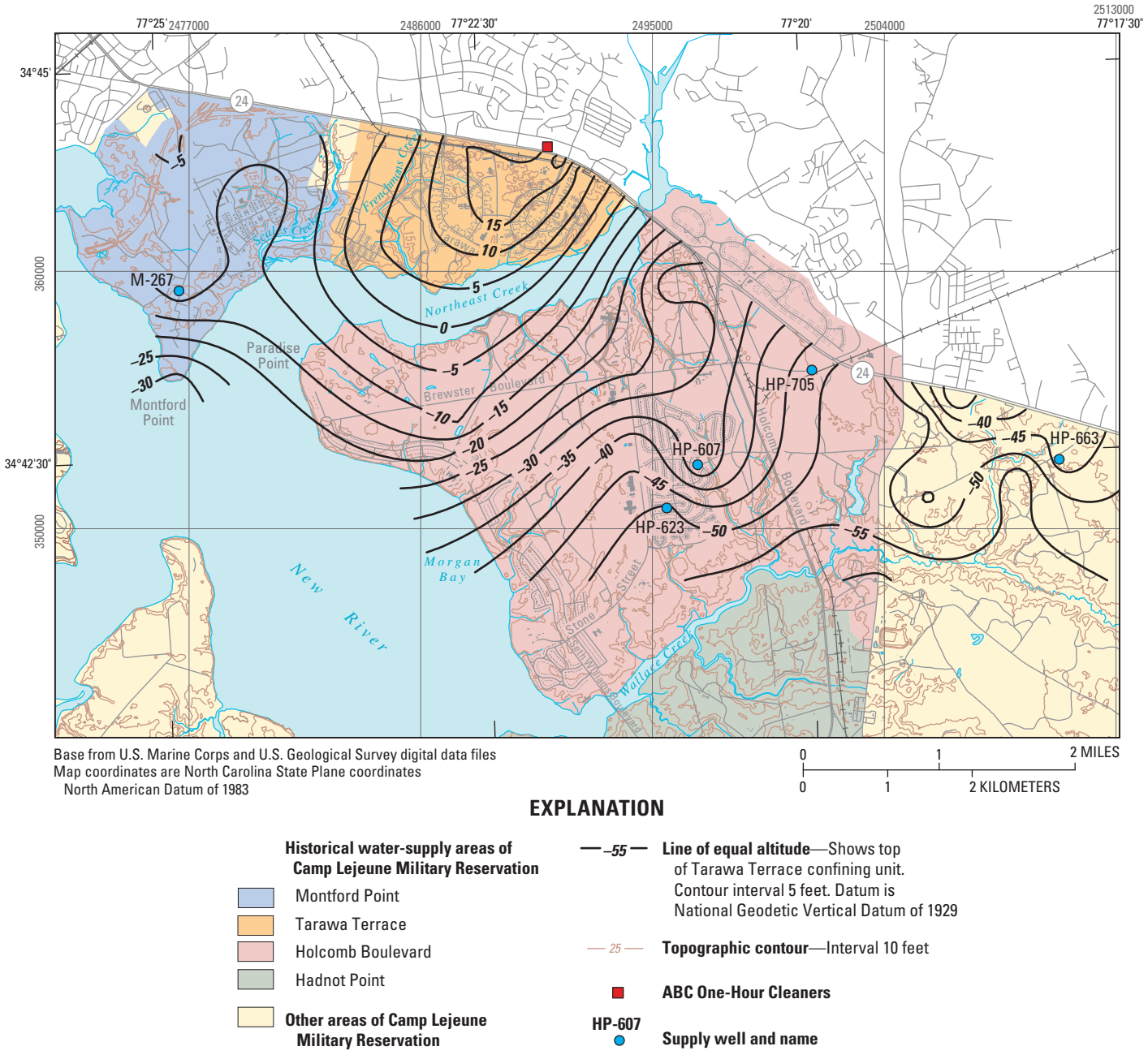
