Stream Simulation

A

Abandoned channel—An inactive channel. One example is an oxbow isolated by a meander cutoff. Abandoned channels also occur where streambed aggradation causes the stream to overflow and shift to a new location.

Active channel—A portion of the channel that is somewhat lower than bankfull, as in the following definition: "the portion of the channel commonly wetted during and above winter base flows... identified by a break in rooted vegetation or moss growth on rocks along stream margins" (Taylor and Love 2003). The ordinary high water mark is sometimes given as the elevation defining the active channel.

Adjustable channel—A channel where dimensions, slope, planform, etc. change relatively readily in response to changes in inputs of water, sediment, and debris. See response reach.

Aggradation—The accumulation of sediment on a streambed, causing streambed elevation to rise.

Alluvium—Sediment deposited by flowing water, as for example on streambeds, flood plains, and alluvial fans. Alluvium does not refer to subaqueous deposits in lakes and seas.

Anastomosing—A type of channel with multiple channels that separate, meander, braid, or remain relatively straight and then rejoin. (A.3.3) Well-vegetated islands separate individual channels. Generally have low bed load and stable banks.

Anadromous—Fish that are born and rear in freshwater, travel to the ocean, then return to spawn in their natal stream.

Armored streambed—In gravel- and cobble-bed streams, the bed is often segregated into a coarser surface layer (the armor layer) over a finer subsurface. This is due to winnowing of the finer particles from the surface that is exposed to the force of flow. (A.3.1 and figure A.5)

Arroyo—Flat-floored gullies of ephemeral or intermittent streams in arid or semiarid areas. Arroyos are often formed in unconsolidated alluvium and have steep walls. They are dry much of the time, but flash floods can transform them into dangerous torrents.

B

Backwater—An area where water-surface elevation is controlled by some downstream obstruction, such as a constricting bridge, dam, or prevailing countercurrent.

Bankfull—Describes the volume of flow, and the flow width or depth associated with the bankfull elevation: that point where water fills the channel just before beginning to spill onto the flood plain. See also active channel. For more discussion of bankfull, see section 5.1.4.2.

Bankline—The sloping ground bordering a stream that confines flow in its natural channel for a range of flows below bankfull.

Barrier—A natural or manmade structure that impedes or prevents movement.

A partial barrier prevents movement of (1) some individuals, or some species some or all of the time, or (2) all species and individuals some of the time. The meaning of this term varies with context, and should be defined whenever used.

A complete barrier prevents movement of all individuals of the species being discussed all the time.

Base level and base-level control—The level below which a stream cannot erode its bed. The ultimate base level is sea level, although there can be local base levels, such as a resistant formation or lake. A base-level control is any structure or feature that prevents downcutting below its elevation.

Bed permeability—The ability of the channel bed materials to transmit fluid. Permeability depends on the size voids between particles, how well the voids are connected, and the tortuosity of the path that the water travels. Surface flow over a permeable bed may infiltrate so that, at low flows, most or all of the water flows below the surface.

Bedforms—Accumulations of bed material in an alluvial channel formed by stream flow over the channel bed. Ripples, dunes, and antidunes are bedforms found mainly in sand-bed channels. Pebble clusters and transverse bars are bedforms found in gravel-bed streams. Steps form in cobble- and boulder-bed streams.

Bedload transport rates—The volume rate of sediment moving on the bed by rolling, sliding, or saltation. Bedload transport rates depend on the transport capacity of the flow, and on the surface characteristics of the bed (packing, armoring).

BMPs—Best management practices are guidelines and procedures for the protection of water quality and beneficial uses during land management activities.

C

Channel adjustment—Changes in channel cross-sectional form, bed configuration, planimetric geometry, and channel bed slope in response to changes in flow, sediment type, and sediment and debris loads. Channels can adjust very slowly (e.g., downcutting over decades or centuries) or rapidly (e.g., sudden channel shift during floods).

Channel avulsion—Sudden switching of the main flow into a new channel. Avulsion can happen, for example, when aggradation or debris jams cause backwatering, overflow, channel incision in a new location, and stream capture (Hooke 1997).

Channel incision—The process of channel bed lowering (also downcutting or degradation). ‘Regional’ channel incision is downcutting over a long length of channel, sometimes on a watershed scale. Many causal factors can enter into regional channel incision, including base level lowering, increases in peak or total flows, and decreases in sediment load.

