

Riparian Monitoring of Wadeable Streams Protocol Implementation Plan for Park Units in the Southern Colorado Plateau Network

Standard Operating Procedure (SOP) # 1

Preparations for the Field Season and Equipment Needed

Version SCPN_Riparian_SOP1_20180930

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP is adopted from the Northern Colorado Plateau Network's SOP #1 Preparations for the field season and equipment needed, Version 1.09 (March 2018) in Weissinger, R., D. Witwicki, H. Thomas, A. Wight, K. Lund, and M. Van Grinsven. 2018. Riparian monitoring of wadeable streams protocol for park units in the Northern Colorado Plateau Network: Version 1.05. Natural Resource Report NPS/NCPN/NRR—2018/1636. National Park Service, Fort Collins, Colorado

And

Northern Colorado Plateau Network's SOP #1 Prior to the field season, equipment lists, Version 1.02 (December 2015) in Perkins, D. W., M. Scott, G. Auble, M. Wondzell, C. Holmquist-Johnson, E. Wahlig, H. Thomas, and A. Wight. 2018. Big River Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network, Version 1.00. Natural Resource Report NPS/NCPN/NRR—2018/1707. National Park Service, Fort Collins, Colorado.

This SOP describes how to prepare for the field season, including a list of field equipment and tasks that are performed before each field trip.

1. Before the Field Season

The following tasks should be completed by the project manager or field crew leader well before the arrival of seasonal field crew members.

1. Post positions for seasonal employees or student interns 3-4 months prior to scheduled field work. Riparian monitoring requires four field crew members for vegetation sampling and three field crew members for surveying and well installation. Hiring must be completed at

least six weeks prior to the beginning of the field season to allow time for federal background check procedures.

2. Review the entire protocol. Understand the goals and procedures of the monitoring program before beginning other preparations. Discuss any proposed or recent changes to the sampling design or protocol with appropriate I&M personnel. If a change has been implemented since the last field season, make sure that all field forms, databases, and relevant SOPs have been updated.
3. Compile a list of reaches that will be monitored. Discuss the season's objectives with appropriate I&M personnel to develop a field schedule.
4. Schedule field work. Use the guidelines below to develop a field schedule that meets the objectives for the field season and maintains some flexibility for unforeseen events.

Seasonality of sampling

Vegetation is sampled during the growing season, typically between June and September. Sampling visits should be scheduled to optimize phenology for the group of NCPN park units included in riparian monitoring. Park units should be visited at approximately the same time each year to maximize repeatability.

Stream channels are surveyed when riparian vegetation is leafless, generally late fall or early spring. The relative timing of surveying and vegetation sampling should be scheduled to minimize the possibility of flooding between sampling events. Well installation can occur at any time the ground is not frozen, but will likely occur in spring or fall to avoid weather extremes.

Field crew schedule

Crew members typically work 8 consecutive 10-hour days, followed by 6 days off, especially when working at distant park units or in the backcountry. Field work that does not require travel and camping has more flexibility. Office work at the beginning and end of the field season is scheduled for 8 hour days Monday through Friday, and additional office days throughout the field season may be scheduled for trainings, field preparation, or data management.

5. Request research permits. Begin the process at least 10 weeks before the start of the field season to allow ample time for processing.
6. Coordinate with the appropriate park staff to make sure that the proper compliance is followed before installing monitoring wells and rebar. It could take several months from the time paper work is submitted until our proposed installations are cleared.
7. Plan travel logistics. Notify appropriate park personnel of the dates the riparian field crew will be in their park unit. Discuss housing availability and needs with appropriate parks, and acquire backcountry camping permits.
8. Review SCPN safety procedures and complete a risk assessment. Review the SCPN Field Safety Plan and make any necessary improvements. Complete a risk assessment (e.g., Green-Amber-Red assessment from the NPS Operational Leadership program) to identify and mitigate risks to field crew members before the field season.
9. Organize and check all equipment. Equipment is usually tested and inventoried at the end of the field season. Review this list to make sure that you have adequate supplies and that all

replacement equipment is ordered and will be available before the field season begins. Tables 1-4 list equipment needed for each SOP.

10. Review plant species lists for each park unit, and update them with new species detected in the previous field season. Print additional copies, if necessary, so that each 2-person team has a copy for the field. Review the species most likely to be encountered in each park and assemble relevant flora, keys, and field herbaria.