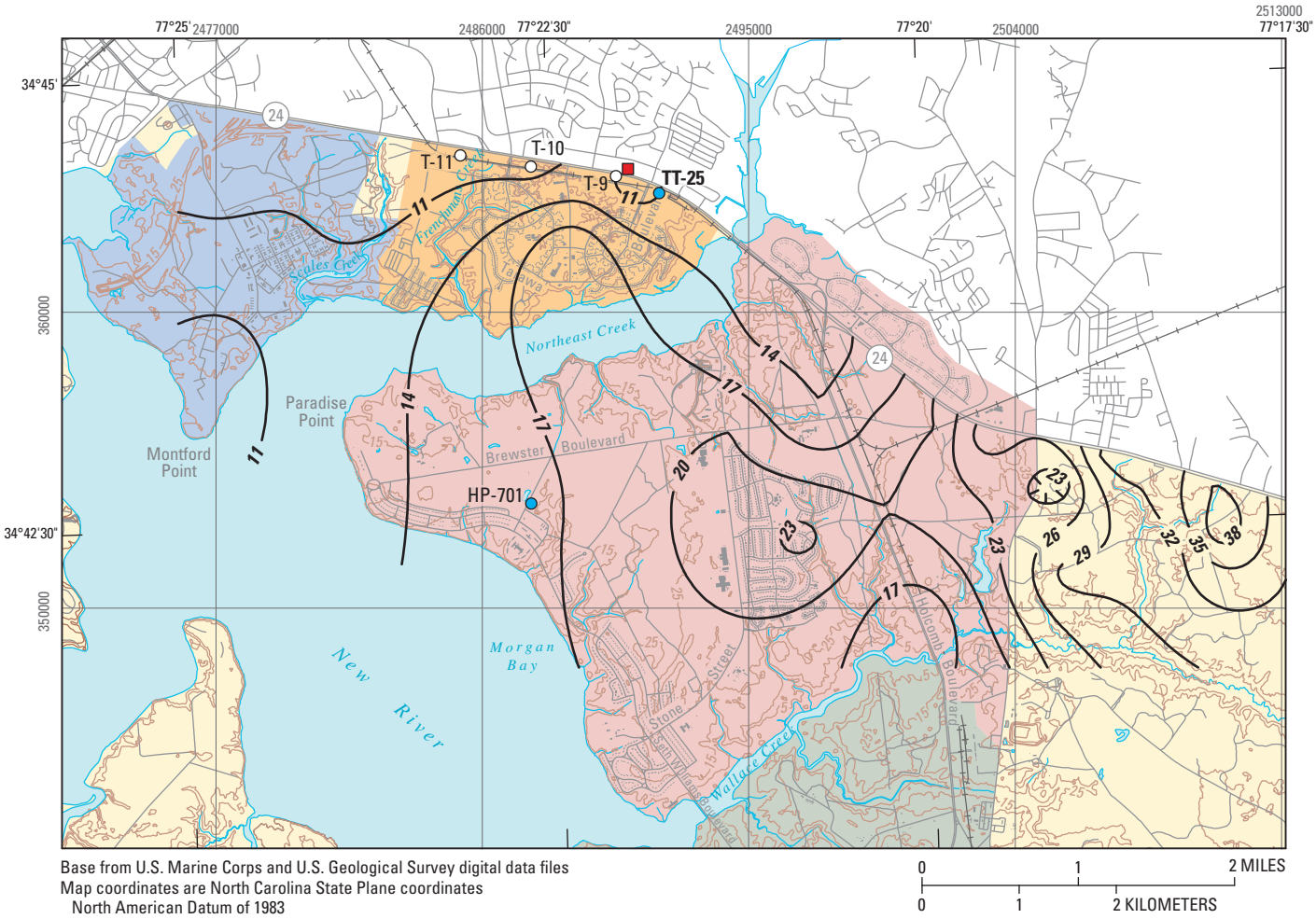


