Prepared in cooperation with the Southern Nevada Water Authority
and the Bureau of Reclamation

Physical and Chemical Water-Quality Data from Automatic Profiling Systems, Boulder Basin, Lake Mead, Arizona and Nevada, Water Years 2001–04

Open-File Report 2006-1284

U.S. Department of the Interior
U.S. Geological Survey

Cover. U.S. Geological Survey Automatic Profiling System near Sentinel Island, Boulder Basin, Lake Mead, Arizona and Nevada, August 2004. Photograph by Ryan C. Rowland.

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Conversion Factors and Datums

Multiply	By	To obtain
	Length	
meter (m)	3.281	foot (ft)
	Volume	
cubic meter (m^3)	264.2	gallon (gal)
cubic meter (m^3)	0.0002642	million gallons (Mgal)
cubic meter (m^3)	0.0008107	acre-foot (acre-ft)
liter (L)	0.2642	gallon (gal)
liter (L)	61.02	cubic inch (in^3)
	Flow rate	
cubic meter per second (m^3/s)	70.04	acre-foot per day (acre-ft/d)
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
cubic meter per second (m^3/s)	22.83	million gallons per day (Mgal/d)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8×°C)+32

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C=(°F-32)/1.8

Vertical coordinate information is referenced to the U.S. Geological Survey datum, adjustment of 1912, locally known as “Power House Datum.” Add 0.17 meter to convert to datum of 1929, leveling of 1935. Add 0.13 meter to convert to datum of 1929, leveling of 1940. Add 0.12 meter to convert to datum of 1929, leveling of 1948. Add 0.01 meter to convert to datum of 1929, leveling of 1963. No elevations have been converted to datum of 1929. Datum of 1929 is known as National Geodetic Vertical Datum of 1929 (NVGD of 1929) and was formerly called “Sea-Level Datum of 1929.”

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

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Physical and Chemical Water-Quality Data from Automatic Profiling Systems, Boulder Basin, Lake Mead, Arizona and Nevada, Water Years 2001–04

By Ryan C. Rowland, Craig L. Westenburg, Ronald J. Veley, and Walter E. Nylund

Abstract

Water-quality profile data were collected in Las Vegas Bay and near Sentinel Island in Lake Mead, Arizona and Nevada, from October 2000 to September 2004. The majority of the profiles were completed with automatic variable-buoyancy systems equipped with multiparameter water-quality sondes. Profile data near Sentinel Island were collected in August 2004 with an automatic variable-depth-winch system also equipped with a multiparameter water-quality sonde. Physical and chemical water properties collected and recorded by the profiling systems, including depth, water temperature, specific conductance, pH, dissolved-oxygen concentration, and turbidity are listed in tables and selected water-quality profile data are shown in graphs.

Introduction

Lake Mead is a reservoir on the Colorado River formed by the completion of Hoover Dam in 1936 and is on the boundary of Arizona and Nevada (fig. 1). The reservoir is comprised of four large basins (Gregg, Temple, Virgin, and Boulder) that trend east-west, several narrow canyons, and one relatively large north-south canyon (Overton Arm) created by the Muddy and Virgin Rivers, which are tributaries of the Colorado River. Lake Mead is the largest capacity reservoir (storage capacity at 372.3 m is 35,200,444,061 m^3 of water, *http://www.usbr.gov/lc/hooverdam/faqs/lakefaqs.html*) in the United States. Lake Mead provides recreational watercraft activities and drinking water to southern Nevada. The Colorado River downstream of Lake Mead provides drinking, industrial, and irrigation water for over 22 million people throughout areas in Arizona and California.

The Colorado River provides an estimated 97 percent of the inflow to Lake Mead (fig. 1). About 3 percent of the inflow is from the Muddy and Virgin Rivers on the northern side of the lake and from Las Vegas Wash on the western side of the lake (fig. 1). Las Vegas Wash carries treated municipal wastewater, stormwater and urban runoff, and ground-water seepage from the Las Vegas Valley to Las Vegas Bay of Boulder Basin in Lake Mead (Boyd and Furlong, 2002; LaBounty and Horn, 1997; Bevans and others, 1996). Urban development in Las Vegas Valley has resulted in increased streamflow into Las Vegas Wash. The average daily streamflow in Las Vegas Wash increased 33 percent, from 5.1 m^3/s in 1992 to 7.6 m^3/s in 2004 (Hess and others, 1993; Bonner and others, 2004).

The need to reduce the potential for deterioration of water quality in Las Vegas Wash and Lake Mead has been recognized by local municipal agencies and private organizations. For example, the Southern Nevada Water Authority (SNWA) Board of Directors approved in January 2000 the Las Vegas Wash Comprehensive Adaptive Management Plan (LVWCAMP) that addresses specific environmental issues associated with Las Vegas Wash. These issues include water quality, long-term enhancement and management, and public outreach. Three important components of the LVWCAMP are (1) the establishment of wetlands along Las Vegas Wash and in Las Vegas Bay, (2) environmental monitoring, and (3) timely dissemination to the public of data collected through various monitoring programs. To assist in the environmental monitoring and data dissemination components of the LVWCAMP, the U.S. Geological Survey (USGS), in cooperation with the SNWA and the Bureau of Reclamation, installed two water-quality monitoring stations on Lake Mead equipped with automatic profiling systems. The USGS water-quality monitoring stations were in Boulder Basin: one downgradient of the Las Vegas Wash in Las Vegas Bay and the other near Sentinel Island (fig. 1). The Las Vegas Bay station has been in operation since October 2000. The Sentinel Island station has been in operation since January 2002. Data collected at the sites included depth, water temperature, specific conductance, pH, dissolved-oxygen concentration, and turbidity.

The automatic profiling systems provide many advantages over manual, instantaneous measurements. These advantages include (1) a continuous record of long-term and transient changes in physical and chemical properties in profiles, (2) detection of changes in physical and chemical properties in profiles related to storm events at tributary inflow sites by remotely initiating unscheduled profiles during storm events, and (3) the ability to access profile data in near real time.

The objectives of the water-quality monitoring program are to (1) collect near continuous, depth-dependent water-quality data at two floating platforms, (2) report data on the internet in near real time <*http://nevada.usgs.gov/lmqw/index.htm*>, and (3) document vertical and temporal changes in the water column at each station in a USGS report.

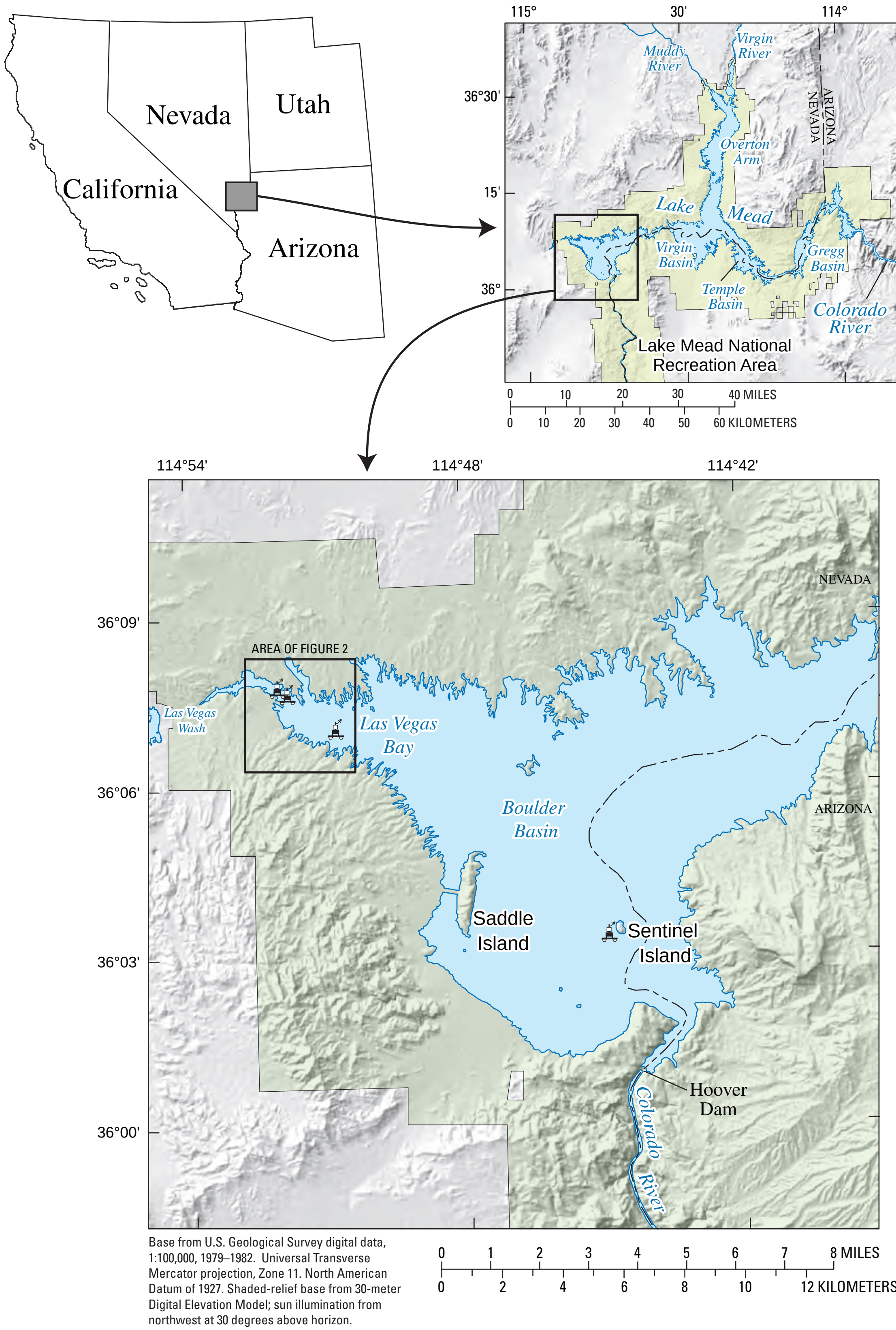


Figure 1. Profiling system locations in Las Vegas Bay and near Sentinel Island, Boulder Basin, Lake Mead, Arizona and Nevada.

