EVALUATING CONSTRUCTION PLANS FOR IMPACTS ON TREES

by Carolyn B. Leach

Abstract. Arborists understand the impact of construction damage to trees, but receive no training on how to read construction plans. These plans utilize a system of standard graphics. The engineer and architect rely on the reader's knowledge of basic lines and abbreviations to understand the work intended. Since the plans provide information vital to the arborists, his or her proper evaluation will show the negative impact and the changes that can be negotiated to lower these impacts. Therefore, arborists need to educate themselves on the reading of basic construction plans.

Arborists possess a wide range of knowledge related to tree health, from pruning methods to soil science. They evaluate disease and insects pests, appraise tree values, and calculate hazard potentials. Training prepares them to understand the many complex relationships between the tree and its environment.

The mechanics of a tree's response to construction damage is one of their areas of expertise. Root injury, site grading and soil compaction from typical construction activity result in a loss of structural and absorbing roots. Trees that are unable to take up adequate amounts of water and oxygen become stressed. A gradual decline in tree health results, often becoming fatal to the tree.

Arborists could advise against construction injury through learning to read and understand construction documents. The plans contain vital information which affects site trees. Arborists should commit themselves to understanding this information. The more that is known about the project before construction begins, the more effective they will be at preserving trees.

Many public agencies now require an arborists' evaluation accompany the construction plans. These agencies rely on arborists to report accurately the effects of the construction, and to suggest adequate protective measures. The report should be precise in the assessment of construction impacts on trees.

Traditionally, arborists gain knowledge about the project from the designers (engineer or architect) and from the owner. However, these persons are often preoccupied with their own concerns for the project. Their priorities tend not to be the impact on site trees. Learning to read the construction plans gives arborists the knowledge to recognize impacts and negotiate changes.

Architects, engineers, and landscape architects all communicate facts about the project through the plans. They use standard symbols and abbreviations to express the work they propose. These graphics, drawn to represent existing site features and proposed construction, are generally recognized throughout the trade.

Project documents are typically comprised of several sheets of plans depicting various aspects of the proposed work. Accompanying these plans may be a specifications manual which provides more detailed project information and legal requirements. What appears in either document is sufficient for a contract requirement. The project engineer is responsible for the site grading, underground utilities, drainage, paving, and other site work. The architect's plans depict information about the building design, and may include additional details for site improvements. Other plans in the project set may be for landscaping, irrigation, site lighting, and other special work proposed.

Engineer's Plans

Plans drawn by the engineer are usually the first available to the arborist for review. They provide information about the proposed project grading and underground work. Careful review of these plans by the arborist is vital.

The site plan depicts the entire site in "plan view," as seen from above. If the plans is too large

to fit on one page easily, the engineer will provide a small drawing to orient the reader and then enlarge it to a more usable scale. In the event the site overlaps onto more than one sheet, the engineer then draws a "match line" showing where the plans match.

A site plan shows existing features such as property lines, grades, building locations, roads, wells, and natural water areas. Existing trees may be shown on this plan. The proposed site improvements either overlap this existing information or appear on a separate sheet. New improvements will include proposed building locations, grade changes, paving, underground work, and retaining walls. The north orientation is shown on each page in addition to the scale the plan is drawn to.

It is important to understand the use of scale in reading construction plans. The designer uses scale to shrink the object being drawn (in this case, the site) in exact proportion to its actual size. Thus, one can use the drawing to measure the relationship of one item to another, to calculate their original size, and their distance apart. The instrument one uses for this is called a scale, and there are two types used. An engineer's scale is divided into tenths of a foot (e.g. 1 in = 10 ft) while an architect's scale is in fractions of an inch (e.g. 1/8 in = 1 ft). While it is possible to use a steel tape to measure dimensions, in the long rung it is easier to buy each of these scales and learn how to read them (Fig. 1). The architect's scale is a bit tricky because each edge has two scales, reading from opposite directions. The numbers are slightly offset for each scale, so you have to keep track of each set of numbers. In addition, the architect's scale indicates inches to the left of each scale. When measuring an object, it is important to begin at the zero mark, not at the beginning of the inches mark.

The designer may show more than one drawing on each sheet, each using different scales. Should this occur, the scale for each drawing should be clearly marked.