Figure B11. Altitude at the top of the Tarawa Terrace confining unit, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.



EXPLANATION

Historical water-supply areas of Camp Lejeune Military Reservation

- Montford Point
- Tarawa Terrace
- Holcomb Boulevard
- Hadnot Point

Other areas of Camp Lejeune Military Reservation

— 17 — **Line of equal thickness of Tarawa Terrace confining unit**—Interval 3 feet. Hachures indicate depression

— 25 — **Topographic contour**—Interval 10 feet

ABC One-Hour Cleaners

HP-701 **Supply well and name**

T-11 **Borehole and name**

Figure B12. Thickness of the Tarawa Terrace confining unit, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.

Upper Castle Hayne Aquifer–River Bend Unit

Contours at the top of the River Bend unit of the Upper Castle Hayne aquifer represent, as well, the top of the Castle Hayne aquifer system as defined by this study. The surface of the Upper Castle Hayne aquifer–River Bend unit varies from a maximum altitude of about 5 ft north of Tarawa Terrace to a minimum altitude of about –80 ft near the southeastern limit of the study area (Table B7, Figure B13). Altitude appears to dip uniformly from the vicinity of Tarawa Terrace to the southeast, beginning with a relatively rapid decline across Tarawa Terrace to Northeast Creek and continuing at a smaller rate of decline toward Wallace Creek. The surface declines less uniformly to the southwest between Tarawa Terrace and Paradise Point. In the northern part and northwest of Tarawa Terrace, the River Bend unit of the Upper Castle Hayne aquifer consists of well-graded, very fine- to coarse-grained, gray, silty sand. Borehole logs in this area frequently indicate "running" or "flowing" sands at depths ranging from about 20 to 30 ft below ground surface and, typically, immediately beneath a zone of clay or silty sand (Roy F. Weston, Inc. 1992, 1994; O'Brien & Gere Engineers, Inc. 1992; O'Brien & Gere Engineers, Inc. 1993).

Table B7. Altitude at the top of the Upper Castle Hayne aquifer–River Bend unit, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.

[NGVD 29, National Geodetic Vertical Datum of 1929; –, below NGVD 29]

Site name[1]	Location coordinates[2]		Unit altitude, in feet above or below NGVD 29
	East	North	
C3	2491433	364437	8
C9	2491730	364800	6
HP-607 (new)	2496820	352510	–55
HP-614 (new)	2512180	353670	–80
HP-619 (new)	2515870	352640	–75
HP-621 (new)	2505510	354290	–73
HP-622	2494248	353323	–55
HP-623	2495617	350860	–64
HP-627 (new)	2508310	354030	–80
HP-629 (new)	2504800	355152	–73
HP-641	2504106	353016	–76
HP-643	2494346	356083	–45
HP-645	2497333	356430	–45
HP-646	2497870	357826	–46
HP-647	2499461	356343	–60
HP-648	2506809	355200	–61
HP-649	2508630	354860	–68
HP-650	2510615	354300	–83
HP-651	2503790	348090	–81
HP-663	2510881	352712	–82
HP-700	2488520	355270	–40
HP-701	2487690	353540	–31
HP-703	2496450	358140	–48
HP-704	2495650	359580	–47
HP-705	2501260	356200	–68
HP-706	2502990	355940	–82
HP-708	2514450	353090	–81
HP-709	2505650	351270	–74
HP-711	2509200	352130	–88
LCH-4009	2499585	358589	–53
M-244	2475713	361306	–20
M-267	2476609	359232	–18
M-628	2479434	362735	–26
ON-T2-87	2487495	353878	–27
PZ-01&02	2490677	364860	0
PZ-05&06	2490707	364926	6
S2	2490787	364883	8
S5	2491244	364081	10
S8	2491312	364938	6
S9	2491682	364593	9
S190A	2487640	353870	–28
STT61to66-MW04	2489186	364740	–1
STT61to66-MW06	2489276	364816	3
STT61to66-MW08	2489219	364885	7
STT61to66-MW10	2489102	364732	1
STT61to66-MW12	2489241	364700	8
STT61to66-MW16	2489247	364603	2
STT61to66-MW20	2489135	364554	2
T-1	2507870	355030	–73
T-7	2500628	349685	–70
T-9	2490489	364648	3
T-10	2487680	364960	5
T-11	2485278	365352	–9
T-12	2476550	355830	–42
T-13	2481170	363930	–18
T-14	2476788	364170	–15
TT-52	2489060	362321	–3

[1]See Plate 1 for location

[2]Location coordinates are North Carolina State Plane coordinates, North American Datum of 1983

The depth at which the "running" sands were reported was selected for this study as the top of the Upper Castle Hayne aquifer–River Bend unit. The zone of clay and silty sand immediately above the "running" sands was identified as the Tarawa Terrace confining unit. In the eastern part of Tarawa Terrace in the vicinity of well TT-25, the River Bend unit consists of gray, fine- to medium-grained, fossiliferous sand and "shell hash" or possibly coquina. The driller reports a loss of circulation at this site between 61 and 70 ft. At Montford Point and vicinity, the River Bend unit consists of fossiliferous, gray, silty sand, zones of which are possibly cemented or indurated. Locally, the sand may be interbedded with shell limestone and thin lenses or beds of clay. At the base of the unit, in the vicinity of well M-267, is likely a zone of cavernous limestone. The driller reported a complete loss of drilling fluid between 54 and 58 ft below ground surface at this site. Southeast of Northeast Creek, the River Bend unit is poorly differentiated at most sites and is typically described as consisting of "limestone and sand" or "sand, clay and limestone." At borehole T-1, near the southeastern limit of the study area, the River Bend unit