Channel migration—Change in channel location, commonly caused by bank erosion, point bar formation, and/or channel avulsion.

Channel pattern—Describes the channel in planview; most common terms are straight, meandering, anastomosing, and braided. (A.3.3)

Channel rocks—A term used in some construction contracts for large rocks used to simulate various types of channel-bed structures and key features, such as banks, steps, boulder clusters, bars, etc. Gradation is specified separately from the stream-simulation bed mix. Placement in the stream-simulation channel often requires special methods (see 7.5.3).

Channel stability—Stable channels adjust to a wide range of flows and sediment loads by eroding and depositing sediments; however, their dimensions and slope fluctuate around averages that remain approximately constant over periods of decades or longer. This means that, on average, the amount of sediment coming into a stable reach is the same as the amount leaving it. Unstable channels are those experiencing large rapid changes in dimensions or slope. (See section A.4)

Channel unit—Section of stream with characteristic bed topography, water-surface slope, depth, and velocity; for example, pool, riffle, step, etc.

Channel-forming flow—Flow that represents a range of flows which determines channel parameters, such as cross-sectional geometry and meander wavelength. It also can be thought of as the flow which performs the most work by transporting the most sediment. It is sometimes called dominant discharge, and is often equated with bankfull discharge. (A.4.1)

Channelized stream—A stream that has been altered by straightening and (usually) deepening (see channelization). Streams are sometimes channelized along roads to drain marshy acreage for farming, or to control flooding.

Complete barrier—See barrier.

Consolidation—Describes a sedimentary unit in terms of bulk density or how closely packed the grains are. After deposition, the unit becomes more compact as particles adjust under the weight of overlying materials.

Cohesive materials—Silt and clay-rich materials that are bound together by attractive forces. Compared to sands, cohesive materials are strong when dry, are more resistant to surface erosion, and have lower permeability. Cohesive streambanks tend to fail due to toppling or caving when banks are undercut or saturated.

Colluvium—Soil and rock that has been moved by gravity processes, such as in landslides, debris flows, avalanches, or rock falls.

Confined channel—A channel that is unable to shift laterally because it is bounded by valley walls, or other topographic or manmade boundary.

Contracting officer's representative (COR)—In the Forest Service, the contracting officer (CO) is responsible for all contract actions. The COR represents the CO in the field, evaluating the progress of the contract and recommending contract actions when necessary.

Cost-risk analysis—A way to assess the desirability of a long-range project by weighing the probability that a costly event will occur in the future against the current cost of a project. For example, in urban flood control planning, engineers might weigh the cost of building higher levees against the probability and consequences of a large flood.

Cutoff channel—Forms when flow takes a shortcut between two points along the stream, straightening the channel and increasing the slope. Neck cutoffs develop across meander bends; chute cutoffs develop over point bars. Cutoffs occur when streams can no longer transport the sediment load at the current gradient.

D

Debris—Material transported by the stream, such as wood or sediment. Commonly used to refer to woody debris.

Debris torrent—A rapid channelized flow of water mixed with rock, soil, and mud. Debris torrents are generally caused by saturation of the land surface or snowpack by heavy rains.

Dewatered stream—A stream affected by water withdrawals or upstream storage. Flow is lower than it would be naturally, and even if there is some water flowing, water temperature, depth, and continuity may be problems for aquatic organisms.

Dip of rock—The angle, measured perpendicular to strike, that a tilted bed or fault forms with the horizontal.

Discontinuous flood plains—Flood plains that are patchy or are obstructed in the longitudinal direction along a channel. Discontinuous flood plains occur where the valley is narrow or constricted by natural or manmade features.

Diversion potential—The possibility for streamflow to leave its established channel and flow down a road or ditch that slopes away from a road-stream crossing (Moll 1997).

Dynamic equilibrium—A stream channel is considered to be in dynamic equilibrium when channel dimensions, slope, and planform do not change radically even though they constantly adjust to changing inputs of water, sediment, and debris. See channel stability.

E

Earthflow—A landform formed by (usually) slow movement of a mass of soil and rock downhill. They usually occur in fine-grained materials and may move slowly over a period of years. Earthflows most often terminate in a lobelike form.