In general, the line width and darkness on a plan is in relation to its importance: dark lines for building walls, light lines for edge of pavement. To distinguish various lines, designers use dashed lines in different ways. A wide, dark long line broken by two short dark lines symbolizes a

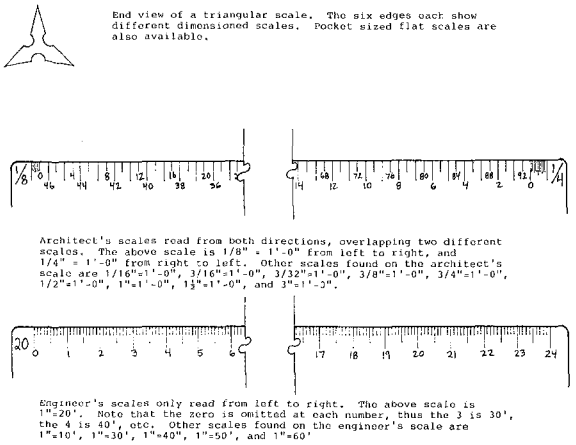

Figure 1

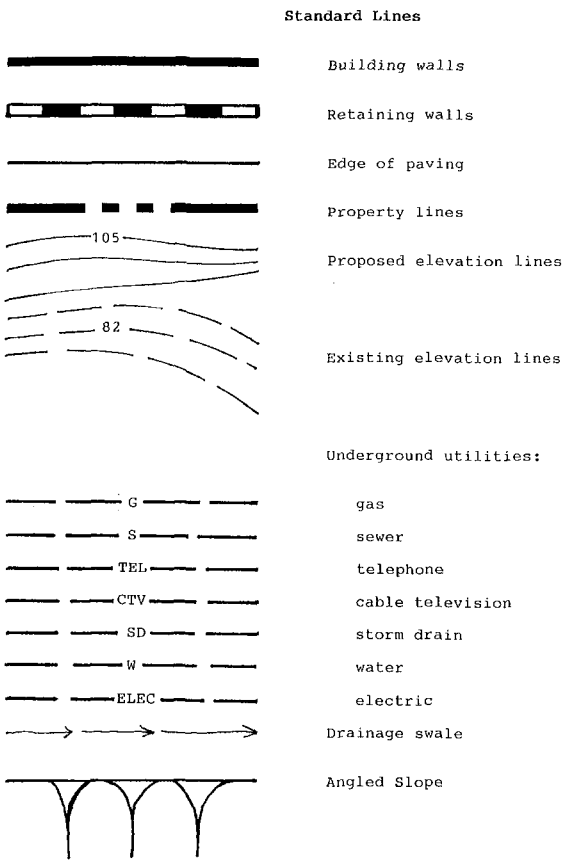

Figure 2

property line. Long, light evenly broken lines are used for grade lines (Fig. 2). Though each designer's style may differ slightly, any changes from the standard lines should be clearly labeled.

A chart of symbols and abbreviations may be provided on the site plan, or on another sheet in the set of plans (Fig. 3). There may also be a "notes" section included. These notes provide additional information on the proposed work and materials to be used. The arborist should read both of these sections in order to be aware of all details of the project.

Utilities

The location of the tree roots needing protection must be determined. This root area varies with tree type and soil changes. Once the root zone is established, the plan must be read to find all lines drawn within this zone. Look for grade changes and the location of all underground utilities

Standard Abbreviations

ABV	above	MH	manhole
ADJ	adjustable	MX	maximum
ALT	alternate	MAS	masonary
AGG	aggregate	MIN	minimum
APX	approximate	MISC	miscellaneous
AD	area drain	NAT	natural
ASPH	asphalt	N	north
BLW	below	NTS	not to scale
BTW	between	OC	on center(s)
BLK	block	PV	pave(d),(ing)
BD	board	PVT	pavement
BOT	bottom	PVC	polyvinyl chloride
BLDG	building	PL	property line
CB	catch basin	RAD	radius
CEM	cement	ROW	right of way
CIR	circle	REM	remove
CIRC	circumference	R/W	retaining wall
CONC	concrete	SEC	section
CCG	concrete curb and gutter	SL	sleeve
		S	south
CONST	construction	SPEC	specification(s)
CFT	cubic foot	SF	square foot
CYD	cubic yard	SY	square yard
DTL	detail	SD	storm drain
DIAG	diagonal	TEL	telephone
DIAM	diameter	TC	top of curb
DN	down	TF	top of footing
DS	downspout	TS	top of slab
DWG	drawing	TW	top of wall
D	drain	TYP	typical
ELEC	electric(al)	VERT	vertical
EL	elevation	W	west, width, wide
EXC	excavate	W/O	without
EXG	existing	WD	wood
FIN	finish		
FLR	floor		
FTG	footing		
FND	foundation		
G	gas		
GSP	galvanized steel pipe		
GD	grade, grading		
GVL	gravel		
HDR	header		
HT	height		
HB	hose bibb		
HYD	hydrant		

Figure 3

(water, sewer, electric, cable, phone, gas' storm drains, lighting, traffic signal electrical, fire hydrants, and irrigation). If any of these utilities are not shown, the arborist should require presentation of that information prior to his or her approval of the project. In addition, a separate underground utility plan may be needed for clarity if the site plan is too crowded with other information. If the utilities are planned for an area too close to the trees, the arborist should recommend an alternate location. In the case of a new subdivision project, the location of the utility easements may be moved to avoid trees.

Utilities are buried at various depths. To install the utility lines, trenches are dug with a backhoe or trenching machine, or tunnels are bored through the subsoil into which the lines are inserted. The arborist can specify which method will be used near trees or if hand digging is required. In areas where different utilities cross, one of the trenches will be deeper as it approaches the cross in order for the lines to clear each other. Utility lines running parallel to each other will need a wider trench so that the appropriate minimum space between each utility is maintained.

Check the depth of each utility, especially storm drains, which can be several feet deep. The trench depth is the total of the inches of fill plus diameter of pipe plus depth of sand base below the pipe. To avoid shoring up the sides of deep trenches, contractors will slope the trench sides to avoid cave-ins. These sloped sides will be very wide (8' deep trenches will be 16' wide or more) and will disturb a much wider area than the plan shows.

Other utilities may be planned which could affect the canopies of trees. These locations should be carefully reviewed in the field to determine impact.

Grading

Existing site grades should be indicated on the plan. Each grade line follows a common elevation across the site with the elevation number indicated (Fig. 4). Grade lines with a higher number are uphill of grade lines with a smaller number.

Grade lines may be drawn at every 1, 5, or 10 ft changes in elevation, depending on the plan scale. It is important to locate the numerals which

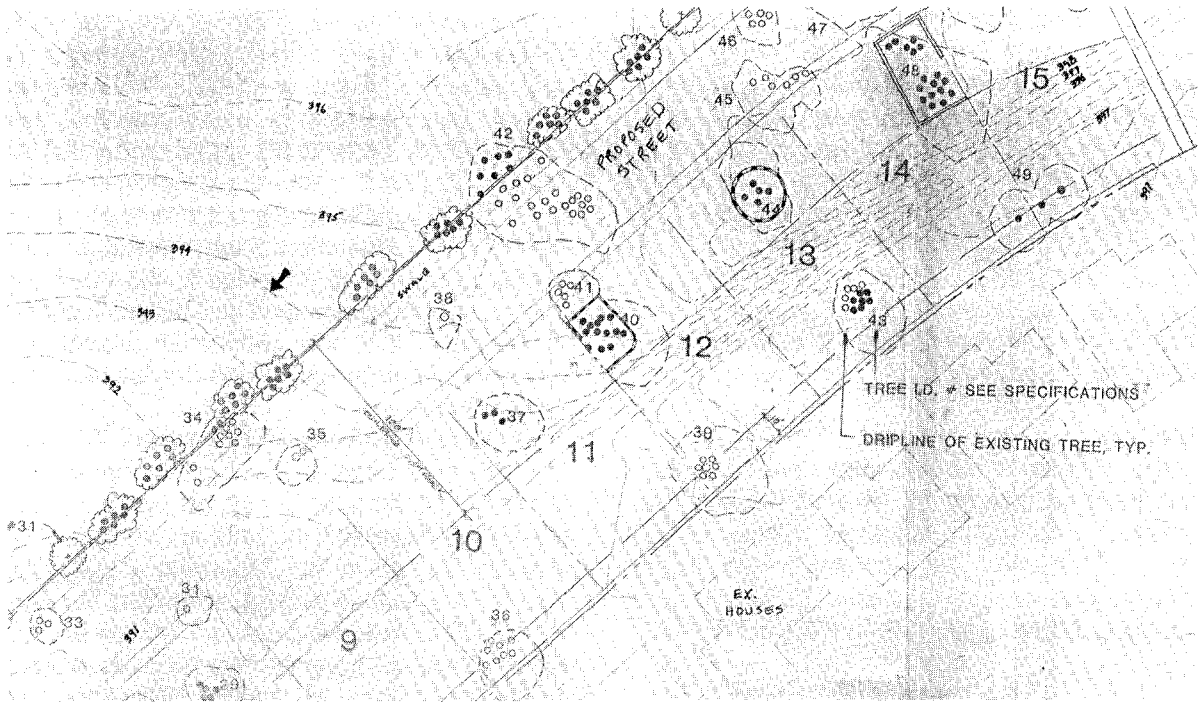

Figure 4. A portion of a plan for a subdivision. Proposed street location and parcel lot lines are shown. Note existing grade lines (small arrow), existing trees to remain (dark dots), and trees to be removed (white dots). Trees #40 and 44 show retaining walls proposed within the dripline. No new grade lines are shown. For this plan, the arborist must learn the elevations of the building pads for each lot and compare that to the existing grades shown.

clarify this. The closer grade lines appear to each other, the steeper the slope. Lowering the grade in an area is known as a cut, while raising the grade is a fill. Grade changes are indicated on the plan as a slightly darker dashed line overlapping the lighter existing grade lines, and should be numerically marked. When a new grade line overlaps existing lines of a smaller number, the area will have soil added (a fill). A new grade line overlapping an existing line of larger number shows soil to be removed (a cut).

Designers often use a numerical method of depicting elevations of site improvements. These are known as "spot elevations." They are often used on retaining walls or curbs which change elevation as they crowd the site. Spot elevations will appear on the plan as small numbers followed with a letter abbreviation, such as: 124.25 T.W. This indicates an elevation of 124.25 feet at the Top of Wall. (Note: Engineers use tenths of a foot rather than inches, thus .25 feet = 1/4 foot = 3 inches.).

If the arborist notes a retaining wall near a tree, the height of the wall can be found by calculating the difference between the existing elevation and the top of footing elevation. This will determine if it is a cut or a fill. Then the detail for the wall footing should be studied, noting the footing depth and depth of any base material required. Excavation into existing soil will occur for either type of wall.

When reviewing the proposed construction, the arborist should remember to allow for working room at each improvement. Construction workers must have room for themselves and their equipment to move about the site. Allow a minimum of 5 to 8 ft. of additional room around buildings. Workers need a minimum of 3 ft. behind a retaining wall (depending on wall height) to set their blocks, and to install drain pipes and gravel behind the wall. Thus, the area of actual impact will be beyond the building or wall lines shown on the plan.

Additional plans for the project may not be

completed at the time of the arborist's initial evaluation. Ask to review these plans as they become available, for they will affect the impact to the trees.

Architect's Plans

The architect's plans provide detailed information on building design and site improvements. The arborist should evaluate these plans for construction below grade, such as basements, split levels, and footings. Roof overhangs, roofs, and upper floors which may extend into the tree canopy should be carefully reviewed. Additional site features such as pools, patios and terraces, paving, garden walls, and fences may also affect the trees.

The building foundation and flooring type is extremely important when buildings encroach into the tree's root area. More grading is needed for a building with a concrete slab foundation than of a building supported on steel pilings with wooden flooring. The arborist may be able to negotiate a foundation and floor type with a lower impact on the trees.

In areas of high impact to important site trees, the arborist can ask the architect to provide cross sections which detail the work proposed. A cross section is a drawing from the side view. The drawing should show the tree trunk, branches, canopy, and existing grade line in relation to the construction impact, and should be drawn to an accurate scale. This drawing will help both the arborist and the architect visualize the impact and discuss alternatives.

Some sheets included in the architect's plans will not concern the arborist. Building elevation are included to show windows, doors, materials, and architectural design. The set may also include schematics for interior electrical, plumbing, heating, and framing layout.

Soil's Report

An important detail often overlooked is the project's soils report. It is not shown on the plans but may appear in the specifications manual. This report includes information on the soil's stability and it's potential to compact. Grading work is dramatically affected if the soil compacts poorly, as in many sandy soils.

Buildings, paving, walls, and curbs all must be built on compacted soil to avoid settling in future years. Some soils require excavation of existing soil in order to re-compact it mechanically. I have worked on projects requiring over-excavation of up to 5 ft deep and 5 ft to each side of the building. This increased the impact to adjacent trees dramatically.

If the soils information is difficult to obtain, the arborist should contact the soils engineer and inquire about compaction requirements.

Landscape Plans

New landscaping proposed within the tree's root area will be shown on the landscape plans. The landscape architect should be contacted to discuss the best design for optimum tree health. Mulching the area within the dripline should be encouraged, as well as allowing native leaf litter to remain. New planting which have watering requirements different from the tree should be avoided, especially for native trees in a dry summer area. Do not allow new irrigation systems to apply excessive water to trees. And of course, trenching or rototilling in the tree root area is destructive to roots.

Arborist's Evaluation

Existing trees should always be field checked by the arborist. Determine the actual trunk location, especially if tree location is taken from an aerial photo. Measure the canopy width in all four compass direction on asymmetrical trees. The plan must accurately show canopy size, trunk diameter, trunk lean, and low branches when the proposed work is close to the tree.

The site should be checked for additional trees not shown on the plan, and neighboring trees which could be affected by the work. Make note of existing features to which the trees have previously adjusted (paving, buildings, disturbed areas).

Site trees need to be inspected in order to determine their vigor and structural integrity. Only trees that are healthy and structurally sound should be considered for preservation. Encourage this inspection early in the design process.

After evaluating the plans and site, the arborist

needs to consider if there are ways to execute the project with lower impact on the trees. If the project is in the early stages of design/development, it may be possible to suggest alternate building, road, or parking locations. The use of permeable paving types should be suggested for paving within the root area of trees. Retaining walls could be post and casing type, avoiding the need for a continuous concrete footing. Underground utilities could be relocated, bored, or hand dug to preserve roots. Shallower utility trenches may be used if the utility lines are protected by a thin concrete cap. Curbs, foundations and sidewalks can "bridge" root areas by reinforcing the concrete with rebar, thus avoiding compacting the subsoil. If access routes for equipment pass unavoidably close to tree roots, the area can be thickly (12 in or more) mulched with wood chips prior to start of construction.Some suggest removing a portion of this layer at the end of construction.

Try to establish a creative, open relationship with the project designers so that sensitivity to each other's goals is maintained. You may both need to compromise on a few points in order to complete the project layout.

A short description of the tree protection requirements should be included on the final set of project plans. Indicate the protective fence location on the plan and specify the conditions of access into the area (e. g. in the arborist's presence). The arborist's basic requirements should be posted where they will be easily seen by workers on the site. More detailed information can be included in the project specifications manual. Requirements set forth either on the plans, or in the specifications, must be followed.

A conference between the arborist, engineer, owner, and all contractors working on the site should be held before construction begins, to allow discussion of tree protection. This is a good time to educate those working on the project about the function of tree roots, their location in the soil, and the effects of root injury and soil compaction.

Technical knowledge of construction plans makes the arborist fully aware of impacts to site trees. Many possible impacts could go unnoticed without this education. Adding this skill to the arborists' already broad knowledge will result in more accurate evaluations of construction work.

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Tree and Landscape Consultant
P.O. Box 734
Avila Beach, CA 93424

Résumé. Les travaux de construction causent des impacts sur la croissance des arbres et peuvent endommager ceux-ci. Les ingénieurs et les architectes préparent des plans de construction qui utilisent un système de graphisme, de lignes de base et d'abréviations standardisés. Les arboriculteurs devraient être entrainés à lire des plans de construction. Ces plans fournissent une profusion d'information que l'arboriculteur peut employer pour évaluer l'impact de la construction sur les arbres. Les modifications peuvent être négociées avec les ingénieurs et les architectes afin d'atténuer les effets de ces impacts.

Zusammenfassung. Baumaßnahmen beeinflussen Baumwachstum und können Bäume schädigen. Ingenieure und Architekten erarbeiten Baupläme, die ein System von Standardgraphiken, Grundlinien und Abkürzungen benutzen. Arboristen sollten geübt sein im Umgang mit Bauplänen. Diese Pläne liefern einen Reichtum an Informationen, die der Arborist benutzen kann, um den Einfluß von Baumaßnahmen auf Bäume zu bewerten. Änderungen, die diesen Einfluß vermindern, können mit den Ingenieuren und Architekten vereinbert werden.