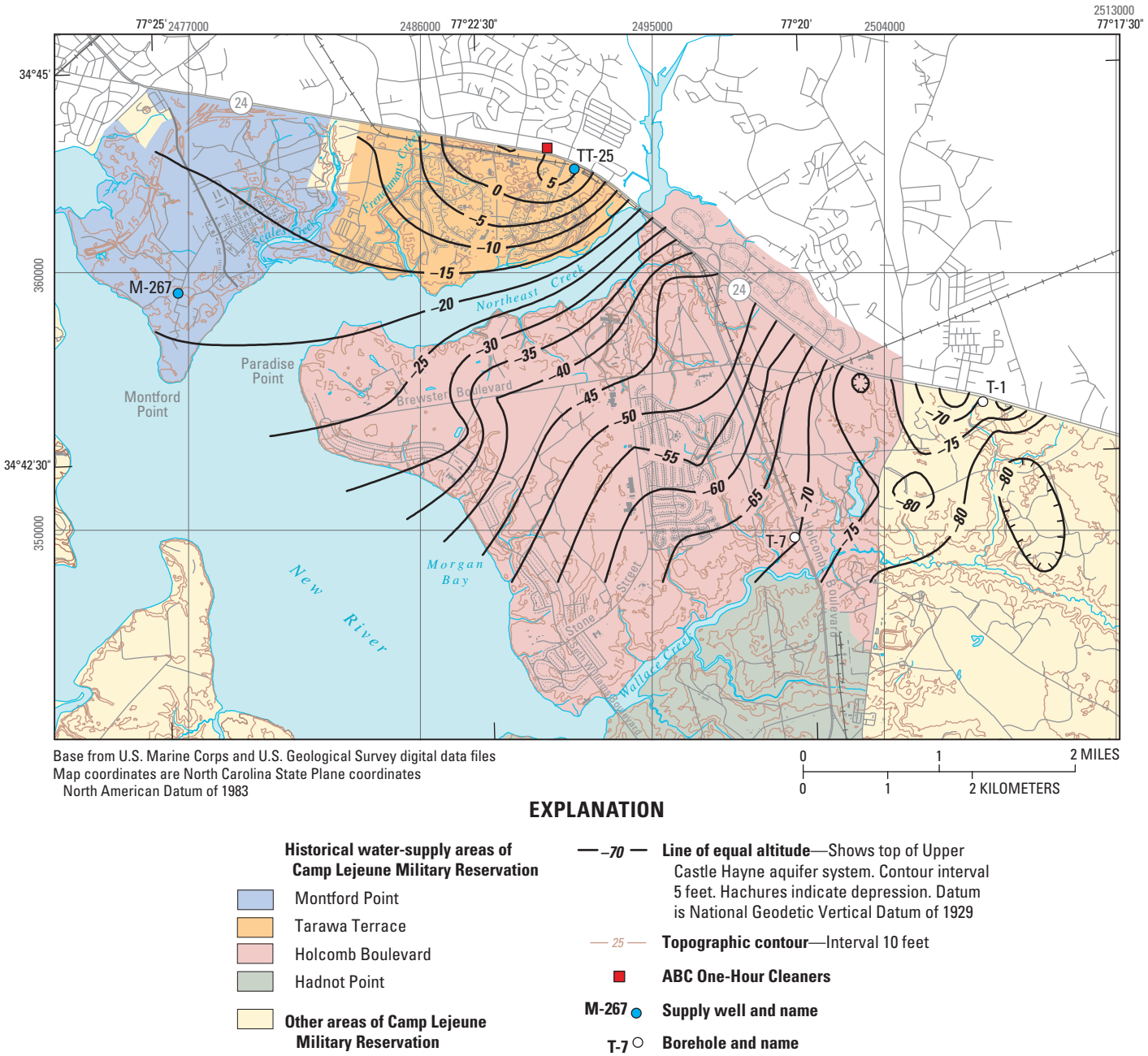


Figure B13. Altitude at the top of the Castle Hayne aquifer system. Corresponds to the top of the Upper Castle Hayne aquifer–River Bend unit, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.

reportedly consists of "shellrock and sand" and traces of clay. Similarly, at borehole T-7 south of Brewster Boulevard and just north of Wallace Creek, the River Bend unit is described in the driller's log as a medium-grained, gray sand with "streaks" and zones of "shellrock."