Purpose and Scope

This report presents data of chemical and physical water properties collected by two automatic profiling systems on Lake Mead during water years 2001–04 (table 1). A water year is the 12-month period from October 1 through September 30 and is designated by the calendar year in which it ends. One automatic profiling system was in Las Vegas Bay and the second was near Sentinel Island (fig. 1). Both sites are within the Boulder Basin of Lake Mead. The Las Vegas Bay system was moved two times (fig. 2) due to decreasing lake levels during the period of data collection (fig. 3).

Equipment

The water-quality monitoring stations were equipped with automatic profiling systems introduced in 2000. The profiling equipment, manufactured by Apprise Technologies, consisted of a variable-buoyancy-leveling device that transports a multiparameter water-quality sonde to user-defined measurement depths at user-defined time intervals (fig. 4). The manufacturer of the variable-buoyancy profiling system suspended the product line and customer support in March 2004. At that time, the USGS decided to cease attempts to redeploy the variable-buoyancy system following a major system failure

Table 1. Location and period of operation for the Las Vegas Bay and Sentinel Island water-quality profiling systems.

[Abbreviation: QW, water quality. Latitude and longitude are in degrees, minutes, and seconds]

Station name	Location		Period of operation
	Latitude	Longitude	
Las Vegas Bay QW Platform site 1	36°07'43"	114°51'59"	October 1, 2000–July 9, 2001
Las Vegas Bay QW Platform site 2	36°07'40"	114°51'51"	September 6, 2001–June 19, 2002
Las Vegas Bay QW Platform site 3	36°07'00"	114°50'51"	April 4, 2003–September 30, 2004
Sentinel Island QW Platform	36°03'14"	114°45'05"	January 24, 2002–September 30, 2004

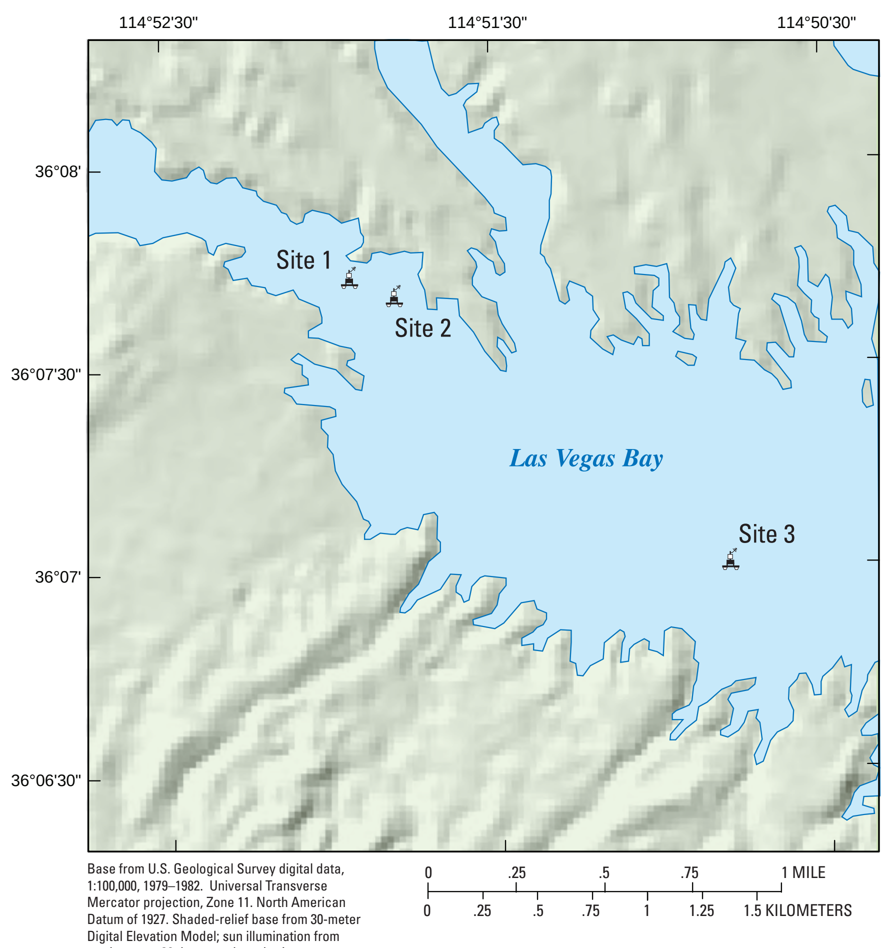
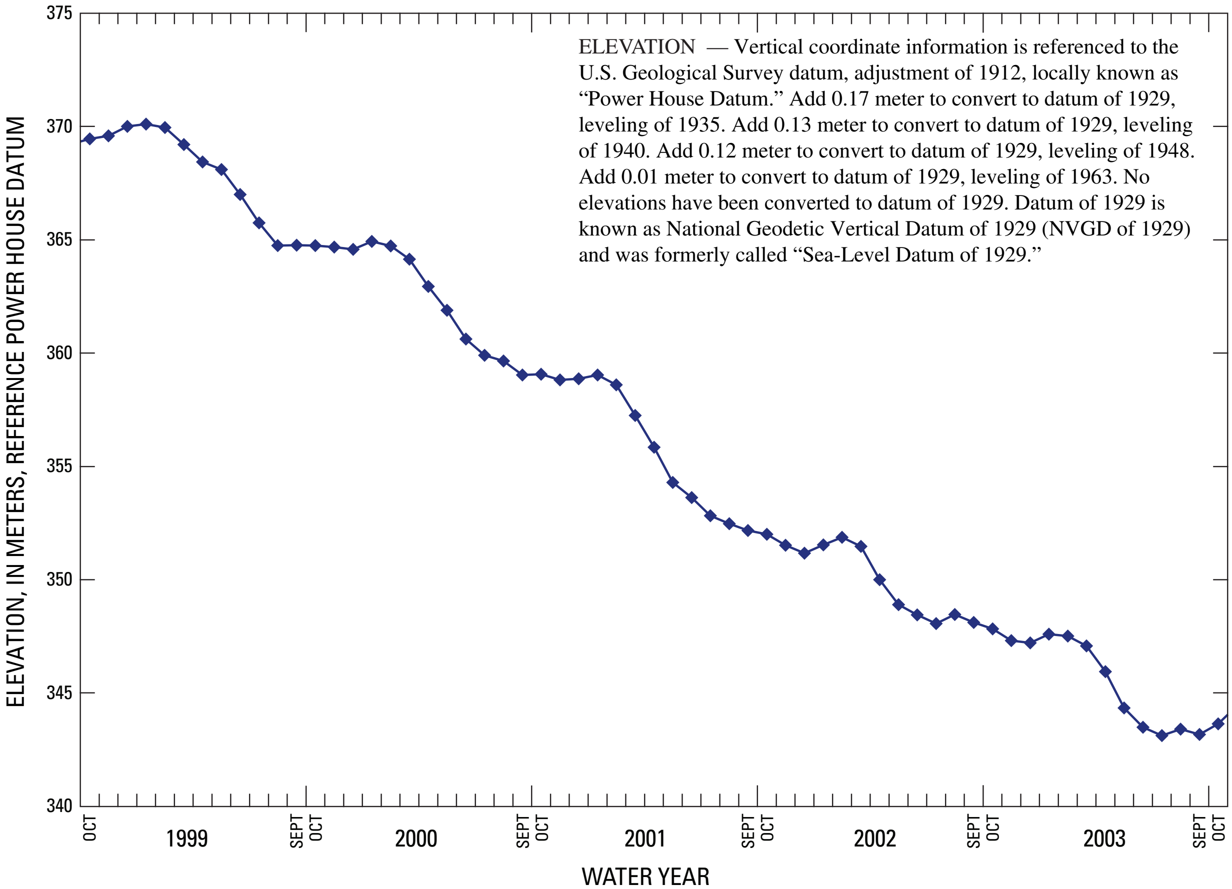


Figure 2. Profiling system locations in Las Vegas Bay, Lake Mead, Arizona and Nevada.



Data from the Bureau of Reclamation available at <http://www.usbr.gov/lc/region/g4000/hourly/mead-elv.html>.

Figure 3. Lake Mead elevation during period of data collection.

(non-operational 15 days or more) at the Sentinel Island site. The USGS began researching an alternative automatic profiling technology. The variable-buoyancy-profiling system at the Sentinel Island site was replaced on August 27, 2004, with a variable-depth-winch system manufactured by Endeco/YSI. This system also provides water-quality profiles at user-defined depth increments and user-defined time intervals (fig. 5). Maintenance for both systems involved routine and periodic site visits. Standard operating procedures for service visits were established to mitigate system failures.

Profiling Systems

The profiling equipment consisted of a variable-buoyancy-leveling device that transports a multiparameter water-quality sonde (fig. 4). When the leveling device reaches a target depth, physical and chemical properties are collected by the sonde (after an equilibration period determined by the dissolved-oxygen sensor), and recorded on the profiling-system data logger. The sondes were equipped with sensors to measure depth, water temperature, specific conductance, pH, dissolved-oxygen concentration, and turbidity. The leveling device consists of a dry cylinder that houses a high pressure pump, valves, and electronic circuits and a wet cylinder that houses an air bladder. The buoyancy of the leveling device is adjusted when the system pumps water into or out of the wet cylinder. The leveling device is suspended below the floating platform by a weighted data cable. The data cable is connected to a system computer, which is housed in a weather resistant shelter on top of the platform. A second communication cable connects the sonde to the electronics in the dry cylinder on the leveling device. The Las Vegas Bay system was equipped with a 30 m data cable and was powered by one 12-volt, deep-cycle marine battery. The Sentinel Island system was equipped with a 100 m data cable and was powered by two 12-volt, deep-cycle marine batteries. The batteries were charged by 50-watt solar panels. Both systems also were equipped with cellular-telephone modems so that at any time the user could download data, change scheduled profile depths and start times, and initiate profiles.

In August 2004, the variable-buoyancy system near Sentinel Island was replaced with a variable-depth-winch system that became available for consumer distribution in 2004 (fig. 5). This system utilizes a winch and reel assembly mounted on a platform to transport the water-quality sonde in the water column. The sondes were equipped with sensors to measure depth, water temperature, specific conductance, pH, dissolved-oxygen concentration, and turbidity. Variable-depth-winch systems are composed of a winch assembly, data cable, data logger/sensor-control module, 95-amps per hour rechargeable gel-cell battery, cellular-telephone modem, and 30-watt solar panels.

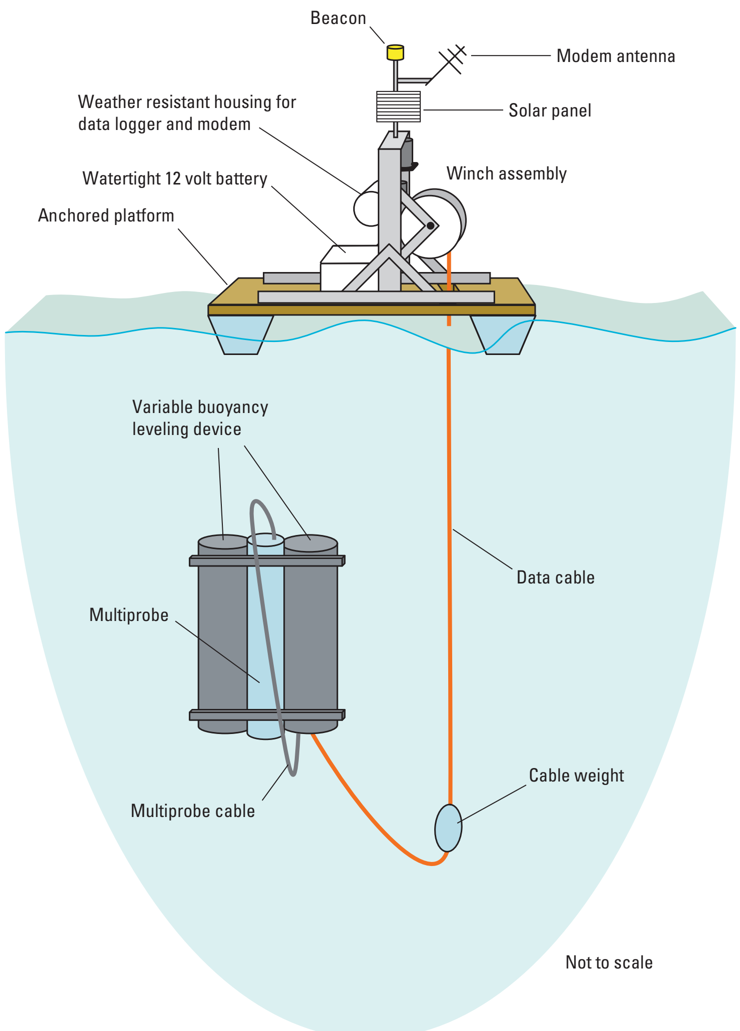
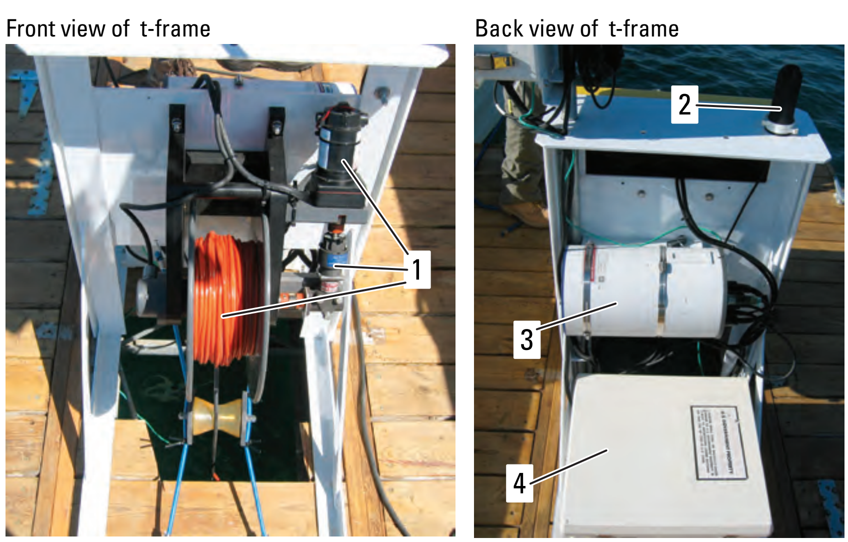


Figure 4. Variable-buoyancy-profiling system.



Components are (1) variable-profiler-winch assembly, (2) modem antenna, (3) watertight housing for data logger and modem, and (4) watertight housing for 12-volt, 95-amps per hour battery.

Figure 5. Variable-depth-winch system components mounted to a t-frame.

System Maintenance

Automatic profiling systems are a relatively new technology. The systems operate in extreme conditions. The sondes, variable-buoyancy devices, and depth-winch systems are exposed to a wide range of water temperatures and pressure during a profile, and the surface-mounted electronics are exposed to large daily and seasonal air-temperature fluctuations. The complexity of the profiling systems combined with the dynamic environment they operate in at Lake Mead led to system failures during the data-collection period. The system failures resulted in periods of missing data or incomplete profiles.

Minor equipment problems were repaired in the field or in the office electronics lab and the amount of missing data record was limited to less than 15 days. Major equipment problems, such as leaks in cable connections and the electronics cylinder on the variable-buoyancy device, had to be repaired by the system manufacturer and resulted in extended periods of missing data (15 days up to 11 months.) The Las Vegas Bay system did not experience a major failure, which can be attributed to the relatively shallow maximum target depth (up to 19 m) at the Las Vegas Bay sites. Whereas, the Sentinel Island system, whose maximum target depth was up to 95 m, experienced several major failures and one vandalism event, which lead to significant periods of missing data.

To minimize periods of missing data and incomplete profiles, sites were visited every 2 to 4 weeks to perform preventative maintenance, and as needed in response to system failures. Standard operating procedures for service visits completed from October 1, 2000, to September 30, 2003, were as follows:

- The leveling device was brought to surface,
- the sonde was removed and placed in a bucket of water collected from the lake's surface,
- a second clean and calibrated sonde (calibration checked less than 24 hours prior to service visit) was placed in the same bucket and concurrent readings from the sondes were recorded, and
- the clean and calibrated sonde was secured to the leveling device and the sonde that was deployed during the monitoring period was brought back to the office where it was serviced (service included cleaning and sensor calibration according to manufacturer directions).

