Conceptual Drainage Assessment

COVELO/ ROUND VALLEY NON-MOTORIZED NEEDS ASSESSMENT AND ENGINEERED FEASIBILITY STUDY

Prepared For

CALIFORNIA DEPARTMENT OF TRANSPORTATION AND MENDOCINO COUNCIL OF GOVERNMENTS

Prepared By

RAU AND ASSOCIATES, INC.
CIVIL ENGINEERS • LAND SURVEYORS
100 NORTH PINE STREET - UKIAH, CA 95482 - (707) 462-6536

November, 2013

Rau Job No.: R12007.2

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RAU AND ASSOCIATES INC.
CIVIL ENGINEERS • LAND SURVEYORS

November 14, 2013
Job Number: R12007

GHD, Inc.
718 Third Street
Eureka, CA 95501

RE: CONCEPTUAL DRAINAGE ASSESSMENT- COVELO/ROUND VALLEY NON-MOTORIZED NEEDS ASSESSMENT AND ENGINEERED FEASIBILITY STUDY

Dear Client:

This report is to provide a summary of the drainage patterns and runoff characteristics for the three highest priority improvement projects proposed for inclusion in the Covelo/Round Valley non-motorized needs assessment and engineered feasibility study. These priorities are 1)trails or walkway improvements on State Highway 162 (SH 162) from Howard Street north to Hurt Road/Mina Road/SH 162 intersection, 2) the intersections of Foothill Boulevard, Henderson Way/Howard Street/Airport Road, and 3)a cross country trail on Tribal Lands from Henderson Way to SH 162. The cross-country trail will be generally east-west at the northern edge of APN 033-013-12. This parcel is owned by the Round Valley Indian Tribes and joins SH 162 just south of the Tribal Economic Center and Hidden Oaks Casino at 76700 Covelo Road. The existing surface drainage patterns and storm drain conveyance system are summarized, with existing site soil and topographic conditions described as they coincide with the proposed trail pathways or sidewalk improvements.

If any questions arise concerning this report, please do not hesitate to call me.

Very truly yours,

George C. Rau
Registered Civil Engineer 21908
Expires 9-30-2015

Introduction and Summary

The highest priority route for non-motorized circulation is along State Highway 162 (SH 162) from Howard Street (Milepost 29.18) to the intersection of Hurt Road, Mina Road and SH162 (Milepost 30.77). The proposed route is along the western shoulder of SH 162. In this area, drainage generally flows west to east and crosses under SH 162. Soil types vary from gravelly sandy loams to clay loams, with runoff factors ranging from 0.27 to 0.30 because all of the area is relatively flat with average slopes ranging from 0% to 5%. At the north end, SH 162 appears to be elevated enough to divert the runoff laterally towards Mill Creek, but the topographic mapping did not extend far enough to the west to confirm this supposition.

The second and third priorities are a cross-country trail from Henderson Road to SH 162 and the improvement of pedestrian facilities at the intersection complex where Foothill Boulevard, Henderson Road, Howard Street and Airport Road intersect in the heart of the public school complex. The soil type in both of these areas is fairly permeable, consisting of gravelly and very gravelly sandy loam.

Drainage facilities appear to range from generally adequate to impeded along SH 162, with some of the small cross-drain culverts and most of the longitudinal culverts partially filled with sediment. Drainage facilities are typically undersized or inadequate during storms of prolonged duration or higher intensities in the areas of the second and third priorities.

Trail and walkway improvements are generally small in incremental size to the overall areas which are currently impermeable, but there is an opportunity to use some low impact development (LID) concepts such as bioswales, raingardens and pervious surfacing in some areas to either reduce impacts of future development of non-motorized facilities, or reduce current seasonal flooding conditions. The downtown area around the schools and around the intersection of Howard Street with SH 162 are two locations where this strategy may be particularly effective because the underlying soils are gravelly. A shallow seasonal water table may limit the depth of the zone of potential infiltration.

Overview of Storm Water Runoff Drainage Areas

TRAIL CORRIDOR DRAINAGE AREAS

The drainage areas along the three highest priority non-motorized routes were assessed by studying a recent Project Study Report (PSR) prepared by Caltrans (Reference 1), by visual observation, by mapping drainage subareas on quadrangles (References 2 and 3), and by interviewing highway maintenance personnel in the area. Then, underlying geology (References 4 and 5) and soil characteristics were correlated to each drainage basin based upon the soil mapping performed by the National Resources Conservation District (Reference 6). Flood Plain mapping (Reference 7), and drainage basin information (Reference 8) were reviewed for pertinent information.