Thickness of the River Bend unit varies from a minimum of less than 20 ft northwest of Montford Point to a maximum of about 59 ft, south of Brewster Boulevard in the vicinity of Paradise Point (Figure B14). Thickness contours are somewhat to highly irregular, particularly near the southeastern limit of the study area. Thickness varies substantially across relatively short distances in the vicinity of Paradise Point and north of Wallace Creek in the vicinity of SR 24. The Upper Castle Hayne aquifer–River Bend unit of this study is largely equivalent to the "surficial aquifer" cited in reports of various remedial investigations of leaking underground storage tanks and studies of groundwater contamination at and in the vicinity of Tarawa Terrace (Roy F. Weston, Inc. (1992, 1994); Law Engineering, Inc. (1994a, b, 1995a, b); Richard Catlin & Associates, Inc. (1995a).

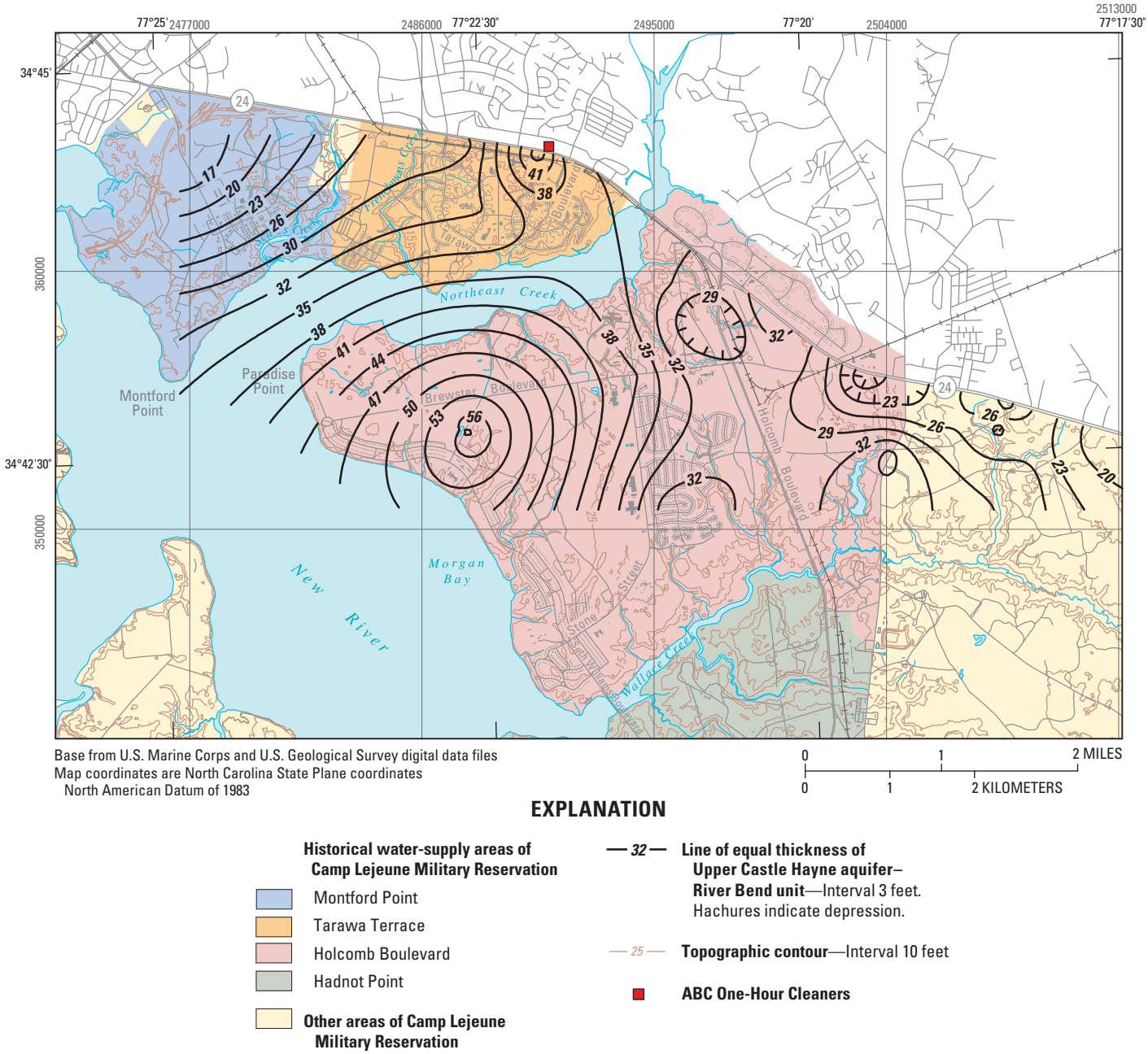


Figure B14. Thickness of the Upper Castle Hayne aquifer–River Bend unit, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.