From October 1, 2003, to September 30, 2004, revised standard operating procedures were followed. The revised procedures were based on published USGS guidelines and protocols (Wagner and others, 2001). The revised standard operating procedures included:

- Bring the sonde to the surface,
- immerse the sonde in a bucket of lakewater that is maintained at surface-water temperature and record readings prior to cleaning sensor,
- check the calibration of the dissolved-oxygen sensor using the saturated air in water method,
- remove the dissolved-oxygen sensor and replace it with a sensor that was serviced less than 24 hours prior to the site visit,
- calibrate the dissolved-oxygen sensor using the saturated air in water method,
- clean the remaining sensors according to manufacturer specifications,
- immerse the sonde in the bucket of lakewater maintained at surface-water temperature and record the cleaned sensor readings,
- check the calibration of the sensors and calibrate the sensors if they exceed the calibration criteria (table 2),
- record postservice sensor readings in the bucket of lakewater maintained at surface-water temperature, and
- reconnect the sonde to the profiling system and deploy.

Methodology

The methodology, for the purpose of this data report, included the collection of near-continuous water-quality data at a total of three sites within Las Vegas Bay and one site near Sentinel Island in Lake Mead, Arizona and Nevada (fig. 1). The data were processed in compliance with USGS quality-assurance and control guidelines, and the data records were computed based on established USGS criteria.

Data Collection

Data were collected at the Las Vegas Bay sites at 2 m increments, starting at 1 or 3 m below the water surface. Data were collected at the Sentinel Island site at 5 m increments, starting at 5 m below the water surface. Maximum depths at the Las Vegas Bay sites ranged from 5 to 19 m. The maximum depth at the Sentinel Island site was 95 m when the variable-depth-buoyancy system was used, and 45 m when the variable-depth-winch system was used. Profiles generally were completed at intervals of 6 hours; usually the first profile was started from 20 to 30 minutes after midnight. Profiles at the Las Vegas Bay sites took about 30 minutes to complete and profiles at the Sentinel Island site took about 60 minutes to complete. The profile duration was related to the maximum profile depths. Total water depth was measured during a majority of the service visits to the Las Vegas Bay sites and selected visits to the site near Sentinel Island. Depth was measured with a weighted tape measure at the Las Vegas Bay sites and with a commercial depth finder at the site near Sentinel Island. Some of the variability in the depth data measured at the Sentinel Island site is due to the platform drifting towards or away from Sentinel Island, depending on the wind direction.

Physical and chemical water-quality properties were collected by a YSI model 6600 multiparameter sondes equipped with sensors to measure depth, water temperature, specific conductance, pH, dissolved-oxygen concentration, and turbidity. Manufacturer's specifications are provided for each type of sensor (table 3). Definitions of the physical and chemical water properties measured by the sensors are provided below:

Depth: water depth, in meters below water surface;

Water temperature: a measure of warmth or coldness of water, in degrees Celsius;

Specific conductance: a measure of the electrical conductance of a substance normalized to a unit length and unit cross section at a specified temperature, in microsiemens per centimeter at 25 degrees Celsius;

pH: a measure of the concentration of hydrogen ions, in standard units. pH values above 7 are basic, pH values below 7 are acidic, and pH equal to 7 is neutral;

Dissolved-oxygen concentration: a measure of dissolved-molecular-oxygen (oxygen gas) concentration in water, in milligrams per liter; and

Turbidity: an expression of the optical properties of a liquid that causes light rays to be scattered and absorbed rather than transmitted in straight lines through a sample, in formazin nephelometric turbidity units.

Data Processing

Automatic near-continuous profiling systems are a relatively new technology and managing the data they generate poses new challenges. Data processing procedures, described in detail below, are specific to managing the profile data in the USGS National Water Information System (NWIS) database; however, the overall approach could apply to any data-management system.

Each measurement depth is assigned a unique station identification number and name, which are used to identify the station and associated depth-specific data that are stored in NWIS (table 4). Station identification numbers contain the station's latitude (first 6 characters) and longitude (characters 7 to 13), in degrees-minutes-seconds format, plus two additional characters that are specific to a target depth at a site. The station name references a nearby landmark, such as an island, bay, or basin. The station name also includes the measurement depth.

Table 2. Calibration criteria for sensors used to measure physical and chemical water-quality properties in profiles at Las Vegas Bay and near Sentinel Island, Lake Mead, Arizona and Nevada.

[Abbreviations: ºC, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; FNU, formazin nephelometric turbidity unit; m, meter]

Property	Calibration criteria
Depth	±0.3 m
Water temperature	±0.2ºC
Specific conductance	The greater of ±5 µS/cm at 25ºC or ±3 percent of the measured value
pH	±0.2 units
Dissolved-oxygen concentration	±0.3 mg/L
Turbidity	The greater of ±2 FNU or ±5 percent of the measured value

Table 3. Manufacturer specifications for sensors used to measure physical and chemical water-quality properties in profiles at Las Vegas Bay and near Sentinel Island, Lake Mead, Arizona and Nevada.

[Abbreviations: ºC, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; FNU, formazin nephelometric turbidity unit; m, meters]

Sensor	Range	Accuracy
Depth, nonvented, deep level.	0–200 m	±0.3 m.
Water temperature, sintered metallic oxide thermistor.	-5–45ºC	±0.15ºC.
Specific conductance, four nickel electrode cell with autoranging.	0–100,000 µS/cm at 25ºC	±0.5 percent of reading +1 µS/cm at 25ºC.
pH, glass combination electrode.	0–14 units	± 0.2 units.
Dissolved-oxygen concentration, rapid pulse Clark type, polarographic.	0–50 mg/L	0–20 mg/L: the greater of ±2 percent of the reading or 0.2 mg/L. 20–50 mg/L: ±6 percent.
Turbidity, optical, 90 degree scatter with mechanical cleaning.	0–1,000 FNU	The greater of ±2 FNU or ±5 percent of the measured value.

The data processing flowchart for the project consists of seven automatic and manual steps (fig. 6).

1. Data from each station are downloaded automatically to a secure and isolated base-station computer every 24 hours.
2. Raw data files are copied automatically to an NWIS server, which operates on a UNIX platform.
3. Data for specific depth ranges are extracted automatically from the raw data files and copied to depth-specific data files.
4. Depth-specific data files are reformatted automatically into standard data-input files by USGS programs (DECODES or SATIN) and entered automatically into the NWIS database.
5. Automated Data Processing System (ADAPS; a suite of USGS programs for managing near-continuous data sets) processes are used to manually apply fouling and drift corrections to data recorded at the first measurement depth.
6. Corrections applied to data recorded at the first depth are copied manually and applied to data recorded at all successive depths in the profile.
7. Corrected (computed) data for each specific depth are retrieved manually from NWIS. These computed, depth-specific data files are concatenated and then sorted by date and time, creating profile data files.

Records Computation

Records computation includes the application of fouling and drift corrections, if required, and a final data evaluation.

A fouling correction is the difference between a sensor reading in the same environmental sample before and after the sensor is cleaned. Fouling is caused by algae growth or sediment deposits on a sensor and contamination or poisoning of a sensor anode. Electronic drift correction is the difference between the cleaned sensor reading in a calibration standard and the calibration-standard value. It is assumed that these processes occur at a linear rate over time, so fouling and drift corrections are interpolated linearly over the time between service visits.

From October 1, 2000, to September 30, 2003, fouling corrections were determined by comparing sensor readings from the deployed sonde with sensor readings from a second sonde that was calibrated within 24 hours prior to a site visit. Drift corrections were determined in the lab by comparing sensor readings from the deployed sonde in a known standard to the standard value. From October 1, 2003, to September 30, 2004, sondes were not exchanged at the sites during service visits. Therefore, fouling corrections were determined on site by comparing sensor readings in the same environmental sample prior to and after cleaning. Drift corrections were determined on site during the sensor-calibration check.