Embeddedness—Describes the degree to which the voids between larger sedimentary particles are filled with finer grains. Embedded gravel streambeds may be less mobile than unembedded ones because fines filling the gaps between the larger rocks reduce the surface area exposed to the pressure of water.

Entrainment (sediment)—The initiation of motion of a sediment particle by flowing water.

Entrainment flow—The lowest flow at which a particle first begins to move.

Entrenched channel/entrenchment—A channel that does not have a wide flood-prone zone (Rosgen 1994). May be gullied or confined. (Section A.3.4 discusses entrenchment)

Ephemeral stream—A stream that flows briefly only in direct response to precipitation or snowmelt (Wilson and Moore 1998).

F

Fines—Streambed particles smaller than 2 millimeters in diameter: sand, silt, and clay.

Flashy—Describes a flow regime characterized by large floods with short peaks. Arid-climate rivers are often flashy.

Flood frequency analysis—The process of analyzing a multiyear record of peak flows (usually a gauging station record) to determine the probability that a flood equaling or exceeding a given magnitude will occur in any year or during a period of years. (D.2)

Flood plain—The flat-lying area adjacent to a channel that is flooded on a fairly frequent basis and is being constructed by the stream. (See section A.5.4)

Flood-plain conveyance—Refers to the volume and rate of flow carried on the flood plain during floods. In this guide, the term is used qualitatively (high or low). Rougher flood plains with forest or dense shrubby vegetation would be considered lower-conveyance flood plains, whereas smoother grassy surfaces are higher-conveyance flood plains. (5.3.1)

Flood-plain function—Flood-plain functions include the temporary storage of sediment and floodwater. Flood plains may also provide diverse habitat for both aquatic and terrestrial wildlife, support riparian vegetation that shades and supplies nutrients and debris to the stream, and they may be movement corridors for large mammals. (See also valley flat.)

Flood-prone zone—The valley bottom area up to an elevation of twice maximum bankfull depth, measured vertically above the thalweg, at any channel/valley cross section. Flood-prone width is the width of that zone at a given cross section.

Flow boundary—The wetted perimeter, or contact zone between stream flow and the channel bed and banks.

Flow regime—Describes how flow in a stream is distributed throughout the year or across years, both in terms of discharge volume and timing.

Flow resistance—Drag force exerted on flowing water by its boundary. Flow resistance is the force that opposes the downslope component of the weight of water (the driving force) and controls water velocity. (A.3.6)

Fluvial—Of or pertaining to rivers or streams.

Forced channel—Montgomery and Buffington (1993 and 1997) define forced channels as those in which flow obstructions (such as wood) "force" a channel morphology that is different from what would exist if the obstructions were not present. For example, a wood-forced step-pool channel has log steps.

Fords—A stream crossing where the road surface is elevated only slightly or not at all above the channel bed.

Free-surface resistance—A component of flow resistance associated with the boundary between the water surface and the atmosphere. Caused by the distortion of the water surface by waves and hydraulic jumps.

Freshet—A flood of any size resulting from rainfall or snowmelt.

G

Gaining streams—An effluent stream, or a stream with a channel below the water table so that base flow is provided from the zone of saturation. Antonym: losing stream.

Genetic drift—A primary mechanism of evolution, by which gene frequency in a population changes from one generation to the next, due to chance processes rather than natural selection, mutations, or immigration. Genetic drift is especially important in small populations. (from Wikipedia and Primate Info Net [Online]. 2008, January)

Geomorphologist—A scientist who studies landforms and land surface processes. Geomorphology is the study of the classification, description, nature, and origin of landforms.

Grade control—Anything that controls channel elevation and therefore local channel slope. Grade controls can be natural streambed structures or manmade dams, sills, culverts, etc. As used in this guide, the term most commonly refers to natural structures, such as logs, riffle crests, boulder steps, etc. See also key features and base level. See section 5.1.3.3.

Granular materials—Sediment made up of small rock fragments, or grains.

H

Headcut—An abrupt change in channel bed elevation resulting in local steepening. Headcuts may be nearly vertical, or more gradual, depending on grain size and consolidation of channel materials.

Headwater streams—Streams at the upstream end of a drainage network. Headwater streams are most often classified as first- and second-order streams (see **zero-, first-, and second-order streams**).

HEC-RAS—Hydrologic Engineering Center, River Analysis System: a step-backwater model for estimating streamflow velocity and other flow characteristics in a river reach.

High bed-design flow—A high flow, which when exceeded may mobilize rocks designed to be permanently immobile and possibly cause the simulated streambed to wash out of the culvert (See section 6.3.2).

Hydraulic jump—An abrupt change in water depth at a transition from supercritical to subcritical flow, forming a stationary wave. Hydraulic jumps occur in a number of situations: over significant obstacles in the bed, below a vertical drop, or where an expansion or contraction of the flow occurs.

Hydraulic radius—The ratio of a streams cross-sectional area to its wetted perimeter. In wide, rectangular channels the depth often is used to approximate hydraulic radius. (Figure E-2)

Hydro-physiographic province—A region with characteristic climate, geology, landforms, and vegetation. The relief features and landforms of a hydro-physiographic province differ significantly from surrounding regions, e.g., Valley and Ridge and Coastal Plain in Eastern United States; Basin and Range and Great Plains in Western United States.

I

Imbricate/imbrication—Overlapping arrangement of rocks in a stream, similar to overlapping of shingles on a roof. Imbricated rocks are more resistant to entrainment than loosely-packed rocks.

Inbreeding depression—A reduction in overall health and vigor of individuals in a population as a result of breeding with close relatives over multiple generations (Primate Info Net [Online]. 2008, January)

Incised channel—See channel incision.

Intermittent stream—A stream that flows part of the year. Intermittent streams generally flow continuously for a month or several months during and after the rainy or snowmelt season—the time of year when the ground water table is high enough to supply surface flow.

Invert—The bottom of a full-bottom culvert.

J-K

J-hook vane—A streambank stabilization structure designed to reduce near-bank shear stress on the outside bank at channel bends. The structure causes scour in the center of the channel, maintaining sediment transport capacity (Rosgen 2006).

Karst—A type of topography formed on limestone, and characterized by dissolution features such as sinkholes, caverns, and underground streams.

Key features—Anything in the stream channel that the current stream either cannot move or that moves only in infrequent floods, and that plays an important role in channel morphology and stability. Key features may control grade, provide roughness, retain bed material, and stabilize banks, among other functions. They can be rocks, logs, living trees, roots, etc. (5.1.6.2)

L

Lateral accretion –Sediment deposition along one bank as a river migrates across its flood plain and erodes the opposite bank. Point bars are a common lateral accretion feature.

Lateral migration—see channel migration.

Longitudinal rib or bar—A ridge of gravel, cobbles, or pebbles extending along the channel parallel to flow. Like transverse ribs, these ridges are microtopographic features found in gravel-bed streams.

Losing streams—Streams that lose surface flow as water percolates into their beds to the water table.

M

Mass wasting—The downslope movement of soil and rock material under the direct influence of gravity. Examples include rockslides, landslides, earthflows, and soil creep.

Maximum bankfull depth—In any channel cross section, the distance from the streambed's lowest point (thalweg) vertically up to bankfull elevation.

Meander belt—The zone along the valley floor across which a meandering stream shifts its channel from time to time. It may be 15 to 18 times the stream width. (Wilson and Moore 1998)

Mobile-bed channels—Channels where streambed materials move frequently, even at relatively low flows below bankfull.

N

Nickpoint or Knickpoint—An abrupt drop, or point of inflection, in the longitudinal profile of a stream. Usually associated with a lowering of base level, nickpoints migrate upstream and can cause rapid channel incision upstream. See also headcut.

Noncohesive—Lacking in attractive forces that cause particles to stick together, so that resistance to erosion is based on intergranular friction. Granular materials (e.g., sands, gravels) are generally noncohesive.

O

Openness—The opposite of confinement. Some species are reluctant to enter a structure if it appears to be too confining, possibly due to lack of light or security (predator ambush potential or lack of escape routes). Openness is often expressed as the ratio of the cross-section area of a structure's opening (m^2) divided by structure length (m).

Ordinary high water—Water surface elevation below bankfull, defined variously by different entities. It is defined as follows in Bates (2003): "The Ordinary High Water mark can usually be identified by physical scarring along the bank or shore, or by other distinctive signs. This scarring is the mark along the bank where the action of water is so common as to leave a natural line impressed on the bank. That line may be indicated by erosion, shelving, changes in soil characteristics, destruction of terrestrial vegetation, the presence of litter or debris, or other distinctive physical characteristics."

Outsloping—Cross-sectional road-surface profile that is angled slightly away from the cutbank. This method of road construction is used to disperse water from the road surface rather than allowing it to flow directly into a stream.

Overbank flow—Water flowing outside the channel boundary over the adjacent land surface. Overbank flow generally occurs during floods or when in-channel flow is constricted.

P

Particle size class—Named categories with standard ranges of sediment particle sizes (e.g., sand, silt, gravel, cobble, etc.). See table A-1.

Pebble clusters—Microtopographic bed features, on the scale of 10 to100 centimeters in length, oriented along the local streamline in gravel-bed streams. Generally, an obstacle protrudes above neighboring grains allowing both upstream and downstream accumulation of smaller grains. Pebble clusters are known to delay both entrainment and transport of constituent class, and to reduce bedload transport rates by increasing flow resistance.

Perennial stream—A stream that flows year round.

Permeable roadfill—Fill material (soil and rock) with a relatively high capacity for transmitting water used to construct road embankments that permit through-flow of water. Objective is often permitting overbank flood flows to filter through the embankment rather than forming a solid dam across the flood plain.

Pivot angle—The angle of repose for noncohesive sediment. The angle that a particle, with a particular diameter, has to overcome when rolling over a particle, with a different diameter, that is partly underneath and partly in front of it.

Planform—The channel pattern, or the appearance of a stream from above. The most common categories are straight, meandering, and braided. (A.3.3)

Plasticity—The ability to be molded into a different shape without breaking, and to retain that shape when the deformating force is removed.

Pool spacing—The distance between two successive pools, measured from pool tail to pool tail or pool head to pool head.

Profile control structure—A structure placed to control grade and elevation of the simulated channel, such as a log or boulder weir. Profile controls can be inside or outside the culvert.

Project profile—The streambed longitudinal profile designed for construction in and around the new crossing structure.

Project reach—The stream segment that will be affected by the project, including segments not directly constructed, but expected to adjust to the changes made by the project.

R

Radius of curvature—Describes the tightness of a meander bend (figure A-11).

Reach—A stream segment. Usually refers to a stream section that is somewhat homogenous, and can be characterized based on discharge, depth, area, or slope. A reach can also be the length of stream between two gauging stations, between two tributary junctions, or between any two points.

Recruitment—Introduction of woody debris or other elements into a stream from banks, valley walls, and from upstream. Wood can be recruited by trees falling into the channel, by landslides, or by transport from upstream. Recruitment can also mean the addition of individual animals to a population.

Recurrence interval—The average time interval, in years, between occurrences of a hydrologic event of a given or greater magnitude. The probability remains the same from year to year for any event of any recurrence interval. A 20-year event will not necessarily occur once every 20 years, but the probability that the event will occur in any given year is 0.05.

Reference reach—A natural stable channel reach used as the design template for stream simulation. (3.2, 5.5)

Regulated river—River whose flow is controlled by artificial means such as a dam.

Residual pod depth—Maximum depth of a pool, measured from pool bottom to the pool tail crest (or riffle head). See figure 5.19.

Residual soil—Soil formed from the underlying rock.

Response reach—A stream reach that adjusts to changes in flow and sediment loads by changing its morphology. Changes can include widening or narrowing, straightening or increasing sinuosity, incising, aggrading, etc. Generally, response reaches have erodible bed and bank material, and they tend to be flatter than transport reaches. When upstream sediment inputs increase, sediment tends to deposit in response reaches.

Riparian vegetation—Vegetative community located near a body of water such as a stream. Riparian vegetation significantly influences and is significantly influenced by its adjoining body of water.

River dynamics—Processes and mechanisms of channel change; water, sediment and debris transport; and interactions between the channel and surrounding area;

Road management objective—A statement of the intended purpose of a road, as well as standards for its design, management, and maintenance.

Roughness (and relative roughness)—Channel characteristic that causes a drag on flow, limiting velocity and increasing diversity. Roughness elements include grains, bedforms, woody debris, manmade structures, and bank irregularities. Relative roughness is the ratio of hydraulic radius to grain size. As depth increases with discharge at a cross section, relative roughness decreases and the effects of grain roughness are drowned out.

S

Sediment load—The amount or volume of sediment that is being transported by a stream, including both bed load (sediment that rolls or bounces along the streambed) and suspended load (finer sediment that travels suspended in the water column).

Sediment regime—Describes how sediment transport in a stream is distributed throughout the year or across years, in terms of particle size, amount, and timing.

Sediment transport capacity—The maximum amount of sediment that a given flow can move in a stream channel.

Shear stress—a measure of the hydrodynamic (erosive) force exerted by flowing water on channel bed and banks (see sections A.5.1 and E.1).

Side channel—A secondary channel that carries a small volume of the total flow. Many processes for side channel development exist; for example, a side channel can be an abandoned meander bend, or it may have formed by scour during overbank flood flows.

Simulated channel—The stream simulation channel bed contained in the crossing installation, generally inside the culvert.

Slump—Type of mass wasting event in which a mass of rock or unconsolidated material slides along a concave slide plane.

Sorting—A process that occurs during sediment transport events by which sedimentary particles are segregated by size, shape or weight. A well-sorted streambed is composed of a narrower range of sediment sizes than a poorly-sorted streambed.

Stage—The elevation of the water surface in a stream channel. A flood stage is the elevation of the water surface during the flood.

Stream connectivity—Describes the transfer of matter, energy, and organisms by water within and between all components of the stream ecosystem including the channel, flood plain, and alluvial aquifer.

Stream corridor—The stream channel and associated riparian area, including the flood plain.

Streambed continuity—Describes how well connected (or how fragmented) the streambed is along its length. Weirs, baffles, bare culverts, etc. disrupt streambed continuity and may limit movement of benthic organisms and aquatic and riparian-dependent species that require dry or shallowly-submerged surfaces for movement.

Streambed structure—The geomorphic forms comprising a streambed: channel units such as pools and riffles, steps, etc.; grade controls; bank configuration and composition.

Strike of rock—The geographic direction and angle between true north and a horizontal line of any planar geologic feature: bedding, faults, or dikes.

Structural design flow—A high flow which, when exceeded may cause the crossing structure to fail. (Contrasts to high bed design flow.)

T

Terrace—A relatively level bench or flat steplike surface above the flood plain. An alluvial terrace is the relict of a former flood plain before regional uplift or increase in discharge caused erosion and incision into the former flood plain. Other types of terraces include marine terraces and structural terraces.

Thalweg—The longitudinal profile line, or line connecting the lowest points along a streambed. (5.1.3)

Tidal rivers—Coastal rivers influenced by tidal fluctuations.

Transport reach—A stream reach that resists changes in morphology when flows and sediment loads change. Transport reaches are generally steeper and coarser-grained than response reaches. When sediment input increases, the added load is simply transported through the reach.

Transverse bars—Relatively broad flat surfaces with a crest oriented perpendicular to flow. Transverse bars are at least several particles in length (from upstream to downstream) and can extend completely or partially across the channel. They typically form downstream of pools where flow begins to diverge as the channel widens, and are located at the pool-tail crest (or riffle head). Coarse-grained bars are typically well armored with particles that are tightly packed and well imbricated. They may be immobile up to high discharges, and usually function as reach-scale hydraulic grade controls.

V

Valley flat—The area adjacent to the channel that is relatively flat and is bordered by hillslopes. The valley flat may include the flood plain and one or more terraces. Also valley floor or valley bottom.

Vertical accretion—Process of accumulation of sediment on flood plains during overbank flows.

Vertical adjustment potential—the vertical range of possible streambed elevations over the life of the structure (5.2.2.2).

W

Well-graded—Refers to coarse-grained sediments that have a continuous distribution of particle sizes, such that smaller grains fill the spaces between the larger grains (AGI 1962). Synonym: poorly sorted.

Width-depth ratio—Bankfull width divided by mean bankfull depth (average across the cross section). (A.3.4).

Woody debris—Logs, limbs, and rootwads found in streams. Woody debris plays important roles in stream ecosystems by increasing boundary roughness and flow resistance; providing storage areas for sediment and organic material; providing cover for fish; controlling grade and increasing profile and substrate diversity.

Z

Zero-, first-, and second-order streams—Stream ordering is a system of classifying stream segments based on location in the drainage network. A zero-order stream is an unchannelized valley or swale. First-order streams are segments with no tributaries. Second-order streams are formed by the junction of two first-order streams.

Stream Simulation

A

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