Local Confining Unit

The Local confining unit separates the River Bend and Lower units of the Upper Castle Hayne aquifer. As discussed previously, the top of the Local confining unit also conforms approximately to the top of the Castle Hayne Formation. Maximum altitude of the Local confining unit surface occurs northwest of Tarawa Terrace at about –30 ft. Minimum altitude is about –110 ft and occurs in the southeastern part of the study area north of the headwaters of Wallace Creek (Table B8, Figure B15). The top of the Local confining unit generally declines uniformly to the southeast; however, a slight rise occurs in the surface east of Brewster Boulevard near Holcomb Boulevard. Such irregularities are not pronounced and generally equal 10 ft or less.

Local confining unit thickness varies from about 6 to 18 ft. In the vicinity of Tarawa Terrace and Montford Point, thickness increases from east to west and from west to east toward an approximately circular center of thickness of about 18 ft west of Tarawa Terrace (Figure B16). South of Northeast

Table B8. Altitude at the top of the Local confining unit, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.

[NGVD 29, National Geodetic Vertical Datum of 1929]

Site name[1]	Location coordinates[2]		Unit altitude, in feet below NGVD 29
	East	North	
C2	2490793	364902	–28
C5	2491233	364107	–20
C9	2491730	364800	–29
C11	2492130	362300	–56
HP-614 (new)	2512180	353670	–98
HP-619 (new)	2515870	352640	–94
HP-621 (new)	2505510	354290	–98
HP-622	2494248	353323	–91
HP-623	2495617	350860	–91
HP-627 (new)	2508310	354030	–102
HP-629 (new)	2504800	355152	–95
HP-641	2504106	353016	–112
HP-643	2494346	356083	–83
HP-645	2497333	356430	–75
HP-646	2497870	357826	–72
HP-647	2499461	356343	–90
HP-648	2506809	355200	–87
HP-649	2508630	354860	–98
HP-650	2510615	354300	Missing
HP-651	2503790	348090	Missing
HP-663	2510881	352712	–104
HP-698	2492410	355870	–69
HP-699	2490430	355560	–73
HP-700	2488520	355270	Missing
HP-701	2487690	353540	Missing
HP-703	2496450	358140	–74
HP-704	2495650	359580	–79
HP-705	2501260	356200	–96
HP-706	2502990	355940	–100
HP-708	2514450	353090	–99
HP-709	2505650	351270	Missing
HP-710	2507770	351490	Missing
HP-711	2509200	352130	–116
LCH-4009	2499585	358589	–89
M-161	2477550	362560	–34
M-168	2477602	362723	–34
M-197	2477626	361621	–43
M-267	2476609	359232	–47
M-628	2479434	362735	–42
ON-T2-87	2487495	353878	–83
S190A	2487640	353870	–88
T-1	2507870	355030	–101
T-7	2500628	349685	Missing
T-9	2490489	364648	–43
T-10	2487680	364960	–23
T-11	2485278	365352	–37
T-12	2476550	355830	–72
T-13	2481170	363930	–42
T-14	2476788	364170	–29
TT-23	2491024	363208	–39
TT-25	2491984	364042	–44
TT-52	2489060	362321	–35
TT-67	2490160	362730	–32
X24C2	2490640	363540	–30

[1]See Plate 1 for location

[2]Location coordinates are North Carolina State Plane coordinates, North American Datum of 1983

Creek in the vicinity of Brewster Boulevard, thickness increases from west to east and from east to west toward a relatively large thickness of about 18 ft near Brewster Boulevard in the vicinity of well HP-643.

At borehole T-13, north of Montford Point, the Local confining unit is described as a "clay medium hard," between 77 and 82 ft. A similar lithology possibly occurs at well HP-649, near the southeastern margin of the study area and adjacent to SR 24, where the Local confining unit is identified in the driller's log as "clay" between 140 and 150 ft below ground surface. Fine-grained materials such as clays are typically suspended in drilling mud during borehole drilling and frequently are indistinguishable from the drilling mud. Consequently, the Local confining unit is undifferentiated in borehole and drillers' logs throughout most of the study area. An exception occurs north of Tarawa Terrace in the vicinity of SR 24 where borehole logs collected by Roy F. Weston, Inc. (1992, 1994) refer to a "silty fine sand" or "lean clay" at depths