There is a point when sensors are so badly fouled or out of calibration that application of a correction to the data does not improve the record. Maximum allowable limits for applying corrections and publishing data were based on USGS

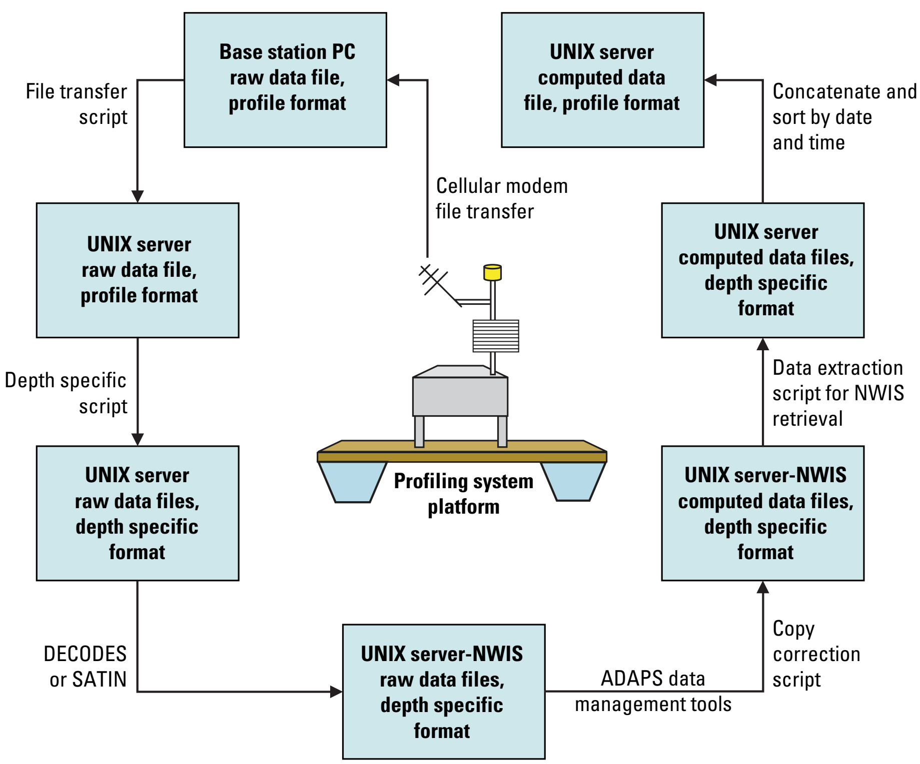


Figure 6. Data processing flowchart for automatic-profile data.

Table 4. Station identification number, station name, and period of record for automatic-profile site target depths, Lake Mead, Arizona and Nevada.

Station identification number	Official National Water Information System station name	Period(s) of record
360743114515901	Las Vegas Bay QW Platform site 1 (1 meter depth)	October 1, 2000–July 9, 2001
360743114515902	Las Vegas Bay QW Platform site 1 (3 meter depth)	October 1, 2000–July 9, 2001
360743114515903	Las Vegas Bay QW Platform site 1 (5 meter depth)	October 1, 2000–July 9, 2001
360743114515904	Las Vegas Bay QW Platform site 1 (7 meter depth)	October 1, 2000–July 9, 2001
360743114515905	Las Vegas Bay QW Platform site 1 (9 meter depth)	October 1, 2000–June 29, 2001
360743114515906	Las Vegas Bay QW Platform site 1 (11 meter depth)	October 1, 2000–May 8, 2001
360740114515101	Las Vegas Bay QW Platform site 2 (1 meter depth)	September 6, 2001–June 19, 2002
360740114515102	Las Vegas Bay QW Platform site 2 (3 meter depth)	September 9, 2001–June 19, 2002
360740114515103	Las Vegas Bay QW Platform site 2 (5 meter depth)	September 9, 2001–June 6, 2002
360740114515104	Las Vegas Bay QW Platform site 2 (7 meter depth)	September 13, 2001–April 19, 2002
360740114515105	Las Vegas Bay QW Platform site 2 (9 meter depth)	September 13, 2001–March 14, 2002
360740114515106	Las Vegas Bay QW Platform site 2 (11 meter depth)	September 13, 2001–September 26, 2001
360700114505102	Las Vegas Bay QW Platform site 3 (3 meter depth)	April 4, 2003–September 30, 2004
360700114505103	Las Vegas Bay QW Platform site 3 (5 meter depth)	April 4, 2003–September 30, 2004
360700114505104	Las Vegas Bay QW Platform site 3 (7 meter depth)	April 4, 2003–September 30, 2004
360700114505105	Las Vegas Bay QW Platform site 3 (9 meter depth)	April 4, 2003–September 30, 2004
360700114505106	Las Vegas Bay QW Platform site 3 (11 meter depth)	April 4, 2003–September 30, 2004
360700114505107	Las Vegas Bay QW Platform site 3 (13 meter depth)	April 4, 2003–September 29, 2004
360700114505108	Las Vegas Bay QW Platform site 3 (15 meter depth)	April 4, 2003–September 30, 2004
360700114505109	Las Vegas Bay QW Platform site 3 (17 meter depth)	April 4, 2003–April 19, 2004
360700114505110	Las Vegas Bay QW Platform site 3 (19 meter depth)	April 4, 2003–May 31, 2003
360314114450505	Sentinel Island QW Platform (5 meter depth)	January 24, 2002–September 29, 2003; August 27, 2004–September 30, 2004
360314114450510	Sentinel Island QW Platform (10 meter depth)	January 24, 2002–September 29, 2003; August 27, 2004–September 30, 2004
360314114450515	Sentinel Island QW Platform (15 meter depth)	January 24, 2002–September 29, 2003; August 27, 2004–September 30, 2004
360314114450520	Sentinel Island QW Platform (20 meter depth)	January 24, 2002–September 29, 2003; August 27, 2004–September 30, 2004
360314114450525	Sentinel Island QW Platform (25 meter depth)	January 24, 2002–September 29, 2003; August 27, 2004–September 30, 2004
360314114450530	Sentinel Island QW Platform (30 meter depth)	January 24, 2002–September 29, 2003; August 27, 2004–September 30, 2004
360314114450535	Sentinel Island QW Platform (35 meter depth)	January 24, 2002–September 29, 2003; August 27, 2004–September 30, 2004
360314114450540	Sentinel Island QW Platform (40 meter depth)	January 24, 2002–September 29, 2003; August 27, 2004–September 30, 2004
360314114450545	Sentinel Island QW Platform (45 meter depth)	January 24, 2002–September 29, 2003; August 27, 2004–September 30, 2004
360314114450550	Sentinel Island QW Platform (50 meter depth)	January 24, 2002–September 29, 2003
360314114450555	Sentinel Island QW Platform (55 meter depth)	January 24, 2002–September 29, 2003
360314114450560	Sentinel Island QW Platform (60 meter depth)	January 24, 2002–September 29, 2003
360314114450565	Sentinel Island QW Platform (65 meter depth)	March 21, 2002–September 29, 2003
360314114450570	Sentinel Island QW Platform (70 meter depth)	March 21, 2002–September 29, 2003
360314114450575	Sentinel Island QW Platform (75 meter depth)	March 21, 2002–September 29, 2003
360314114450580	Sentinel Island QW Platform (80 meter depth)	March 21, 2002–September 29, 2003
360314114450585	Sentinel Island QW Platform (85 meter depth)	March 21, 2002–September 29, 2003
360314114450590	Sentinel Island QW Platform (90 meter depth)	March 21, 2002–September 29, 2003
360314114450595	Sentinel Island QW Platform (95 meter depth)	March 21, 2002–September 29, 2003

established criteria (table 5). Data that exceeded maximum allowable limits for data corrections are not reported. Professional discretion was used to determine the point in a data-collection period where data deteriorated to values unfit for publication.

Table 5. Maximum allowable limits for applying data corrections to near-continuous water-quality data.

[From Wagner and others, 2001]

Property	Limit
Depth	±1.0 meter
Water temperature	±2.0 degrees Celsius
Specific conductance	±30 percent
pH	±2 pH units
Dissolved-oxygen concentration	The greater of 2.0 milligrams per liter or 20 percent
Turbidity	±30 percent

Final data evaluation was completed by two or more qualified individuals and consisted of reviewing the data record, checking fouling and drift corrections, and making any needed final corrections. After final data evaluation, the data were rated for quality according to guidelines (table 6). For example, if values reported by the dissolved-oxygen sensor during the saturated air in-water calibration check exceeded the theoretical concentration of dissolved oxygen by greater than ±0.8 mg/L, then all dissolved-oxygen data collected during the data-collection period were rated as "Poor." Likewise, if the average difference between the values reported by the conductance sensor and the values of three known standards fell between ±3 and 10 percent during the calibration check, then all conductance data recorded during the data-collection period were rated as "Good." Accuracy ratings were determined prior to the application of corrections.

Data quality ratings were assigned for each period of data collection (a period of data collection contains data recorded between service visits) at Las Vegas Bay sites 1, 2, and 3 and at the Sentinel Island site (table 7). Profile data also were recorded at Las Vegas Bay sites 1, 2, and 3, and the Sentinel Island site (tables 8, 9, 10, and 11, respectively). Total water depth was measured at the Las Vegas Bay sites and the Sentinel Island site (table 12).

Selected profile data were plotted for Las Vegas Bay sites 1, 2, and 3 (figs. 7, 8, and 9, respectively). Selected profile data also were plotted for the Sentinel Island site (fig. 10). These figures show the variability of the physical and chemical properties measured at each site.

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Table 6. Criteria for rating near-continuous water-quality data.

[From Wagner and others, 2001. Abbreviations: <, less than; >, greater than]

Measured physical property	Excellent	Good	Fair	Poor
Depth, in meters	<±0.3	>±0.3–0.5	>±0.5–0.8	>±0.8
Water temperature, in degrees Celsius	<±0.2	>±0.2–0.5	>±0.5–0.8	>±0.8
Specific conductance, in percent	<±3	>±3–10	>±10–15	>±15
pH, in units	<±0.2	>±0.2–0.5	>±0.5–0.8	>±0.8
Dissolved-oxygen concentration, in milligrams per liter	<±0.3	>±0.3–0.5	>±0.5–0.8	>±0.8
Turbidity, in percent	<±5	>±5–10	>±10–15	>±15

Table 7. Data quality ratings for physical and chemical water-quality properties measured in profiles at Las Vegas Bay and Sentinel Island sites, Lake Mead, Arizona and Nevada.

[Time, military format. E, excellent; G, good; F, fair; P, poor; ND, no data for period. See table 6 for quantitative definitions of these terms]

Period of measurement							
Start Date — Time (Pacific time)	End Date — Time (Pacific time)	Depth	Temperature	Specific conductance	pH	Dissolved-oxygen concentration	Turbidity
Las Vegas Bay site 1							
10/01/2000 — 0600	10/12/2000 — 1200	E	E	E	G	P	P
10/12/2000 — 1300	11/08/2000 — 1200	E	E	E	G	P	P
11/08/2000 — 1300	11/21/2000 — 1200	E	E	E	E	P	E
11/21/2000 — 0600	12/05/2000 — 1200	E	E	E	E	E	E
12/05/2000 — 1300	12/19/2000 — 1200	E	E	E	E	E	E
12/19/2000 — 1300	01/23/2001 — 1200	E	E	E	E	F	E
01/23/2001 — 1300	02/06/2001 — 1200	E	E	E	E	P	E
02/06/2001 — 1300	02/12/2001 — 1200	E	E	E	E	E	E
02/20/2001 — 1300	03/06/2001 — 1200	E	E	E	G	P	E
03/06/2001 — 1300	03/16/2001 — 1200	E	E	E	G	P	E
03/16/2001 — 1300	03/27/2001 — 1200	E	E	E	ND	P	E
03/27/2001 — 1300	04/13/2001 — 1200	E	E	E	G	P	E
04/13/2001 — 1300	04/25/2001 — 1200	E	E	E	G	P	E
04/25/2001 — 1300	05/09/2001 — 1200	E	E	E	G	P	E
05/09/2001 — 1300	05/17/2001 — 1200	E	E	E	P	P	E
05/17/2001 — 1300	05/22/2001 — 1200	E	E	E	E	P	E
05/22/2001 — 1300	06/15/2001 — 1200	E	E	E	E	P	E
06/15/2001 — 1300	07/03/2001 — 1200	E	E	E	E	P	E
07/03/2001 — 1300	07/09/2001 — 1200	E	E	E	E	G	E
Las Vegas Bay site 2							
09/12/2001 — 0930	09/26/2001 — 1130	E	E	E	E	P	E
09/26/2001 — 0930	10/16/2001 — 1130	E	E	P	E	G	E
10/16/2001 — 0930	10/31/2001 — 1130	E	E	E	E	P	E
10/31/2001 — 0930	11/13/2001 — 1010	E	E	E	E	G	E
12/05/2001 — 1530	12/27/2001 — 1010	E	E	G	E	E	E
12/27/2001 — 1010	01/08/2002 — 1000	E	E	E	E	P	E
01/24/2002 — 1100	02/13/2002 — 0845	E	E	E	E	P	E
02/13/2002 — 0900	02/27/2002 — 0845	E	E	E	E	P	F
02/27/2002 — 0945	04/02/2002 — 0930	E	E	E	E	P	F
04/02/2001 — 1030	04/19/2001 — 0850	E	E	E	E	P	F
04/02/2002 — 1030	04/19/2002 — 0850	E	E	E	E	P	F
04/19/2001 — 0950	05/07/2001 — 0800	E	E	E	E	E	F
05/07/2002 — 1000	05/29/2002 — 0830	E	E	E	E	E	F
05/29/2002 — 1000	06/19/2002 — 0850	E	E	E	E	E	F

Table 7. Data quality ratings for physical and chemical water-quality properties measured in profiles at Las Vegas Bay and Sentinel Island sites, Lake Mead, Arizona and Nevada—Continued.

[Time, military format. E, excellent; G, good; F, fair; P, poor. See table 6 for quantitative definitions of these terms. Measurements made between 3 meters and 15 meters]

Period of measurement		Depth	Temperature	Specific conductance	pH	Dissolved-oxygen concentration	Turbidity
Start Date — Time (Pacific time)	End Date — Time (Pacific time)						
Las Vegas Bay site 3							
04/04/2003 — 1600	04/18/2003 — 0830	E	E	P	E	E	G
04/18/2003 — 1000	04/28/2003 — 0900	E	E	E	E	E	E
04/28/2003 — 1000	05/16/2003 — 1030	E	E	E	E	P	E
05/16/2003 — 1200	06/03/2003 — 0900	E	E	E	E	P	E
06/03/2003 — 1100	06/20/2003 — 0830	E	E	E	G	P	E
06/20/2003 — 1030	07/08/2003 — 0930	E	E	E	G	P	E
07/08/2003 — 1130	08/01/2003 — 0930	E	E	E	E	P	E
08/01/2003 — 1130	08/20/2003 — 1200	E	E	E	G	P	E
08/20/2003 — 1330	09/05/2003 — 0900	E	E	E	G	P	E
09/05/2003 — 1100	09/25/2003 — 0830	E	E	E	E	P	E
09/25/2003 — 1030	10/15/2003 — 1200	E	E	E	G	P	P
10/15/2003 — 1400	10/20/2003 — 1200	E	E	E	E	E	E
11/07/2003 — 1200	11/19/2003 — 0900	E	E	E	G	P	E
11/19/2003 — 1100	12/08/2003 — 0930	E	E	F	G	P	P
12/08/2003 — 1100	01/07/2004 — 1030	E	E	F	G	P	P
01/07/2004 — 1230	02/17/2004 — 1000	E	E	G	E	G	E
02/17/2004 — 1200	03/11/2004 — 0930	E	E	E	E	G	E
03/11/2004 — 1130	03/30/2004 — 0900	E	E	E	G	G	F
03/30/2004 — 1000	04/20/2004 — 1000	E	E	E	E	E	E
04/20/2004 — 1200	04/27/2004 — 0830	E	E	E	F	F	F
04/27/2004 — 1400	05/25/2004 — 0850	E	E	E	G	G	E
05/25/2004 — 1100	06/18/2004 — 0915	E	E	E	G	P	F
06/18/2004 — 1100	07/09/2004 — 0900	E	E	E	F	F	F
07/21/2004 — 0900	08/04/2004 — 0830	E	E	E	G	F	E
09/20/2004 — 1400	09/30/2004 — 2300	E	E	E	G	P	E
Sentinel Island site							
01/24/2002 — 0800	03/21/2002 — 1000	E	E	G	F	P	G
03/21/2002 — 1100	05/21/2002 — 1330	E	E	E	G	P	P
05/21/2002 — 1200	07/02/2002 — 0740	E	E	E	E	P	P
07/02/2002 — 0840	07/10/2002 — 1900	E	E	G	G	P	P
10/10/2002 — 1000	11/12/2002 — 0900	E	E	E	E	P	E
11/14/2002 — 1425	11/22/2002 — 1300	E	E	P	E	E	E
12/03/2002 — 1200	12/23/2002 — 1215	E	E	P	G	G	G
12/23/2002 — 1315	01/13/2003 — 1000	E	E	E	G	P	G
01/13/2003 — 1000	02/14/2003 — 1000	E	E	E	P	P	G
02/14/2003 — 1000	03/12/2003 — 0830	E	E	E	E	E	E
03/12/2003 — 0830	05/06/2003 — 1200	E	E	E	G	G	G
07/23/2003 — 1300	08/20/2003 — 1015	E	E	E	G	E	E
08/20/2003 — 1300	09/25/2002 — 0900	E	E	E	G	F	E
09/25/2003 — 0900	09/28/2003 — 1915	E	E	E	G	F	E
08/27/2004 — 1000[a]	09/16/2004 — 1200[a]	E	E	P	E	P	P
09/20/2004 — 1400[a]	10/14/2004 — 0900[a]	E	E	E	E	F	G

[a] Measurements made between 0.5 meter and 45 meters.

Tables 8–11 are provided as Microsoft Excel files; table names below are linked to the Excel files. If assistance is needed in using these files, please contact the Nevada Water Science Center Public Information Assistant by phone (775-887-7649) or email (GS-W-NV Public Information@usgs.gov).

Table 8. Physical and chemical water-quality data in profiles at Las Vegas Bay site 1, October 1, 2000–July 9, 2001. *Size : 850 kb.*

Table 9. Physical and chemical water-quality data in profiles at Las Vegas Bay site 2, September 6, 2001–June 19, 2002. *Size : 600 kb.*

Table 10. Physical and chemical water-quality data in profiles at Las Vegas Bay site 3, April 4, 2003–September 30, 2004. *Size : 1.2 Mb.*

Table 11. Physical and chemical water-quality data in profiles at Sentinel Island site, January 24, 2002–September 30, 2004. *Size : 2.2 Mb*.

Table 12. Total water depth measured at Las Vegas Bay sites and at Sentinel Island site, Lake Mead, Arizona and Nevada.

[Depth in meters]

Las Vegas Bay site 1		Las Vegas Bay site 2		Las Vegas Bay site 3		Sentinel Island site	
Date	Depth	Date	Depth	Date	Depth	Date	Depth
10/12/2000	13.2	09/06/2001	12.6	04/04/2003	22.6	12/19/2001	103.6
11/08/2000	13.1	09/26/2001	11.8	04/18/2003	21.6	01/24/2002	105.2
12/05/2000	12.9	10/16/2001	11.5	04/28/2003	21.0	05/21/2002	94.5
12/19/2000	13.0	10/31/2001	11.5	05/16/2003	20.1	07/02/2002	96.6
01/23/2001	12.2	11/13/2001	11.6	06/03/2003	19.5	12/03/2002	92.7
02/06/2001	13.5	12/05/2001	10.6	06/20/2003	19.2	01/13/2003	89.9
02/20/2001	12.4	12/27/2001	10.2	07/08/2003	18.9	02/14/2003	91.4
03/06/2001	12.3	01/08/2002	9.8	08/01/2003	18.8	09/25/2003	85.3
03/09/2001	12.6	01/24/2002	10.3	08/20/2003	18.9	08/27/2004	85.0
03/16/2001	12.7	02/13/2002	10.1	09/05/2003	18.9		
03/27/2001	12.8	02/27/2002	9.8	10/15/2003	19.3		
04/13/2001	12.0	04/02/2002	8.2	11/05/2003	18.6		
04/25/2001	11.8	04/07/2002	8.0	02/17/2004	18.0		
05/09/2001	11.0	04/19/2002	7.4	03/30/2004	17.6		
05/17/2001	10.9	05/07/2002	6.5	04/20/2004	17.1		
05/22/2001	10.7	05/29/2002	5.3	04/27/2004	16.8		
06/15/2001	10.1			05/25/2004	15.5		
07/17/2001	7.5			06/18/2004	14.3		
				07/09/2004	14.3		
				08/04/2004	13.8		
				09/20/2004	13.7		

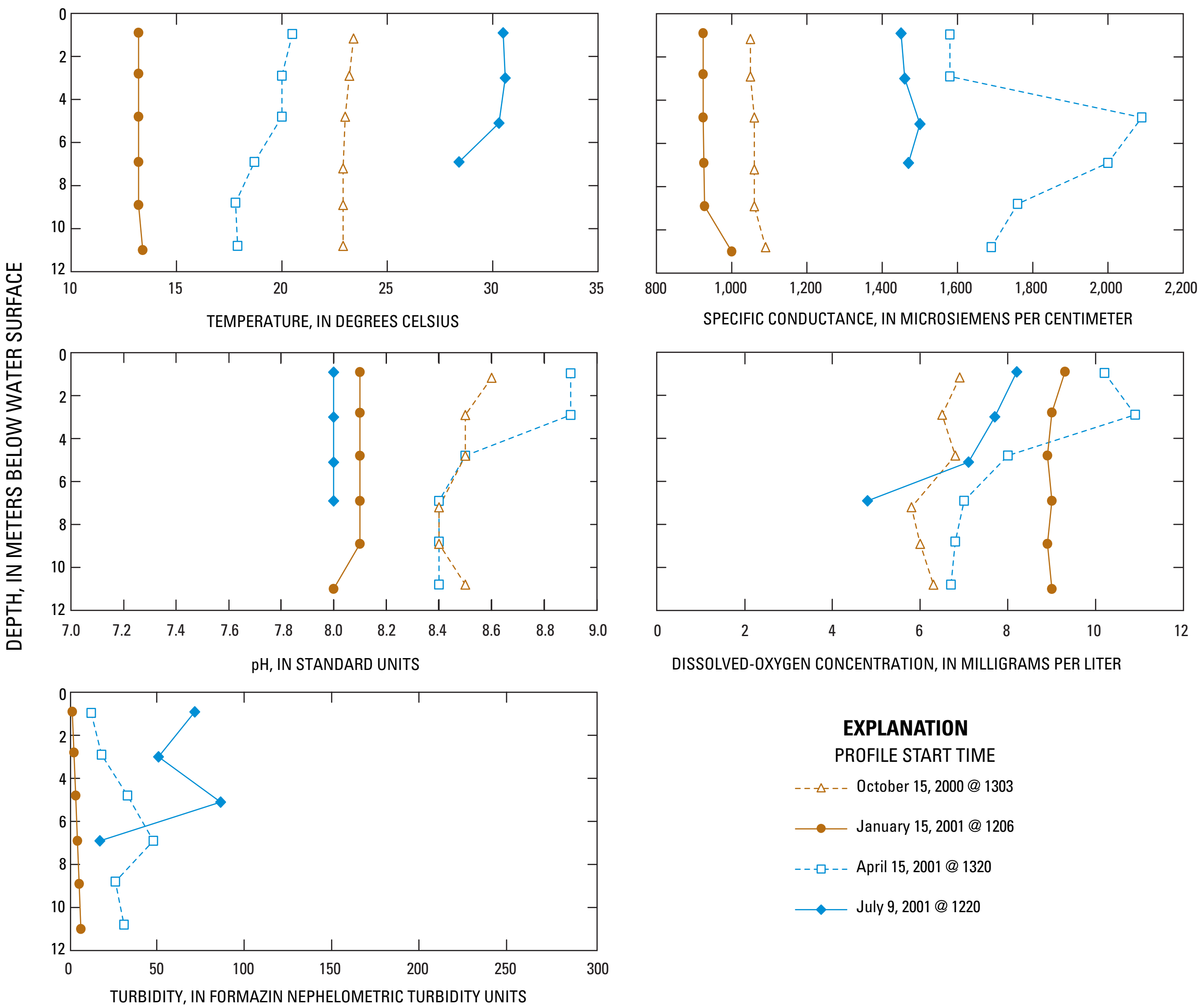

Figure 7. Plots of physical and chemical water-quality properties in selected profiles recorded at Las Vegas Bay site 1, Lake Mead, Arizona and Nevada.

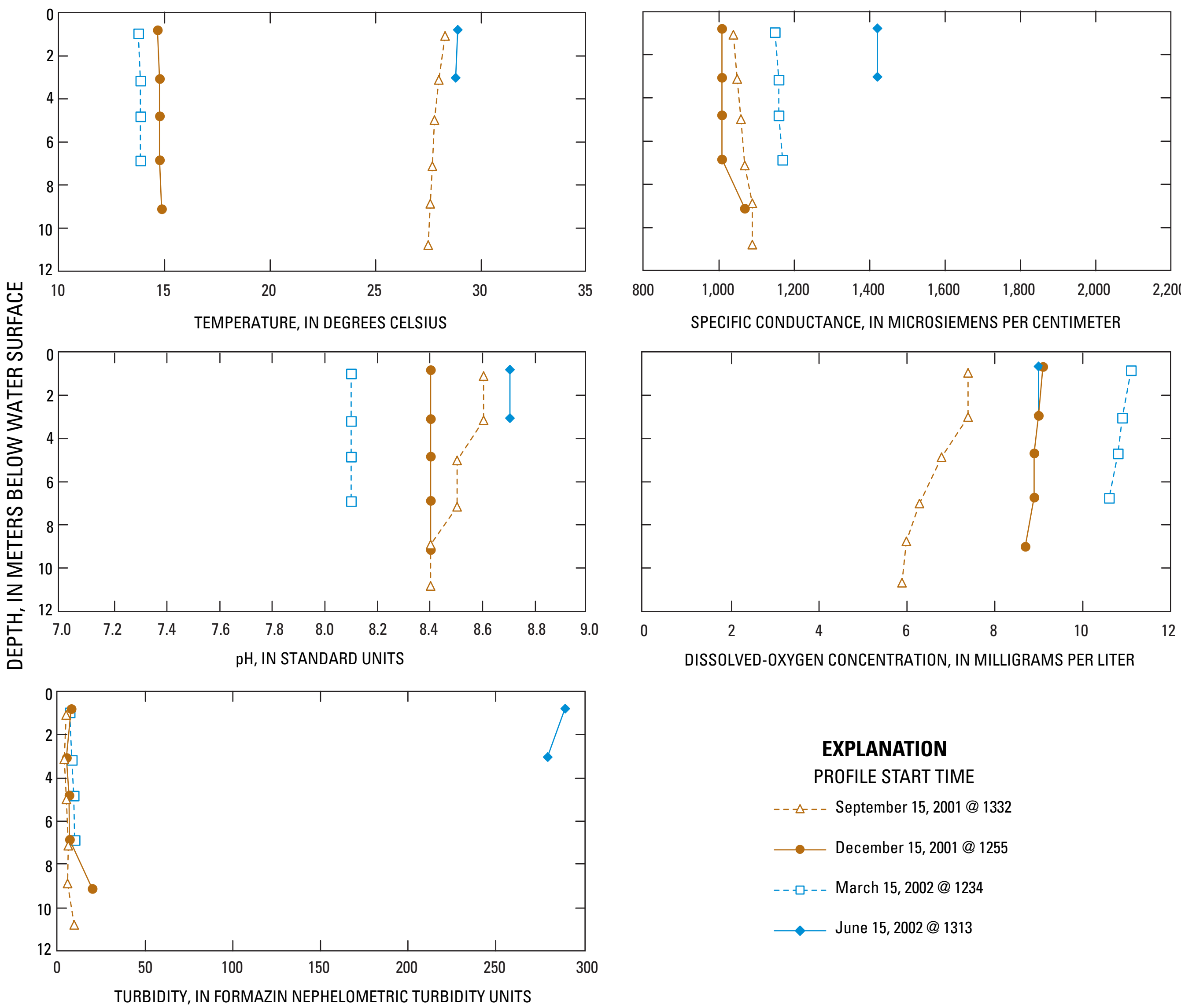

Figure 8. Plots of physical and chemical water-quality properties in selected profiles recorded at Las Vegas Bay site 2, Lake Mead, Arizona and Nevada.

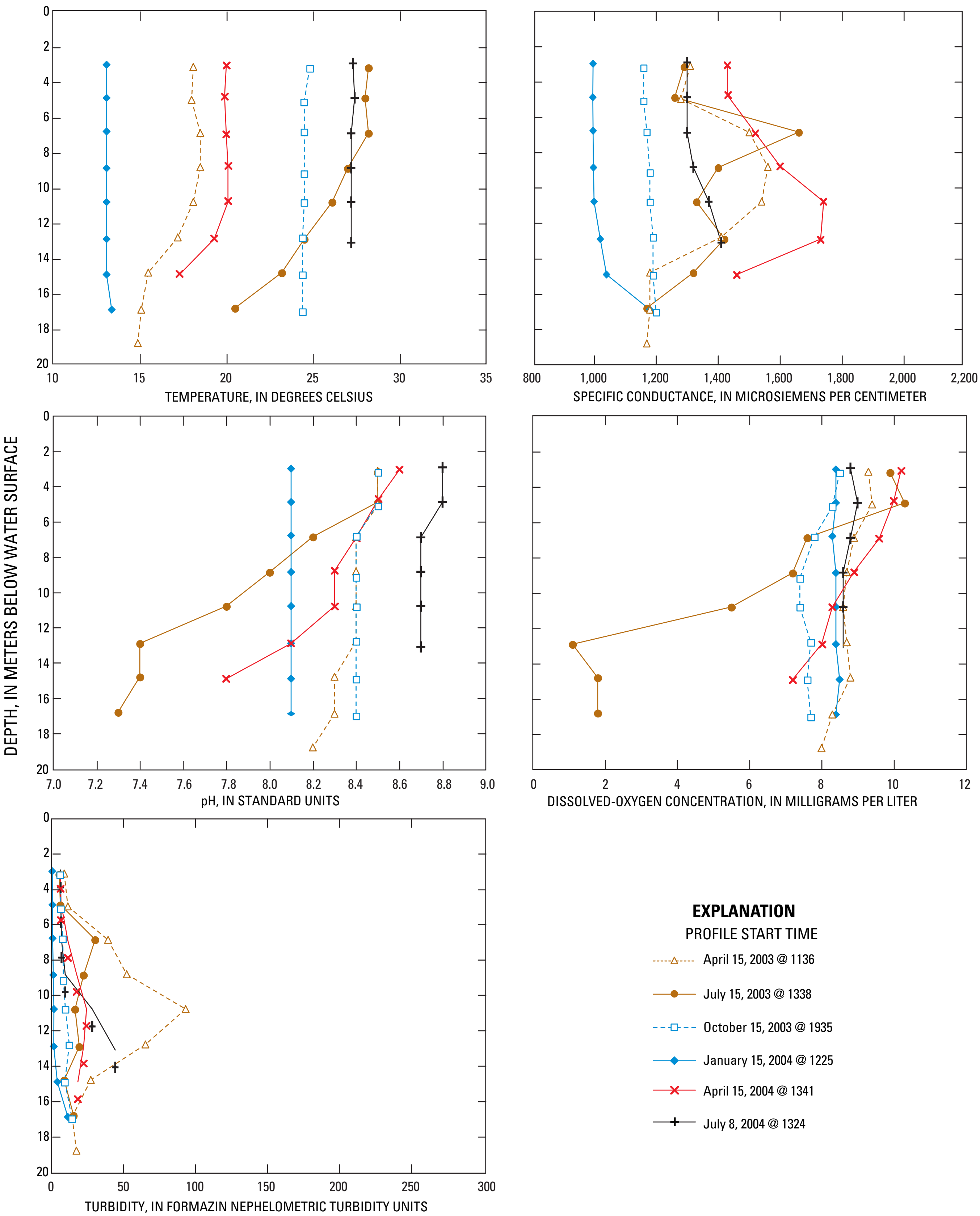

Figure 9. Plots of physical and chemical water-quality properties in selected profiles recorded at Las Vegas Bay site 3, Lake Mead, Arizona and Nevada.

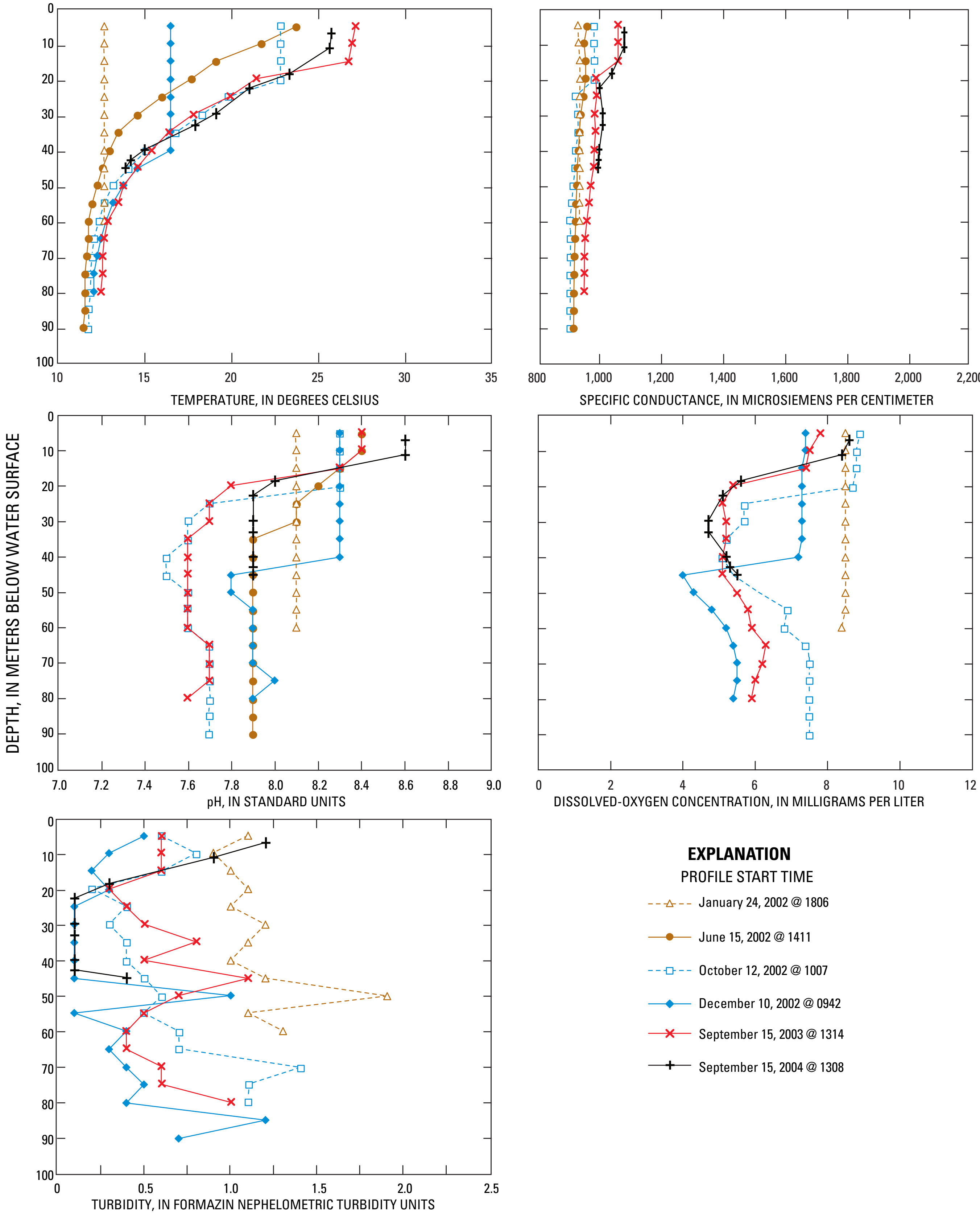

Figure 10. Plots of physical and chemical water-quality properties in selected profiles recorded at Sentinel Island site, Lake Mead, Arizona and Nevada.

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