Geologically, Round Valley is considered to be formed by a down-faulted block or graben partially filled with alluvium from two different ages. The first layer is from Pliocene and Pleistocene age; the second (top) layer is of Holocene Age (Reference 9). Subsidence of the valley with respect to the mountains occurred repeatedly during Holocene times and resulted in unconsolidated alluvial deposits up to 800 feet thick (Reference 9).

Soil types were identified from the National Resources Conservation District (Reference 6). A general characterization of soil types and permeability of each drainage basin is as follows:

- Intersections at Foothill Boulevard, Henderson Road, Airport Road, and Howard Street: are underlain by Talmage very gravelly sandy loam, 0-2% slopes (#204.) This soil type is described as having moderately rapid permeability, with a range of 2.0-6.0 in/hr in the upper 33 inches, 6.0 to 20.0 inches per hour below 33 inches.

- The proposed cross-country trail between Henderson Road and SH 162 is underlain primarily by Russian loam, Gravelly substrate (#190) and Talmage Gravelly sandy loam (#203). The western end is shown to be underlain by Gielow sandy loam (#128). Permeability of these soils ranges from 0.6 to 2.0 inches per hour in the Russian Loam to up to 20 inches per hour below about 33 inches in the Talmage Gravelly sandy loam.

- Along State Highway 162 (South to North from PM 29.181 to PM 30.77)

    - Howard Street to East Lane (PM 29.181 to PM 29.37): consists of Cole clay loam, 0-2% slopes (#115.) The permeability is slow in this soil type since silt and clay are the predominate constituents in this soil. It has a listed permeability range of 0.2-0.6 in/hr in the top 8 inches and a range of 0.06-0.2 in/hr below a depth of 8 inches
    - Cross Country Trail, SH 162 to Henderson Road (PM 29.37 to PM 29.67): consists of Russian loam, with gravelly substratum and 0-2% slopes (#190) and Talmage gravelly sandy loam, 0-2% slopes (#203.) Permeability in the Russian loam is moderate to a depth of 30 inches and rabid below that where the soil type becomes more gravelly and sandy. Its permeability ranges from 0.6-2.0 in/hr in the top 30" and 2.0-6.0 in/hr below 30". The Talmage soil has moderately rabid permeability with a range of 2.0-6.0 in/hr.
    - Cross Country Trail to Biggar Lane (PM 29.67 to PM 30.30): consists of Gielow sandy loam, 0-5% slopes (#128.) This soil has moderate permeability, with a range of 0.6-2.0 in/hr.
    - Biggar Lane to the Tribal Community Center (PM 30.30 to PM 30.66): consists of Russian loam, 0-2% slopes (#188) and Talmage very gravelly sandy loam, 0-2% slopes (#204.) The Russian loam is moderately permeable while the Talmage soil has moderately rabid permeability. The Russian loam has a range of 0.6-2.0 in/hr and the Talmage soil ranges from 2.0-6.0 in/hr.
    - From the Tribal Community Center to Intersection of Hurt Road and SH162 (PM 30.66 to PM 30.75): consists of same soil (#115) as first section between PM 29.181 and PM 29.37, see above.
    - Intersection of SH 162 and Hurt Road (PM 30.75 to PM 30.77): consists of Pinole gravelly loam, 0-2% slopes (#177.) The permeability of this soil type is described as being moderately slow. It has a permeability range of 0.6-2.0 in/hr in top 25" and 0.2-0.6 in/hr below 25".

In general, the permeability of the underlying soil along the full length of the proposed trail which parallels SH 162 ranges from moderate permeability in the Russian loams to slow to very slow permeability in the Cole clay loam and Gielow sandy loam. When prolonged rainfall

events occur, the slowly permeable soils are quickly saturated and most of the rainfall runs off, similar to paved surfaces.

A summary of drainage basin characteristics is found on the following page. A copy of the soil type map, soil type descriptions and characteristics, and the basis for calculating the runoff factor for each soil type is found in Attachment 2.

Overview of Storm Water Conveyance Systems

A "Drainage Area" and Culvert Location Map" is located in Attachment 1 to this report. It provides an overview of the areas in Round Valley which have the highest priority for improvements which will aid the non-motorized movement of people in the areas of most critical need. The map shows culvert locations along SH 162 which will be affected by construction of a trail or pathway. It also shows the largest drainage basin which drains towards SH 162 and passes under SH 162 in a dual culvert installation at PM 30.01. This drainage basin was estimated by Caltrans to have an area of approximately 721 acres. The remaining drainage basins ranged from about 1 acre to 166 acres, as estimated by Caltrans, but the mapping of these watersheds was not included in the scope of this study and their boundaries were not clear from simply observing the flat topography. Therefore, only the largest basin with relatively distinct boundaries was mapped.

The culverts, ditches, and curb and gutter sections were all mapped as part of the strip mapping performed for the development of the conceptual plans for non-motorized movement of people and are annotated on the topographic maps developed for the project. Structures and their drainage characteristics found within each of the projects included in the three highest priorities are discussed in the following sections.

INTERSECTIONS AT FOOTHILL BOULEVARD/HENDERSON ROAD/HOWARD STREET/AIRPORT ROAD

According to the Area County Road Foreman, Tim Hopkins, the area of these four intersections is poorly drained and leads to flooding in front of the Covelo High School on Howard Street. Observations revealed a ditch on the south side between the paved walkway leading from west to east along Foothill Boulevard. At Henderson Road, the ditch has an 8 inch diameter culvert under the walkway, followed by another ditch segment along the west side until it reaches the first driveway on the west side in front of the elementary school. There is a badly crushed corrugated pipe, which appears to be 12 inches in diameter which then apparently runs parallel with the west side of Airport Road, approximately 400 linear feet to a point south of the school bus maintenance yard. The drainage system changes to an open ditch for approximately 340 linear feet, until it enters a catchbasin and then traverses across Airport Road to the east in front of the high school football field. This whole system is poorly functional to non-functional.

Street water is collected on the east side of Henderson Road/Foothill Boulevard in a recently constructed curb and gutter which was part of a sidewalk improvement project. The curb and gutter continues around the corner for a couple of hundred feet on the north side of Howard Street. The curb and gutter is part of sidewalk improvements, recently constructed by Mendocino County. The curb and gutter terminates along with the sidewalk improvements

Summary of Drainage Basin Characteristics

Post Mile Interval	Cross Culvert	Long. Culvert	Approx. Drain Area (Acres)	Runoff Factor, C, From Fig. 819.2A					Soil Type	Permeability, in/hr		Shrink - Swell	Corrosivity (uncoated steel)
				Relief	Soil Infil.	Veg. Cover	Surface Storage	Total					
29.18-29.37									115 - Cole clay loam	8"	0.2-0.6	Moderate - High	High
29.25 Rt.		18" x 120', CSP	92	0.08	0.10	0.06	0.06	0.30		60"	0.06-0.2		
29.25	12" x 28', RCP		88										
29.37-29.67									190 - Russian loam, gravelly substrate	30"	0.6-2.0	Low	Moderate
29.50	28" x 20" x 34', CSPA		132	0.08	0.07	0.06	0.06	0.27		51"	2.0-6.0		
29.66 Lt.		N/A, CSP	1						203 - Talmage gravelly sandy loam	33"	2.0-6.0	Low	Moderate
										66"	6.0-20.0		
29.67-30.30									128 - Gielow sandy loam	4"	2.0-6.0	Low	Moderate
29.75 Rt.		N/A, CSP	1	0.08	0.07	0.06	0.06	0.27		60"	0.6-2.0		
29.76	18" x 32', CSP		167										
29.82	36" x 35', CSP		135										
30.00	24" x 30', CSP		21										
30.01	36" & 48" x 38', CSP		721										
30.02 Rt.		18" x 70', CSP	2										
30.30-30.66									188 - Russian loam	60"	0.6-2.0	Low	Moderate
30.30 Lt.		18" x 46', CSP	N/A	0.08	0.07	0.06	0.06	0.27					
									204 - Talmage very gravelly sandy loam	33"	2.0-6.0	Low	Moderate
										66"	6.0-20.0		
30.66-30.75				0.08	0.10	0.06	0.06	0.30	115 - Cole clay loam	8"	0.2-0.6	Moderate - High	High
										60"	0.06-0.2		
30.75-30.77				0.08	0.08	0.06	0.06	0.28	177 - Pinole gravelly loam	10"	0.6-2.0	Low - Moderate	Moderate
										61"	0.2-0.6		
Foothill-Howard				0.08	0.06	0.06	0.06	0.26	204 - Talmage very gravelly sandy loam	33"	2.0-6.0	Low	Moderate
										66"	6.0-20.0		
Cross Trail Hend.-SH 162				0.08	0.07	0.06	0.06	0.27	190 - Russian loam, gravelly substrate	30"	0.6-2.0	Low	Moderate
										51"	2.0-6.0		
				0.08	0.06	0.06	0.06	0.26	203 - Talmage gravelly sandy loam	33"	2.0-6.0	Low	Moderate
										66"	6.0-20.0		
				0.08	0.07	0.06	0.06	0.27	128 - Gielow sandy loam	4"	2.0-6.0	Low	Moderate
										60"	0.6-2.0		

approximately 200 feet from the intersection, and discharges stormwater along the north side of Howard Street towards the east.

These intersection areas are noted in one location on the **Drainage Area and Culvert Location Map** found in Attachment 1 to this report. The scale is too small to show the details on this map. However, the topographic mapping for the project, Sheet 8 of 10, shows the drainage structures and details.

In front of the high school on the south side of Howard Street, between Airport Road and High School Street, there is a system of shallow ditches and damaged culverts which apparently were originally intended to convey street water to the east in front of the high school and around onto a shallow ditch system on High School Street. This system also works poorly during prolonged rainy periods according to the Area Road Foreman, and causes flooding in front of the high school.

Lovell Street, one block east of High School Street is also prone to flooding during prolonged rainy periods. Although the underlying soils are very pervious, the streets are impervious and create enough runoff to cause minor flooding along their edges. A private landowner has placed a berm parallel with the north side of Howard Street near Lovell to block street runoff from entering the private property and ponding there.

These streets are named on the **Drainage Area and Culvert Location Map** found in Attachment 1 to this report. Although they are peripheral to the intersection improvement project nearby, drainage from that project could have an adverse effect if current conditions were not identified.

Both High School Street and Lovell Street run north-south and the south end terminates near Town Creek in very gravelly soil. There should be an opportunity for storm water disposal in the gravelly soils, but because of the limited ditches, poor conditions of culverts and very flat grades, local minor flooding frequently occurs and must be considered if improvements to the non-motorized circulation elements are improved.

CROSS-TRAIL BETWEEN HENDERSON ROAD AND SH 162

This proposed trail is favored highly by the Tribal Government, as it would connect their housing at the west end of Foothill Boulevard with the Economic Center at SH 162 along a direct route. If the route along the west side of SH 162 is also improved, it would help in having a direct route, safe from motorized traffic to the Health Center on Biggar Lane and the Tribal Offices north of Mill Creek.

This route is on very flat ground which slopes approximately 14 feet in approximately one-half mile from Henderson Road to SH 162. Although the topographic mapping was limited to a narrow strip, it seems likely that the trail corridor will be on a ridge in the general area with runoff flowing northeast and southeast from it. This supposition is drawn from the local topographic mapping of the trail corridor and from the USGS quadrangles (References 2 and 3) which show the same pattern. The location of the cross-trail is noted in one location on the **Drainage Area and Culvert Location Map** found in Attachment 1 to this report. The scale is too small to show the details on this map. However, the topographic mapping for the project, Sheet 9 of 10, shows the strip of topography over which the trail would pass in more detail.

No culverts or other drainage structures currently exist in this corridor, which serves as an interior access road to tribal lands.

TRAIL PARALLEL WITH STATE HIGHWAY 162

At the intersection of Howard Street and SH162, a catch basin collects water from the easterly block of Howard Street and directs it southerly along SH 162 through a shallow storm drain system. The County Area Foreman indicated that there is occasional flooding of part of this intersection, because the storm drain system is very flat in grade and is somewhat impacted by partial filling with sediment. This area is shown on the soils maps to be underlain with Talmage very gravelly sandy loam, so there may be an opportunity for pervious pavement or other LID measures to be used in any improvements, depending on the depth to high seasonal water table.

The culvert system from Howard Street (PM 29.18), north along SH 162 to Biggar Lane (PM 30.27) is comprehensively described and photographed in the PSR prepared by Caltrans for this segment (Reference 1). All of the detail will not be repeated here, but the culverts which would be affected by construction of a trail on the west side of SH 162 are summarized as follows:

- PM 29.25 – 12 inch diameter by 28 foot long reinforced concrete pipe drains poorly from west to east. The Caltrans PSR recommends replacing it with a 28 inch by 20 inch (28x20 inch) corrugated steel pipe arch (CSPA), with concrete backfill, with flared end sections and ditch improvements at inlet and outlet.
- PM 29.50 – 28x20 inch CSPA by 34 foot long CSPA, drains poorly from west to east. The Caltrans PSR recommends replacing it with a double 28x20 inch CSPA with concrete backfill, with flared end sections and ditch improvements at inlet and outlet.
- PM 29.66 – Longitudinal culvert of unknown size and length, is full of sediment and not functional. It is in the vicinity of an archaeological site. The Caltrans PSR recommends replacing it with a 12 inch diameter corrugated steel pipe (CSP) with concrete backfill, with flared end sections and ditch improvements at inlet and outlet.
- PM 29.76 -18 inch diameter by 32 foot long CSP drains poorly from west to east. The Caltrans PSR recommends replacing it with a double 24x18 inch CSPA, with concrete backfill, with flared end sections and ditch improvements at inlet and outlet.
- PM 29.82 - 36 inch diameter by 35 foot long CSP drains poorly from west to east. The Caltrans PSR recommends replacing it with a double 57x38 inch CSPA, with concrete backfill, with flared end sections and ditch improvements at inlet and outlet.
- PM 30.00 - 24 inch diameter by 30 foot long CSP drains adequately from west to east. The Caltrans PSR recommends replacing it with a 30 inch CSP, with concrete backfill, with flared end sections and ditch improvements at inlet and outlet.
- PM 30.00 - 24 inch diameter by 30 foot long CSP drains adequately from west to east. The Caltrans PSR recommends replacing it with a 30 inch CSP, with concrete backfill, with flared end sections and ditch improvements at inlet and outlet.
- PM 30.01 – 36 and 48 inch diameter by 38 foot long CSP drains adequately from west to east. The Caltrans PSR recommends replacing it with a double 6 foot by 4 foot

reinforced concrete box culvert, with concrete backfill, with slanted concrete headwalls, and ditch improvements at inlet and outlet.

This completes the summary from the Caltrans PSR.

North of Biggar Lane, there were two more longitudinal culverts. The first is across a driveway just south of the bridge across Mill Creek at PM 30.30 (Lt). This culvert is an 18 inch diameter by 46 long culvert with the ends nearly completely buried. There appears to be very little runoff which reaches this culvert and it would only come from the intersection of Biggar Lane north about 300 feet. Biggar Lane and SH 162 both appear to be high spots with storm water sheet flowing away from the roadways. Underlying soils are moderately permeable to very permeable.

North of Mill Creek, there was one completely buried driveway culvert at the north entrance to the Tribal Community Center at PM 30.61, but the topographic relief was generally westerly away from SH 162 in this area, leading to the conclusion that storm water likely sheet flows southerly across the parking areas towards Mill Creek and does not accumulate near SH 162.

Photographs of these two culverts are shown in Attachment 4 of this report.

Runoff Factors

The "Summary of Drainage Basin Characteristics" found in the preceding pages of this report, contains runoff factors for each soil type and sub-basin. Figure 819.2A of the 2010 Edition of the Caltrans Highway Design Manual was used to determine the factors. The estimated factors include topographic relief, soil infiltration, vegetal cover, and surface storage. These four factors are added together to a runoff coefficient, C, used in the rational formula

Equation 1: $q(cfs) = CiA, with\ i = \frac{in}{hr}\ and\ A = acres$

Although the computation of runoff to each culvert or other storm water conveyance was not a part of this study, the factors reveal that the runoff is relatively low, ranging from 0.26 in the very gravelly soils to 0.30 in the clayey soils. The low factors are due to the relatively flat relief with good vegetative cover over most of the watershed and only small amounts of surfacing which would raise the runoff factor significantly.

Figure 819.2A is included in Attachment 2 of this report.

Mill Creek Drainage

Mill Creek has a watershed area of approximately 20.1 square miles (Reference 8). The USGS regression equations (Reference 10) resulted in predicting a stream flow of 3,168 cfs with a 10 year return period and of 5,753 cfs with a 100 year return period. A separate pedestrian bridge to cross Mill Creek is anticipated to be required as the existing highway bridge is only about 22 feet wide from inside of railing to inside of railing.

A map of the watershed area, watershed information, and a printout of the results of using the regression formulas is found in Attachment 1.

Flood Plain Mapping

Flood plain mapping by FEMA is very general or not available for Mill Creek. Town Creek is south of the proposed improvements on Howard Street. Those improvements are several hundred feet north of the 100 year flood plain determined by FEMA for Town Creek (Reference 7).

The available flood plain maps are included in Attachment 3 of this report.

Discussion

The area for intersection improvements around Foothill Boulevard, Henderson Road, Airport Road and Howard Street have underlying soils which may, depending on seasonal water table heights, lend themselves to pervious pavements, bioswales or raingardens or other LID (low impact design) strategies to reduce or eliminate runoff from any improvements.

The cross country trail between Henderson Road and SH 162 is likely at a high point in the topography and also is on soils which are generally permeable. Again, depending on the seasonal high water table, LID strategies could eliminate any potential increase in drainage which might be caused by the construction of the means for non-motorized circulation.

At SH 162, because of the relatively large drainage basins which currently drain to the State Highway, culvert improvements will be needed in conjunction with the construction of improvements for non-motorized circulation elements.

Conclusions

If design for construction of approved facilities considers LID principles, the improvement sites, in general, will not develop significantly more run-off, post-construction, than they currently have. There is an opportunity to improve the infiltration rate in some areas in downtown Covelo and alongside SH 162 to reduce the amount and duration of storm water ponding, which may be desirable as improvements to the non-motorized circulation facilities occur.

Prepared By: Rau and Associates, Inc.

By: George C. Rau 11/20/13
George C. Rau
Registered Civil Engineer 21908
Expires 9-30-2015

Attachments:

Attachment 1

- Drainage Area and Culvert Location Map
- Mill Creek Watershed Mapping and Basin Characteristics
- Mill Creek Regression Formula Results

Attachment 2

- Soil Map
- Soil Type Descriptions
- Runoff Coefficients for Undeveloped Areas

Attachment 3

- FEMA Floodplain Information

Attachment 4

- Photos – Culvert at PM 30.30
  Culvert at PM 30.61

Selected References

1. Pimentel, Jeffrey L., "Project Study Report- 01-MEN-162- PM 29.25/30.27; 01216-49500; STIP", California Department of Transportation, July, 2012.
2. _____, Covelo, West, 15 Minute Quadrangle, United States Geological Survey, 1967.
3. _____, Covelo, East, 15 Minute Quadrangle, United States Geological Survey, 1967.
4. _____, Ukiah Sheet, Geologic Map of California, Department of Conservation, Division of Mines and Geology, 1960.
5. Jayco, A.S., M.C. Blake, Jr., R.J. McLaughlin, H.N. Ohlin, S.D. Ellen, and Harvey Kelsey, Reconnaissance Geologic Map of the Covelo 30-By 60-Minute Quadrangle, Northern California, U. S. Geological Survey Map MF-2001, 1989.
6. _____, "Soil Survey of Mendocino County, Eastern Part, and Trinity County, Southwestern Part, California" ; United States Department of Agriculture, Soil Conservation Service; January,1991;
7. _____,FIRM, Flood Insurance Rate Map, National Flood Insurance Program, Federal Emergency Management Agency (FEMA), Mendocino County, California, Unincorporated Areas, Community Panel Number 060045C0517F, Community Panel Number 060045C0536F, and Community Panel Number 060045C0550F, June 2, 2011.
8. _____, Basin Sizer, version 1.46, Office of Water Programs, California State University, Sacramento.
9. Muir, K.S. and D.A.Webster, "Geohydrology of Part of the Round Valley Indian Reservation, Mendocino County, California", U.S. Department of Commerce, U.S. Geological Survey, Water Resources Investigation 77-22, July, 1977; Page 6.
10. U.S. Department of the Interior, U.S. Geological Survey. (2012). *Methods for Determining Magnitude and Frequency of Floods in California, Based on Data through water year 2006.* Reston, Virginia.

Attachment 1

Drainage Area and Culvert Location Map
Mill Creek Watershed Mapping and Basin Characteristics
Mill Creek Regression Formula Results

END-PM 30.77

PM 30.61
BURIED DRIVEWAY
CULVERT

PM 30.30 LT.
18"x46', CSP

PM 30.00
24"x30', CSP

2-64"x41"
CSPA

PM 30.01
36"x38', CSP
48"x38', CSP

PM 29.76
18"x32', CSP

PM 29.82
36"x35', CSP

PM 29.66 LT.

PM 29.50
20"x28"x34', CSPA

PM 29.25
12"x28', RCP

BEGIN-PM 29.18

X-TRAIL

INTX

LEGEND

- WATER COURSE
- BASIN BOUNDARY
- CULVERT/SIZE, TYPE INTERSECTION
- INTX — IMPROVEMENTS
- X-TRAIL — CROSS TRAIL BETWEEN HENDERSON ROADD AND SH 162

SCALE: 1"=800'

0 800 1600
SCALE IN FEET

DATE:	REVISION:	BY:
9-3-13	REVISION PER DISCUSSION: CT & GHD	GCR
11-20-13	MISC FORMATTING PER DISCUSSION: CT & GHD	GCR

COMPUTER NO. SERVER
PATH: Z:\R12007\DRAWINGS\
FILE:
PSVIEW:
MSVP:
MSVIEW:

OWNER: VARIOUS PUBLIC, TRIBAL AND PRIVATE OWNERS

LOCATION: COVELO, CALIFORNIA

RAU AND ASSOCIATES INC.
CIVIL ENGINEERS · LAND SURVEYORS
100 NORTH PINE STREET · (707) 462-6536 · UKIAH, CA 95482

DRAWING: DRAINAGE BASIN/CULVERT MAP

PROJECT: NON-MOTORIZED NEEDS STUDY
ENGINEERED FEASABILITY STUDY

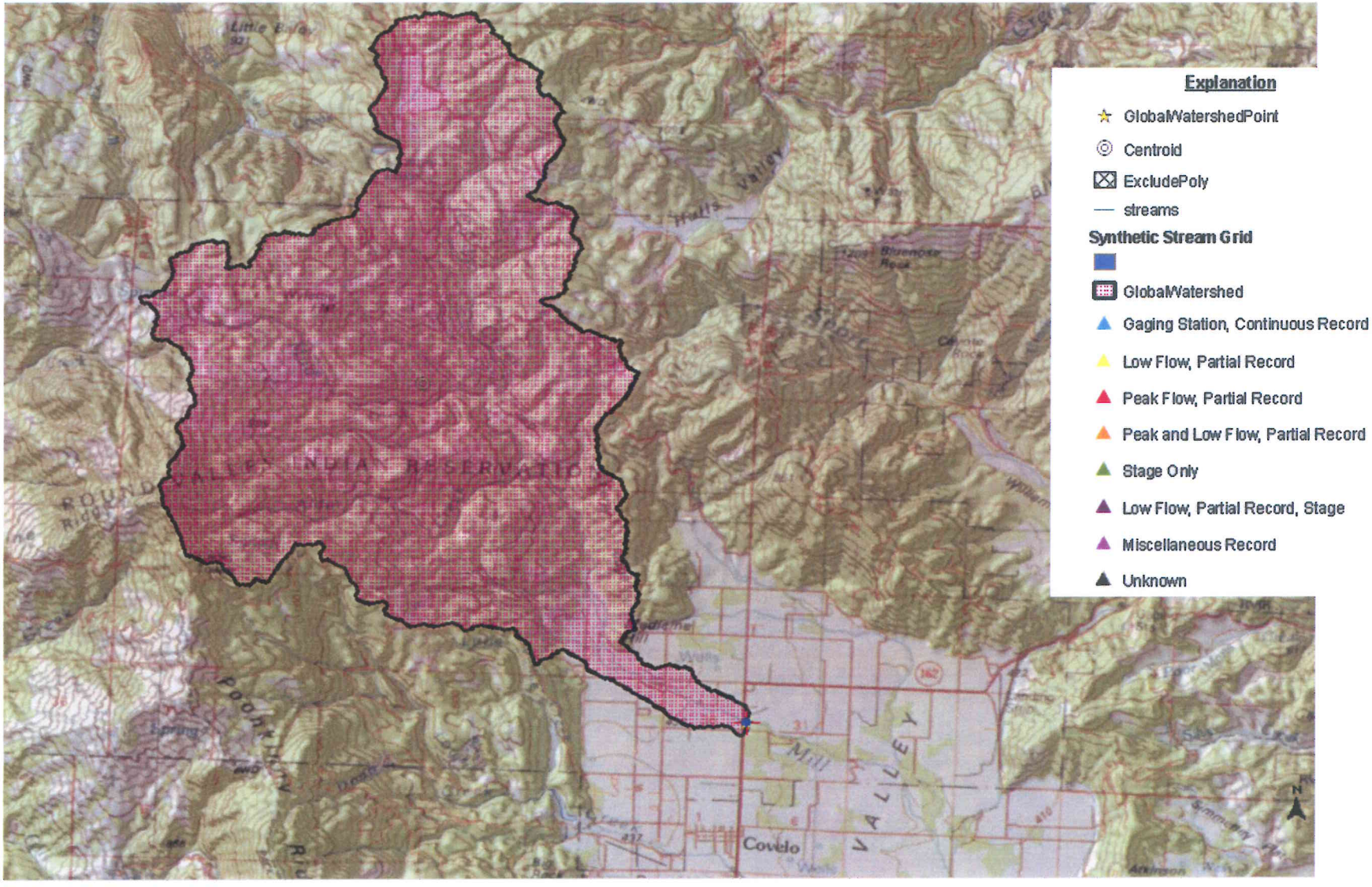
Date:	MAR. 2013
Scale:	AS SHOWN
Drawn:	RH
Checked:	GCR
Reviewed:	GCR
JOB NO.	R12007

SHEET 1 of 1 SHEETS

Xrefs: R12007 BORDER.dwg
Path: Z:\R12007 MCOG\Drawings\Civil\R12007_DRAINAGE-BASE.dwg Plot Date: Nov 20, 2013 at 4:19pm

USGS California StreamStats

R12007.2 - Covelo Drainage



11/6/2013 11:59:23 AM

USGS California StreamStats

Basin Characteristics Report

Date: Wed Nov 6 2013 11:55:02 Mountain Standard Time
NAD27 Latitude: 39.8113 (39 48 41)
NAD27 Longitude: -123.2467 (-123 14 48)
NAD83 Latitude: 39.8112 (39 48 40)
NAD83 Longitude: -123.2478 (-123 14 52)

Parameter	Value
Area, in square miles	20.1
Mean annual precipitation, in inches	50.2
Average maximum January temperature, in degrees Fahrenheit	50.4
Average minimum January temperature, in degrees Fahrenheit	34.3
Maximum elevation, in feet	4599
Minimum elevation, in feet	1391
Relief, in feet	3208
Elevation at outlet, in feet	1392
Average basin elevation, in feet	2667
Relative relief - Basin relief divided by basin perimeter, in feet per mile	91.2
High Elevation Index - Percent of area above 6000 feet	0
Altitude Index, in thousands of feet. Estimated as 0.00083 times mean basin elevation.	2.21
Mean basin slope computed from 30 m DEM, in percent	25.3
Percentage of basin covered by forest	36.1
Percent of area covered by lakes and ponds	0
Percentage of impervious area determined from NLCD 2001 imperviousness dataset	0.1
X coordinate of the centroid, in map coordinates	-2283558.8
Y coordinate of the centroid, in map coordinates	2201848.3
Latitude of the outlet, NAD83	39.81118
X coordinate of the outlet, in map coordinates	-2280300.0
Y coordinate of the outlet, in map coordinates	2194980.0
Basin perimeter, in miles	35.2
Distance in miles from basin centroid to the coast	28.3
Length of the longest flow path in meters	17745
Elevation relief in meters	978

R12007.2 - Covelo

Regression Equations for Estimating Peak Flow (Table 5 - Methods for determining Magnitude and Frequency of floods in California, 2012)

Watershed:	Mill Creek
Drainage Area (mi^2):	20.1
Mean Annual Percipitation (in):	50.2
Region:	North Coast, Region 1

Watershed		Mill Creek
T-year recurrence interterval	Percent annual exceedance probability	Flow (ft/s^3)
2	50	1,288
5	20	2,387
10	10	3,168
25	4	4,188
50	2	4,959
100	1	5,753
500	0.5	6,502
1000	0.2	7,507