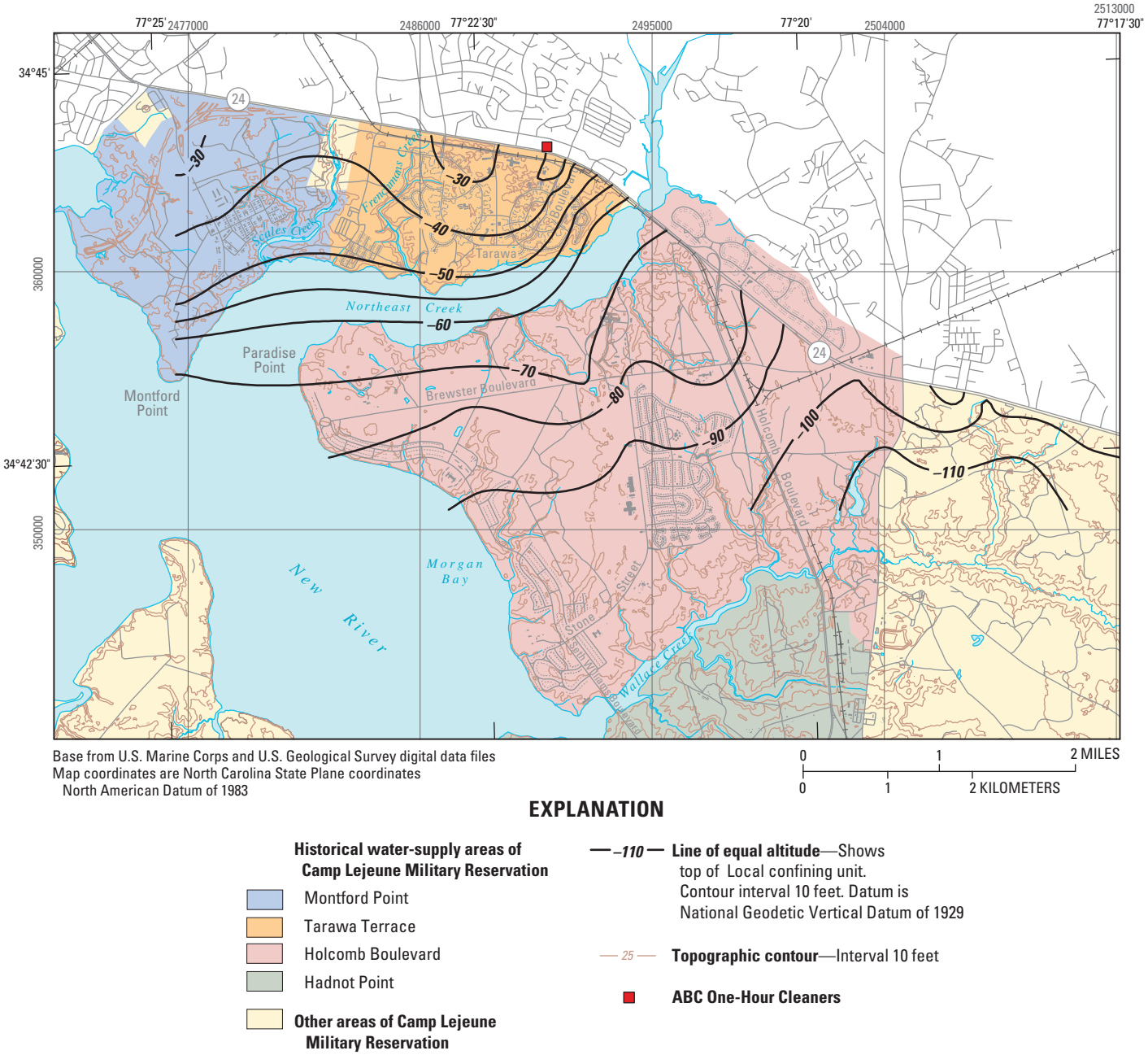


Figure B15. Altitude at the top of the Local confining unit. Approximates the lithostratigraphic top of the Castle Hayne Formation, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.

ranging from about 50 to 60 ft. Thickness of the silty sand or clay varied from 3 to about 10 ft and typically was about 10 ft. Underlying the clay or silty sand were fossiliferous, calcareous sands identified by Roy F. Weston, Inc. (1992, 1994) as the Castle Hayne Formation. Findings of this study conform to these interpretations, and the silty sand is identified herein as the Local confining unit in that area. Harned et al. (1989) in their Section B–B' recognized a zone of low resistivity, designated herein the Local confining unit, in the electric log of well HP-643 between 100 and 110 ft, and correlated this unit continuously eastward for about 3 miles to the site of borehole T-1 (Figure B3). The Local confining unit is locally thin or absent in the vicinity of wells HP-641, HP-650, HP-651, HP-709, and HP-710 and borehole T-7. These local anomalies are not considered areally extensive and are not represented on Figures B15 and B16.

