

Sandy Gulch (Lindo Channel) Resource Inventory



Sandy Gulch circa 1895

Prepared for:
City of Chico, Park Department
Contact: Mr. Dennis Beardsley
Park Director

Prepared by:
Geo Environmental Management
Contact: Terri Lee Eagan
Project Director

July 2001

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Section 1.0 Introduction

Inventory Purpose.....1-1

Background1-1

Study Area1-1

Sandy Gulch Drainage Basin1-1

Flood Control Structure Maintenance and Flow Constraints.....1-7

Section 2.0 Historical Land Uses

Agriculture2-1

Urbanization and Flood Control.....2-1

Gravel Mining.....2-3

Section 3.0 Bank Condition/Channel Stability

General Background3-1

Channel Stability3-2

Relictual Channel.....3-7

Summary3-8

Section 4.0 Biological Resources

Methods4-1

Results4-1

Section 5.0 Report Preparers and References

Report Preparers.....5-1

References.....5-1

Appendices

Appendix A - Archaeological Inventory Survey

Appendix B – Biotechnical (“Soft”) Streambank Stabilization Methods

LIST OF FIGURES/TABLES

FIGURE/TABLE	PAGE
Figure 1.1 Project Area	1-3
Figure 1.2 Plat of Rancho Arroyo Chico	1-4
Figure 1.3 Chico, Mud, and Sandy Gulch Project Diversion Structures	1-5
Figure 2.1 Sequential Aerial Photo Comparison.....	2-2
Figure 2.2 Subdivisions of the John Bidwell Rancho.....	2-3
Figure 3.1 River Processes.....	3-1
Figure 3.2 Bankfull Discharge Map	3-3
Figure 3.3 Geology of Study Area.....	3-4
Figure 3.4 Comparison of Bidwell Deed vs. Current Channel Configuration	3-10
Figure 3.5 Erosion and Streambank Protection Locations, Map 1 of 2.....	3-11
Figure 3.5 Erosion and Streambank Protection Locations, Map 2 of 2.....	3-12
Table 4.1 Special Status Plant Species	4-4
Table 4.2 Special Status Wildlife Species.....	4-5
Figure 4.1 Occurrence of Blue Elderberry Shrubs	4-6

1.0 INTRODUCTION

INVENTORY PURPOSE

This resource inventory represents a review, inventory, and the mapping of resources located in an area known historically as Sandy Gulch (present day Lindo Channel) from Sycamore Bypass to approximately 600 feet west of Highway 32. This study's review of existing literature was augmented with on the ground reconnaissance-level surveys. The information and analysis should serve as a baseline for future land use planning.

A valuable component of this study involved the development of a Project geographic information system (GIS) database for each of the resources investigated. A GIS was utilized to capture the raw data collected in the field or delineated on aerial photographs into a digital format. The data thus collected and stored in a GIS is now readily available to City of Chico staff and will enhance future planning efforts.

BACKGROUND

In 1905, a tract of the most desirable land along Big Chico Creek, totaling more than 1,900 acres, was donated to the City of Chico by Annie Bidwell. This was the conception of Bidwell Park, and includes the upper portions of what was once called Sandy Gulch which encompasses the extreme eastern section of the Study Area. Six years later, in 1911, Mrs. Bidwell gifted to the State of California a section of Sandy Gulch, now held by the City of Chico and designated as undeveloped park area. The deeded land represents the majority of the remaining portion of the Study Area. The Annie Bidwell-deeded areas, in addition to a parcel deeded over to the City in 1996 by Baldwin Contracting, represents the extent of the Study Area and has been digitized and added to the Project GIS (see **Figure 1.1**).

STUDY AREA

The Study Area consists of a linear corridor of approximately six miles in length, extending for approximately 25 feet on both sides of the outer margins of the channel "bluff". The study corridor originates at the Sycamore Bypass which is just west of the Five Mile Recreation Area within Bidwell Park, and proceeds westerly (downstream) for approximately six miles, terminating 600 feet west of Highway 32. The Study Area is located within the Richardson Springs, Chico, and Ord Ferry USGS 7.5 minute quadrangles.



Sandy Gulch, circa 1895
Source: Meriam Library. Special Collections

SANDY GULCH DRAINAGE BASIN

As previously mentioned, Lindo Channel was originally called Sandy Gulch, a name that more accurately denotes both the physical characteristics and historical references of the stream.

Therefore, the name Sandy Gulch will be used throughout the remainder of this report when referring to the Lindo Channel.

Sandy Gulch is a natural intermittent overflow channel that formed on the Chico Fan and was then modified for flood control purposes. Prior to settlement of the Chico area, the rapid diminishment of a stream gradient as Big Chico Creek flowed out onto the valley floor caused deposition of coarse sediments, which led to channel shifts and the typical instabilities associated with alluvial fans. This led to the creation of Sandy Gulch, which acted as a flood overflow channel, or distributary, and reduced flows in Big Chico Creek, the main channel. The question of whether Big Chico Creek or Sandy Gulch was the “primary” stream course through Chico has been argued over the years. Strong evidence supports the issue in favor of Big Chico Creek as the main watercourse. The research supporting this finding consists of historic maps, geomorphological evidence, and a number of written historic sources and documents. Big Chico Creek appears, at least during the past 200-300 years, to represent a perennial stream and the primary channel through which flows emanating from Big Chico Canyon reach the valley floor and, during high water flows, the Sacramento River.

The following evidence supports the conclusion that Sandy Gulch has been a distributary to Big Chico Creek (the main watercourse) at least since before the arrival of European settlers:

- In his 1884 testimony related to the California Supreme Court case regarding impacts of hydraulic mining to California streams, John Bidwell stated “[w]e have a channel *which in high water leaves the channel of the creek and also runs in it again* and we call it Sandy Gulch because there is considerable land that fills when there is high water, that will leave a little sand just at the very mouth where it *reenters Chico Creek again*” (emphasis added) (Bidwell Testimony, 1884). This nearly describes the manner in which Sandy Gulch functions presently.
“[w]e have a channel which in high water leaves the channel of the creek and also runs in it again and we call it Sandy Gulch...”
--John Bidwell, 1884
- Inspection of the earliest available maps from the 1800s shows Sandy Gulch’s existence. A beautifully illustrated 1859 map entitled *Plat of the Rancho Arroyo Finally Confirmed to John Bidwell* (see **Figure 1.2**) shows Big Chico Creek as a perennial stream connected to the Sacramento River bordered by a mature riparian forest, while Sandy Gulch is represented as a smaller unconnected (intermittent) distributary that leaves Big Chico Creek at a point, and follows a configuration in much the same fashion as it does today.
- In most cases, California land grant boundaries followed major physical landmarks (i.e., ridgelines separating watercourses or watercourses themselves). The southern boundary of the 1844 Rancho Arroyo Chico Grant was demarcated by Big Chico Creek (see **Figure 1.2**). It therefore follows general expectations, that this watercourse was the “primary” or perennial watercourse, not Sandy Gulch (Jensen, pers. comm., May 2001).

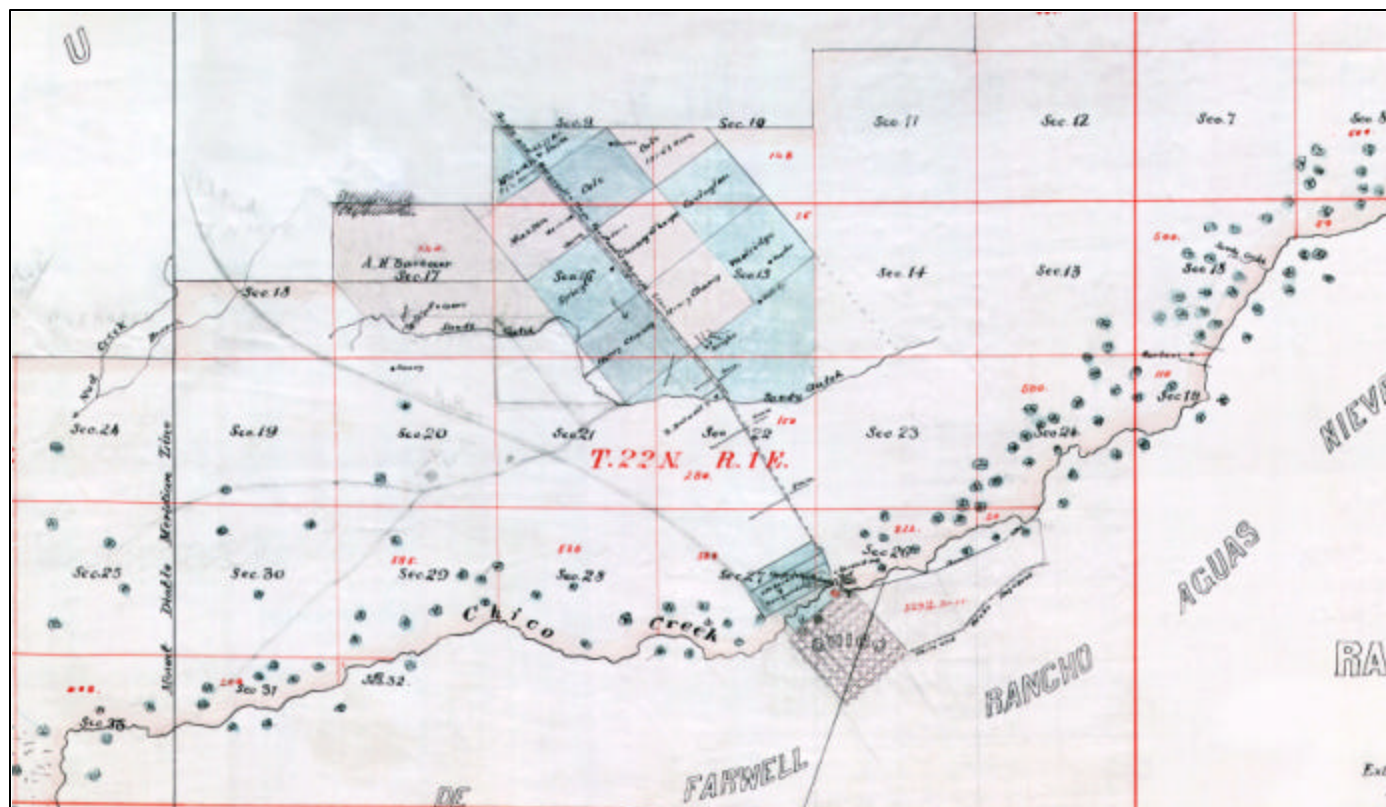


Figure 1.2: Portion of the Plat of the Rancho Arroyo Chico, 1859, showing the prominence of [Big] Chico Creek.
(Source: Meriam Library, Special Collections)

Regardless of whether Sandy Gulch was perennial or intermittent, the preceding evidence nonetheless reaffirms that high flows have been part of the flow history in Sandy Gulch for centuries.

However, Sandy Gulch underwent a substantial change in its flow regime due to flood control improvements, which were installed in the mid-1960s. The US Army Corps of Engineers (Corps) completed the *Chico, Mud, and Sandy Gulch Channel Improvement and Levee Construction Project* in 1965 as part of the *Sacramento River and Major and Minor Tributaries Project* (see **Figure 1.3**). The system consists of gated dam structures at the head of Big Chico Creek at the Five-Mile Recreation Area, another near the head of Sandy Gulch to divert peak flows, and a weir at the head of Sycamore Bypass, which connects Sandy Gulch with Sycamore Creek. The flood control system is designed to create a pool in the stilling basin below the Five-Mile pool, thereby allowing controlled flows through the Big Chico Creek and Sandy Gulch flow control structures and the Sycamore Bypass Channel. In the past, the pool created by the stilling basin was also used extensively for recreation.

Flow to the Sandy Gulch/Sycamore Creek diversion channel is controlled by a concrete sill that in some years is covered with gravel deposits. Runoff diverted from Big Chico Creek flows into the Sandy Gulch/Sycamore Creek diversion channel for approximately 1,400 feet before encountering two adjoining diversion structures. The first structure is a series of box culverts

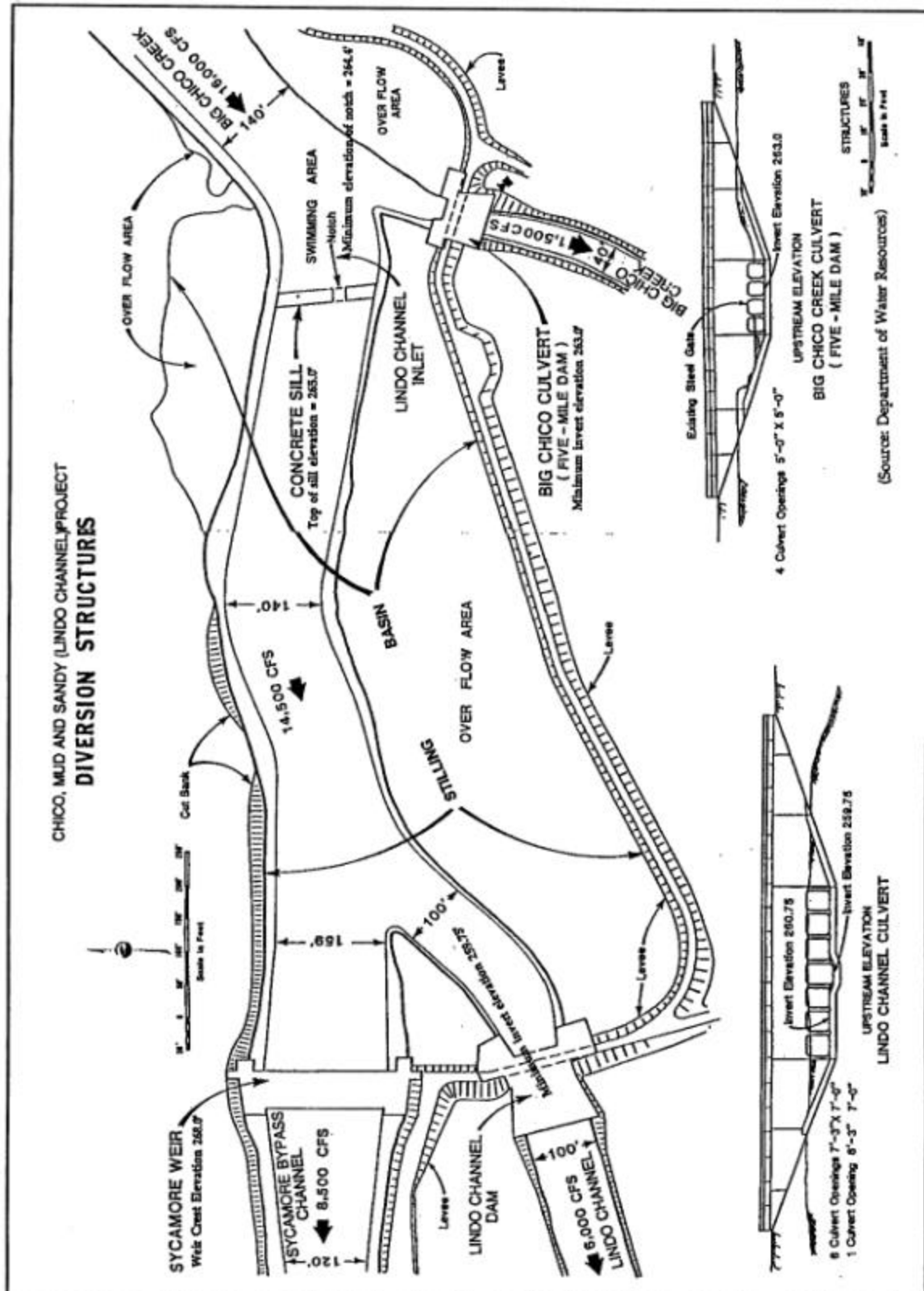


Figure 1.3: Chico, Mud, and Sandy Gulch Project Diversion Structures
Source: Department of Water Resources



Photo 1.1: Box culverts regulating flow on Big Chico Creek into Sandy Gulch.

that regulate flow on Big Chico Creek and pass water into Sandy Gulch (see **Photo 1.1**).

A nearby concrete weir controls flow into the Sycamore Creek Diversion Channel (see **Photo 1.2**). During high flows, water may overtop the weir and flow north in the diversion channel to the “south branch” of Sycamore Creek. During summer months, there is little or no flow in Sandy Gulch. In addition to overflow from Big Chico Creek, Sandy Gulch conveys runoff from

the adjacent urban area. Sandy Gulch flows rejoin Big Chico Creek west of the City of Chico.

According to an article prepared by Department of Water Resources (DWR), improvements designed to increase the capacity of Sandy Gulch to 6,000 cubic feet per second (cfs) were only partially completed so that even though the gate dam and other completed improvements were designed for 6,000 cfs, channel capacity in lower Sandy Gulch is less than 6,000 cfs (DWR, 1999a). DWR is finalizing a report due to be completed by the end of the summer 2001, which will determine the present flow capacity of Sandy Gulch, as well as the 1965 as-built flow capacity of the channel. The DWR report should help clarify outstanding questions related to both upper and lower Sandy Gulch flow capacity.

During high flow periods, Upper Big Chico Creek leaves the narrow foothill canyon at high velocities carrying substantial bed load (course materials that are dragged along the bed of a stream) until it encounters the Five-Mile Area stilling basin. At this point, the velocity and bed load mobilizing capacity is significantly reduced, causing larger sediment to fall out of the water column depositing gravel just upstream of the Five-Mile Area flow control structures.

The Corp's *Chico, Mud, and Sandy Gulch Channel Improvement and Levee Construction* project involved a maximum allowable flow down Big Chico Creek through the Big Chico Culvert at 1,500 cfs. Where Sandy Gulch splits off at Five-Mile the flow capacity is 14,500 cfs, until the Sycamore Diversion split which is capable of receiving 8,500 cfs, leaving the remaining flow in Sandy Gulch with the design capacity of 6,000 cfs (see **Figure 1.2**) (US Army Corps, 1961). The purpose of the flood control project was, and remains, to carry potentially damaging peak flood flows around the central portion of the City of Chico. The flood control structures are operated and maintained by Butte County in conjunction with the California Department of Water Resources (DWR).

Based on flow records from the DWR gage on Bidwell Avenue, which date back to 1956, Hydro Science concluded that some type of flood control was practiced on Big Chico Creek prior to the installation of the current flood control improvements in the mid-1960s (Hydro Science, 1999). It is important to note, however, that the installation of the high flow by-pass from Big Chico Creek-Sandy Gulch into Sycamore/Mud Creek has essentially “capped” the flows that can enter Sandy Gulch. Flows in excess of 1,500 cfs are diverted into Sandy Gulch. There are gates that limit inflows to ensure capacity is available for urban runoff (see **Photo 1.3**).

FLOOD CONTROL STRUCTURE MAINTENANCE AND FLOW CONSTRAINTS

Flood control improvements within the Chico Urban Area are maintained primarily by Butte County. Sandy Gulch improvement projects are funded by County Service Area #24, and administered by Butte County Public Works.

Historically, approximately every three years a large gravel bar that formed at the bifurcation of Big Chico and Sandy Gulch (Five Mile Area) was removed (up to approximately 200 yards of materials), or the channel reshaped to maintain the proper flow (EIP, 2000). However, more recently, according to the Butte County Public Works Department (Edell, pers. comm., April 2001), the California Department of Fish and Game (CDFG), has requested that Public Works



Photo 1.2: Concrete weir controlling flow into the Sycamore Creek Diversion Channel

no longer remove gravel at Five Mile due to aquatic resource concerns. As long as the concrete sill, located within the stilling basin, remains relatively clear of gravel, the 1965 flood control flow split system appears to function as planned (McCullom, pers. comm., April 2001).

According to Butte County's former Public Works Director, Jim Schultz, from the 1960s through the 1970s, after water levels receded, Sandy Gulch between Manzanita Avenue and Longfellow Avenue was cleared of large woody debris and the channel was straightened, flattened, and recontoured (Schultz, pers. comm., April 2001). The yearly clearing was performed to maximize water conveyance and ensure stream capacity. Much of Sandy Gulch's current configuration, including the raised banks in the upper channel, are a reflection of the early instream work conducted by the Butte County Public Works Department during these two decades.

CDFG has placed an additional constraint on flow maintenance in Sandy Gulch. CDFG allows diversion of Big Chico Creek flow into Sandy Gulch only if flows in Big Chico Creek are maintained at 75 cfs or greater, in order to maintain fish habitat. In the past, the City of Chico has manipulated gravels at the fork of the two waterways to direct some water into Sandy Gulch. The timing of these diversions was consistent with the CDFG policy - only during late spring and early summer. Under almost all circumstances, surface flows into Sandy Gulch cease in June or July, either as a result of natural conditions or because the 75 cfs criterion cannot be met (EIP, 2000).



Photo 1.3: Lindo Channel Dam at the Head of Sandy Gulch

2.0 HISTORIC LAND USES

Historic uses of Sandy Gulch were examined through the use of historical maps, aerial photos, interviews, review of documents, and field observations. Most of the area along Sandy Gulch has been affected by a variety of land use activities, including historic farming and ranching dating back to the middle of the 19th Century, and dredging for sand and gravel dating back to around the turn-of-the-Century through the 1980's. While these activities have substantially impacted segments of the channel, effects upon the channel have also accompanied intensive residential and related developments undertaken during the past four to six decades along both sides of the stream.

As part of this inventory, a comprehensive archaeological inventory survey (see Appendix A) was conducted for the entire Study Area. The study included an evaluation of documents and records maintained by the Northeast Information Center at CSU-Chico, consultation with the Mechoopda Tribe of Chico Rancheria and the Chico Museum, consultation with local historians and review of the City of Chico Planning Department records and plans, and a pedestrian archaeological survey.

Notwithstanding the effects of land use activities discussed below on lands within (gravel extraction) and adjacent to the stream channel (farming, and residential/commercial developments), archaeological sensitivity throughout this area was initially considered to range from moderate to high for both prehistoric and historic-periods sites and features.

AGRICULTURE

Sandy Gulch, like other streams in the Chico area, was first altered for agricultural development in the mid- and late-1800s when drainage and irrigation of land for farming and grazing was a priority. In general, this process involved deepening and straightening main channels, levee building, and filling subsidiary flood channels. In addition, vegetation growth along the sides of the channel and within the floodplain was usually stripped off, especially when land was used for grazing. Early aerial photographs show that agricultural and urban encroachment had sizeable influence on the stream corridor, including loss of riparian vegetation (see **Figure 2.1**).

URBANIZATION AND FLOOD CONTROL

A comparison of historical aerial photographs (see **Figure 2.1**) reveals the rapid urbanization along Sandy Gulch in the post-war era. The photos show a dramatic increase in urban cover and density, as well as the effects of channel encroachment and loss of subsidiary channels, which is clearly evident when comparing the 1944 and 1964 aerials for upper Sandy Gulch.

Reclamation practices were also employed to accommodate urban development. Early maps show construction and planned construction of bridges and subdivision development directly adjacent to the channel banks well before the turn of the century (see **Figure 2.2**). These practices potentially had an immediate effect by reducing stream corridor width and bank side vegetation. By the turn of the century, Sandy Gulch had been substantially altered from its pre-settlement condition.

Urbanization in the post-war period led to a series of flood control projects throughout California. As previously mentioned, the most notable flood control project for Sandy Gulch was the 1965 *Chico, Mud, and Sandy Gulch Channel Improvement and Levee Construction Project*. Again, the purpose of the project was to carry potentially damaging peak flood flows around the central

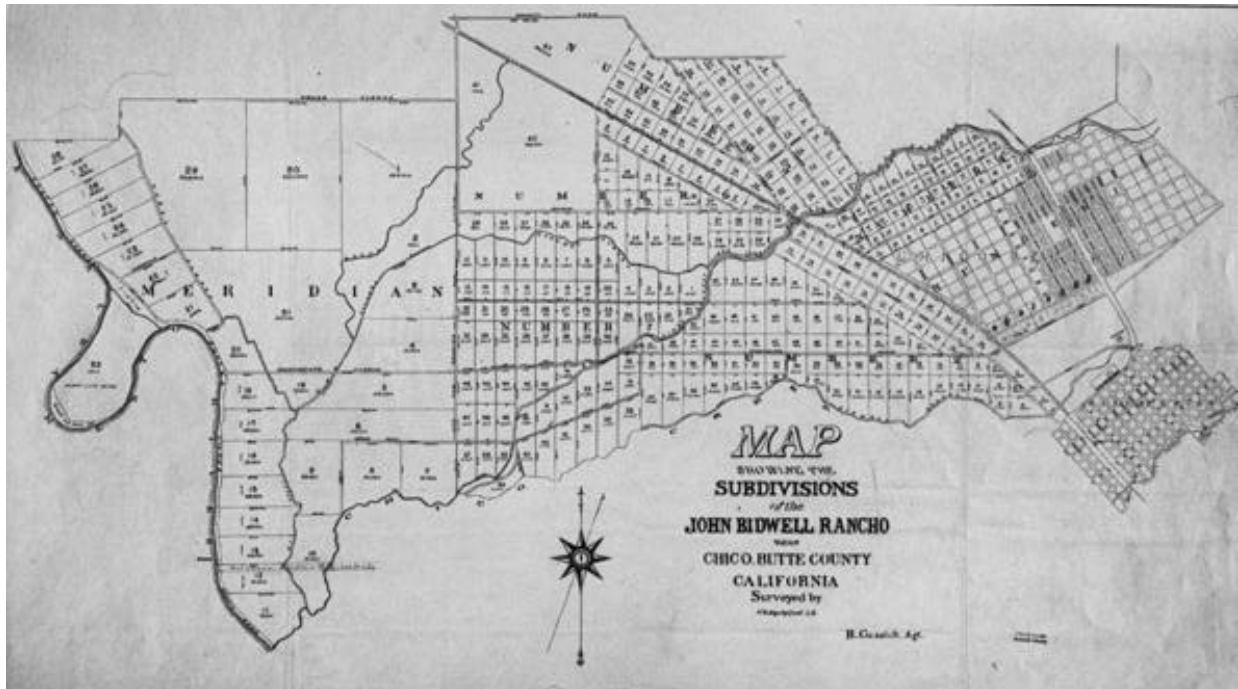


Figure 2.2: Map showing the Subdivisions of the John Bidwell Rancho, circa 1900.
Source: Special Collections, Meriam Library

portion of the City of Chico. This project affected flood flows and created a physical barrier that reduced sediment supply and channel shifting on Sandy Gulch.

GRAVEL MINING

Growth in Butte County and Chico over the last 50 years required rock, concrete, and asphalt, and an active stream channel bed such as Sandy Gulch provided a considerable source of aggregate. Alluvial deposits of gravel were mined for construction aggregate for use in concrete, asphalt, road base and sub-base, for fill, and for landscaping. When aggregate is mined from the active channel, as opposed to digging a pit, it is called instream mining. Instream gravel mining involves the physical removal of gravel from the streambed utilizing heavy equipment, including CATs, loaders, bulldozers, scrapers, crushers, and trucks.

Active channel deposits are particularly desirable as aggregate because river transport eliminates weak materials by abrasion and attrition and the resulting deposits are of high quality: durable, rounded, well-sorted, and relatively free of interstitial clay (Kondolf, 1991). Consequently, this gravel requires less processing than gravel from other sources. Also, transportation costs are a large part of the total production costs for aggregate and a gravel-bed stream, like Sandy Gulch, is conveniently located near urbanizing areas and highway routes that are major markets for construction aggregate. For a discussion of the potential impacts to Sandy Gulch from instream gravel mining review the *Bank Condition/Channel Stability* section of this report.

Based on interviews and a search of public records, it was determined that formal instream gravel mining operations on Sandy Gulch were conducted by several entities. These included the Butte County Public Works Department, Baldwin Contracting (previously Butte Creek Rock), Teichert Land Company, and a consortium of contractors known as Graff, Vickory,

2.0 HISTORIC LAND USES

Dubach, Wenchel & Schmall. In addition, according to interviews with individuals involved in the local gravel mining industry, until the 1980s “any individual with a gravel need would just pull their pick-up into the channel and take what they needed” (Alldredge, pers. comm., May 2001). The formal mining operations were generally located between Longfellow Avenue and Manzanita Avenue. Approximate locations of the sites have been added to the project GIS (see **Figure 2.3**). According to Butte County Public Works Director Stuart Edell, gravel mining was popular in this stretch because the bed material is self-sorted by the stream, so that the most useful gravel was deposited there (Edell, pers. comm., April 2001). Below are brief summaries of known gravel extraction operations in Sandy Gulch.

Butte County Public Works Department

According to Public Works personnel field notes, Butte County sustained some form of gravel extraction on Sandy Gulch from the early 1960s to the mid-1980s. The quantity of extraction is not clearly documented. Although, stockpiles were measured yearly, additions to and extractions from the stockpile during the year were not catalogued. According to discussions with past Public Works’ field crew members, the County would truck out crushed rock from the stockpile, which is still visible, just upstream from Longfellow for shoulder work, filling mud holes, and minor roadwork (see **Photo 2.1**). The County rock-crushing unit would visit the site



Photo 2.1: Butte County's old aggregate stockpile.

approximately every 10 years or as needed, in order to maintain a stockpile mound approximately 20 feet high and 200 feet long. The main supply area was called the “Ceanothus Pit” as it was located in Sandy Gulch adjacent to where Ceanothus Street is perpendicular with Sandy Gulch (see **Figure 2.3**). An additional stockpile was kept just downstream of Madrone Avenue on the southern side of the stream.

In addition, every three years a large gravel bar that formed at the bifurcation of Big Chico and Sandy Gulch (Five Mile Area) was removed (up to approximately 2000 yards of materials) or the channel reshaped to maintain the proper flow (EIP, 2000). Extracted gravel from the Five-Mile Area was stored on nearby levee banks for later use. However, more recently, the California Department of Fish and Game, due to aquatic resource concerns, has requested that the Public Works Department no longer remove gravel at Five Mile (Edell, pers. comm., April 2001).

Baldwin Contracting (previously Butte Creek Rock)

Baldwin Contracting harvested gravel on an approximately 12-acre parcel along Sandy Gulch upstream of Madrone Avenue from the 1950s to the 1960s (see **Figure 2.3**). A remnant of an old service road still exists along the southern edge of the parcel. The quantity of extraction is not clearly documented. A site visit and interviews suggest that the parcel was not harvested very aggressively, and that rock material was simply hauled off for local use. No crushing or processing facilities existed. The parcel has been deeded over to the City in 1996 and is currently zoned Open Space. The property is located between the Study Area and a 1980s subdivision. Where Sandy Gulch flows through the property, streambank stability is a concern being addressed by the City and adjacent residents.

Graff, Vickory, Dubach, Wenchel & Schmall

Beginning in the late-1950s and extending into the early 1960s, several contractors came together in a joint venture to meet the material and construction needs for building Highway 99 through the Chico area. The consortium, Graff, Vickory, Dubach, Wenchel & Schmall, was also known as the “Big 5”. Each company brought to the effort specific expertise needed to complete the large-scale project (i.e., earth-moving, gravel extraction, rock crushing, concrete pouring, etc.). While the gravel pits now known as Teichert Ponds (located adjacent to Highway 99 just south of Highway 32) provided the necessary rock material for Highway 99 between Highway 32 and East 1st Avenue, gravel from Sandy Gulch was the major source of aggregate used north of East 1st Avenue. According to Dick Alldredge, a former employee of both the “Big 5” and Baldwin Contracting, the gravel was “scraper hauled” down Sandy Gulch’s streambed from just upstream of Longfellow Avenue to Sandy Gulch’s terminus with Highway 99 (see Figure 2.3 Gravel Mining Locations). Gravel immediately downstream of Highway 99 was also “scraper hauled” for use on the Highway 99 project. There was widespread support from residents and local government for clearing and flattening the channel because it increased capacity and removed obstructions, which reduced localized flooding. Specific quantities of aggregate utilized were not documented, but based on the duration of extraction and interviews there was a “substantial” amount of gravel extracted from the channel for the Highway 99 project (Alldredge, pers. comm., May 2001).

Teichert Land Company

According to interviews with individuals involved in gravel mining along Sandy Gulch, Teichert harvested gravel on an 18-acre parcel along Sandy Gulch upstream of Longfellow Avenue from the late 1950s to the late 1960s (see **Figure 2.3**). Again, the quantity of extraction is not clearly documented. A site visit suggests that a majority of the 18-acre site was harvested, as the parcel is approximately 10 to 15 feet below adjacent parcels. The site is currently City parkland deeded over to the City in 1993. The property is adjacent to the Study Area and surrounded on three sides by subdivisions. A remnant haul road runs along the western edge of the property. The site had rock-crushing capabilities and a hot batch mix plant. Teichert provided varying sizes of aggregate, as well as asphalt, for local jobs (Alldredge, pers. comm., May 2001).

Lower Sandy Gulch Gravel Extraction

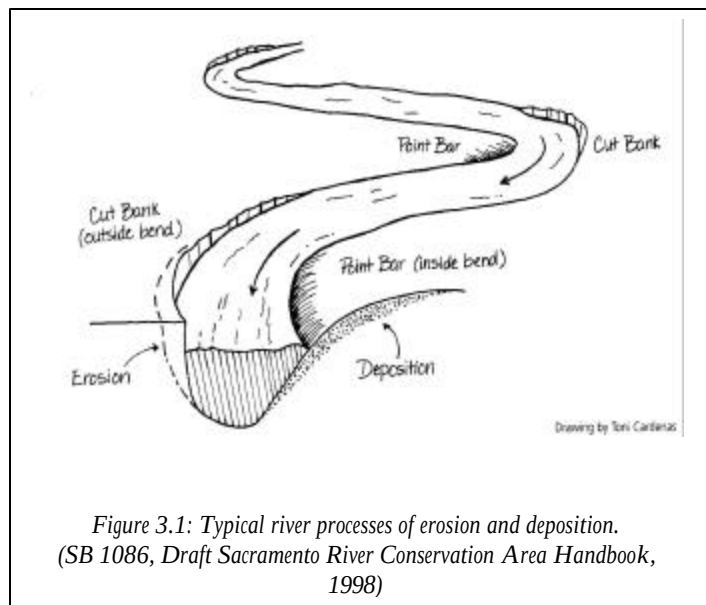
In 1987, DWR removed approximately ten to twelve thousand cubic yards of gravel from lower Sandy Gulch between Highway 32 and Grape Way (Corry, pers. comm., April 2001). According to Jim Schultz (2001), former Butte County Public Works Director, the channel was “cleaned out” in an effort to increase flow capacity to levels compatible with the 1965 flood control project.

3.0 BANK CONDITION / CHANNEL STABILITY

GENERAL BACKGROUND

Although streamflow and sediment supply can be highly variable, especially in streams within California, stream channels nonetheless tend to conform to “the most probable form” (Leopold, 1994). Despite the high degree in variation in flow, stream channels are often in a state of “dynamic equilibrium.” The processes of erosion and deposition within a channel are natural and never cease; the channel may migrate, but the overall form of the channel, i.e., its width, sinuosity, and meander belt width (see **Figure 3.1**), will overtime tend to remain constant. Bank erosion along the outside of a meander bend and deposition inside the bend on the point bar is a part of natural channel migration. However, this dynamic equilibrium can be disrupted, and when it is, the channel form can be expected to change.

Channel form is most directly controlled by those flows, which are capable of moving the bed material. Such material, in transit, is called “bed load.” While large amounts of bed load can be transported during extreme floods, such events may have little influence on the persistent channel form and width, which tends to reform following major floods. In 1994, the California Department of Water Resources (DWR) performed HEC-2 modeling as part of an investigation of the hydrologic and hydraulic conditions, and the impact of potential urban encroachment on water surface elevation, in Sandy Gulch. DWR is currently re-running HEC-2 modeling and a final report is due to be complete by the end of this Summer, which will determine the present flow capacity of Sandy Gulch, as well as the 1965 as-built flow capacity of the channel. This report should help clarify outstanding questions related to both upper (upstream of The Esplanade) and lower (downstream of The Esplanade) Sandy Gulch flow capacity.



Overall, however, channel form is more directly controlled by smaller floods, which occur with greater frequency. These smaller floods are the most important in defining and maintaining the channel geometry. The flow that transports the most bed load is referred to as “bankfull” flow. Bankfull discharge is defined by Leopold (1994) as:

The bankfull stage corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, are generally doing work that results in the average morphologic characteristics of channels.

Bankfull flow for most streams is generally in the range of the 1.5 to 2-year recurrence interval peak flow. The DWR modeling discussed above determined that the 1.5-year recurrence

3.0 BANK CONDITION/CHANNEL STABILITY

interval flow for Sandy Gulch was 1,300 cfs for upper Sandy Gulch. DWR's bankfull discharge level data has been added to the project GIS (see **Figure 3.2**) (DWR, 1999b).

A body of evidence indicates that channel geometry is proportional to bankfull flow. And because bankfull flow is strongly associated with peak flow with recurrence interval in the range of 1.5 to 2-years, it generally follows that changes in land use which increase the magnitude of this relatively frequent flow can affect channel morphology. This "rule of thumb", however, is somewhat muted by the control of flow into Sandy Gulch at the Five-Mile Area. Factors that affect channel morphology, and may cause bank instabilities, include anthropogenic alterations to bed load supply and stream flow. These variables are considered below in relation to streambank stability on Sandy Gulch.

CHANNEL STABILITY

Big Chico Creek flows out from the foothills, which are composed primarily of the Tuscan formation. The foothill soils are very shallow and cobbly and underlain largely by volcanic mud flows. The mud flows are consolidated and often very hard, the functional equivalent of bedrock. The mud flows dip down below the surface and extend westward onto the Valley floor. The majority of Sandy Gulch is within alluvial fan deposits (see **Figure 3.3**).

The actual geology and soils as they relate to channel morphology are much more complex than is shown on the general geologic map. The two most important considerations are that the gradation of surface materials in an east-west direction becomes progressively finer, and the fact that the Tuscan

formation, and perhaps remnants of other consolidated deposits of different origin, can be present in the bed or banks of the stream (see **Photo 3.1**).

These consolidated deposits are at sufficient depth that they are not specifically discriminated in soil mapping efforts. As Sandy Gulch flows westward, the occurrence of hardpan, Tuscan formation mudflow remnant, or other



Photo 3.1: Tuscan Formation in Sandy Gulch upstream of the Manzanita Avenue Bridge

functionally equivalent formations diminish. Similarly, the occurrence of cobble and gravels in the streambank also quickly diminishes. Generally, the preponderance of gravel, cobble, and hardpan or mudflow exposures occur in upper Sandy Gulch east of Highway 99.

Sandy Gulch does not receive late season flows emanating from the Big Chico Creek watershed. This is because Sandy Gulch is a flood overflow channel and CDFG only allows diversion of

3.0 BANK CONDITION/CHANNEL STABILITY

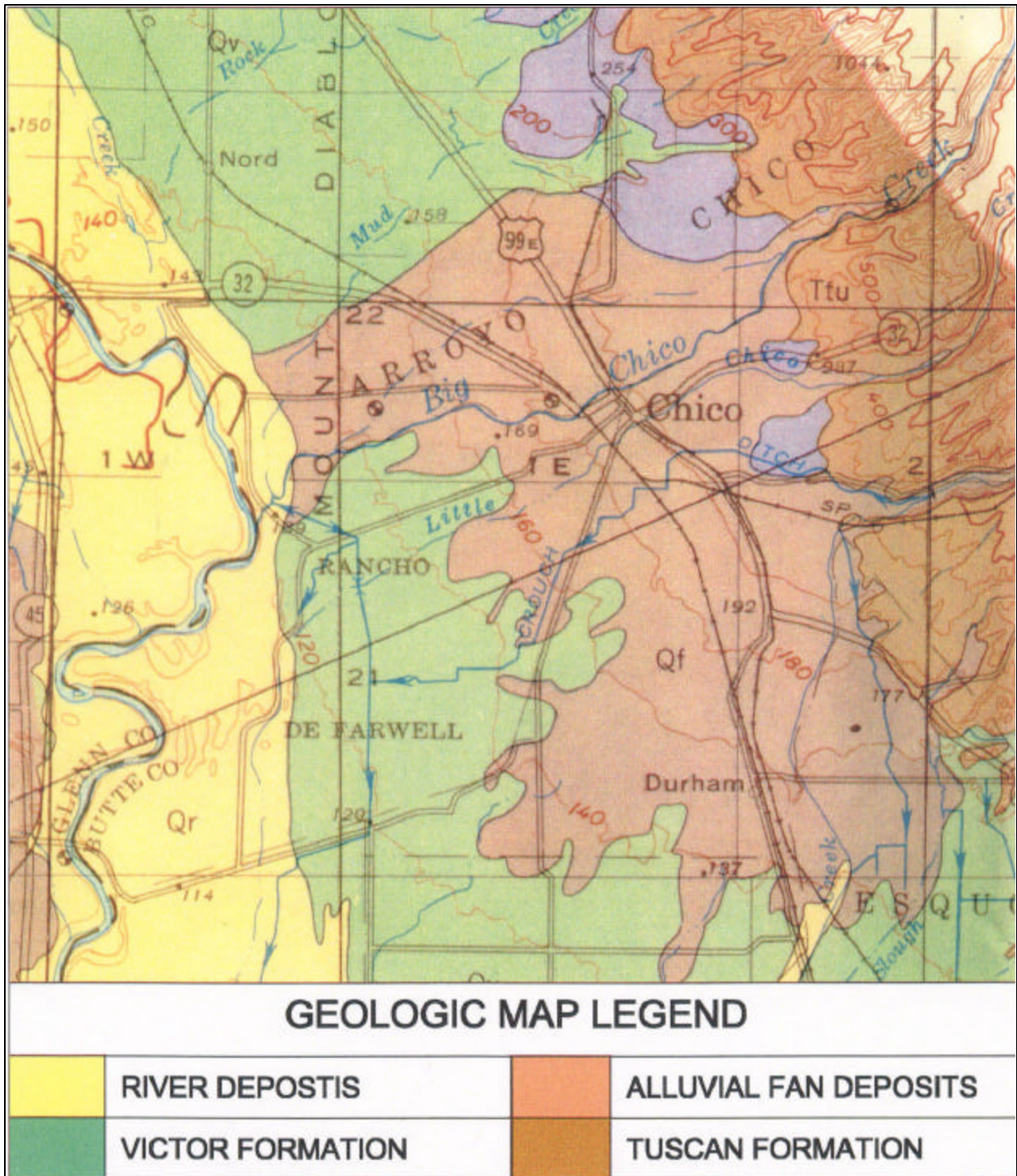


Figure 3.3: Geology of Study Area, Adapted from Swanson (USGS 1961).

3.0 BANK CONDITION/CHANNEL STABILITY

Big Chico Creek flow into Sandy Gulch if flows in Big Chico Creek are maintained at 75 cfs or greater. The lack of year round flow reduces the channel's potential to support riparian vegetation in its upper reach, such that overall, it has less bank stability. While landscape irrigation is probably an offsetting factor, it is still not as effective as streamflow in establishing woody vegetation in the channel. Additionally, Sandy Gulch east of Highway 99 is generally much wider than the lower reach because exposures of hardpan or mudflow deposits restrict the ability of the channel to erode downward, and, as a result, there has been more lateral erosion (Hydro Science, 1999).

In Sandy Gulch's lower reach, west of Highway 99, the materials composing the alluvial fine become very well sorted and virtually devoid of cobble and gravel. Here the channel generally becomes more "entrenched" (narrow and deep). This entrenchment is both a function of a lack of erosion resistant materials on the bottom, but also of the interaction of the streambed materials and streamside vegetation. However, as mentioned above, there are periodic outcrops of hardpan materials that control vertical erosion. These occurrences provide local bank stability and also act as structural vertical controls.

Although the channel banks themselves typically lack erosion resistant cobbles and are more uniformly sandy in texture, these attributes, unlike Sandy Gulch's upper reach, allow deep-rooted woody vegetation to flourish (see **Photo 3.2**). This relatively dense cover of riparian vegetation stabilizes the banks through the influence of roots and through physical protection of the banks by stems, limbs, exposed roots, and the trunks of trees (Hydro Science, 1999). The bank materials in some locations also have a large enough percentage of clay to add some cohesive strength to the banks. Overall, however, it is the existence of the dense riparian vegetation, which maintains the high steep banks and allows the existing entrenchment to persist.



Photo 3.2: Deep-rooted riparian vegetation along lower Sandy Gulch.

3.0 BANK CONDITION/CHANNEL STABILITY

It is important to recognize that the present stability of Sandy Gulch is greatly influenced by past formal and informal flood control measures, which have been in place for several decades. Flood control activities serve as a fundamental backdrop for understanding Sandy Gulch, since in many cases they have substantially changed the hydrology of the stream, which has, in turn, caused changes in the geometry and character of the channel (Hydro Science, 1999). According to former Butte County Public Works Director Jim Schultz, prior to the formal 1965 flood control improvements, Sandy Gulch between Manzanita Avenue and Longfellow Avenue was dragged with scrapers to straighten and flatten the channel. Additionally, informal levees were “pushed up”, giving this portion of the stream the configuration it has today (Schultz, pers. comm., April 2001).

Installation of the 1965 high flow by-pass from Big Chico Creek-Sandy Gulch into Sycamore/Mud Creek has essentially “capped” the flows that can enter Sandy Gulch. According to the City of Chico’s Environmental Impact Report for the Storm Drainage Master Plan (EIP, 2000), existing and future peak flows for Sandy Gulch are essentially the same. During storm events, there may be a minor increase in runoff rates associated with increased development, but the increase in runoff occurs before the introduction of high flows from the upper Big Chico Creek watershed. The capping effect of the flood control project serves to “dull” flood flow peaks with an attendant reduction in sediment transport capacity.

As discussed above, another effect of the “maintenance” of Sandy Gulch is a lack of year round base flows which limits the amount of bank stability provided by riparian vegetation; therefore, localized bank erosion and bar formation processes are expected to continue. A bed mobility analysis prepared for the City of Chico’s Storm Drainage Master Plan concluded that the median-sized bed material is unstable in Sandy Gulch (EIP, 2000). A lack or diminishment of replacement bed load and suspended load trapped at the stilling basin and above the screw gate structure at the head of Sandy Gulch may yield a situation where the larger materials are slowly moved out of the system without replacement. Water released below the flood control structures with reduced bed load and suspended load is relatively clear water, or “hungry water”, which has excess energy and typically erodes its bed and banks to regain at least part of its sediment load.

Conversely, however, the flood control improvements have partially tempered the excess stream power of “hungry water” by reducing the flood flows. In the lower reaches of Sandy Gulch where the banks lack gravels and cobbles, the potential for localized erosion is heightened. One mitigating factor to further erosion on Sandy Gulch is the previously discussed outcrops of Tuscan formation mudflows, or similar deposits which resist incision.

In addition to the diminishment of bed material replacement caused by the flood control improvements, a substantial amount of bed material has been extracted from Sandy Gulch, as gravel mining was a common practice between Longfellow (Mariposa) Avenue and Manzanita Avenue from the 1950s into the 1980s. For a discussion of gravel mining and other historical uses of Sandy Gulch please review the *Historical Land Uses* section of this report.

Instream gravel mining involves the direct removal of streambed sediments by heavy equipment usually conducted during low water, resulting in a local depression in bed profile. During subsequent high flows, bed material transported from upstream is deposited in the depression, depriving downstream reaches of bed load sediment supply, potentially inducing incision downstream of the gravel mining operation (Kondolf, 1993). This incision can propagate upstream and downstream of the mining site, undermining bridges and other structures and

3.0 BANK CONDITION/CHANNEL STABILITY

causing channel instability such as bank undercutting and channel widening. Channel widening and incision can both lead to the loss of riparian habitat, which can further destabilize streambanks. While a fluvial geomorphic study has not been conducted for Sandy Gulch, there is sufficient evidence that the balance between stream power and bed load supply has been altered in Sandy Gulch as a result of the flood control improvements, and to a lesser degree gravel mining. However, Sandy Gulch presents an interesting case. Over the last 60 years, the channel has been so regularly manipulated throughout its entire course for both flood control and gravel mining purposes, that the large-scale impacts associated with these activities most certainly override the incremental downstream and upstream effects of site-specific gravel mining.

RELICTUAL CHANNEL

According to Hydro Science (1999), analysis of historic aerial photographs and maps has generally not revealed significant gains in channel width or shifts in alignment. However, one stretch of Sandy Gulch between Manzanita Avenue and Longfellow Avenue, in particular, has shifted significantly from its original channel alignment. This shift is clear when comparing Sandy Gulch's current stream channel against the relictual, or Bidwell-deeded, stream configuration (see **Figure 3.4**). Over the past century, this stretch underwent a change in pattern from a wide multi-channeled configuration to a more sinuous, mostly single-thread channel. The channel has "straightened out" and now flows north of its historic channel through a parcel deeded over to the City by Baldwin Contracting in 1996. As evidenced by Sandy Gulch's main channel in relation to the private parcels adjacent to the Baldwin-deeded property (shown in yellow), the stream continues to laterally erode at the outside of the meander bend. Significant bank protection measures are in place along the outside of the streambank to



Photo 3.3: Rip-rap in place as bank protection measure.

3.0 BANK CONDITION/CHANNEL STABILITY

protect structures and property (see **Photo 3.3**). It is unclear why the stream channel shifted so significantly in this stretch. Possible scenarios include: 1) during high flows the stream either denuded or jumped the bank and reclaimed an historic channel, or 2) the old channel (which matches the Bidwell-deeded area) was filled and flows redirected, and therefore either a concerted public or private effort was undertaken to shift Sandy Gulch's channel, perhaps for flood control concerns. Other possible explanations include, reduced rates of bed load sediment supply, a decrease in flood peaks and sediment transport capacity, or possibly prolonged bankfull flows. There is a significant remnant riparian forest where the channel historically flowed (see **Photo 3.4**). The area is currently an upland zone adjacent to existing homes used as open space.



Photo 3.4: Remnant riparian forest where channel historically flowed

SUMMARY

Any channel erosion in Sandy Gulch in the future will likely be associated with individual storm flows, local scour at outfalls, or minor shifts in the channel thalweg (location of the low flow “thread” within the channel), which could redirect flows into erodible banks potentially threatening structures and property (EIP, 2000). Sandy Gulch's streambank has moderate to high erodibility such that continuing flood flow diversions into the channel, in addition to the disruption of sediment supply caused by the floodgates at the head of the channel, continue to influence channel morphology. Based on field surveys, localized incidences of bank erosion that threaten private property adjacent to Sandy Gulch have been identified and added to the GIS (see **Figure 3.5**).

Although currently no system-wide effects on channel stability are apparent, the effect of flood control improvements, including diminished bed load supply, limited base flow, and capped

3.0 BANK CONDITION/CHANNEL STABILITY

peak flows, have had localized impacts on the stability of Sandy Gulch. According to the Hydro Science Report (1999), Sandy Gulch may be prone to minor shifting and local occurrences of erosion over time, but, overall, it is expected to hold the same channel dimensions. There is insufficient evidence to precisely determine what the future risk of incision or lateral erosion may be.

Instances of localized bank erosion have increased formal and informal efforts to maintain and enhance bank stability. Even when bank erosion results from natural stream processes, resources (i.e., property, structures) threatened by erosion or flooding have created the demand for bank protection measures. The majority of bank protection measures on Sandy Gulch are considered hard, or “engineered.” This includes placement of gabion baskets, riprap, masonry walls, concrete walls, and boulder walls along the channel toe or banks. In addition, there are many informal bank protection efforts, which utilize material such as concrete rubble or yard waste (see **Photo 3.5**). Bank armoring measures are predominantly located at bridge crossings and at the outside of meander bends where structures and property are at risk. Based on field surveys, local bank protection measures along Sandy Gulch within the Study Area have been identified and added to the GIS (see **Figure 3.5**).

A study detailing bank erosion areas, and potential remedies, along Sandy Gulch, between Manzanita and Madrone avenues, was recently finalized for the City by Interactive Design (2000). The report provides “soft” biotechnical engineering techniques, which utilize combinations of willow cuttings, logs, boulders, and geotextile fabric, to reinforce banks, but also provide aquatic habitat. The biotechnical techniques matrix and graphics are provided as **Appendix B** to this report.



Photo 3.5: Example of informal bank protection measures.

4.0 BIOLOGICAL RESOURCES

METHODS

The primary purpose of this investigation was to document and map the distribution of blue elderberry shrubs (*Sambucus mexicana*) along a six-mile section of Sandy Gulch in Chico, California. Field surveys were conducted on 3/12/01, 4/9/01, 5/2/01, 5/3/01, 5/5/01, 5/15/01 and 5/16/01. The study area was first defined on an aerial photograph. The study area included the bed and banks of the topographical drainage as well as any undeveloped habitat that extended beyond to developed or landscaped private property. For the Study Area in Bidwell Park east of Manzanita Avenue, a 30' distance from the top of the bank was surveyed. This study corridor was walked entirely on foot. The entire channel and banks were surveyed from within the bed. Where lateral visibility was limited, surveys were also conducted along the upper banks from the outside edge.

Elderberry plants and plant clusters were mapped with a Trimble GeoExplorer 3 global positioning system (GPS) unit as either a point or line feature. In cases where the GPS unit was not receiving signals, the bushes were mapped by hand onto 1:40,000 scale aerial photographs. Since the accuracy of differentially corrected features from a GeoExplorer 3 is within three meters, plants less than 30 feet from each other were considered as a single mapped point or line feature. Due to the often-impenetrable structure of riparian vegetation and the large bushes and bush clusters, no attempts were made to delineate the clusters as polygons or to determine the number of plants or stems occurring within a colony. The survey results are found in **Figure 4.1**. The results represent a baseline inventory and are intended for use as a planning tool, not for site-specific analysis. **Figure 4.1** provides an excellent summary of both the number and distribution of bushes and clusters within the study area. Due to the denseness of riparian vegetation in some portions of the stream corridor, as well as the large survey area, there is a high potential that individual plants may be omitted.

A search of the California Department of Fish and Game Natural Diversity Data Base (CNDDDB 1999) for the Chico, Richardson Springs, Nord, and Ord Ferry USGS 7.5' Quadrangles was conducted to determine whether any rare, threatened, or endangered plant or animal species are known to occur or have potential habitat within the Study Area.

RESULTS

A query of the CNDDDB covering all four USGS 7.5' Quadrangles listed above revealed occurrences of 11 special-status plant and 14 special-status animal occurrences. However, none of the reported CNDDDB occurrences are located within 250' of the Sandy Gulch Study Area corridor. Tables 4.1 and 4.2 list each of these species and their habitat preferences.

Special-Status Plant Species

The CNDDDB listed occurrences of 11 special-status plant species within the four-quad search performed for this project. The results of the search are listed in Table 4.1, which includes each species' current status, habitat preference, and whether habitat necessary to support the species is present within the Study Area. As Table 4.1 reveals, no suitable habitat exists within the Sandy Gulch Study Area to support any of the listed occurrences.

Special-Status Wildlife Species

Table 4.2 provides a summary of the 13 special-status wildlife occurrences listed by the CNDDDB as well as results of a literature search of the area. Of the animals within this group, it was determined that suitable habitat exists within the Sandy Gulch Study Area for two of the species. One species, the Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*) inhabits blue elderberry shrubs that are common within the Study Area. Potentially suitable spawning and rearing habitat also exists for several special-status anadromous fish species, including spring-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead trout (*Oncorhynchus mykiss*) (EIP Associates, February 2000).

Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)

Although the 1999 CNDDDB query did not report Valley Elderberry Longhorn Beetle (VELB) as occurring in Sandy Gulch, the Draft Environmental Impact Report for the Storm Drainage Master Plan, prepared for the City of Chico, mentions its occurrence within the channel (EIP Associates, 2000). The CNDDDB does list VELB occurrence nearby in Bidwell Park. It should be noted that a single mature female Valley Elderberry Longhorn Beetle was observed during the course of the present survey. This individual was on a large blue elderberry bush located north of The Esplanade, on the south bank of the channel, on the north side of West Sandy Gulch Avenue.

The VELB depends entirely on elderberry plants (see **Photo 4.1**) for food and reproduction;



Photo 4.1: Blue elderberry located along Sandy Gulch

therefore, elderberry plants themselves are protected as critical habitat. Blue elderberry shrubs are very common along the channel and in many places occur as the dominant shrub species (see **Figure 4.1**). In the lower section of the channel west of The Esplanade, blue elderberries are the primary shrub component of the riparian corridor. Although some elderberries occur as isolated and discrete plants, the majority of these shrubs occur in very large and dense colonies with hundreds of stems greater than one inch in diameter at ground level (an important consideration for VELB).

The upper section of the channel east of The Esplanade generally lacks well-developed riparian vegetation and supports fewer blue elderberry shrubs. There are also a number of non-native plant species and several occurrences of noxious weeds including French-broom (*Genista monspessulana*), giant reed grass (*Arundo donax*), periwinkle (*Vinca major*), English-ivy (*Hedera helix*), Chinese firethorn (*Pyracantha fortuneana*) and yellow star-thistle (*Centaurea solstitialis*). Owing to these factors, the suitability of habitat for VELB is probably reduced to a certain extent along this segment.

Chinook Salmon (*Oncorhynchus tshawytscha*) and Steelhead Trout (*Onchorynchus mykiss*)

Sandy Gulch downstream of the Five Mile Recreation Area has the potential to provide marginal salmon and steelhead spawning and rearing habitat. (EIP, February 2000). According the City of Chico's Storm Drainage Master Plan, steelhead trout and fall, late-fall, and spring-run Chinook salmon are known to have used this area (EIP, 2000). However, gravel recruitment and water quality are concerns due to upstream flood control structures. In addition, a lack of flushing flows has resulted in armoring, compaction, and siltation of spawning gravel in the channel. The suitability of the gravel for anadromous fish spawning has been the subject of a Master's Thesis at CSUC and Dr. Paul Maslin has studied the use of intermittent Sacramento Valley watercourses (such as Sandy Gulch) for use as anadromous fish rearing habitat.

TABLE 4.1. SPECIAL-STATUS PLANT SPECIES

<i>Species</i>	<i>Status (Fed/State/CNPS)</i>	<i>Habitat Type</i>	<i>Habitat Potential in Study Area</i>
Adobe-lily <i>Fritillaria pluriflora</i>	SC/--/1B	Heavy clay soils of valley and foothill annual grassland	None
Ahart's paronychia <i>Paronychia ahartii</i>	SC/--/1B	Thin , rocky, clay soils in valley and foothill annual grassland	None
Butte County Checkerbloom <i>Sidalcea robusta</i>	SC/--/1B	Rocky bluffs, slopes and draws in blue oak woodland and savannah and shrub communities	None
Butte County fritillary <i>Fritillaria eastwoodiae</i>	FSC	Brushy areas and roadcuts in foothill woodland and lower coniferous forest	None
Butte County meadowfoam <i>Limnanthes floccosa ssp. californica</i>	E/E/1B	Vernal pools and swales	None
California beaked-rush <i>Rhynchospora californica</i>	--/--/1B	Seep wetlands	None
California Hibiscus (Rose-mallow) <i>Hibiscus lasiocarpus</i>	--/--/2	Seeps and wetlands	None
Fox sedge <i>Carex vulpinoidea</i>	--/--/2	Perennially moist gravel bars and marshy areas	None
Red Bluff Dwarf Rush <i>Juncus leiospermus var leiospermus</i>	--/--/1B	Vernal pool edges and seasonally wet sites, often in clay or rocky areas	None
White-stemmed clarkia <i>Clarkia gracilis ssp. albicaulis</i>	--/--/1B	Roadcuts and openings on dry brushy slopes in foothills and lower coniferous forest	None
Woolly meadowfoam <i>Limnanthes floccosa ssp. floccosa</i>	--/--/4	Vernal pools and swales	None

Source: CA Dept of Fish and Game Natural Diversity Database, Special Plants List, updated April 2000.

Notes: E=Endangered; R=Rare; SC= Federal Species of Concern = species that are in danger of extinction throughout all or a significant portion of its range.

List 1B = plants that are rare, threatened, or endangered in California and elsewhere.

List 2 = plants that are rare and endangered in California, but more common elsewhere.

List 4 = plants of limited distribution – a watch list.

TABLE 4.2 SPECIAL STATUS WILDLIFE SPECIES

Species	Status (Fed/State)	Habitat Type	Habitat Potential in Study Area
Bank swallow (nesting) <i>Riparia riparia</i>	ST	Colonizes vertical eroded sandbanks along riparian corridors	None
Burrowing owl (Burrow sites) <i>Athene cunicularia</i>	FSC	Nests in ground squirrel holes in valley and foothill annual grassland	None
California linderiella <i>Linderiella occidentalis</i>	--	Vernal pools	None
Chinook Salmon <i>Oncorhynchus tshawytscha</i>	FT, ST	Spawns in clean oxygenated gravels; permanent, and to some extent, seasonal creeks provide rearing habitat for smolts	Present (marginal)
Great blue heron (Rookery) <i>Ardea herodias</i>		Nests in tall trees, occasionally shrubs and rarely on the ground near lakes, rivers and other bodies of water	Development, vehicle and pedestrian traffic limits quality of nesting and foraging habitat
Great egret (Rookery) <i>Ardea alba</i>	---	Nests in tall trees in undisturbed areas	Development, vehicle and pedestrian traffic limits quality of nesting and foraging habitat
Osprey (nesting) <i>Pandion haliaetus</i>	--	Nests in tall trees in or near riparian areas, lakes and other permanent bodies of water	Development, vehicle and pedestrian traffic limits quality of nesting and foraging habitat
Steelhead Trout <i>Onchorynchus mykiss</i>	FT, ST	Spawns in clean oxygenated gravels; permanent, and to some extent, seasonal creeks provide rearing habitat for smolts	Present (marginal)
Swainson's hawk (nesting) <i>Buteo swainsoni</i>	ST	Riparian areas and oak savanna	Development, vehicle and pedestrian traffic limits quality of nesting and foraging habitat
Tricolored blackbird (nesting) <i>Agelaius tricolor</i>	FSC	Colonies nest in freshwater emergent marsh near open water	None
Valley elderberry longhorn beetle <i>Desmocurus californicus dimorphus</i>	FT	Blue elderberry bushes are the sole host plant	Present
Vernal pool fairy shrimp <i>Branchinecta lynchi</i>	FT	Vernal pools	None
Vernal pool tadpole shrimp <i>Lepidurus pac kardi</i>	FE	Vernal pools	None
Western Yellow-billed cuckoo (nesting) <i>Coccyzus americanus occidentalis</i>	SE	Well-developed, relatively undisturbed riparian forest	None

Source: CA Dept of Fish and Game Natural Diversity Database 1999.

Notes: FSC= Federal Species of Concern; FT= Federally Threatened; FE= Federally Endangered; SE= State Endangered; ST=State Threatened

REPORT PREPARERS

Geo Environmental Management, Terri Lee Eagan – Project Director

Pacific Municipal Consultants, Brendan Vieg, Project Manager

Pacific Municipal Consultants, Kent Lundberg, Project Manager

Peter M. and Sean Jensen, Jensen and Associates, Archaeologists

Josephine Guardino, Botanist

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