2. A few weeks before each field visit

The following tasks should be completed by the field crew leader in the weeks before a scheduled field visit.

1. Review existing maps for each park, and request additional maps from the GIS technician if necessary. Make sure that the locations of existing benchmarks are added to maps for surveying trips.
2. Pack and review relevant information for each reach.

All visits

Access document – contains useful information for navigating to remote areas of park units.

Trip reports - from the previous field season. At the end of each field trip, the crew leader writes a brief report describing general field conditions, access issues, logistical challenges, safety concerns, equipment problems, and suggestions for improving efficiency.

Reference photos – photos used to help relocate each headpin, photo point, or control point for surveying.

Vegetation sampling

Revisit data sheets – provides directions to the reach, coordinates of headpins, and any other specific information from the previous visit.

Reach species list - list of species detected during previous monitoring visits.

Reach census revisit list – list of trees measured and tagged during previous monitoring visits.

Reach overview photo points – reach overview photos from previous monitoring visits and location, height, bearing, tilt angle, and recommended time from original visit.

Surveying

Field notes – a copy of notes from the previous survey.

Revisit data sheets – provides directions to the reach, coordinates of headpins, and any other specific information from the previous visit.

Hydrologic sampling

Well measurements – review distance between top and bottom of each well (TOC-BW) from Well Installation data sheet, and record these values on the Well Revisit data sheet for comparison with field measurements.

3. Print and copy the field data sheets. Print all pebble count data sheets and at least 1/4 of each of the other data sheets on Rite-in-the-Rain® paper to ensure data collection can continue in

wet conditions. Copies of each form are found at the end of the appropriate SOP. Data sheets for field measures are listed below with the minimum number needed to sample a reach.

Vegetation sampling

- Reach establishment or re-visit – 1
- Photos – 2
- Point-intercept – 14
- Canopy closure and exotic frequency - 7
- 5-m belt – 7
- Reach census – 4
- Unknown Plants – 10
- Pebble count – 2
- Site assessment – 1

Hydrologic sampling

- Well installation or re-visit – 1

4. Coordinate with the GIS technician to reserve GPS units and load UTM coordinates for the reaches to be sampled.
5. Load data from the previous total station survey on the datalogger.
6. Contact parks and provide detailed trip information. Contact the resource staff and chief ranger and provide dates the crew will be working in the park, names of field crew members, vehicle descriptions, and approximate locations of monitoring activity. Make sure that these park personnel are familiar with the safety procedures used by NCPN crews (see the NCPN Field Safety SOP for details) and that the NCPN crew is aware of any special safety procedures required by each park.
7. Check stream flows and weather forecasts. Stream flows can be referenced at waterdata.usgs.gov.

Storm activity should be carefully monitored for its potential impact on crew safety and sampling. Do not sample during flood events.

3. Immediately before each field visit

The following tasks should be completed by the field crew leader immediately before each field visit.

1. File a travel plan. Crew leaders should review the SCPN Field Safety Plan for specific procedures.
2. Perform a vehicle safety inspection and replace any necessary fluids.
3. Make sure that the **batteries are fully charged for all rechargeable equipment**, including cameras, GPS units, satellite phones, vehicle jump starters, lasers, total station, data logger, PDA, field laptop, and/or cordless drill.

Table 1. Equipment needed for all riparian sampling.

Item	Number needed	Description	Notes
General Equipment - Necessary for all SOPs			
GPS with extra batteries	2	Trimble GeoXM or more accurate	main unit and backup
GPS car charger	1		
Digital camera	2		transect headpins and mid-channel, survey control points, wells
Extra battery for digital camera	2		
Camera charger	1		for charging camera batteries
Waterproof cases for cameras	2		for perennial streams (ZION & CARE)
Carabiners	2		to attach waterproof case while crossing the stream
Inverter	1	plugs into vehicle	charge electronic equipment
Permit	2 per vehicle		one on dashboard, one with crew
Maps	1 per 2 people		
Data sheets	variable		at least 25% on rite-in-the-rain paper
SOPs	1 per 2 people		
Access documents	1		Specific to park
Previous trip reports	1		
Clipboard	1 per 2 people	lightweight with interior storage	
Field notebook	variable	small, Rite-in-the-Rain©	field notes
Pencils	5 - 10		
Waders	1 per person	3 mm neoprene	optional during hot weather
Wader repair kit	1	Includes Aquaseal and patches	Fix holes in waders
Magnetic Locator	1	Metal detector in hard case	
Safety Equipment - Necessary for all SOPs			
First aid kit	1 per 2 people		content list in NCPN Field Safety SOP
Satellite phone	1 per 2 people		
Satellite phone charger	1 per phone		
NCPN Field Safety SOP	1 per 2 people		
NCPN Accident Log Forms	1 per 2 people		found in NCPN Field Safety SOP
NCPN Medical Information Forms	1 per person		found in NCPN Field Safety SOP
Pump sprayer	1	2- gallon herbicide pump sprayer	decontaminate equipment and personal items

Item	Number needed	Description	Notes
Protective eyewear	1		use while mixing Quat solution
Quaternary ammonium	Pre-diluted	Quat128	decontaminate equipment and personal items
Quat-Chek test paper	1		test dilution of decontamination solution
Scouring brush	1		decontaminate equipment and personal items
Rubber gloves	10		protect hands during decontamination
Group Camping Equipment – Necessary for all field work that requires car camping			
Stove	1-2		Include spare, if available
Propane	1-2		Ideally full containers
Kitchen box	1	Includes pots, pans, plates, bowls, silverware	
Tarp / rain shelter	1		If available. For tarp, bring ropes necessary to put it up.
Roll-a-table	1		If available when the crew is not camping in a campground
Water jugs	min. 1 gal/person/day		
Tent repair	1	Tent tape and zipper wax	
Duct tape	1		
Backpacking Equipment – Necessary for backpacking			
Water filters (hand pump)	2	MSR Sweetwater	
Bucket	1		For settling water
Alum	1	Spice used to help settle particles out of water	
Water bladders	2		For water storage
Backpacking stoves	2		One that attaches to canister fuel bottle; one that attaches refillable fuel bottle
Fuel	various	White gas for refillable fuel bottle or canister fuel bottles	Bring extra
Lighters	2		For stoves
Cook set	2		Includes pots of various sizes
Trowel/shovel	1		
Wag bags	1/person/day		Use if camping in main basecamp
Spare tent	1		If available. Works out well to store extra equipment and use as back-up.

Item	Number needed	Description	Notes
Transect Set-up - SOP #2, <i>Necessary for all visits (except hydrologic monitoring revisits) unless noted with an E = establishment or R = re-visit.</i>			
Permanent rebar	E -min. 18	3/8" diameter cut into 18" lengths	permanent headpins and temporary markers to secure taglines
Rebar caps	E - 15	1 1/2" pre-stamped with NCPN	label rebar and cover top for safety, includes spare
Aluminum tags	min. 16	Oval	label rebar; use as backups for rebar caps
Wire		18-20 gauge	attach tags to rebar
Wire cutters	1	small	
Stamp kit	E - 1	Letters and numbers set	label rebar caps
Leather piece	E - 1	piece of old belt or glove	protects rebar cap when pounding
100-m Kevlar taglines	7	Kevlar string with meter markings	set up transects through dense vegetation
Temporary rebar	min. 4	3/8" diameter cut into 18" lengths	secure taglines
Sledgehammer	2		drive in rebar
100-m transect tapes	5	fiberglass reel tapes	cross-section transects, includes spare; use tapes with meters on both sides
Chaining pins	min. 10	striped metal pins	secure tapes
Reference headpin photos	R - 2	reference photos taken during establishment	
Reach revisit data sheet	R - 2	Directions, headpin coordinates, specific info, etc.	
Compass	3	with declination setting	set declination, take transect bearings, includes spare
Pin flags	min. 21	narrow steel pins with flag top	mark locations
Flagging	2 rolls	brightly colored	mark locations
Orange vests	4		increase visibility of crew members in dense vegetation
2-way radios	5		crew communication, includes spare & lanyards on each radio
Extra radio batteries	min. 15	AA alkaline, 3 per radio	1.5 sets per radio per day
Prisms with padded cases	2		attaches to prism poles
Prism poles with attached levels	2		use to help line up transects in reaches with dense vegetation

Table 2. Equipment needed for riparian vegetation sampling by a four-person crew. Some equipment is used for more than one activity but is listed under the most appropriate activity in this table.

Item	Number needed	Description	Notes
Point Intercept Vegetation - SOP #4, Necessary for all visits.			
Point-intercept lasers	3		includes spare
Laser monopods	2		mount lasers
Extra laser batteries	min. 6	1.5V silver oxide watch batteries	lasers take 3 per unit
Densitometer	2	periscope canopy instrument	point-intercept of tall shrub canopy
Screwdriver	1	small Phillips head	change laser batteries
Reach species list	R- 2	species previously recorded at reach	
Exotics and canopy closure - SOP #4, Necessary for all visits.			
Folding ruler	4		delineate exotic frequency quadrats
Spherical densiometer	2	modified concave	canopy closure
5-m Belt Transects - SOP #4, Necessary for all visits.			
2.5-m poles	2	made of 1.25-m PVC lengths with coupler	delineate 5-m belt boundaries
15-cm DBH calipers	2	diameter calipers in cm	measure sapling
DBH tape	2	diameter tape in cm	measure trees; also used for reach tree census
Reach Tree Census - SOP #4, Necessary for all visits.			
Tree tags	E - min. 200, R - min. 50	pre-stamped 1-1000 round aluminum	use different numbers for adding trees during re-visits
Nails	E - min. 200, R - min. 50	6d 2" galvanized steel	
Clawhammer	2		
Tool pouch	2		holds equipment
Reach census revisit list	R - 2		list of previously tagged trees
Plant Identification and Unknown Plants - SOP #4, Necessary for all visits.			
Hand lenses	2		
2-gallon resealable plastic bags	min. 6	2- gallon or larger	collect plants
Masking tape	2		label plant collections
Permanent marker	2		label plant collections
Trowel	2	small garden tool	extract specimen roots
Plant press	1	field press with card, blotter, and paper	store plant collections for identification

Item	Number needed	Description	Notes
Relevant floras and park species lists		varies by park	Utah Flora, Intermountain Flora, Field Guide to Intermountain Sedges, Field Guide to Intermountain Rushes, Grasses & Grasslike Plants of Utah
Photos - SOP #3, Necessary for all visits.			
Chalkboard	2	5 x 7"	label photos
Chalk	2		
Clinometer	1		used for tilt angle of reach overview photos
Reach overview photo revisit sheet	1	Location, height, bearing, tilt angle, and recommended time from establishment	needed to accurately repeat reach overview photos
Previous reach overview photos	1		used to align repeat reach overview photos
Rebar	3	3/8" diameter cut into 18" lengths	mark location of overview photo point in soil; not needed for re-visits
Chisel	1		mark location of overview photo point in bedrock (only with permission from park)

Table 3. Equipment needed for stream channel surveys by a three-person crew.

Item	Number needed	Description	Notes
Stream Channel Surveying - SOP #6, Total Station surveying <i>Necessary for all visits unless noted with an I = initial survey or R = re-visit.</i> *Equipment needed for transect setup is listed in Table 1.			
Total station with 6 batteries	1		make sure batteries are fully charged before leaving; includes tribrach
Charger for total station	1		Including power cord; use when electricity is available
Hand-held weather unit	1		Highgear brand, WeatherPort model. Used for calibrating temperature & pressure in total station. Stored in total station case.
Datalogger with Survey Pro software	1		make sure batteries are fully charged before leaving
Charger for datalogger	1		use when electricity is available
Datalogger holder	1	Folding metal holder	attaches to tripod leg
Battery/Generator	1	12-volt battery with inverter or Goal Zero Yeti Generator	charging equipment in the backcountry

Item	Number needed	Description	Notes
Solar panel	1		charging equipment in the backcountry
Tripod	2	1 wooden and 1 metal with screw-mount adjustable legs	to mount total station, includes spare & carrying cases
Prism poles	3	identical	includes attached levels and both flat foot and a point on the end
Prism poles extenders	3	orange & white stripe sections	good for visibility in thick vegetation
Leveling rod	3	identical, telescoping to 5 m	with adapters to mount prisms
Levels for leveling rods	3		need to attach to rods before surveying
Bipods	2		used to turn a prism pole into a free-standing tripod
Prisms	4	identical	for rods and backsight, includes spare & padded cases for each prism
10-m engineer's tape or rolling metric tape (>5 m)	4		measure instrument and rod heights; one for each person, includes spare
Tool pouch	1		holds equipment for survey lead
Survey notebook	1		
Ear piece with microphone	1	compatible with radios	for person running total station
Survey umbrella	1		
Umbrella stand	1	separate tripod to support the umbrella	
Rebar	I - min. 12, R - 4	3/8" diameter cut in 0.5 m lengths	permanent survey markers
Survey rebar caps	I - 12	1 1/2" pre-stamped with NCPN and dot in center	label rebar and cover top for safety
Permanent bedrock marker for horizontal bedrock	I - 1 per control point	5" piece of 1/2"-diameter threaded rod	Cut with hacksaw or other saw borrowed from maintenance
Permanent bedrock marker for vertical wall	I - 1 per control point	7" piece of 1/2"-diameter threaded rod	have maintenance grind down the threads on one side, so the pointed foot of the prism pole can be placed there without threads in the way
Hammer drill with extra batteries	I - 1		drill rock for permanent bedrock markers
Concrete drill bit	I - min. 1	1/2"-diameter	used with hammer drill

Item	Number needed	Description	Notes
Small, flexible hose	I – 1	small diameter tube or straw that fits in ½" drill hole	blow sediment out of drilled hole
Small broom	I – 1		brush away sediment from drilled hole
Small baggie of concrete mix	I – 1	Quikrete brand	fasten metal rod to bedrock for permanent marker; pass mix through 2 mm sieve first to get larger rocks out
Small paper cup, plastic spoon, and water	I – min. 1 set per bedrock marker		mix concrete
Straw with spoon end	I – min. 1 per bedrock marker	slushie straw	put concrete slurry into and around threaded rod
Screwdriver, pliers, and allen wrench set	1 each		attach prisms, tighten rods, troubleshoot equipment
Flagging	4 rolls	brightly colored	mark locations
GPS	2	survey grade with horizontal accuracy < 0.1 m	includes spare
Field notes from previous survey			Includes files to be uploaded to datalogger and reference photos for survey control
Reference geomorphology photos	R -2	reference photos taken during survey control establishment	
Total station & Survey Pro manuals	1 each		
Pipe wrenches	2		use to tighten fittings, open and close wells; only needed for reaches with wells
Cheater bars	R - 2		assist with opening rusted well caps; only needed for reaches with wells
Personal floatation device	2-3		safety gear for surveying the thalweg or deeper channel cross-sections
Dry Suit	1-2		optional safety gear for surveying the thalweg or deeper channel cross-sections in colder weather
Stream Channel Surveying - SOP #6, RTK equipment Necessary for all visits unless noted with an I = initial survey or R = re-visit. *Equipment needed for transect setup is listed in Table 1.			
RTK base	1		In yellow Pelican case including Trimble R6 receiver, 2 batteries, 1 antennae, 1 tribrach with optical plummet, 1 extender, 1 battery charging cradle, 1 charging power cord, 1 tape measure. Make sure batteries are fully charged before leaving

Item	Number needed	Description	Notes
Base Battery	1		Small yellow jug Trimble battery. Make sure batteries are fully charged before leaving.
Container of cords	1		3 cords for RTK base (2 black, 1 yellow). 1 black cord for RTK rover.
Tripod	2		For base radio. In orange canvas cases.
Base Radio	1		In yellow Pelican case, including cord to connect to base and battery
Base Radio antennae	1		35 Watt high-powered radio antennae
Base Radio battery	1		Usually a motorcycle or car battery
RTK rover	1		In yellow Pelican case, including Trimble R6 receiver, 2 batteries, 1 antennae, 1 battery charging cradle, 1 charging power cord
Seco carbon rod	1		For rover. Comes with quick-release attachment for receiver and flat topo boot
Data collector	1		Trimble TSC 3 with all the necessary files uploaded before leaving
Data collector holder	1		Attaching to rod. Two pieces.
Data collector charger	1		Power cord
Survey rebar caps	I - 12	1 1/2" pre-stamped with NCPN and dot in center	label rebar and cover top for safety
Stamp kit	1		Label rebar caps
Sledgehammer	1		Placing rebar
Screwdriver, pliers, and allen wrench set	1 each		attach prisms, tighten rods, troubleshoot equipment
10-m engineer's tape or rolling metric tape (>5m)	1 per surveyor + 2 spares		measure instrument and rod heights
Survey notebook	1		
Field notes from previous survey			Includes files to be uploaded to data collector
Reference geomorphology photos	R - 2	reference photos taken during survey control establishment	
Generator	1	Honda EU1000i	Used to recharge batteries

Item	Number needed	Description	Notes
Gas & oil for generator	one 5 gallon + enough oil		
Chisel	1		Marking control points in rocks
White marker	1		Marking control points in rocks

Table 4. Equipment needed for well installation and hydrologic monitoring.

Item	Number needed	Description	Notes
Below Ground Hydrologic Installation, driven steel well - SOP #5			
<i>*Equipment needed for transect setup during well installation is listed in Table 1.</i>			
Well points	3	1.25" I.D. x 3' length, 60 Gauze (Campbell)	
Galvanized pipe	min. 36 ft.	1.25" x 4' lengths, threaded on both ends	for riparian wells
Screened riser	1	1.25" I.D. x 2.5' length 60 Gauze well point (Campbell) without point, threaded	for instream well
Fence post driver	1	large diameter, heavy-weight	drive in wells
Drive caps	4	1.25" I.D.	
Drive couplings	12	1.25" I.D.	
Sacrifice pipe	3	1.25" x 8" length, threaded on both ends	
Teflon tape	3 rolls		protect threads while installing pipe
Ear protection	3	ear-muff style	safety
Padded gloves	3 sets		safety
Bubble level	1		level pipe during installation
Shovel	1		prepare hole for well
Rope	1	min. 15 ft.	guide casing during installation
Bentonite pellets	6 shovels worth		seal space around riparian well
Bucket	1	5-gallon	add water to purge well
Peristaltic pump	1	Geotech Geopump 2	purge well
Flexible tubing	min. 25 ft.	Masterflex	used with peristaltic pump
Metal file	1		file a notch in top of well for water level measurements
Cordless power drill	1		vent well
Drill bit	2	1/8" split point	vent well
Drill bit	1	¼"	drill cap for eyebolt

Threaded cap	1 per well	1.25"	
Eyebolt	1 per well	¼"	
¼" nut	1 per casing		keep eyebolt in place
¼" washers	2 per casing		keep eyebolt in place
¼" stopper nut	1 per casing		keep eyebolt in place
Below Ground Hydrologic Installation, augered PVC well - SOP #5			
<i>*Equipment needed for transect setup during well installation is listed in Table 1.</i>			
Ratcheting soil auger with extensions	min. 20 ft.		augering well hole
Auger buckets	2	2.75 or 3.25", regular and mud-clay	augering well hole
PVC solid riser pipe	min. 30 ft.	1.5 or 2", 10' lengths, threaded on both ends	for riparian wells
PVC screened pipe	min. 5 ft.	1.5 or 2", 5' or 10' lengths, threaded	for riparian wells
PVC slip-thread couplings	2	1.5 or 2"	for caps if needed
PVC primer	1 can		prime any glued joints
PVC glue	1 can		glued joints
Flexible gloves	2 pair		handle PVC glue
Rags	3		clean-up
Teflon tape	3 rolls		lubricate threads
Bubble level	1		plumb well pipe
Shovel	1		replace soil cuttings
"Clean" sand	min. 50 lbs.		pack well screen annulus
Bentonite pellets	10 lbs.		seal well annulus
Bucket	1		purge well
Inertial hand pump	1	semi-rigid tubing (HDPE) with footvalve (Waterra)	purge well
Tubing for hand pump	30 ft.		
Metal file	1		MP notch in top well lip
Cordless drill	1		vent well; drill caps
Drill bit	2	1/8" split point	vent well
Drill bit	1	¼"	drill cap for eyebolt
Post pounder and/or 3–8 lb. sledgehammer	1		drive protection pipe
Galvanized pipe	5–8 ft.	1"	
Wood block	1		drive protection well
Hacksaw	1	metal blade	cut PVC or protector pipe
Locking well plug	1	1.5 – 2"	if locked well is desirable
Threaded cap	1-2 per well	1.5 or 2"	Top and bottom caps
Slip cap	1 per well	1.5 or 2"	Bottom cap if screened section is unthreaded

Eyebolt	1 per well	¼"	
¼" nut	1 per casing		keep eyebolt in place
¼" washers	2 per casing		keep eyebolt in place
¼" stopper nut	1 per casing		keep eyebolt in place
Above Ground Hydrologic Installation on Bedrock – SOP #5			
1 ¼" schedule 40 PVC slotted well casing	1 per installation	cut into 8" or longer lengths	casing for pressure transducer
1 ¼" threaded PVC sleeve	1	must fit snugly over well casing	glue to casing
1 ¼" threaded PVC cap	1		
hacksaw			cut well casing
PVC primer			prep PV surface
PVC glue			glue sleeve to casing
Disposable gloves			protect hands while gluing
Drill with ¼" drill bit			drill cap for eyebolt
Spray paint		to match native rock	reduce visibility of installation
Cardboard			cover ground while spray painting
Hammer drill	1	fully charged	bring extra batteries
Drill bit	5	¼" concrete	drill into rock for mounting
Level	1		level casing prior to drilling holes
Permanent marker	1	dark-colored	mark locations of holes for drilling
Expansion bolt	4 per installation	2 ¼" with washer and nut	bring spares
U-shaped metal bracket	2 per installation	to fit around 1 ¼" casing	hold casing to rock
Extra washers		to fit expansion bolts	make sure casing is snug against rock
Hammer	1		deploy expansion bolts
Above Ground Hydrologic Installation in Channel – SOP #5			
Galvanized or Sched. 80 PVC pipe or well casing	1 per installation	1 ½" diameter	cut to 8" length and threaded on both ends at hardware store
Teflon tape	1 roll		prep threads for couplers
Threaded coupler	2 per installation	1 ½" diameter	attach to casing
Shovel	1		prep channel surface
Drill	1		drill holes in casing unless well casing is used
Drill bit	1	1/8"	drill holes in casing unless well casing is used
Drill bit	1	¼"	drill hole in cap for eyebolt
Stainless tap bolt	2	#10, 1.5 – 2"	attach pipe to angle iron
Combination wrench	2	min. 8" length	Attach pipe to angle iron

Metal file	1		mark measuring point on top coupler
Threaded plug or cap	1 per installation	1 ½"	
Angle iron	2 per installation	1 ½" x 1 ½"	drive into channel, at least 3 feet in length
Sledge hammer	1		drive in angle iron
Level	1		level angle iron
Hacksaw	1		trim mangled angle iron
Ziptie	2	Large, heavy duty	attach casing to angle iron
Hose clamp	2	1 ½" heavy duty	attach casing to angle iron
Tape-down Pipe Installation– SOP #5			
Galvanized pipe	1	1", 6–8 ft.	tape-down pipe
Sledge hammer	1		drive in pipe
Level	1		plumb pipe
Hacksaw	1		notch MP on pipe
All Hydrologic Installations			
Pressure transducer	1 per installation	non-vented (Solinst)	records water stage
Barometric pressure logger	1 per reach	Solinst Barologger	records atmospheric pressure
Kevlar rope or line	min. 45 ft.	1/8" braided or kite line (U.S. Rope & Cable)	install pressure transducers
Knife or scissors	1		cut Kevlar rope
Eye bolt	1 per casing	1/4" x 2" threaded	install pressure transducers
Nut	1 per casing	¼"	keep eyebolt in place
Washers	2 per casing	¼"	keep eyebolt in place
Stopper nut	1 per casing	¼"	keep eyebolt in place
Carabiner	1 per casing	2"	attach Kevlar rope to eyebolt
Ring Terminals	2 per casing		connect Kevlar rope to eyebolt carabiner and pressure transducer
Crimping tool or pliers	1		clamp ring terminals to Kevlar rope
Hydrological monitoring (<i>all visits</i>) - SOP #5 <i>Necessary for all visits unless noted with an R = re-visit.</i>			
Pipe wrenches	2		tighten fittings, open and close wells
Cheater bars	R – 2		assist with opening rusted well caps

Plumber's grease	R – 1		grease well threads
Water level meter	1	Solinst	measure depth to water in wells
Flow measuring equipment	1	Current meter, 10-m transect tape, 2 chaining pins	measure stream flow > 1 cfs
		Flume, level, trowel	measure stream flow 0.25 – 1 cfs
		Weir, level, trowel	measure stream flow <0.25 cfs
Inertial lift pump	1	semi-rigid tubing (HDPE) with footvalve (Waterra)	remove fine sediments
Folding ruler	1		measure to ground surface
PDA and interface cable	R – 1	Solinst Leveloader and cable specific to the PDA	download pressure transducer and barometric logger data
Field laptop and cable	1	with Solinst software and optical interface USB cable is specific to pressure transducer /barometric logger	download pressure transducer and barometric logger data; reprogram instruments
Camera download interface	1		Download stage gage card
Batteries	6-12	per camera requirements	replacements for stage gage camera
Laptop access card	1	DOI Access Card	log in to laptop