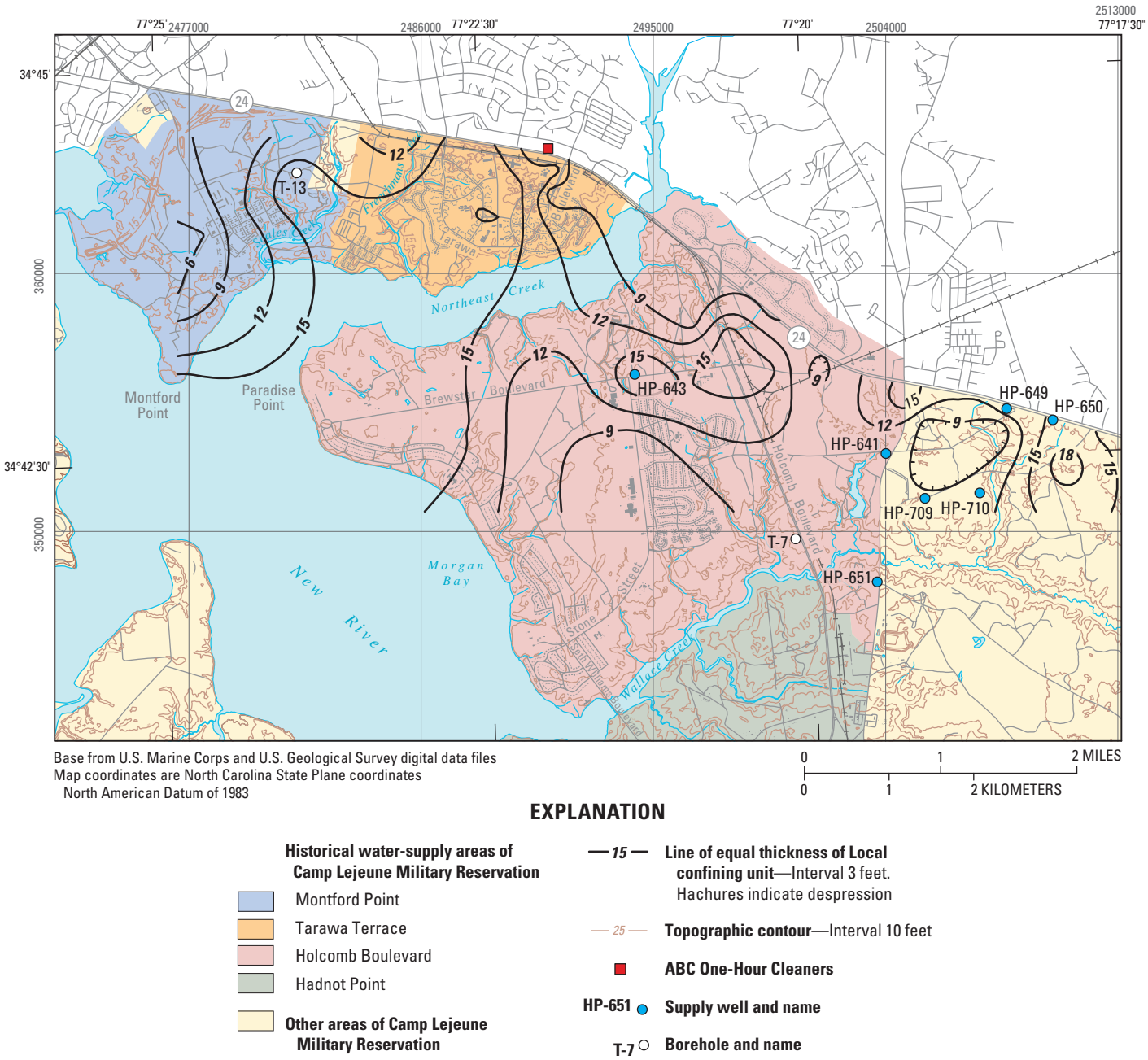


Figure B16. Thickness of the Local confining unit, Tarawa Terrace and vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina.